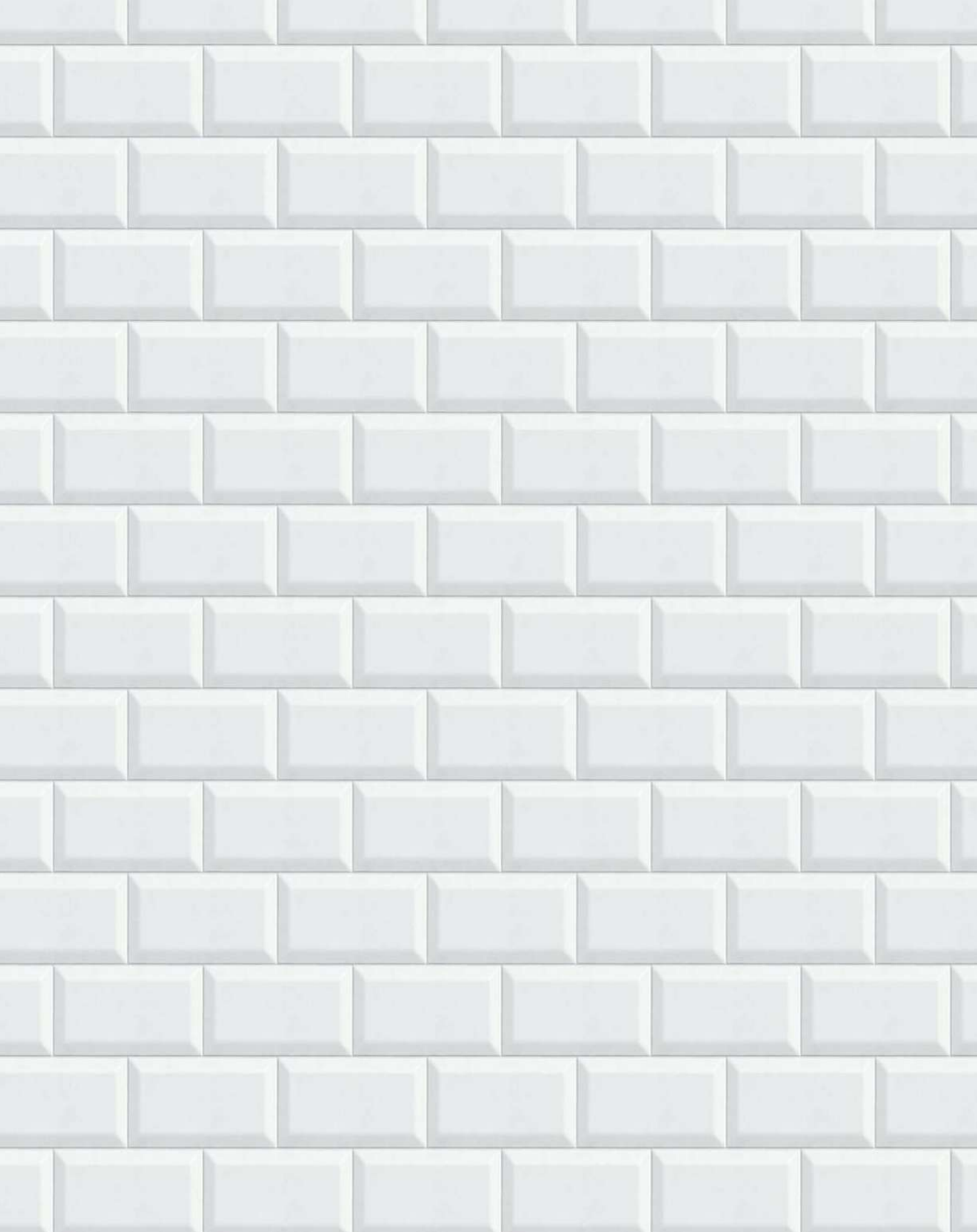


Sample Extract – The Ice Cream Grammar

This is a representative selection from the beginning of the book, showcasing its technical clarity, structured explanations, and tone.

Topics in this extract may include ingredient functionality, balancing techniques, and scientific fundamentals relevant to artisanal ice cream and gelato production.



The Ice Cream Grammar

The complete guide to Gelato and Ice Cream
making

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Foreword

By Riccardo Bellaera
Corporate Pastry & Bakery Chef for Costa Crociere S.P.A.
Word Pastry Star 2019

It is a true pleasure to write the foreword for the first book of the Pastry Chef Alessio Piantanida, a friend, an artist, a visionary. Alessio is one of the prodigies of his generation, successful and imaginative in many fields.

I`ve had the pleasure of working alongside him for a few years and I quickly discovered his passion for the profession, his pleasure in sharing, his love and simplicity.

I am always amazed by his creations, as they are so perfect and exquisite, yet simple and honest.

This book is a valuable compendium of Alessio`s knowledge shared by him to whoever wants to learn the secret behind the word of the Ice Cream and its formulation.

Preface

As the global pandemic was flaring up, like many others, I suddenly found myself confined at home. And because I work as Executive Pastry Chef, I certainly cannot perform my job from home or via videoconference. Thus, I decided to keep myself busy by studying. Almost as a joke, I uploaded a short educational video course about ice cream balancing on an e-learning platform online. The video garnered much appreciation and loads of messages started pouring in. In particular, a guy from Hong Kong reached out to me with interesting technical questions and we kept expounding on this intriguing subject. He then asked me where I had studied the world of ice cream and if I could suggest some quality reading. At that moment, I had an epiphany. I realised that, to the best of my knowledge, there was no complete and professional book thoroughly discussing artisanal ice cream and gelato making.

Several English books have been written about this extraordinary product. Most of them are meant to be simple cookbooks and collections of recipes perfect for home ice cream making. In contrast, others are manuals written for the manufacturing industry, perfect if your production is measurable in hundreds of tons per day. No one seemed to be tackling the problem from an artisanal point of view.

I constantly meet ice cream professionals and pastry chefs who, while producing ice cream day in and day out, have a very loose grasp on the rules that make ice cream function. They tend to be blind followers of recipes and try out adjustments "by heart". This is because they have learned from various product manufacturers or apply dogmas without raising logical questions about them. It is equally common to find recipes in books or specific magazines with ingredients placed just to make the formulation look fancier when the fact remains that these components do not have a technical reason to be included or anyway, not in a certain dosage. These low-level gimmicks can only impress those who cannot understand the mechanics of these formulations, whilst inducing a giggle amongst those who are deeply familiar with it.

In many ways, this process is like learning a new language. Initially, we will be more interested in memorising some "survival" sentences and commonly used words. By doing so, we might learn how to communicate with others using basic

idiomatic expressions and a limited vocabulary. But we have to first master the grammar to become proficient, to be able to play with the words, read between the lines, and create complex sentences with different shades of meanings.

It is my earnest hope that after reading this manual, you will be able to understand what lays beneath an ice cream recipe, why a specific ingredient has been chosen and why it is present in a specific amount. I hope you'll be able to critically analyse the job of others and correct it where needed, without being fooled by the (increasingly common) self-proclaimed Chefs and ice cream experts.

This book is intended to fill the gap in the knowledge required to intimately understand the ice cream game rules, in fact, its grammar.

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Some Chemistry Notion

Before we can dive into the actual ice cream "action", it would be useful to undertake a general discussion of general chemistry. Yes, I know what you are all thinking, but bear with me and I promise, I'll try to be simple and concise.

Atoms are the basic building blocks from which everything around us is built. This includes the book you are now holding, the chair you are sitting on, the air you breathe, and the stars you see at night. Yes, everything consists of atoms.

Atoms can bond together into groups of two or more and form a molecule. When atoms of the same element bond together forming a molecule, we have the so-called simple elements and there are only a few of those, 118 are the natural ones. If the molecule comprises different types bonded together, it can be called a compound. Water is, for example, a compound made of two atoms and one atom of Hydrogen and Oxygen, respectively. The possible combinations of atoms into molecules are basically unlimited, and so are the possible compounds. The science, duly combining the 118 basic elements, produces thousands of new compounds every day.

The 118 natural elements are denoted by symbols, usually the first or first two letters of their respective Latin names. This is because, in the past, chemists tried to create a universal and understandable language for all. So we have C for Carbon, Ca for Calcium, O for Oxygen, H for Hydrogen, and so on. The elements are also subdivided into METALS, NON-METALS, and METALLOIDS, they might also be solids, liquids, or gases... Then the analysis of the periodic table of elements can go deeper and deeper, but let's proceed further.

The compounds, on the other hand, are represented by formulas, which, in turn, are an assembly of symbols and numbers (index). The symbol tells us which elements are present in the molecule and the index of the number of atoms in each element. So, for example, we might have Dextrose $C_6H_{12}O_6$, which implies that this specific molecule comprises two atoms of Carbon, six atoms of Oxygen, and 12 atoms of Hydrogen.

All the molecules of every compound are bound by the so-called "bonds." There are different types of bonds but, for us, this is already too much information for us to assimilate. For the sake of simplicity, just know that each element atom can have varying capacities to create bonds. Some atoms can create only one bond with another atom, others can create two bonds, others three, and so on. Put succinctly, each atom has different "valence"; therefore, Hydrogen will be mono-valent since it can form only one bond, while Oxygen will be bi-valent since it is capable of forming a double bond or two single bonds and so on.

So, we can now imagine our atoms like distinct building blocks, capable of being assembled through "arms-like" bounds, following specific game rules.

How do we build with these blocks?

Through chemical reactions, of course.

A chemical reaction catalyses a set of substances' chemical transformations into another with different attributes. The chemical reaction is often represented as an equation made of two parts divided by a = symbol.

$\text{CH}_4 + 2\text{O}_2 = \text{CO}_2 + 2\text{H}_2\text{O}$; this is an example of methane combustion reaction. The substance (or substances) initially involved in the reaction are called reagents, whereas the outcome is referred to as product(s).

For any given reaction to happen, specific values in temperatures, concentrations, (and way more complicated things) are needed. As you might have noticed, the equation follows chemical laws as well as mathematic laws. In the example, we can see a "2" coefficient must be placed before Oxygen on the reagent side and on the products' side before water. By doing so, the "amount" of any reagents remains unchanged during the reaction.

It's also interesting to appreciate that although we might write a chemical equation into a specific direction of the reaction, reactions may proceed in the forward or reverse direction up to the point they reach their specific equilibrium in given environmental conditions.

Therefore, certain reactions capable of proceeding forward without any external "help" are called spontaneous; other "non-spontaneous" reactions require energy input to occur. This energy input may come in the form of heating, light, or radiation.

Other reactions, even if considered spontaneous, may take a very long time to occur or reach an advantageous balance, whereas many products as possible are generated. Such reactions may be aided by the introduction of proper catalysts. While the catalyst does participate in the chemical reaction, it resumes its initial state and amount when the reaction ends, distinguishing it from actual reagents.

Poignant examples of catalysts are vitamins and enzymes, which allow all the biochemical reactions that keep us alive. Bread yeast is a natural catalyst; the enzymes within it carry out the fermentation that turns starch into CO_2 gas and water, thus causing the bread to rise. Also, several other enzymes are found in common food industry reactions such as amylases, lactases, invertase, etc.

pH and Acidity

pH indicates the concentration of hydrogen ion in water solutions and is used for defining a solution's alkalinity or acidity. The scale of pH is in the range of 0-14. A 7.0 pH level at 20°C is deemed neutral since H_3O^+ concentration is equal to OH^- concentration within pure water. However, some liquids are devoid of pH values. In fact, pH only applies to water solution systems. In the past, pH was measured using

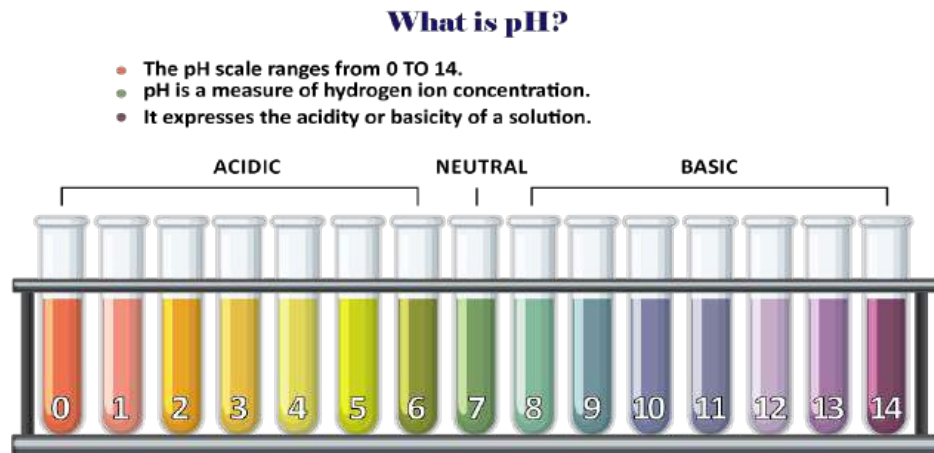
litmus paper or other liquid reagents that changed colours upon being exposed to varying acidity levels. Those systems are still in use; however, the cost reduction in technology has made more sophisticated electronic devices like pH meters more affordable.

Common examples of pH in substances:

- pH 0 hydrochloric acid
- pH 2.0 lemon juice
- pH 2.2 vinegar
- pH 4.0 wine
- pH 4.5 yogurt
- pH 7.0 pure water (neutral)
- pH 7.4 human blood
- pH 9.5 soap
- pH 13.0 lye
- pH 14.0 sodium hydroxide

The measure of pH assumes significance in ice cream and sorbets. Some ingredients like fruit puree and juices can be strongly affected by acidity changes, and exhibit colour variation. The ice cream maker must take these changes into account and take appropriate measures to prevent unwanted discolouration.

Other substances, like proteins, are also sensitive to acidity. It is well known that adding lemon juice to some milk causes it to curdle. A similar problem may manifest in ice cream where dairy or egg proteins are mixed with acidic fruit.



Pic. 8 The pH scale

Did I puzzle you enough by now?

If you already feel overwhelmed by this "boring stuff", you can skip to the juicy part of the ice cream making, although I still believe you will find some of these notions useful later on. For those who are still bearing with me, let's keep on going a bit further.

Some chemical reactions are "more special" than others. When some of these reactions occur between carbon-containing compounds and usually involve atoms of Hydrogen and Oxygen, the chemists refer to them as "organic reactions." The organic compounds come in an extremely wide array of substances, from hydrocarbons to carbohydrates, from gasoline to bread. The organic molecules are so versatile that their combinations are infinite. But why so?

First, it is pertinent to note that the Carbon atoms can link together in chains, and "branches", giving a theoretically never-ending number of combinations.

Secondly, we must consider how atoms can be bound in organic chemistry.

The rules for these "building blocks" to combine are fairly straightforward:

- Carbon atoms link four times
- Oxygen atoms link two times
- Hydrogen atoms link only one time

Let's see what we can build with these versatile blocks

Obviously, we will mostly focus on the kinds of molecules that are likely to be encountered in the world of ice cream, such as:

- Alcohols
- Sugars
- Organic Acids
- Fats and fatty acids
- Proteins
- Hydrocolloids

The Alcohols

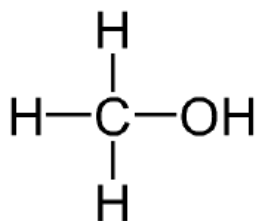
I start with alcohols, the simplest of all.

The chemists define alcohol as an organic compound which carries at least one hydroxyl functional group (-OH) bound to a carbon atom.

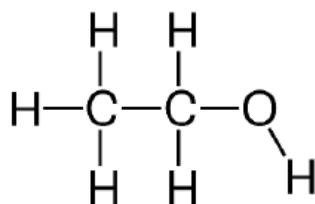
However, for lesser mortals, it's quite easy to discern whether we actually have them before us.

All the alcohols end with the suffix *-ol*; some examples, among many, are as follows:

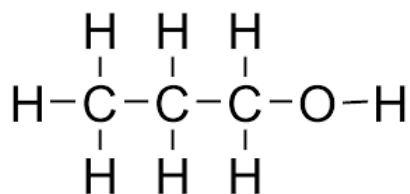
Methanol



Ethanol

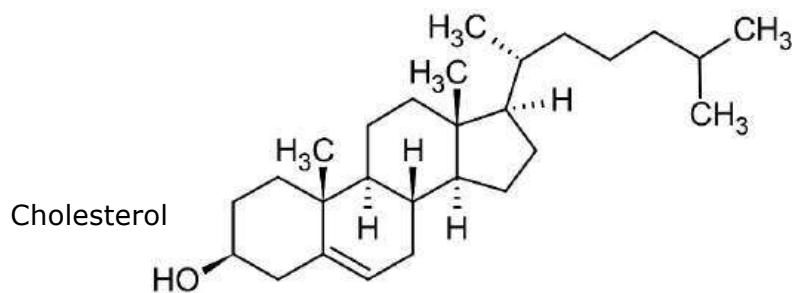


Propanol

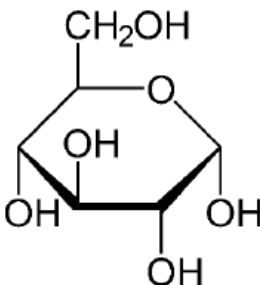


Come to think of it, several many commonly named substances actually carry an alcoholic functional group such as cholesterol, paracetamol, glycerol, and many others.

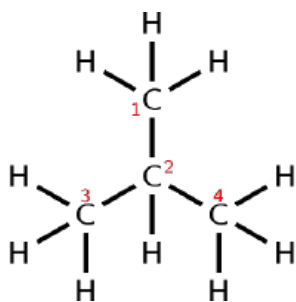
This is how the cholesterol compound looks:



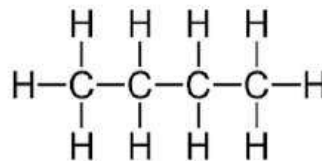
As evidenced in their structure formulas, in organic chemistry, we can build quite large and complex molecules, which is why chemists found a more convenient and compact way to denote them: Molecular Formula. For instance, the Molecular Formula of glucose will be simply $C_6H_{12}O_6$ instead of drawing its complex structure formula like:



Sure enough, this molecular formula easily tells us how many atoms of each kind are present in this specific molecule, although it is possible for more than one molecule to have the same molecular formula!



Iso-butane C_4H_{10}



n-Butane C_4H_{10}

Besides, this representation does not give us any info about the molecule's connectivity, so we still need something a tad more specific. Not unexpectedly, the smart chemists sorted it all out. Our *Iso*-Butane $(CH_3)_3CH$ while our *n*-Butane is now $CH_3CH_2CH_2CH_3$

Now, even if they comprise atoms (same) in the same amount and ratio, we can easily distinguish them, brilliant!

Other alcohols are then sorted:

- Methanol CH_3OH
- Ethanol CH_3CH_2OH
- Propanol $CH_3CH_2CH_2OH$
- Butanol $CH_3CH_2CH_2CH_2OH$

This is good for now. Later on, we will delve deeper into alcohol in ice cream and its "tipsy" behaviours.

The Sugars

The word 'sugar' is generically used when referring to a sweet-tasting carbohydrate and there are several of them. Once again, we can easily spot a sugar by the characteristic suffix -ose.

This definition accommodates different kinds of sugar, which we can summarise in monosaccharides, disaccharides, and oligosaccharides.

Most of the monosaccharides (or simple sugars) share the basic generic formula $C_nH_{2n}O_n$ where "n" is between 3 and 7.

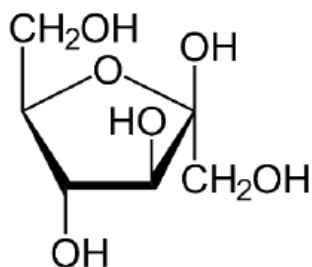
For example, Glucose and Fructose abide by $C_6H_{12}O_6$. However, as we are going to see later, they differ in other crucial attributes.

The monosaccharides sugars are the simplest of all and Mother Nature makes use of them as basic Lego-like blocks to build more complex sugar molecules just by bonding them together. So, we have two bonded monosaccharides forms, a disaccharide, and three monosaccharides together giving trisaccharides, and increasing even further – and we find the polysaccharides.

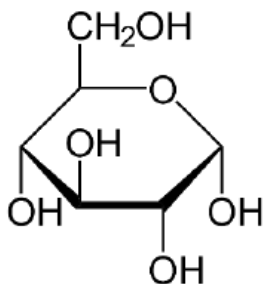
As a case in point, two dextrose molecules form maltose, while a dextrose molecule and a fructose molecule make up sucrose, the common table sugar.

After being aware of the rules of the same, let's see some of the commonest types of sugar we can encounter in our journey towards perfect-tasting ice cream.

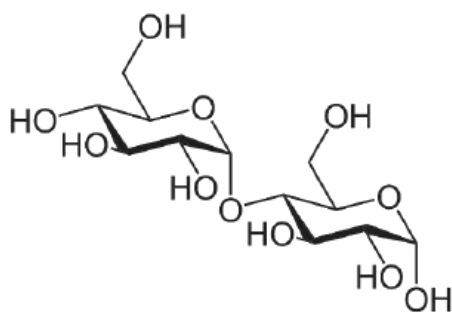
Fructose



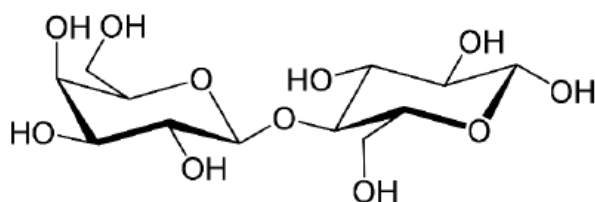
Glucose



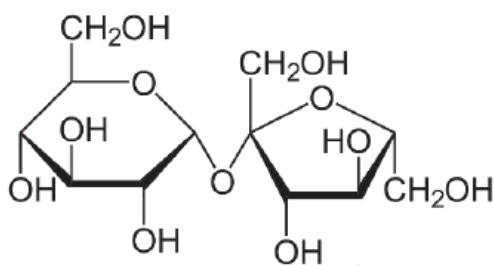
Maltose



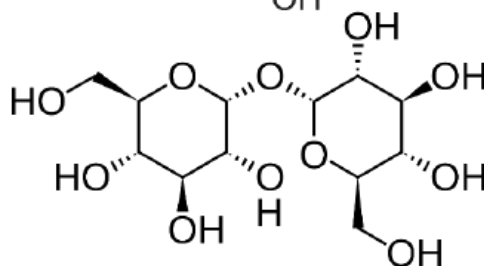
Lactose



Sucrose



Trehalose



As of now, this schematic treatment of these sweet, lovely compounds will suffice. Later, we will devote sufficient time to learn all their properties and secrets.

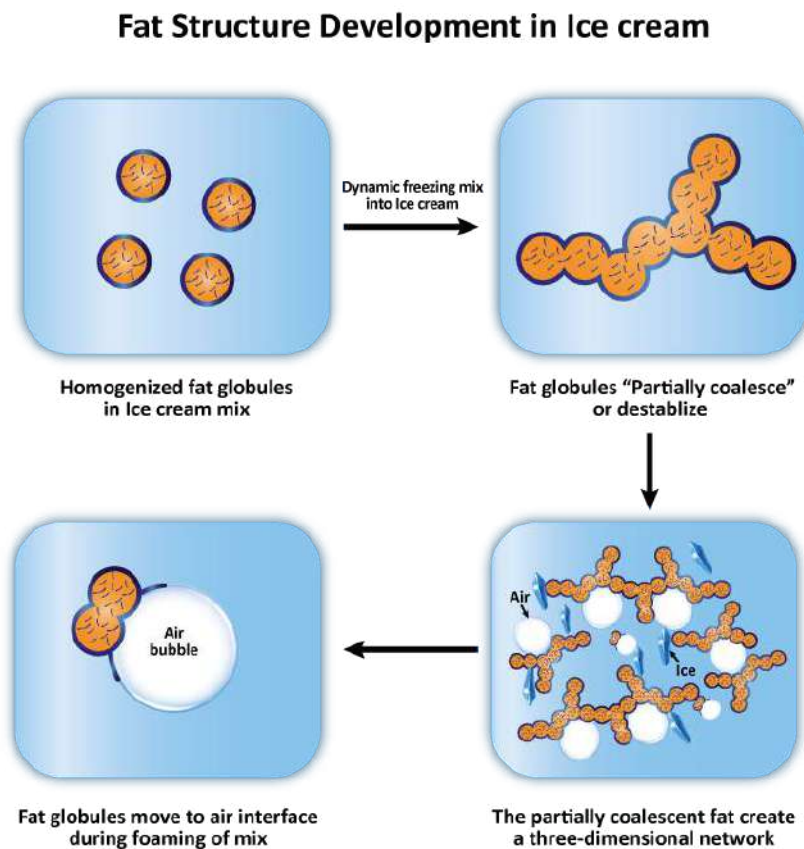
Organic Acids

Reading aloud may sound a bit silly... although the chemists define an organic acid as "any organic compound with acidic properties." Who am I to say otherwise?

At a chemical formula level, they are associated with the carboxyl functional group -COOH .

Partial Coalescence of Fat

We now know that ice cream is, among many other things, a fat into water emulsion. Due to the thermodynamic instability of emulsions, the high interfacial tension between the surfaces of water and oil separates fat and water. During the homogenisation process, the fat disintegrates into various small droplets suspended in the cold mixture. Proteins and emulsifiers quickly bond around the surface of these small fat droplets, thereby forming a membrane, which, in turn, lowers the interfacial tension. This prevents the fat droplets from pooling together into larger lumps of fat by stabilising them.



Pic. 28 Partial coalescence in ice cream mixture takes place starting from the ageing process

Partial coalescence is a phenomenon whereby one fat globule's fat crystal enters another globule's interfacial film, creating a strong linkage between the globules' internal phases, albeit without having to pool them together into a large one. This is possible due to the mechanical agitation occurring during the batch freezing of the ice cream. At the same time, a completely new larger globule of fat remains undeveloped due to the low temperature that keeps the fat in a solid state. These

globules of fat are at the base of the smooth, dry texture and resistance against meltdown - characteristics every ice cream maker aims to achieve.

Whenever I will use the expression "dry ice cream", I will refer to an ice cream that does not feel "wet" in the mouth after having developed a proper partial coalescence.

Once again, a perfectly balanced recipe is the key to achieving the optimum level of partial coalescence. The type and quantity of fats used are crucial in determining the level of partial coalescence of an ice cream mix. Emulsions with a high-fat volume fraction are more susceptible to partial coalescence than those with low-fat content.

Other factors also assume significance. The emulsifiers play a very important role in improving partial coalescence. A high total solid content is also proven to be enhancing this phenomenon. On the other hand, partial coalescence is limited as the protein presence increases. Finally, ageing is also pivotal. Nowadays, ageing is often underestimated; however, correct ageing at 4°C is crucial for developing an ideal partial coalescence. In the absence of ageing, ice cream mixes do not go through a lot of partial coalescence and are known to be deficient in the body upon being frozen.

These days, it is easy to find a wide variety of vegetable fat and margarine with varying characteristics. Examples include non-hydrogenated fat margarine, cholesterol-free margarine, fractionated oils, melanges (margarine containing a certain amount of butter), etc.

However, for our kind of production, I would recommend using milk fat as the primary source of fat in any ice cream formula because even the best margarine money can buy doesn't contain proteins. Proteins contained in a milk fat emulsion (like cream) facilitates its emulsion.

Milk fats must be considered the best source of fat in ice cream because:

- They just taste better! As simple as that
- They naturally come in an emulsified form, thus making it easier to incorporate them into the mix. For this reason, they don't require homogenisation
- They are preferred by customers on labels
- The low melting point (under 36°C), causes the butterfat to easily melt into the mouth, without leaving a waxy or greasy sensation.

The main sources of milk fat are:

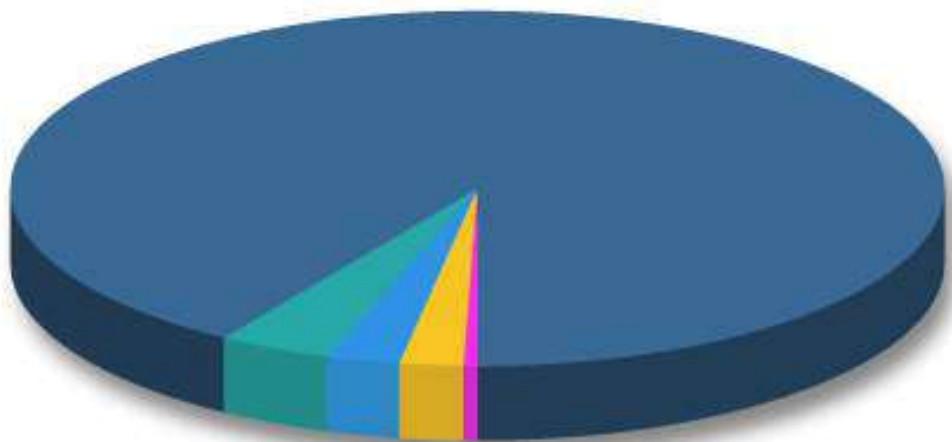
Milk

Typically being the largest component, this ingredient makes, by itself, the crux of almost any ice cream. Every ice cream maker remembers (by heart!) the average composition of full-fat milk.

On average:

- 85% water
- 5% lactose
- 3.5% fat
- 3.5% proteins
- 0.5% minerals

Average Composition of Milk



■ Fat 3.5% ■ Lactose 5% ■ Water 85% ■ Proteins 3.5% ■ Minerals 0.5%

Besides cattle, many kinds of livestock provide milk used by humans for dairy products. These animals include buffalo, goats, sheep, donkeys, and horses. While cow's milk is mainly used for ice cream making, other animals might also find application in delicious niche production.

MILK COMPOSITION ANALYSIS COMPARISON ON BASIS OF 100G

 CONSTITUENTS	 UNIT	 COW	 GOAT	 SHEEP	 BUFALO
WATER	g	87.5	89	83	81
PROTEINS	g	3.5	3	5.5	4.5
FAT	g	3.5	3.5	6	8
SATURATED FATTY ACIDS	g	2.5	2	4	4
MONOUNSATURATED FATTY ACIDS	g	1	1	1.5	1.5
POLYUNSATURATED FATTY ACIDS	g	0.1	0.1	0.3	2
CARBOHYDRATES (SUGAR : LACTOSE)	g	5	4.5	5	5
CHOLESTROL	mg	14	10	11	8
CALCIUM	mg	120	100	170	195
ENERGY	kcal	66	60	95	110

When this book refers to milk, we will always consider the general composition for whole cow's milk, unless specified otherwise.

This section is anyway about FATS, so let's come back and focus on this milk component.

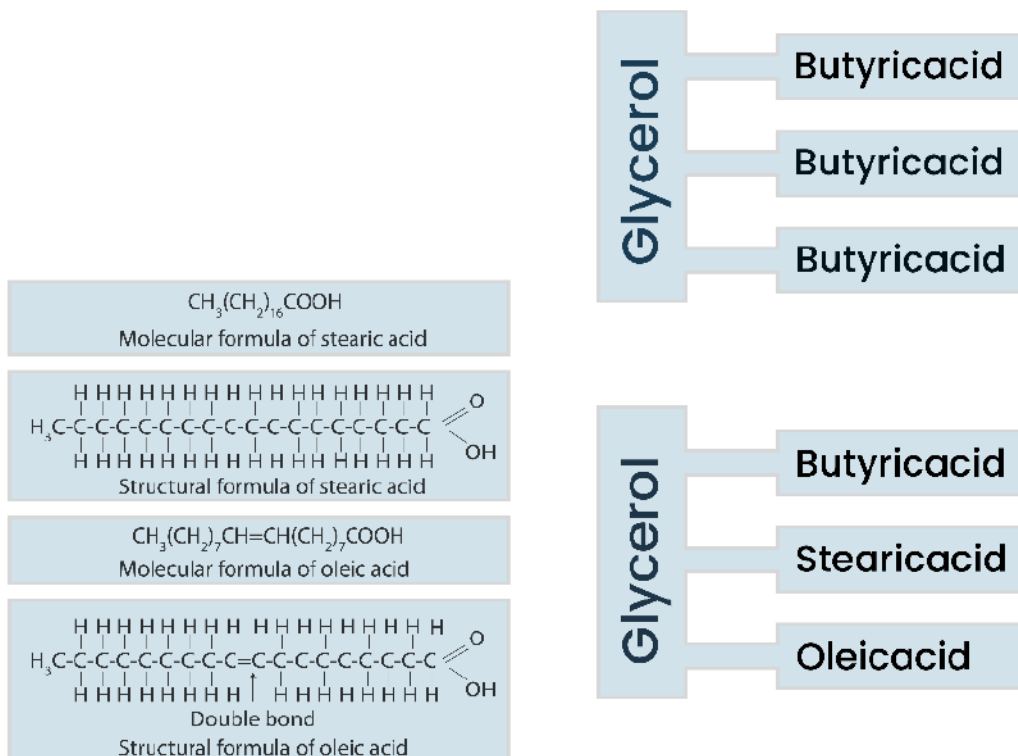
Despite not being the first fat source, milk still carries a certain percentage of fat into the recipe and must be taken into consideration.

In the USA, whole milk usually contains 3.25% of milk fat, reduced fat milk contains 2% of MF, low-fat milk 1%, while skimmed milk is fat-free (between 0% and 0.5%).

In the UK, the minimum content of butterfat in whole milk (aka full-fat milk) is 3.5% and is usually in the range of 3.7%. Similarly, semi-skimmed milk must be between 1.5 and 2% and skimmed milk must be below 0.3% (usually 0.1%).

Similar regulations are enforced in Australia, Europe, and Canada.

Milk (and cream) is an example of fat in water emulsion, suspended in small droplets or globules through the milk serum. As seen before, fats are esters of glycerol and three fatty acids. Milk fat is no exception, as it is a mixture of different fatty-acid esters with glycerol called triglycerides. Triglycerides account for 99% of all milk fat. Milk-fat triglycerides are butyric acid, oleic acid, and stearic acid and are the most present fatty acid.



Molecular and structural formulae of stearic and oleic acid

Milk fat is a mixture of different fatty acids and glycerol

Pic. 29 Fat are esters of glycerol and different fatty acids

The milk we use in ice cream, exactly like the one found in supermarkets, went through several treatments to ensure its safety and consistency.

Pasteurisation

Pasteurisation is used to kill harmful pathogenic bacteria by getting the milk heated and then having it cooled. Notably, the high-temperature short time (HTST) process of 72 °C for 15 seconds completely eliminates pathogenic bacteria inside milk, which makes it safe for drinking for a period of three days. This process is applied also to other dairy products like cream, flavoured dairy products, and skimmed milk.

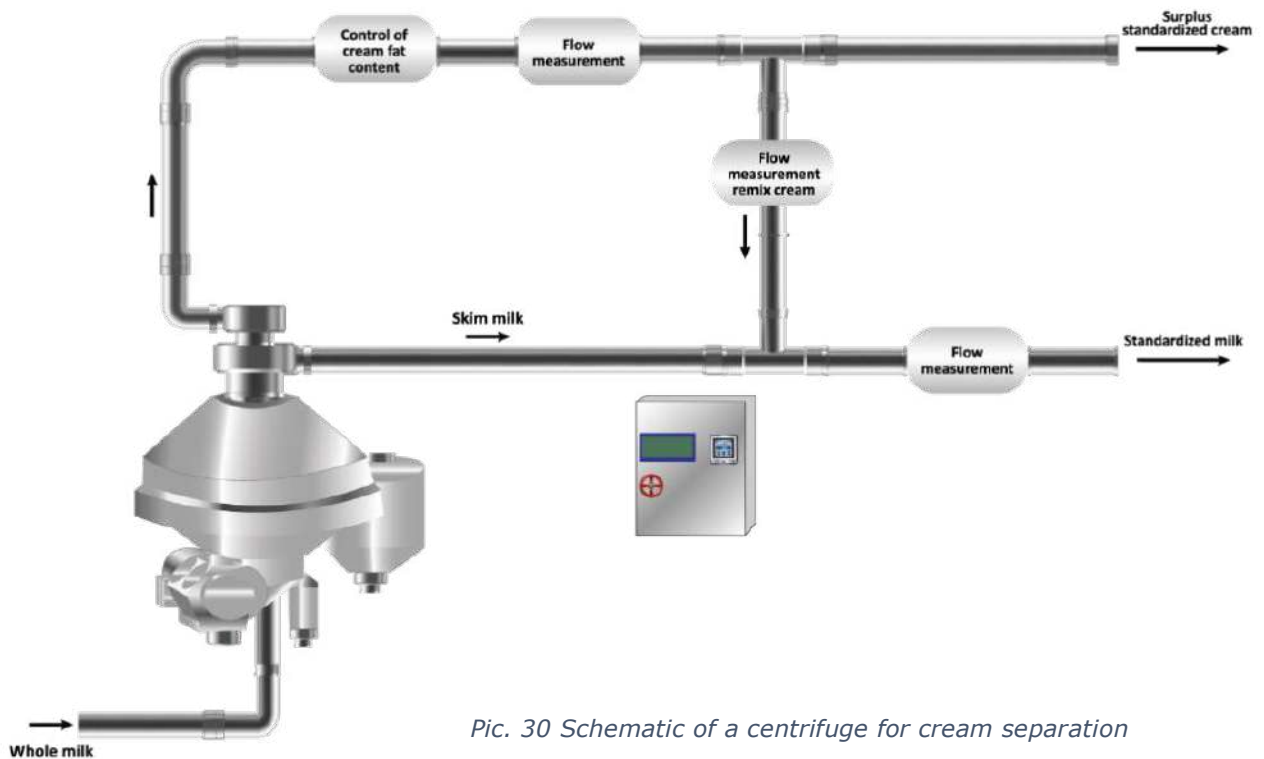
UHT

Ultra-Heat Treatment (UHT), is a process where the homogenised milk is heated for one to three seconds at 138 °C. After being cooled, the milk is then placed inside a container that is sterile. Heightened heat obliterates all bacteria to make sure its shelf life extends to six months, provided the package remained unopened.

Creaming and homogenisation

Nowadays, the cream is sold separately from the milk and its separation is accomplished using the centrifugation method. To accommodate all the different commercial needs, manufacturers title the milk in fat content: full-fat, semi-skimmed, and so on. Later on, milk is homogenised, and this treatment prevents a cream layer from getting separated on the milk surface.

During homogenisation, milk is heated at around 75°C and compressed at high pressure (up to 150 bar) into a nozzle ending in a low-pressure chamber. The milk is atomised, after which, its fat globules are reduced in size.



Pic. 30 Schematic of a centrifuge for cream separation

Microfiltration

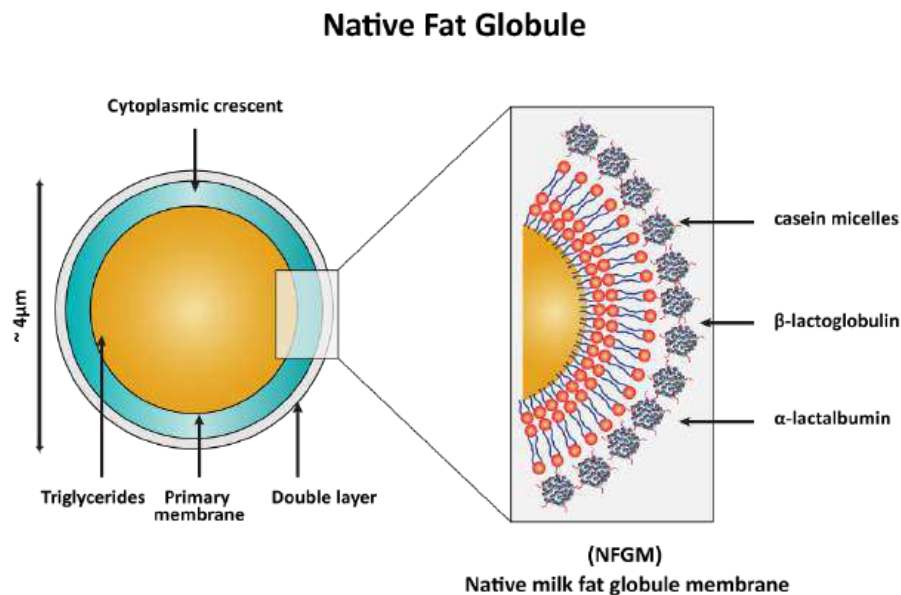
Without delving deep into this interesting matter, the various types of milk microfiltration aim to remove bacteria cells by blocking them into a filter and substituting thermic treatments. This system cannot ensure the 100% removal of bacteria. Thus, a lighter pasteurisation is typically used, but the combination of these two methods allows a much longer shelf life in the fridge.

Often manufacturers also use other treatments to ensure the milk is purified:

- Ultrasounds treatment
- Ultra-high pressure treatment
- Bactofugation
- Antibacterial substances addition
- Peroxide addition
- Radio treatment
- Others...

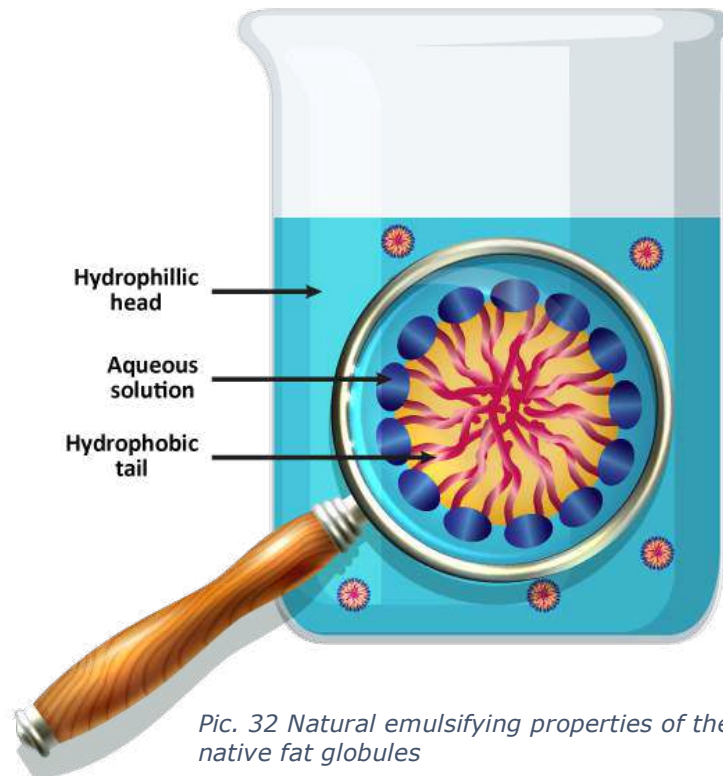
Butter

Butter is a dairy product – obtained from the protein and fat component of cream - typically made from cow's milk and may also be produced from other mammals' milk, including those of goat, buffalo, or sheep. As a water-in-oil emulsion, it is produced by churning cream/milk to get the fat globules separated from buttermilk.



Pic. 31 Structure of native fat globule in milk

Why does this happen? We have to understand how fat is distributed throughout the milk. It is no secret that water and oil are not mixable, so how did mammals manage to add fat to their milk? Mother Nature is again full of surprises. Unhomogenised milk contains butterfat between 0.1 and 10 microns in microscopic globules. Some membranes (made from phospholipids) surround these globules (a fatty acid with emulsifying properties) and glycoproteins, which prevent the fat in milk from gathering into a single mass.

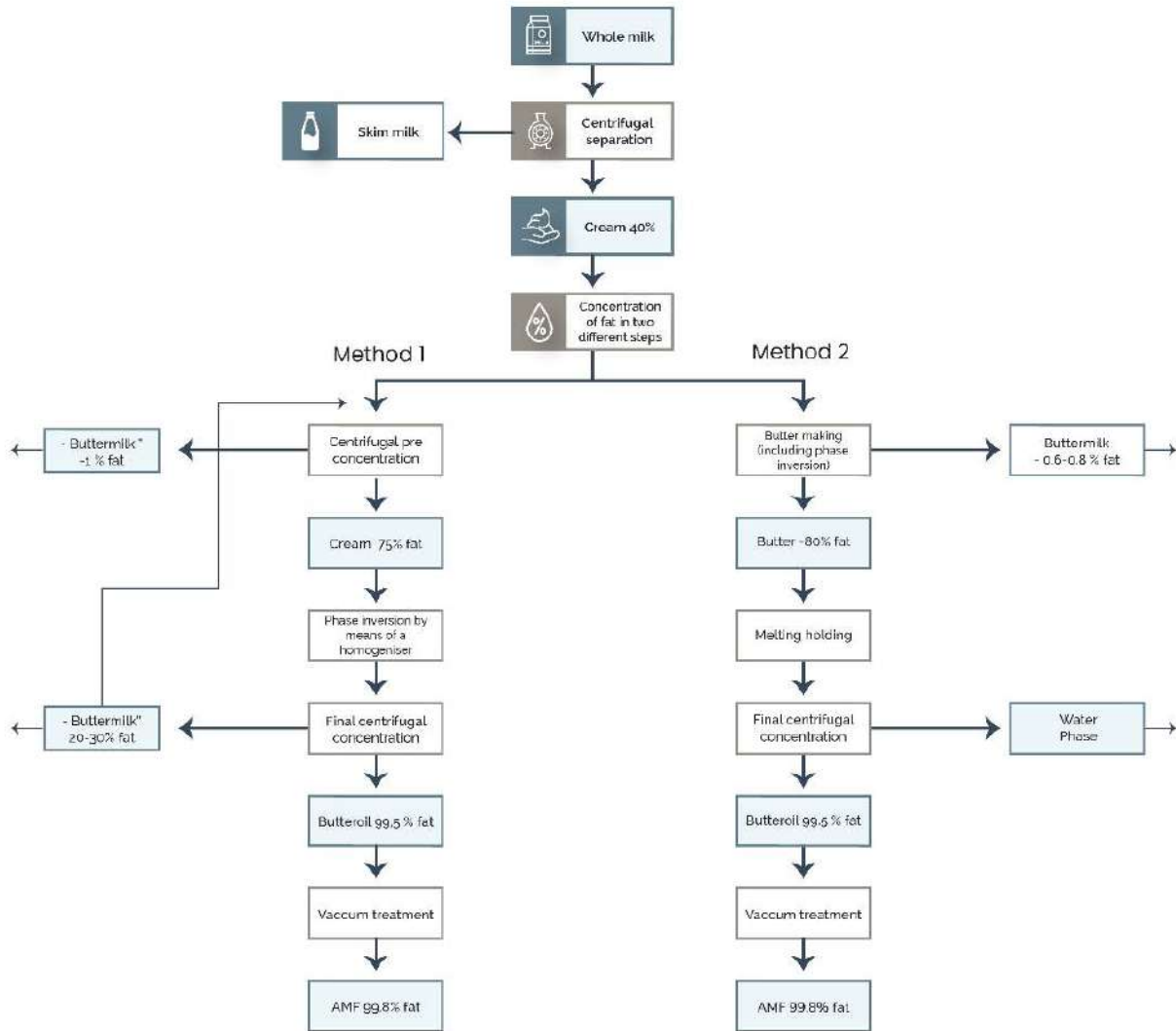


In the aforementioned pictures, we can appreciate how phospholipids work. At one end (the head in blue), they are compatible with water, whilst at the other end, (the red tails), they are compatible with fats. As we will discuss later, this principle is the base of all emulsifying additives. By agitating the cream, the globules' membranes are damaged, which allows the separation of milk fats from other elements of cream.

Butter produced from a fermented cream is called cultured butter. During fermentation, several chemical processes take place around the cream. The fermentation produces additional aromatic compounds, above all the diacetyl, which gives the butter a fuller flavour and the distinctive "buttery" taste. Today, pasteurised cream is used to make cultured butter. Butter can also be made directly from fresh cream (sweet cream), having lactic acid and bacterial cultures added after the churning process. This system allows for more convenient and cheaper manufacturing. Cultured butter, which consists of 15% water and 82% butterfat (whereas conventionally produced butter has 30% water and 65% fat), is the most common type sold in Europe.

In Italy, for example, the butter must contain at least 82% of butterfat and not more than 16% of water, while a minimum butterfat amount of 80% is allowed in the USA. For ice cream makers, butter can be a valid ingredient when a butterfat integration is needed in the formula. In this case, fresh and high-quality butter should be preferred. Another form in which butter can be used is dry butter, or

anhydrous butter, often known as Anhydrous Milk Fat (AMF). It is basically butterfat from which all the water has been removed.



Pic. 33 Various systems for butter and butterfat production

Butteroil is another kind of AMF. This product is particularly interesting due to its lower melting point (usually, it is liquid at room temperature), facilitating an easier mixing in the formula.

Cream

Cream is made from a high-fat layer removed from milk prior to homogenisation. In unhomogenised milk, fat with lesser density gets to the top of the milk. In terms of industrial production, the cream is processed by using centrifuges. It usually

carries 30 to 40% of fat but this title varies, and several grades are found for each country.



For ice cream manufacturing in Europe, the most commonly used cream is at 35% or 38%, whereas the so-called double cream is at around 50%.

Her Majesty, the Cream, must be considered the most important (and most expensive) ingredient of any high-quality ice cream formula. A prudent ice cream chef will always prefer it over any other fat source, for both quality and ease of use.

TYPES OF CREAM AND HOW THEY ARE LEGALLY DEFINED

U.K		U.S	
Product Name	Minimun fat content	Product Name	Minimun fat content
Clotted Cream	55%	Half and Half	10.50%
Extra-thick double Cream	48%	Light Cream	18%
Double Cream	48%	Whipping Cream	30%
Whipping Cream	35%	Heavy Whipping Cream	36%
Whipped Cream	35%	Manufacturer's Cream	40%
Sterlized Cream	23%		
Single Cream	18%		
Sterlized half Cream	12%		

Pic. 34 Cream comes in various types and names differ from country to country

It is possible to dry the cream into a powder to be shipped internationally. Cream contains high saturated fat levels, making it suitable for a rancid turn. Its production is similar to the dried milk one. It usually contains 42% of fat and 52% of Milk Solids Non-Fat (MSNF) aka Lean Milk Solids (LMS) and can be easily reconstituted by adding 165g of water to 835g of dried cream to obtain a 35% fat cream. Although dried cream won't whip up, it is still considered a valid option in ice cream making, above all, due to the simple use in balancing the formulas.

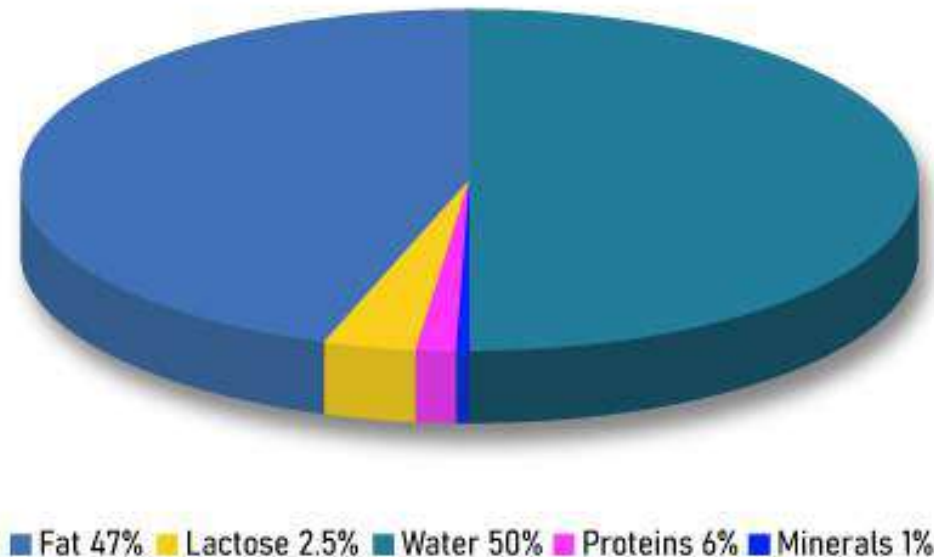
Mascarpone

I must briefly mention those rich dairy products which are also an important butter-fat source.

Mascarpone is a fresh cream "cheese" obtained by the coagulation of heavy cream by adding acidic substances like citric or tartaric acid. It is not a proper cheese in that it does not require any rennet or enzymes added to occur. Originally, it is from the area around Milano in North Italy.

It is not aged nor processed in any way. After draining the excess whey, mascarpone is packaged and sold refrigerated. Mascarpone is milk-white in colour, creamy and

Average Composition of Mascarpone Cheese



spreadable. Sweet in taste and not acidic at all. It finds application in many desserts, creams, sauces and is the salient component on the world-famous Tiramisù.

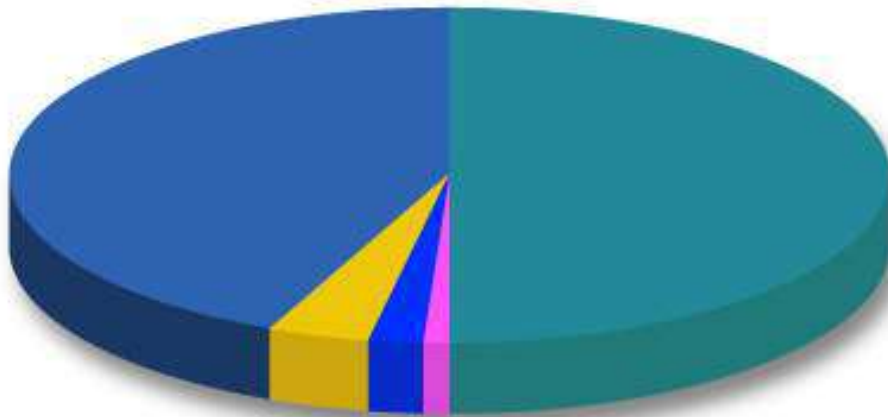
It can be easily mixed and used in special flavours of ice creams. For example, I use it to make Tiramisù ice cream.

Cream cheese

The other ubiquitous favourite dairy product is cream cheese, a soft cheese made from cream and milk. The U.S. Food and Drug Administration (FDA) says that it is imperative for cream cheese to contain a minimum of 33% milk fat with a maximum moisture content of 55%, and a pH range of 4.4 to 4.9.

Cream cheese cannot be aged, and its taste, despite being slightly more sourish, resembles that of mascarpone. By the 1820s, dairy farms around the cities of Philadelphia and New York City were becoming famous for producing this creamy cheese. Cream cheese is used in never-ending recipes, from appetizers to desserts, from bakery products to creams. It goes without saying that cheesecake is the most noticeable sweet use for this cheese.

Average Composition of Cream Cheese



■ Fat 38% ■ Lactose 4% ■ Water 50% ■ Proteins 6% ■ Minerals 2%

In making ice cream, cream cheese is used in conjunction with red berries or to make cheesecake ice cream.

Vegetable whipping cream

Vegetable cream is a cream-like oil-water emulsion, and if desired can be free of milk constituents, with purely vegetable fat content.

Vegetable cream substitutes are interesting in the production of ice creams and frozen desserts. They are cheaper and more stable than real cream, offer greater overrun, and can be used in vegan and dairy-free products when completely vegetable.

In general, vegetable whippings are made by accurate proportioning, mixing, pasteurising, homogenising, and curing the necessary ingredients:

Water, vegetable fats and oils, emulsifiers, stabilisers, thickening agents. Sugar is often added, although unsweetened versions are also available. Depending on the desired product, manufacturers may add also colours (carotenoids usually), flavours (milk or cream flavour, vanilla, diacetyl, etc.). Sodium caseinates as milk protein are also often used to improve stability and texture.

American System:

$$\frac{100 - (\% \text{ sugars} + \% \text{ fat})}{6,9}$$

Italian System:

$$100 - (\% \text{ sugars} + \% \text{ fat}) \times 0.15$$

Let's guess an ideal mixture with 20% of sugars and 8% of fats.

$$\frac{100 - (20 + 8)}{6,9} = 10,4\% \text{ max}$$

$$100 - (28 + 8) \times 0.15 = 10,8\% \text{ max}$$

Principal LMS commercial sources are:

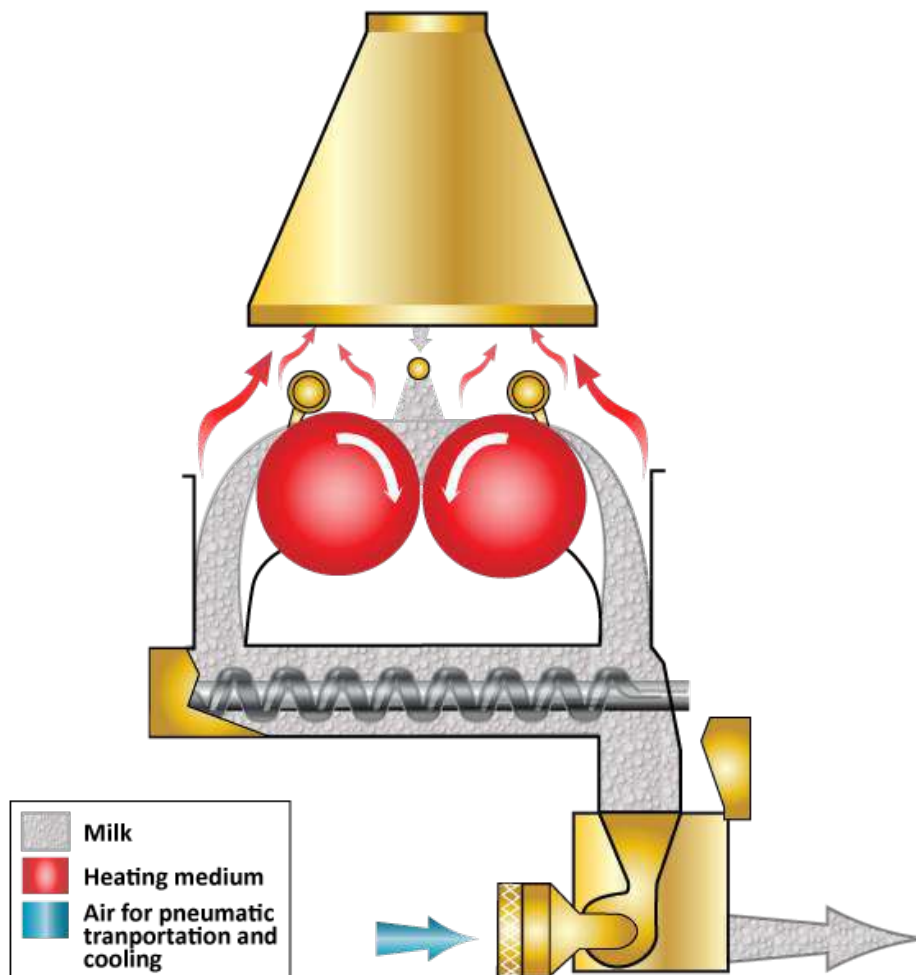
Dried Skimmed Milk

We already spoke about DSM in the formulation. At a practical commercial level, it is basically a white-yellowish hygroscopic powder sold in packages from 1 to 25Kg.

It's manufactured by evaporating (skimmed) milk to dryness. Perks of DSM are its longer shelf life and the reduction in bulk, thus making for economic transportation. Furthermore, dried milk allows adding LMS to food preparation without the inconvenience of adding water that would dilute the recipe. For this reason, it finds large use in the ice cream sector, dry sweet cream food industry, baking industry, etc.



It can be produced through two systems: spray drying DSM or drum drying DSM. In the spray drying system, milk is atomised at high pressure through nozzles into tall chambers. A flow of hot air meanwhile runs across the fog to remove the moisture from the single tiny milk droplets. This system produces powder having very small particulate, thus facilitating easier hydration and use. Moreover, the spray system is gentler and does not denature the milk proteins, rendering a whiter and fresher and tasting like dried milk. For these reasons, sprayed dried milk is usually more expensive.



Dried milk production with heated rolls system

In a hot drums drying system instead, the milk is simply pureed over rotating, high-capacity drums that dries it at relatively low temperatures to produce sheets of drum-dried product. Then, this is milled to flakes or powder form. Drum-dried milk is typically slightly more yellow in hue and may taste like cooked.

Spray-dried non-fat dry milk and skimmed milk powders are available in two forms: ordinary or non-agglomerated (non-instant) and agglomerated (instant).

In its "instant" form, DSM makes the solubility quicker and easier, avoiding the formation of lumps. This product is usually more expensive than others.

Concentrated Milks

By the term 'concentrated,' we generally refer to milk (skimmed milk) from which a vast portion of original water (around 60%) has been removed by some sort of evaporation process.

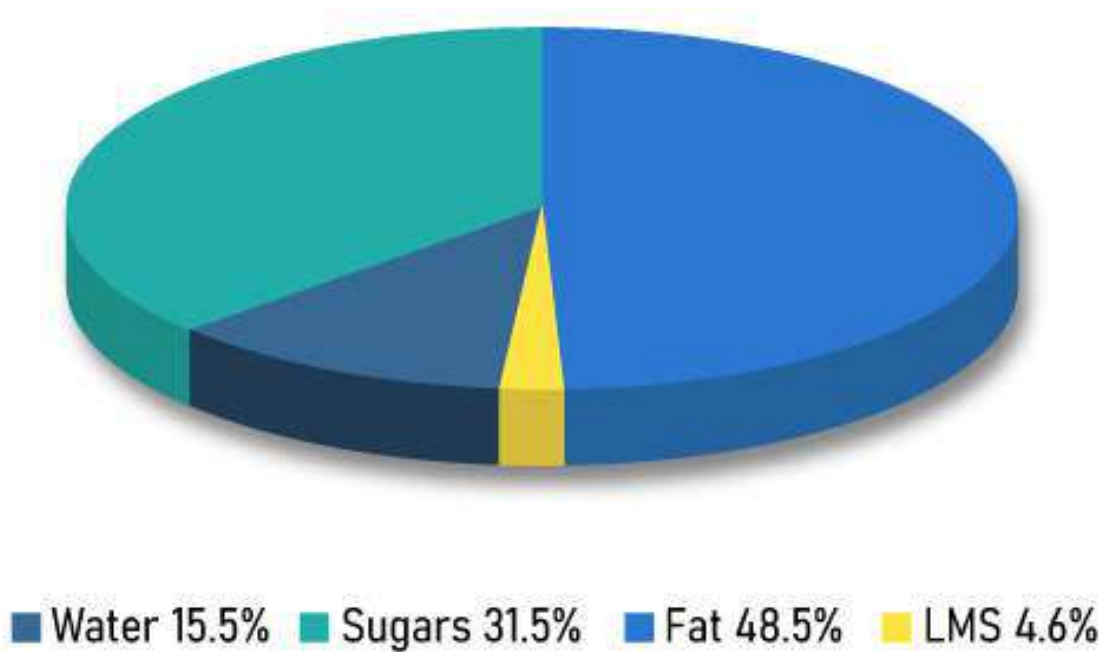
The evaporation is carried out in vacuum conditions to reduce the necessary heat and evaporate the water without cooking the milk, thus preserving its flavours. We can have evaporated milk (also known as unsweetened condensed milk) or sweetened condensed milk (SCM).

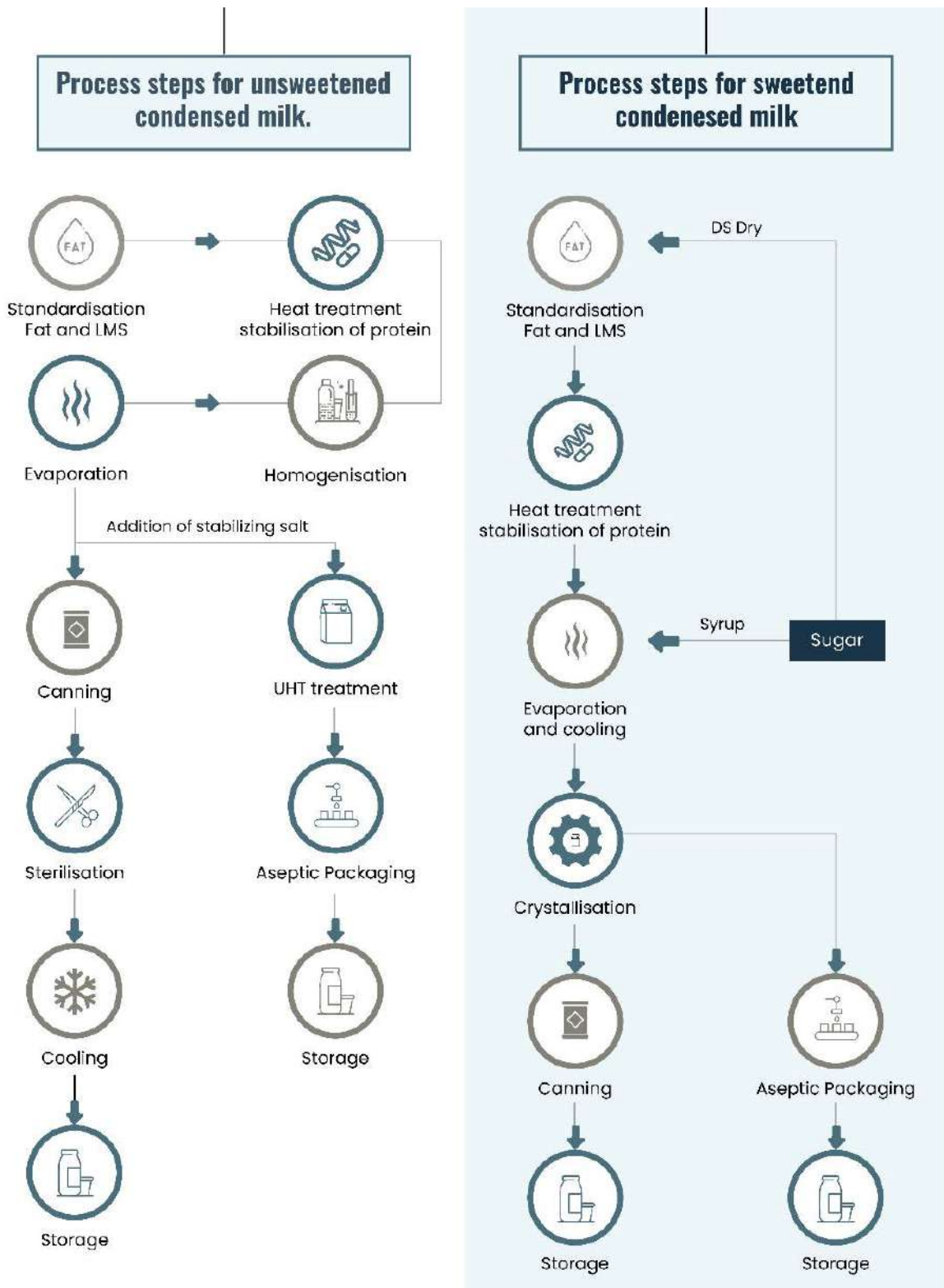
The unsweetened evaporated milk is a convenient product in ice cream manufacture; it's easy to dose and mix and is normally sold pasteurised, requiring refrigeration.

It brings 25 – 35% of LMS, according to this degree of concentration; the remaining part is just water, making for easy computation of the formula.

SCM is instead added with about 40 – 45% of sugar (sucrose) which increases the water's osmotic pressure, preventing microorganism's growth. For this reason, SCM obviates the need for refrigeration.

Average Composition of Condensed Milk








Pic. 36 Condensed milk production scheme

SCM is thicker and more viscous than evaporated milk, which means that it is more challenging to handle and mix. A typical defect caused by this product is the sandiness caused by the formation of large lactose crystals in the ice cream. In SCM, the low water amount induces the lactose to crystallize. Manufacturers guide the crystallisation to obtain the smallest possible crystals; nevertheless, those crystals might act as seeds in the growth of larger lactose crystals in ice cream too.

A special type of SCM, the "superheated concentrated milk", finds a particular application in the ice cream industry. Since the density of superheated SCM is far more than the regular, it is sometimes used in recipes where, mostly for labelling reasons, the manufacturers choose not to use stabilisers and emulsifiers. The resulting ice cream will show stability and melting resistance within acceptable parameters.

SWEETENED CONDENSED MILK COMPOSITION

 CONSTITUENTS	 U.S STANDARD	 U.K STANDARD
Water	27	25.5
LMS	20	22
Fat	8	9
Lactose	10.3	11.4
Sucrose	45	43.5

Pic. 37 Condensed milk composition might vary from country to country

The ice cream maker must keep in mind that replacing a large amount of sugar with trehalose may lead to a metallic aftertaste. Small amounts of trehalose are used to enhance and intensify some flavours in ice cream.

High potency artificial sweeteners

These substances should maybe be somewhere else in the book, probably among the additives. They are not sugars whatsoever, and therefore must not be considered in sugar balancing: they don't even have an AFP, to begin with.

However, I eventually decided to spare some paper space here and get the weight off my chest. Despite not quite being proper sugars, these substances have an (often impressive) SP and, if used in recipes to replace some part of the sugar, must be taken into account. So, we would do well to know something more about them.

We refer to sugar substitutes as a food additive that provides a sweet taste while being devoid of food energy, making it a zero-calorie sweetener. High-intensity artificial sweeteners are usually processed by chemical synthesis.

They find extensive and convenient use in low-calorie food, beverages, and wherever sweetness is required but total solids content or the freezing point are not important.

Inevitably, this imposes a huge limitation on their use in ice cream because, as we know, we can't replace only the sweetness without taking the AFP into account, as well as the total solid content of the mixture.

To serve dietary needs or caloric reduction in the case of products for a diabetic diet, ice cream can be made using a duly balanced combination of high-intensity sweeteners and other bulking agents such as polyols, polydextrose, or our beloved inulin, when necessary.

SWEETENER	SP	FP
Sorbitol	0.6	1.9
Mannitol	0.6	1.9
Xilitol	1	2.2
Sucrose	1	1
Cyclamate	30-50	1.7
Aspartame	130-250	1.2
Acesulfame K	160-250	1.7
Stevioside	300	0.4
Saccharine	300-500	1.9
Sucralose	320-1000	0.9

Pic. 40 Intensive sweeteners have an extremely high SP but negligible AFP

In the USA, six sugar substitutes have gained approval for usage: sucralose E955, aspartame E951, neotame E961, saccharin E954, advantame E969, and acesulfame potassium (acesulfame-K) E950. Other high-intensity sweeteners are consumed outside of the USA but cannot be produced as a sweetener within the country, such as cyclamate E952.

NAME	SWEETNESS (by Weight)	TRADE NAME	APPROVAL	NOTES
Acesulfame Potassium	200	Nutrinova	FDA 1988	E950 Hyet Sweet
Advantame	20,000		FDA 2014	E969
Allitame	2,000		approved in Mexico, Australia, New Zealand and China.	Pfizer
Aspartame	180	NutraSweet, Equal	FDA 1981, EU-wide 1984	E951 Hyet Sweet
Salt of aspartame-acesulfame	350	Twinsweet	New Zealand and China.	E952
Sodium cyclamate	40		FDA Banned 1969, approved in EU and Canada	E952, Abbott
Dulcin	250		FDA Banned 1950	
Glucin	300			
Neohesperidin dihydrochalcone	1650			E959
Neotame	10,000	NutraSweet	FDA 2002	E961
P-4000	4,000		FDA banned 1950	
Saccharin	350	Sweet'N Low	FDA 1959, Canada 2014	E954
Sucralose	660	Kaltame, Splenda	Canada 1991, FDA 1998, EU 2004	E955, Tosten & Lyle

Aspartame

Accidentally discovered in 1965, aspartame is a methyl-ester of two amino acids, L-aspartic acid and L-phenylalanine. It tastes like sucrose but its sweetness exceeds it by 200 times. More than 100 regulatory bodies in various nations such as the European Food Safety Authority (EFSA), Health Canada, and UK Food Standards Agency have declared it safe to be consumed by humans. It is also known as an additive under the number E951.

It shows sweetening synergy with other sweeteners and is often used in combination with them.

Acesulfame K

As with several other artificial sweeteners, there are concerns over the safety of acesulfame potassium. Critics point out that acesulfame potassium is yet to be studied adequately and may well be carcinogenic; however, the FDA and EFSA have dismissed these claims. Moreover, the FDA has approved its general use, and it is extensively used in many countries. Similar to aspartame, it is 200 times sweeter when compared with sucrose and is listed under the number E950 as an additive. As with aspartame, it shows sweetening synergy with other sweeteners and is often used in conjunction with them.

Saccharin

Like many other synthetic sweeteners, saccharine was also discovered accidentally while researching very different chemical compounds. Saccharin is about 400 times sweeter in comparison to sucrose but has a metallic and bitter aftertaste at high concentrations. In 2000, after a deeper scientific investigation, saccharin was delisted from the list of carcinogenic substances and was exempted from the obligation to insert the warning label requirement for products containing saccharin. In 2001, the state of California and the FDA declared saccharin safe for consumption. In a release dated December 2010, the EPA declared that saccharin should no longer be seen as a substance that can endanger human health.

Saccharin is now widely used in more than 100 countries; however, some restrictions regarding its use in ice cream might still be in place.

Sucralose

Often called Splenda in the USA, it is known under the E number E955 in the European Union (EU). Its sweetness is a whopping 600 times higher than sucrose. Despite gaining safety approval from several global food-safety regulatory bodies, several concerns remain about its safety. Recent studies suggest that sucralose decomposes at relatively low cooking temperatures, generating potentially harmful chemical substances.

After all this "brutally" chemical stuff, let's see what Mother Nature can offer us. Well, actually, there are some natural high-intensity sweeteners. The most important ones to mention are Thaumatin and Stevioside.

Thaumatin

It is extracted from the fruit of the tropical tree *Thaumatococcus deniellii*. This vegetable protein is safe for human consumption, which explains why it has gained approval as a sweetener in Japan, Israel, and the EU. However, it is typically known as a flavouring agent (in the USA), as opposed to a sweetener per se. It's up to 3000 times sweeter than sucrose but its sweetness tends to build very slowly. Thaumatin leaves a liquorice-like taste at high amounts, which inhibits its use.

Stevioside

It is extracted from the leaves of *Stevia rebaudiana*, a Brazilian plant species. As is the case with certain artificial sweeteners, it does not have any calories. Stevia may have a liquorice-like aftertaste at high concentrations and its sweetening effect has a slower onset than that of sugar. In December 2008, the FDA granted the GRAS

status to stevia extracts containing sweeteners. By 2020, Stevia glycosides are deemed safe and permissible in food items sold across the USA.

Stevia extract is also known to be stable at high temperatures.

Shortly after its approval, stevia sweetener appeared in several beverages (sodas and colas) and, for commercial reasons, became ubiquitous. Due to its peculiar taste, stevia extracts find limited employment in ice creams.

easier to mix with water. At this moment, the roasted and alkalinised nibs can take two distinct paths. Some will be used to produce cocoa powder while the rest will become chocolate.

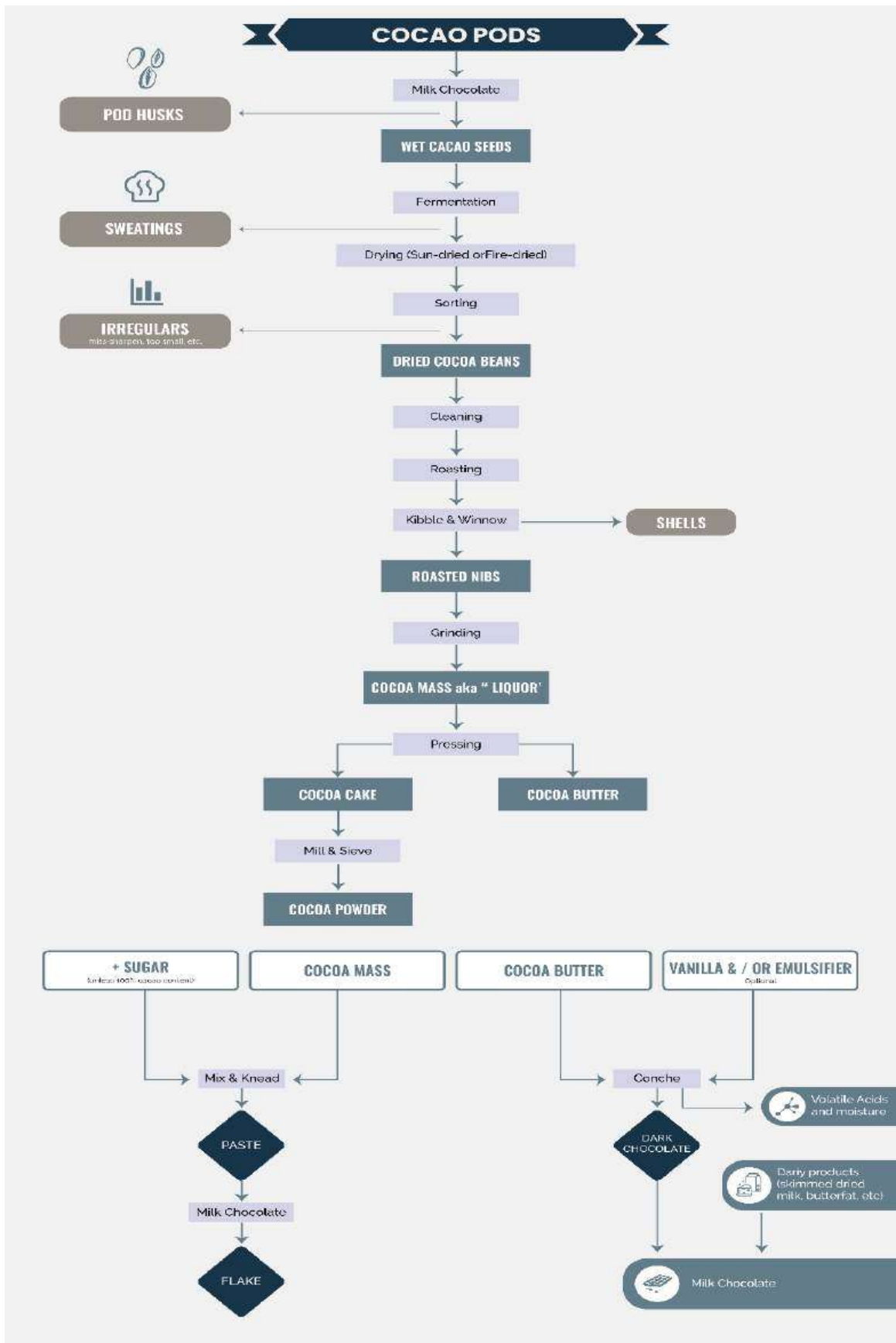


Pic. 47 Cocoa powder before and after Dutching process

We obtain a variety of amazing products from this amazing planet; the most relevant for ice cream making are the following.

- Cocoa powder
- Cocoa butter
- Cocoa liquor aka cocoa mass
- Chocolate

Pic. 48 (next page) Schematic for cocoa processing



Cocoa powder

As shown in the chart, cocoa powder production comes, in parallel with cocoa butter, from the grinding and pressing into the so-called liquor of roasted cocoa nibs.

From the cocoa liquor's squeezing, most of the liquid cocoa butter is separated, giving various fat content to cocoa powder. On average, the commercially used cocoa powder contains 22-24% of cocoa butter, 7-11% of cocoa mass, and 5% of ashes. It goes without saying that the flavouring action is attributed to the non-fat portion of cocoa. Therefore, cocoa with a lower content of fat will have a more intense aroma.

The pH of natural cocoa powder is between 5.3 and 5.8. Its colour is light brown. Meanwhile, alkalisated cocoa powder has a darker hue and its pH is between 6.8 and 8.1. The alkalisation process reduces bitterness and improves solubility, which assumes significance for beverage products.

Cocoa powder is extensively used in ice cream manufacturing. It is often used as it is, in combination with other dry ingredients to ease its dispersion in the mixture. Cocoa powder is also used as an ingredient in several types of semi-processed pastes specifically designed for ice cream making.

Those pastes, often called "bitter paste", usually consist of cocoa powder conveniently mixed and refined with vegetable oils which impart a paste-like consistency at room temperature. Typically, they are not added in sugars; consequently, it is easier to balance them in the recipe for they add only fat and fibre (other solids) in the recipe computation.

With regard to the cocoa powder dosage, it mostly depends on personal preference and on the type of product we intend to produce. Cocoa powder is the most concentrated source of "chocolate taste" to be used in ice creams, more so if it is leaner (10 – 16% fat cocoa powder). Industrial chocolate ice cream usually has a cocoa powder content somewhere in the range of 2.8 – 3.5%. Sometimes, a lower cocoa powder percentage is used in addition to a certain amount of cocoa liquor.

High-quality artisanal gelato and ice cream are usually around 4 to 10%.



Pic. 49 The so-called "bitter paste" is another way to incorporate cocoa into the recipe

We must observe, however, that manufacturers of chocolate ice cream often opt for a low-fat cocoa powder rather than the 22-24% cocoa powder commonly used in pastry and small ice cream labs. This is mostly attributed to the cost of cocoa butter, which makes leaner cocoa powder far more economic.

The customers' growing attention to the nutritional fact in labelling also plays a key role. It is mandatory to declare the total fat content and saturated fat content, and customers are increasingly opting against ice creams with a high content of these. By using leaner cocoa powder, the manufacturer can save money and have a "cleaner" label.

Defatted cocoa with extremely low-fat content is also available in the market (mostly for industrial manufacture). Those are specifically used, often mixed with regular low-fat cocoa powder (10-14%) to produce virtually "fat-free" ice cream, with less than 0.5% of fat in order to meet the labelling requirements for non-fat ice creams.

Cocoa butter

Cocoa butter is derived from the cocoa liquor process that separates it from cocoa powder. Besides chocolate, this edible fat is also used in pharmaceuticals, toiletries, and ointments. The pale-yellow cocoa butter is known for its distinctive aroma. The melting point of this ingredient is 34–38 °C (93–101 °F), lending a creamy taste in the mouth. Cocoa butter also contains monounsaturated oleic acid and saturated fats.

In the recent past, the cost of cocoa butter has been steadily increasing, prompting manufacturers to seek other viable alternatives. In the USA, any product that claims to be called chocolate must have 100% of this ingredient, while the EU mandates that alternate fats must not account for over 5% of the overall fat content. Although it is rarely used in making ice cream, it must be considered a fat when used together with other commonly used ingredients such as chocolate, ivory paste, couverture, etc.

I recommend the use of cocoa butter, mixed with various types of chocolates, to produce chocolate couvertures for ice cream popsicles and for crunchy chocolate variegation in ice cream flavours like *stracciatella*.



The added cocoa butter makes the normal chocolate more fluid, allowing a thinner chocolate crust on these delicious products without compromising the flavour.



I usually add 10 to 15% of molten cocoa butter to the chocolate of choice, sometimes together with another 10% of coconut oil. This concoction is then used when it reaches about 30-35 °C by simply dipping the popsicle in it, or for the variegation by pouring it on the ice cream upon being extracted from the batch freezer.

Cocoa mass (or cocoa liquor)

We must not be misled by the wording; the name liquor does not refer to an alcoholic substance. Instead, it denotes the original meaning of 'fluid.' It results from direct grinding and fine pasting of roasted cocoa nibs, without any addition or removal of any other element. In some sense, we can consider this as 100% bitter dark chocolate, still bearing the proportion between fat and non-fat components as decided by Mother Nature. Cocoa mass is commonly added to cocoa butter for the production of chocolate. It is also used in ice cream making and ice cream industrial manufacturing. Cocoa mass gives a stronger flavour than chocolate because it doesn't contain any sugar "diluting" the taste. For this reason, is also easier to compute its insertion into a formula.

Chocolate

Finally, saving the best to the last. It just so happens that, although I am now writing a book about ice cream, my actual profession is that of an Executive Pastry Chef. My relationship with chocolate can therefore be described as deeply intimate.

Nevertheless, on this occasion, I will discuss this mouth-watering matter from the point of view of ice cream, trying to limit myself in the treatment of this vastly fascinating world.

We have seen how the liquor found two different paths ahead of its time. Some became cocoa butter and cocoa powder; the remaining mass now proceeds for further processing. The cocoa mass must be refined using powerful rotating pairs of drums. These drums crash the cocoa particles down to less than 30 microns. At this moment, other ingredients are added, allowing the development of the varieties of chocolate we are used to.

Blending of different origins is also imperative. Different cocoas from different regions bearing specific characteristics are wisely blended to obtain the desired balance in taste, aroma, texture, fluidity, acidity, etc.

To schematize the compounding of different chocolate we may have:

DARK CHOCOLATE: cocoa mass + cocoa butter + sugar

MILK CHOCOLATE: cocoa mass + cocoa butter + sugar + milk powder

WHITE CHOCOLATE: cocoa butter + sugar + milk powder

GIANDUJA CHOCOLATE: cocoa mass + cocoa butter + sugar + milk powder + praline paste

Usually, an emulsifier, commonly soy lecithin, is added at this point. Few manufacturers prefer to exclude this ingredient mostly for commercial reasons in order to maintain a “pure and authentic” product.



Pic. 50 First grinding and pasting of the cocoa nibs with sugar and other ingredients

The texture of the chocolate, so far, still needs to be “sanded down” without any residue particulate (sandiness). The chocolate then undergoes a process called conching.

The chocolate paste is then moved into the basins (containers up to 1000KG) heated up at 80°C for many hours to allow the tannic substances to leave the mass. Other cocoa butter might be added to obtain the couverture chocolate.

Oxygenation of the liquid chocolate mass takes place, reducing the sourness, and freeing the finest aromas. Meanwhile, the chocolate is continuously frictioned and gently stirred, as it becomes increasingly smoother until it attains the well-known shining look, and the harmonious, fine, and round taste that made it famous worldwide.

The conching process causes sugar particles and cocoa to get so small that the tongue cannot trace them, thus explaining the smooth feel. The duration of the process affects the chocolate's smoothness and overall quality.






Pic. 51 Old style horizontal conching

High-quality chocolate can be conched for up to 72 hours, while cheaper and lower grade ones can undergo as little as six hours of conching. Now we just have to cool our chocolate down and wait until it sets into bars right?

Well, not exactly. The state changing from liquid to solid phase is referred to as the crystallization of cocoa butter. The latent fat present in cocoa butter is capable of being crystallized in six different forms. Also, uncontrolled crystallisation leads to crystals of varying behaviours and sizes. We must then "guide" the crystallisation, by using the tempering process.



 CRYSTAL TYPE	 MELTING TEMPERATURE	 CHARACTERISTICS
I	17°C or 63° F	Soft, easy melting, crumbly
II	21°C or 70° F	Soft, easy melting, crumbly
III	26°C or 79° F	Firm, easy melting, poor snap
IV	28°C or 82° F	Firm, easy melting, good snap
V	34°C or 93° F	Shiny, Firm, best snap, highest melting temperature
VI	36°C or 97° F	Hard, difficult to crystallize

Pic. 52 The six phases of cocoa butter crystal

The tempering process is essential because it generates a sufficient rate of stable crystals capable of recognising all the cocoa butter crystals into a regular structure, which gives a neat breaking, shining, and silky look to the chocolate.

The tempering process basically entails precisely controlled heating and cooling of the chocolate, and can generally be summed up in three phases.

1. The chocolate melts all six kinds of crystals by heating it to 45°C (113°F).
2. Next, it is cooled to around 27°C (81°F), allowing the creation of crystal types IV and V. The chocolate is then agitated to form several small crystal "seeds" serving as nuclei to generate small-sized crystals.
3. The chocolate then undergoes reheating to 31°C (88°F) so that IV crystals can be completely eliminated, only leaving type V.

All these steps are nowadays automatically executed by large continuous-flow machinery in chocolate manufacturing. At a smaller scale, the Pastry Chef is also called to temper, by hand or by means of a small tempering machine, any time he intends to use chocolate in his productions.



Pic. 53 Tempering machine model K24 Evo Duo Series. Photo courtesy of ® BRAVO.

In ice cream production, however, chocolate processing is limited to its mixing within the recipe or its insertion in the solid-state into the finished ice cream. In the first case, the ice cream maker will necessarily balance the recipe, taking into account all the components chocolate bears with itself; fat, sugar, solids, and LMS. In the second case, the solid chocolate insertions in frozen ice cream will be extra-recipe.

The "Codex Alimentarius" CODEX STAN 87 - 1981, Adopted in 1981. Revision: 2003. Amendment: 2016 dictates the international food STANDARD FOR CHOCOLATE AND CHOCOLATE PRODUCTS.


Knowing that skimmed dried milk is 50% lactose, the maximum amount of skimmed dried milk we can use will be 12%.

Other Solids

- The use of stabilisers is capped at 0,5% and they are considered other solids
- Cocoa powder fibre, nut paste fibre, and salts are grouped into other solids
- Egg yolk carries about 20% of other solids

The ingredients to supply the formula’s functional component can be chosen based on different parameters like availability, cost, desired quality, etc.

Now, we need some reference value for the most commonly used materials like dairy products and sugars. These values are easily found in standard commodity tables.

 DAIRY PRODUCTS	 FATS	 LMS	 SOLIDS	 WATER	 SUGARS
Full Fat Milk	3,50%	9%	12,5%	87,5%	0,0%
Semi skimmed Milk	1,50%	9%	10,5%	89,5%	0,0%
Skimmed Milk	0,30%	9%	9,3%	90,7%	0,0%
Cream	35%	6%	41,0%	59,0%	0,0%
Butter	82%	3%	85,0%	15,0%	0,0%
CEE Butter	99%	0%	99,0%	1,0%	0,0%
Mascarpone	47%	8%	55,0%	45,0%	0,0%
Full fat dried Milk	26%	71%	97,0%	0,0%	0,0%
Semi skimmed dried milk	16%	81%	97,0%	0,0%	0,0%
Skimmed dried milk	1%	96%	97,0%	0,0%	0,0%
Condensed sweetened Milk	9%	22%	74,0%	43,0%	43,0%
Dulce de leche	6%	24%	70,0%	40,0%	40,0%
Evaporated Milk	10,50%	27%	37,0%	0,0%	0,0%
Full fat yougurt	3,80%	10%	13,0%	0,0%	0,0%
Skimmed Yogurt	0%	10%	10,0%	0,0%	0,0%

Pic. 60 Standard reference parameters for dairy products

 SUGAR	 WATER CONTENT	 TOTAL SOLIDS	 SP	 FP
Sucrose	0,0%	100,0%	100	100
Dextrose	8,0%	92,0%	75	180
Glucose syrup 62 DE	20,0%	80,0%	50	60
Glucose syrup 38 DE	5,0%	95,0%	42	50
Fructose	0,0%	100,0%	140	190
Inverted sugar	27,0%	72,0%	126	190
Honey	20,0%	80,0%	125	190
Lactose	0,0%	100,0%	16	100
Maltodextrine 19 DEv	5,0%	95,0%	30	20

Pic. 61 Standard reference parameters for various sugars

It is now time to begin the juicy part. We will compile a simple table where each row will be used for an ingredient and each column will hold the various components this ingredient will contribute to the balance. In the end, we will study the total at the bottom of the column and determine if they respect the standard values we had fixed initially. I will proceed step by step redrawing the table at the addition of each ingredient. At every step, I will highlight the row we are working on and the numbers we are modifying.

Example of problem 1:

Let's hypothesise the balance of a simple mixture of white cream ice cream with the following required values:

- 20% Sugars
- 9% Fats
- 1% (circa) Other Solids

We also have to deal with the available materials:

- Full fat fresh milk
- 40% fat cream
- Skimmed dried milk
- Sucrose
- Dextrose
- Stabiliser/Emulsifier

While we don't know the necessary LMS content, this is a simple task since we have learned more than one system to obtain this information. We calculate as follows to obtain the maximum amount of LMS we can insert:

$$100 - (\% \text{ sugars} + \% \text{ fats} + \% \text{ other solids}) \times 0.15 = \% \text{ LMS}; \text{ therefore:}$$

$$100 - (20 + 9 + 1) \times 0.15 = 10.5\% \text{ of LMS}$$

This is the very highest amount possible before getting into solubility defects. To be on the safe side, we'll round down to 10%. Now we have all the functional components for our ice cream.

- 20% Sugars
- 9% Fats
- 1% Other Solids
- 10% LMS

40% Total Solids

As a common practice, the recipe is always calculated on 100Kg of recipe. We have also learned that sucrose cannot be used alone and that, usually, it is a good idea to replace around 15% of it with other simple sugars. For the sake of simplicity, we will replace 15% of sucrose with dextrose in this case. We can then place the sugars in our table.

20% of 100 kg is 20kg of total sugar.

15% of 20Kg is 3 kg of Dextrose; the remaining 17 kg will be sucrose.

Our commodity table reveals that while sucrose is anhydrous, dextrose contains 8% of moisture. To detract the moisture, our calculation is as follows:

$$\frac{3000\text{g}}{0,92} = 3260\text{g of Dextrose}$$

We can insert these values in the table in this manner:

Ingredient	Quantity	Sugars	Fats	LMS	Other Solids	Total Solids
Sucrose	17,000	17,000	/	/	/	17,000
Dextrose	3,260	3,000	/	/	/	3,000
TOTALS		%	%	%		

The sugars are now complete; we can take care of the fats. In this recipe, we can obtain fat from the milk and the cream. In total, we want to get to 9% or 9 kg of fat. Here, we have to use some experience to guess the approximate amount of cream to use; let's try to obtain the 7% (7 kg) of the total fat from the cream. The milk should carry the rest.

$$\frac{7000g}{0,40} = 17,500g \text{ of Cream } 40\% \text{ fat}$$

To get 7 kg of butterfat, we need 17.5 Kg of cream 40%. The cream also carries LMS in reason of 6%; therefore, we will have:

The 6% of 17.5 kg is 1,050g

We can also directly add the stabilisers/emulsifiers as they will concur to 0.5% of the recipe.

Ingredient	Quantity	Sugars	Fats		LMS	Other Solids	Total Solids
Sucrose	17,000	17,000	/		/	/	17,000
Dextrose	3,260	3,000	/		/	/	3,000
Cream	17,500	/	7,000		1,050	/	8,050
Neutrals	500	/	/		/	500	500
TOTALS	35.26	20%	%		%	0,05%	

As we can notice, the total weight of the recipe is only 35.26 kg so far, but we want to reach 100 kg. Whole milk and lean skimmed milk will fill up the missing weight.

We cannot add more than 10% (10 kg) of LMS. The cream has brought in already 1,050 Kg; therefore, 8,950 are still missing.

We also miss some fat, 2 kg, after adding the cream. To obtain 2 kg of fat from whole milk at 3.5%, we will need:

$$\frac{2,000g}{0,035} = 57,143g$$

About 57 kg of milk will complete our fat column.

Milk carries 9% of LMS; therefore, 57 kg will carry:

$$\frac{57,000g}{0,09} = 5,130g$$

Let's add what we have so far in the table.

Ingredient	Quantity	Sugars	Fats	LMS	Other Solids	Total Solids
Sucrose	17,000	17,000	/	/	/	17,000
Dextrose	3,260	3,000	/	/	/	3,000
Cream	17,500	/	7,000	1,050	/	8,050
Neutrals	500	/	/	/	500	500
Milk	57,000	/	2,000	5,130	/	7,130
TOTALS		20%	9%	%	0,05%	

The far column is now complete. We only miss the LMS column. So far, we have brought in our recipe 1,050 g + 5,130 g of LMS, but we know we have to get to 10 kg.

$10,000 - (1,050 + 5,130) = 3,820g$ of LMS are needed.

We know from the commodity table that skimmed dried milk is 97% of LMS; therefore, we will have:

$$\frac{3,820g}{0,97} = 3,940g$$

To complete our fixed amount of LMS, we have to add 3.94 kg of skimmed dried milk into the recipe

Ingredient	Quantity	Sugars	Fats	LMS	Other Solids	Total Solids
Sucrose	17,000	17,000	/	/	/	17,000
Dextrose	3,260	3,000	/	/	/	3,000
Cream	17,500	/	7,000	1,050	/	8,050
Neutrals	500	/	/	/	500	500
Milk	57,000	/	2,000	5,130	/	7,130
Dried milk	3,940	/	/	3,820	/	3,820
TOTALS	99,2 kg	20%	9%	10%	0,05%	39,5%

Brilliant! Luckily, I wasn't proved wrong. All the columns are correctly filled and we have got very close to 100kg. The missing 800g is due to the unavoidable approximations we have accepted, but this kind of calculation, although simplified compared to more analytical systems, leads to a more than adequate accuracy. Very good, we have completed our first recipe balancing from scratch.

Alternatively, we could have left the whole milk as the last ingredient to be calculated after having defined the dried milk. This would have implied an approximation in the milk quantity - leading certainly to an exact total of 100 kg but probably moving the fat column to some degree. Both these systems are more than accurate and reliable for artisanal products, as well as for small to medium manufacturers.

However, industrial manufacturers use more systematic and analytic methods. These systems require more elevated mathematical processing and resourcing to algebraic equations with numerous variabilities. While these systems are theoretically (slightly) more accurate, their impracticality renders them difficult to understand and use in a small day-to-day operation. Moreover, in big ice cream plants, where just a few grams off in a given recipe may translate into hundreds of thousands of dollars per year of variance, computerised systems, and proprietary software are used for the recipe calculation. Now, let's try something slightly more intricate. In the next problem, we are going to calculate the formula for a hazelnut ice cream. We will also consider the AFP and SP of the recipe in the exam.

Example of problem 2:

Let's suppose we want to balance a hazelnut ice cream recipe with the following parameters:

- We want a relative sweetness at 20% (SP 200), therefore simplifying a sugar amount of 20%*
- LMS content of 9%
- 10% of fat
- We want it to contain 8% of pure hazelnut paste
- We want its service temperature at about -11°C

We have the following available materials:

- Whole fresh milk 3.5% fat
- UHT cream 38% of fat
- Dextrose
- Sucrose
- Inverted sugar
- Skimmed dried milk
- Stabilisers / Emulsifiers
- Hazelnut pure paste 60% fat

*We simplify overlapping sweetness (SP) and sugar content in consideration of the 50/50 dextrose/inverted sugar trick. By doing so, we can lower the AFP without tampering with the SP

We start by inserting the data we already know. Therefore, we have the following: Neutral ingredients go straight in, and hazelnut paste brings in 60% of fat, whereas the remaining 40% is fibre.

60% of 8 kg is 4800g fat
40% of 8 kg is 3200g other solids

Ingredient	Quantity	Sugars	Fats	LMS	Other Solids	Total Solids
Neutrals	500	/	/	/	500	500
Hazelnut paste	8,000	/	4,800	/	3,200	8,000
TOTAL						
%		%	%	%	%	

In this case, we try inserting the milk first and work out our recipe accordingly. To determine the appropriate amount of milk we need, we must go by hit and miss and experience. As a rule of thumb, we might guess its amount as follows:

The Ice Cream Technology and Manufacturing

After a thorough study of the ingredients' functional components and after having smacked our heads on charts, tables, computations, and equations, it is now time to make some actual ice cream! We must know what needs to be inside the mix but still we have to turn the recipe into ice cream. While slightly different systems can be encountered in ice cream manufacturing, generally, they can be summarised in the following seven steps.

1. Dosing and Blending of the ingredients
2. Pasteurisation
3. Homogenisation
4. Ageing (Ripening) of the mix
5. Freezing / whipping
6. (Packaging) / Hardening
7. Storing, and holding of the finished product

Dosing and Blending

The first operation for the mix preparation is the dosing. The ingredients selected during the recipe design, are weighted separately, after which powders are usually mixed together while the liquid ingredients go directly into the pasteurizing machine.

Nowadays, no one still uses the direct cooking system in pots on heated stoves or fire; however, the principle is the same. Usually, cream, milk, condensed milk, water, glucose syrup, and inverted sugar are poured directly into the pasteuriser tank while the latter is heating up. Other ingredients are added after the mixture has reached around 35-50°C. First yolk or eggs, then all the powders, and finally, the butter, fats, or other ingredients. Once all the ingredients are in the tank, we close the lid and the machine will blend the mix thoroughly while heating it up.

Pasteurisation

The pasteurisation is a thermic treatment designed to destroy pathogenic bacteria to safeguard the health of customers and reduce the microorganism responsible for spoilage. The heat also helps by destroying several naturally occurring enzymes in raw milk and cream that could lead to damages in the flavour and texture of the final product.

Furthermore, the elevated temperature of this process greatly enhances the hydration of hydrocolloids and proteins (LMS, stabilisers), making it possible to dissolve components like mono and diglycerides of the fatty acids and many other emulsifiers. It is also very convenient that, at these temperatures, homogenisation can be carried out at its best.

The pasteurisation process entails quickly heating the mixture at the peak temperature of between 69°C and 85°C, maintaining it at this temperature for a given period of time, and then cooling the mix down as quickly as possible. There are different types of pasteurisation processes. The most important subdivision must be made between *continuous pasteurisation* and *batch pasteurisation*.

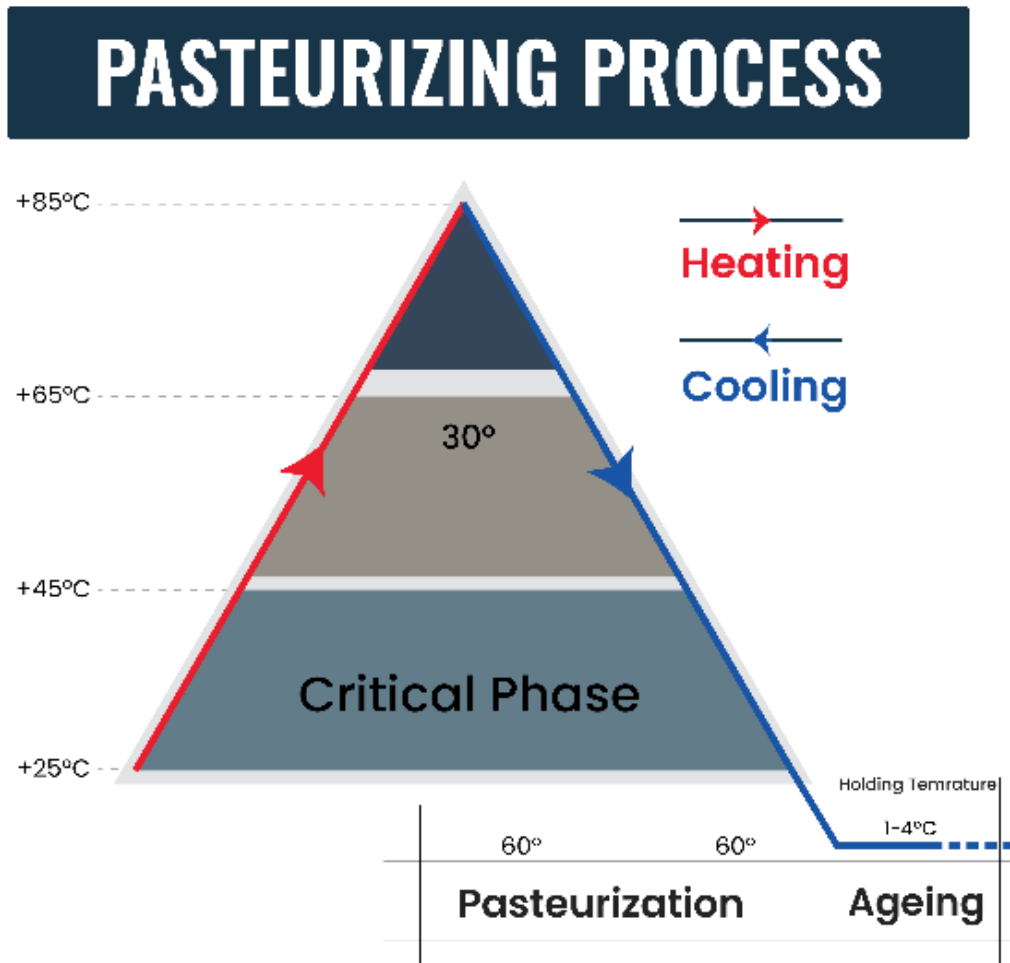
Continuous pasteurisation is largely used in big plant and industrial manufacturers. According to the temperature reached and the speed wherein heat is exchanged, we can have HTST (high-temperature short time), HHST (high heat short time), or UHT (ultra-high temperature).



Pic. 62 Self-contained ice cream mix plant model 150 batch. Photo courtesy of © ROKK Processing Ltd

I will not delve deep into the details of the process as this technique is used only by the large food industry, but it is carried out in large apparatus consisting of stacks of metal plates separated by thin gaps which form chambers. On one side of the plate, the mixture is pressurised by a pump which runs through all the chambers. On the other side, hot water or steam is pumped through. The mixture is then exposed at a high temperature for a very short time, which depends on the temperature itself. The higher the temperature reached, the lower the exposure time needed. All these parameters are fixed by law, and the manufacturer must be fully aware of all the norms and regulations that could be applicable to the products in his specific area of competence. The regulations are different for each country

and often, for each state. Those parameters can refer to the obligatoriness of the treatment, time, temperature to be reached within the pasteurisation process, maximum bacterial count before and after the process, etc.



The batch process is of great interest to small ice cream makers and artisans. It involves using a jacketed metal tank wherein all the ingredients are mixed (see Dosing and Blending) and subsequently heated up while being kept in constant agitation. These containers can range from 60 to 2000 litres. Once again, the cycles' time and temperature are interrelated and limits are imposed by law. However, in artisanal production, ice cream parlours and shops' practical/fully programmed pasteurisers are used, ensuring perfect adherence to the rules on this topic.

In these machineries, the temperature is monitored and controlled electronically. The operator only needs to set the chosen program and the machine will do the rest. The program usually differs on the highest temperature reached, allowing one to choose a delicate cycle when using materials particularly sensitive. The computer will then adjust the time accordingly.

By the end of the cycle, the machine will automatically stop and will immediately start cooling down the mixture by running refrigerated water through the jacket around the tank. This is a critical aspect, it is crucial to ensure that the mix is quickly cooled and not held in temperature below the pasteurisation and above 5°C. It is very important to understand that, while the pasteurisation process effectively destroys most microorganisms in the mix, it DOES NOT sterilise them. This means that there will still be (few) microorganisms cells alive and capable of thriving and multiplying at the end of the cycle if given the chance. Bacteria mostly grow between 4°C and 60°C, increasing as much as two-fold within 20 minutes, a range called "Danger Zone."

To put it simply, pasteurisation involves heating the mixture to 85°C and cooling it down right after to 4°C. The process must be completed in no more than 2 hours and, more importantly, the cooling time must be less than an hour.

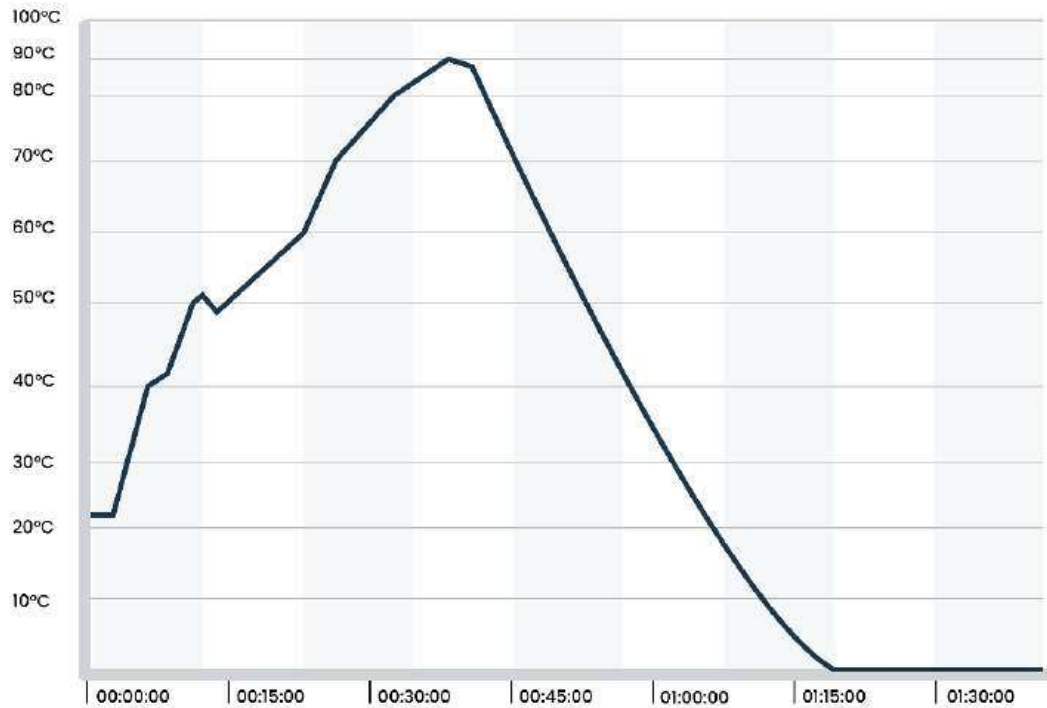


Pic. 63 Modern ice cream mix pasteurizer model Pastomaster 60. Photo courtesy of © Carpigiani

Once the mix inside the tank has reached 4°C, the cooling system stops, after which the mixture is held within the machine tank until the moment of its usage. The pasteuriser will keep the mix at 4 °C, mixing on a regular basis to ensure the mixture's homogeneity and temperature dispersion. By keeping the mix closed in

the pasteuriser tank, we minimise handling of the product and, therefore, the contamination it might be exposed to.

Pasteurization Curve



This working method is the most commonly used and entails preparing large batches of "white cream base" that undergo pasteurisation and is then stored directly within the equipment. The following day, the ice cream maker will simply tap the needed amount of white base, add the chosen flavouring ingredient or paste, and proceed to freeze it into ice cream.

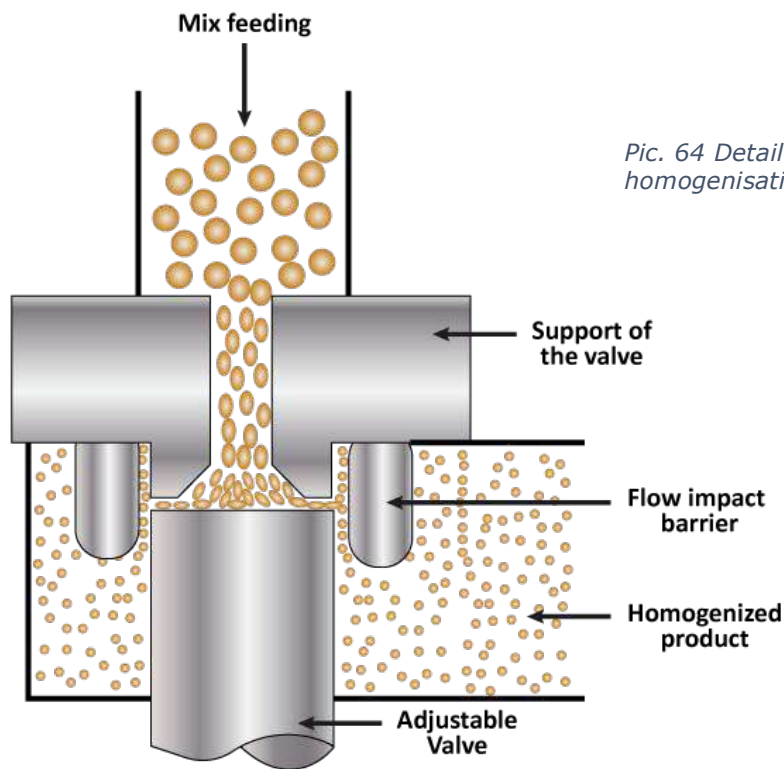
Homogenisation

The ice cream mixture is a complex matrix composed of solutions (sugars, salts...), colloidal systems (proteins, stabilisers...), suspensions (fibre, particulates...), and emulsions (fat and oils).

We know that milk fat is arranged in globules of varying dimensions throughout the dairy portion of the mix. These globules are kept separated from one another by a coating membrane made of phospholipids, to which proteins and other fats are adsorbed. By reducing the volume of the fat globules, the surface is increased dramatically, and with it, the number of substances that can be bonded to it. Thus the more we reduce the size of the globules, the more material will be captured on the surface of the globules and therefore the more stable the emulsion (and all the mix systems) will be.

The purpose of the homogenisation is then to reduce the size of the fat globules to 1 – 2µm, producing a stable and uniform suspension of the fat. If the fat is properly homogenised, there will be no fat separation on the surface and the ice cream will have a pleasant mouthfeel, and a smooth, dry appearance. Also, the resistance against melting will be improved.

This process is always beneficial but must be considered paramount when present fats are in the mix that are prone to generate unstable emulsions (vegetable oils above all). Homogenisation consists of forcing the (hot) mix through a very small valve orifice under extremely high pressure. The pressure of these pistons can be adjusted from 500 to 2500 psi, according to the composition of the mixture and the process is often carried out in two stages.



Pic. 64 Detail of a homogenisation nozzle

Particular attention must be paid when homogenising mixes with a high amount of cocoa fibre or undispersed solids since these substances are prone to damage the delicate equipment valves. Homogenisation must occur at the pasteurisation temperature as the process exerts its peak efficiency at around 80°C (175°F). The high temperature eases the breaking up of fat globules.



Pic. 65 Full ice cream production line including (from the right): Pasteurizer, Homogenizer, Holding and Ageing device, two batch freezers.



Pic. 66 Laboratory size homogenizer. Photo courtesy of © ROKK processing ltd.



Pic. 67 Turbomix emulsifier / homogenizer machine. Photo courtesy by © Carpigiani

When dealing with a larger amount of production, the homogeniser is strongly recommended and must be placed between the pasteuriser and the cooling/ageing tanks (see pic). As a matter of fact, industrial manufacture requires the incorporation of a larger amount of air into ice cream compared to the artisanal process. In commercial production, types of fat such as hydrogenised fats are more



Pic. 72 Typical Italian style ice cream batch freezer model Maestro HE 3. Photo courtesy of © Carpigiani.

Once the required stiffness is achieved, the program ends and the operator can extract the ice cream. This is easily propelled out from a purposely designed extraction port in the cylinder's lower part and can be collected in the chosen containers.

Traditionally, batch freezers produce ice cream with a lower overrun than continuous freezers. Notably, this is caused by the shape of the scraping blade, and above all, because batch freezers operate at atmospheric pressure as opposed to the continuous freezer in which a certain positive pressure is forced into the barrel. For this reason, particular attention must be paid to the ice cream formulation, ensuring proper emulsification and whipping properties. Nonetheless, it is possible to adjust the overrun ratio by introducing less or more mixture in the freezing chamber at each cycle. A lower amount of mixture will allow more air to be whipped

into the mix because of the increased contact surface air/mix. On the contrary, a fuller drum will generate a harder and more compact ice cream with less overrun. However, equipment manufacturer instructions must be followed concerning the proper loading of each machine.

The cycle duration depends on the amount of mixture loaded and on the machine specifications, on average it takes somewhere between 6 and 12 minutes. In these types of machinery, the ice cream is extracted at a temperature of -5 -6°C, slightly higher than with continuous freezers.

Commonly, the mix is added with flavouring ingredients right before being inserted into the batch freezer. Other ingredients might be incorporated through the upper hopper while running the freezing program towards the end of it, just before the ice cream extraction.

Other recipes instead require some ingredients to be added at the moment of extraction, directly mixing the ice cream in the container (stracciatella for example). A properly balanced ice cream will easily extrude through the discharge port in a ribbon flowing down into the container below. The operator will guide the ribbon using a hard plastic spatula to obtain an even distribution in the tub. When pieces of nuts, dried fruit, or chocolate morsels are added to the freezing chamber, a complete dismantling of the blades is necessary to allow complete cleaning. It is recommended to plan a proper sequence of production to minimize those operations and to reduce the risk of the cross contamination of allergens.

Although the vast majority of ice cream makers today opt for the most convenient horizontal batch freezers, vertical batch freezers are still available on the market, although they are mostly employed in show-laboratories where the customer can witness the production operation. This is because these types of machinery are the heritage of the past in traditional Italian gelato making and, therefore, are capable of evoking a special "handcrafted" romanticism.

Vertical batch freezers produce Italian-style ice cream with a typically lower overrun and a stiffer consistency. They allow easier insertion of particulate materials such as chocolate pieces, cookie crumbs, dry fruit, etc. but their challenges include a longer production cycle, a difficult complete manual extraction, and a far more challenging cleaning process.



Pic. 73 Vertical batch freezer model Effe 6 for production Italian-style gelato. Photo courtesy of © Ice Team 1927

It is important to mention that combined machines which include in one piece of equipment, both pasteurizer and batch freezer, are available in the market. These

machineries are extremely convenient when dealing with limited floor space, allowing an entire ice cream lab to be condensed in one single machine.



Pic. 74 Combined machine capable of mixing, pasteurizing, homogenizing, cooling down and batch freezing. Photo courtesy of © BRAVO spa.

In this combined machinery, we find two discrete cylinders. The upper one is heated and serves as a mixer/pasteurizer. All the raw ingredients are inserted in it and an automatic program will proceed to agitate the mixture while bringing the temperature up to the needed pasteurisation point. Once the pasteurisation program is completed (usually takes 10-15 minutes), the still hot mixture is transferred into the lower cylinder. In here the mix is rapidly cooled to 4°C and the freezing process starts seamlessly. Once the mixture is dumped in the freezing chamber and, therefore, the boiler is freed, another pasteurisation program can be simultaneously run, optimizing the production times. We can notice that the boiler cylinder is smaller compared to the freezing chamber; this is because a larger contact surface is needed during the freezing process to ensure a correct overrun.



Pic. 75 Combined machine model Compacta VariO 12 Elite. We can see the above cylinder used for pasteurisation, the pouring mechanism and the lower part for the batch freezing. Photo courtesy © Ice Team 1927.

These types of machinery have great perks. First of all, albeit expensive, they cost less than buying two distinct machines (pasteurizer and batch freezer). The second advantage is the extreme ease of use coupled with the very high food safety (no storage of the mixture). Also, the ice cream maker can produce every single flavour by using a different and specifically balanced recipe, enhancing the best of each ingredient. However, this method completely neglects the ageing of the mix, thus affecting coalescence, fat crystallisation, overrun, and texture. For this reason, a specific stabilisation/emulsion profile must be designed when using this machinery. Furthermore, the extemporaneous scaling - boiling - cooling - freezing of small batches one after another can dramatically slow down the production. All pros and cons must be taken into consideration and weighed according to the specific production need.

Alternative systems are on certain occasions used to prepare a very small quantity of ice cream. Some examples can be manufacturing an ice cream with liquid nitrogen or using specific powerful appliances capable of blending frozen products directly into a sort of ice cream (see www.pacojet.com). These systems, though convenient in certain specific applications such as small restaurants, cannot be

classified into the ice cream production process. In very recent times, we have seen another type of machinery which I hesitated to place in either continuous or batch freezer categories.

I am talking about the screw ice cream freezer.



Pic. 76 The new system that uses an Archimedean screw to freeze the ice cream mix. Model "Mantecatore a Vite". Photo courtesy of © LA NUOVAGEL SRL

These machineries can run either as a batch freezer, being fed by manually pouring the mixture in the upper tank, or as a continuous ice cream freezer when connected to a pasteuriser or ageing vat via the integrated pump. The machine design loosely resembles the continuous freezer ones. A stainless steel cylinder is cooled below freezing temperature and the mixture freezes while being scraped on the internal surface. Here, the difference is that instead of by fast rotating dasher and scraper blades, the ice cream is slowly scraped off the barrel and propelled by a continuous screw.

In this system, a smaller amount of mixture is frozen at the time, making the freezing process quicker. The whipping / freezing is greatly accelerated, and the ice cream starts being extruded after less than one minute from the time of introduction of the mix. The super-fast cooling time produces extremely small ice crystals, making for a more stable and dry product, with a distinctive smoothness. Due to the peculiarly microcrystallised structure, the ice cream so obtained also shows a better shelf-life, either packaged or when kept in tubs for showcase.

Food Additives



Food additives are substances deliberately added to food products to perform certain technological functions, for example to colour, sweeten, preserve, or improve the appearance, flavour, and aroma. The three major groups of additives include:

- those that preserve foods' freshness: preservatives, which slow down the growth of microbes, and antioxidants, which prevent rancidity and colour changing.
- those that enhance foods' sensory characteristics: dyes, thickeners, emulsifiers, sweeteners, flavour enhancers.
- those that are used for facilitating food processing, but lack a specific function (also called adjuvants): anti-foaming agents, anti-caking agents, etc.

Additives are found in almost all foods, except for staple foods such as virgin olive oil or sugar. All additives must be indicated on product labels; however, it is not legally mandatory to mention them as an ingredient.

Additives undergo a safety assessment process at the European and international levels before being authorised for food use. In Europe, the assessment is carried

out by the Food Safety Agency (EFSA), and by the Joint Expert Committee on Food Additives (JECFA - Joint Expert Committee on Food Additives) of WHO (World Health Organisation).

For regulating the additives, each one of them is assigned a unique "E number" used across Europe. The Codex Alimentarius Commission has extended the scheme to globally identify all approved and unapproved additives.

In European countries, "E" prefixes the E numbers, but nations outside of the content only make use of the number. As a case in point, E260 refers to acetic acid in Europe. However, other countries just refer it to as 260. In Europe, unapproved additives do not have this number. It is important to name and number all food additives.

Aromas are not clearly encoded with any E number and the regulations about their use in food are sometimes tricky.

The FDA lists these items as GRAS (generally recognised as safe) under both Chemical Abstracts Service number and FDA regulation in accordance with the United States Code of Federal Regulations. In the USA, it is important to consult the regulations for food additives in 21 Code of Federal Regulations.

- E100–E199 (colour additives)
- E200–E299 (preservatives)
- E300–E399 (antioxidants, acidity regulators)
- E400–E499 (thickeners, stabilisers, emulsifiers)
- E500–E599 (acidity regulators, anti-caking agents)
- E600–E699 (flavour enhancers)
- E700–E799 (antibiotics)
- E900–E999 (miscellaneous)
- E1000–E1599 (additional chemicals)

E NUMBER RANGE	SUBRANGES	DESCRIPTION
100–199 Colours	100–109	yellows
	110–119	oranges
	120–129	reds
	130–139	blues and violets
	140–149	greens
	150–159	browns and blacks
	160–199	gold and others
200–299 Preservatives	200–209	sorbates
	210–219	benzoates
	220–229	sulfites
	230–239	phenols and formates
	240–259	nitrates
	260–269	acetates (ethanoates)
	270–279	lactates
	280–289	propionates (propanoates)
	290–299	others
300–399 Antioxidants and acidity regulators	300–305	ascorbates (vitamin C)
	306–309	Tocopherol (vitamin E)
	310–319	gallates and erythorbates
	320–329	lactates
	330–339	citrates and tartrates
	340–349	phosphates
	350–359	malates and adipates
	360–369	succinates and fumarates
	370–399	others
400–499 Thickeners, stabilisers and emulsifiers	400–409	alginates
	410–419	natural gums
	420–429	other natural agents
	630–639	inosinates
	640–649	others
700–799 Antibiotics	700–713	
900–999 Glazing agents, gases and sweeteners	900–909	waxes
	910–919	synthetic glazes
	920–929	improving agents
	930–949	packaging gases
	950–969	sweeteners
	990–999	foaming agents
1100–1599 Additional additives	1100–1599	New chemicals that do not fall into standard classification schemes

This list is made available solely for the purpose of information. It has no legal value. The author declines any responsibility or liability whatsoever for errors or deficiencies in this data. Information in the book may not be timely, complete, or accurate. The author is not responsible with regard to the improper use of the book and its contents. The official authorisations of food additives are published in the Official Journal of the European Union and on the regulations for food additives in 21 Code of Federal Regulations for the USA.

In UK legislation, when listing allergens on the label, certain ingredients must be preceded by their function, such as colours, thickeners, and emulsifiers. Any additive that accounts for more than 2% of the finished product must be listed in descending weight order as any other ingredient. Additives present in a concentration less than 2% of the finished product are usually grouped together at the end of the list.

There are myriad additional legal labelling requirements that the manufacturer and ice cream maker must be aware of. For example, in European and UK legislation, certain colours are thought to be associated with hyperactivity. Sunset Yellow (E110), Quinoline Yellow (E104), Carmoisine (E122), Allura Red (E129), Tartrazine (E102), and Panceau Red (E124). Their name must be displayed and the label must state "may have an adverse effect on activity and attention on children".

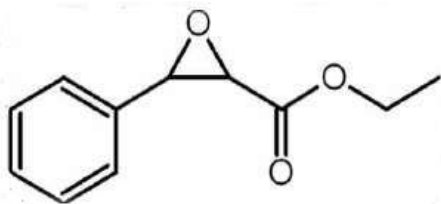
There is also other stuff...

We already spoke about some of the most commonly used additives in ice creams while talking about stabilisers and emulsifiers. Most of these substances were natural substances and often hydrocolloids; however, there are worse things that manufacturers might stuff into ice creams.

An ice cream can be made in many ways and at many costs, we might produce a rich and super-premium ice cream but it is also possible to produce ice cream to the very bottom of the allowed parameter. Such an ice cream would carry the lowest possible fat content, less cream, and less LMS while containing loads of air with incredibly high overrun. Unfortunately, these kinds of products are very common because of their ridiculously low price, and several tricks are used to make up for the lack of creamy rich texture and mouthfeel.

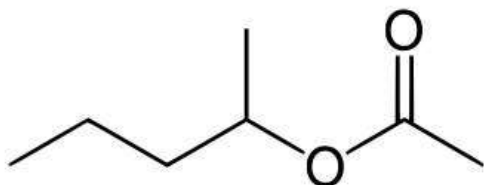
I will now mention some of these chemical additives with a brief description and comment.

Aldehyde C 17



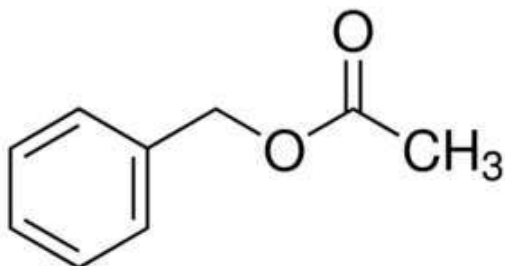
Ethyl-3-phenyl Glycidate is allowed in food because of being included in the Code of Federal Regulations Title 21. It is a flammable yellow aromatic substance, having a delicate and sweet strawberry aroma. It is used in shampoo, deodorant, cosmetics, and as well in dyes, plastics, and rubber. When used in food as a synthetic aroma, it is found in doses between 10.00000 and 20.00000 ppm.

Amyl acetate



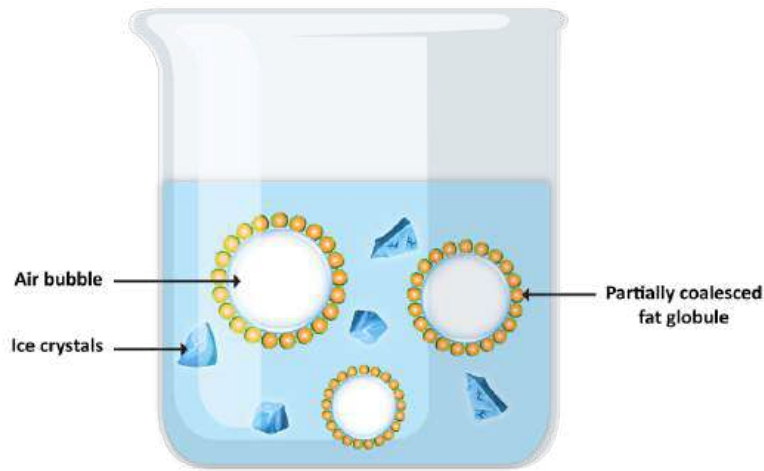
Amyl acetate, along with Isoamyl acetate (also known as isopentyl acetate), is a naturally occurring flammable aliphatic ester in banana fruit. It finds application as banana and pear essence. It is used as a test odorant in studies of olfactory function. as well as paint and varnish solvent. Was used in the past as a solvent and carrier for materials such as nitrocellulose in aeronautical painting. However, it has low toxicity.

Benzyl acetate



It is formed by the condensation of benzyl alcohol and acetic acid. Benzyl acetate occurs naturally in jasmine, apple, cherry, guava fruit and peel, wine grape, white wine, tea, plum, cooked rice, and Bourbon vanilla. Due to its sweet floral-fruity jasmine freshness, it is attractive to various male species of flies and orchid bees. It is widely used in air scents, soaps, detergents, plastic, solvents, lacquers, and food.

Thanks to the mechanical action of the dynamic freezer and the shear forces it applies, the single fat droplets are forced together.



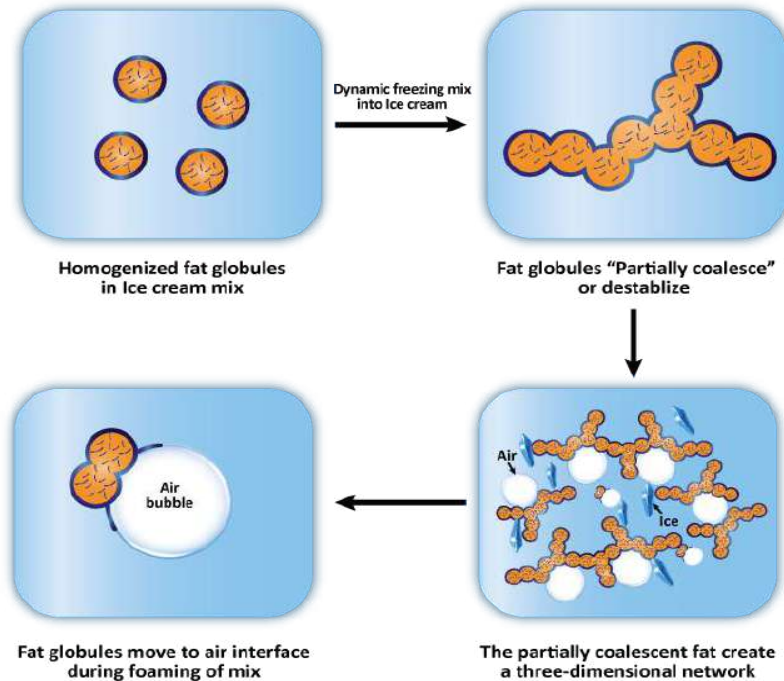
As these fat droplets are crystallized (due to the cold and ageing), they pierce each other, interconnecting (partial coalescence) instead of pooling together in larger globules (coalescence), originating a scaffolding structure. Thanks to the partial coalescence so obtained, the ice cream retains small air bubbles and achieves air/fat stability.

Furthermore, we want the air bubbles to be trapped in our ice cream in the smallest size possible. To achieve this, it is important for the mix to have the correct surface tension. By lowering the surface tension of the mix with proper substances, the overrun, whippability, and fluffiness of the ice cream is dramatically improved. An excessive amount of surface-active components, therefore, is a too low surface tension that leads to over whipped ice cream that is too airy and with a short mouthfeel, typically prone to shrinkage.

During the dynamic freezing process, proteins and phospholipids readily migrate on the surface of the newly formed air bubbles, stabilising them.

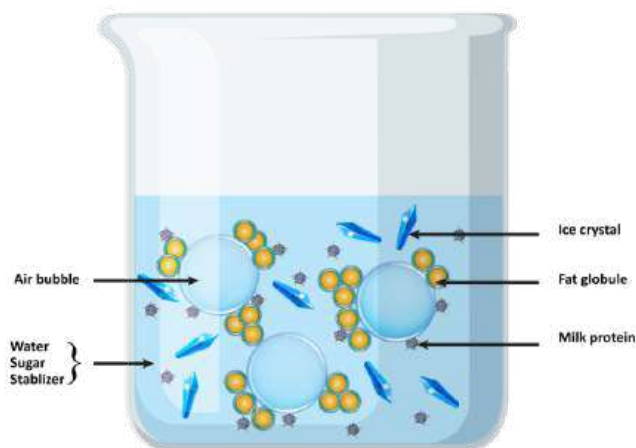
The overrun capability and the quality of air bubble distribution in ice cream are a function of several factors. An effective agitation, sometimes performed under positive pressure (continuous freezers), is necessary to begin with. The proper balancing of surface-active substances (emulsifiers) and the correct protein content are also crucial. The best proteins to improve whippability are the ones from LMS. Sodium caseinate is also extremely effective in improving the mix overrun, whereas egg yolk proteins are also good emulsifiers that positively influence the whipping properties

Fat Structure Development in Ice cream



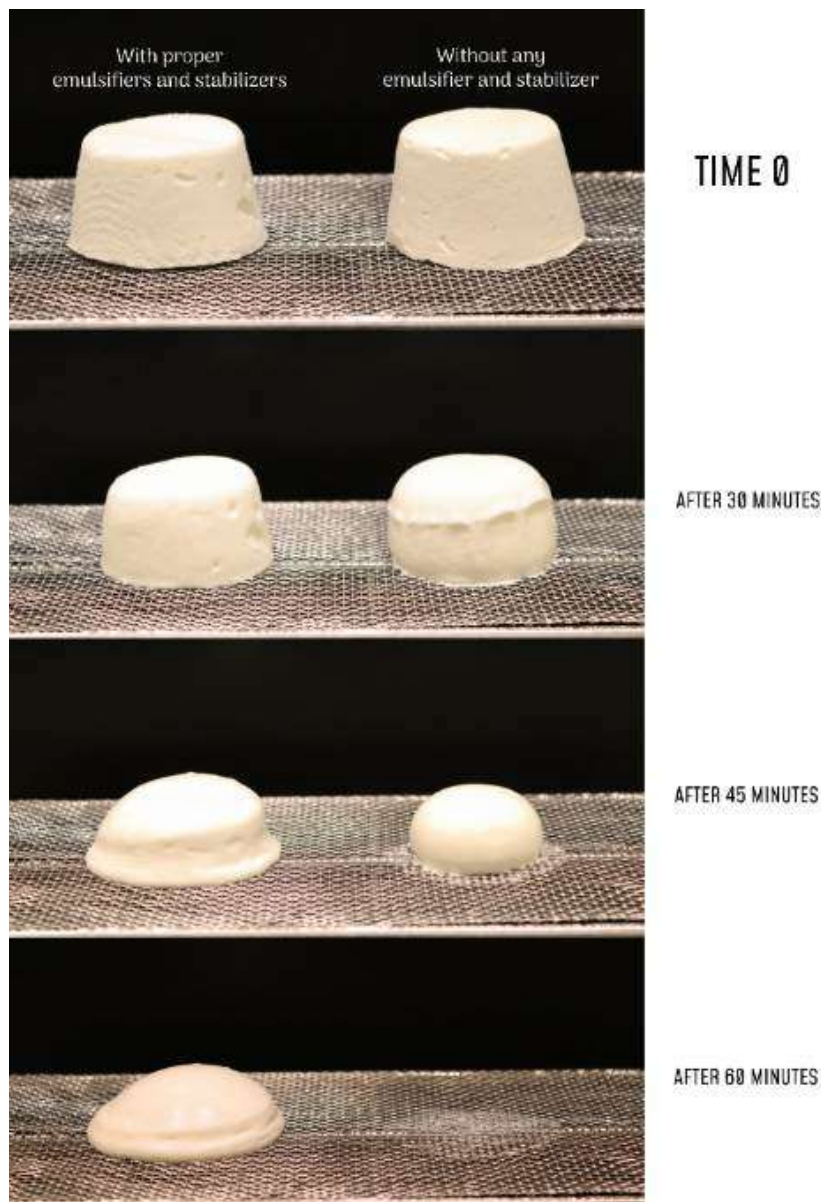
As we have learned, proteins are sensitive to changes in temperature, salinity, and pH. The correct mix formulation must ensure the appropriate balance of all these factors, allowing the proteins to perform their functions without denaturation or precipitation. The most common among all the protein instability issues is serum separation (syneresis). This phenomenon can occur in the mix (leading to the formation of a transparent layer on top of the mix) and in ice cream where clear serum can melt out the ice cream's surface.

This is a congenital issue due to the intrinsic incompatibility of proteins and most of the stabilisers. Hence, (as we know), stabilisers are typically used in combination because their synergetic actions reduce syneresis. In particular, carrageenans are often added to other stabilisers in a small amount to reduce this problem.



Meltdown

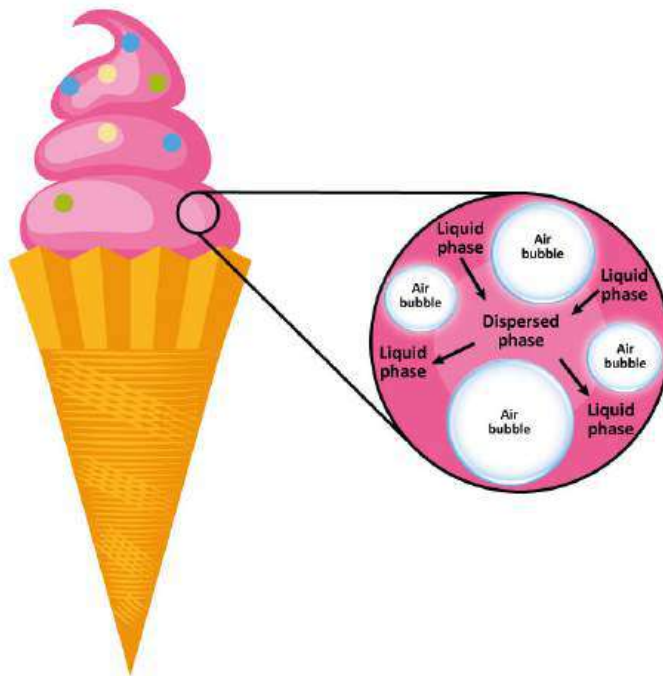
It does not require any explanation; ice cream is always eaten at a temperature higher than its melting point. Ice cream melting can refer either to its meltdown during transportation, storing, serving and consumption, or the melting properties in the mouth. We have already discussed the method the ice cream maker can use to limit the unwanted meltdown during storage and transportation, above all the correct balancing and stabilisation of sugar. We can also observe how the overrun of an ice cream can affect its meltdown properties. The rate of meltdown is affected, among other things, by the thermal diffusivity of the product, namely the resistance of the ice cream to allow heat penetration. A slower rate of meltdown is observed amid a higher overrun. This is due to the insulation effect of the air cells acting as a coat to protect the core of the ice cream.



Also, the dimension of the air bubbles is important, as smaller air cells retard the melting while a calibre of air bubble facilitates it.

The viscosity of the mixture is another pivotal aspect influencing the speed rate of meltdown. Proper use of thickener and stabilizer is needed to increase the serum phase viscosity, thus reducing the dripping down from the frozen mass.

The ice cream maker will have to keep into consideration the season and the geographical location in which his products are sold and correct the recipe accordingly. Such correction will regard fat content, sugar content, type, and the number of stabilisers and emulsifiers used.



The ice cream is in a continuous shifting balance between the liquid phase and the dispersed phase.

The Ice Cream Defects



By now you should have learned everything you need to make ice cream, hopefully, a good one at that. Anyway, many things may go wrong in the quest to make a perfect cone. One must identify possible defects in the product and mastering the

necessary knowledge that allows a good Chef or ice cream maker to understand what went wrong and take corrective measures.

We've already discussed various technical parameters such as acidity, overrun, density, bacteria count, etc. These are all measurable values, for which the standard parameters for evaluation are available. Things are different when it comes to sensory analysis. The determination of the ice cream quality is still personal and individual; besides, an ice cream can still be awful even with all the technical parameters perfectly fitting in standard ranges.

In general, defects in ice creams can occur in terms of flavour, body, texture, colour, etc. I will attempt to list out the most commonly encountered defects, correlating them with their causes and subdividing them by the sensory system.

Body Defects

Ice cream is hard, stiff, and heavy

- High content of total solids
- Low sugar content
- Incorrect emulsifiers/stabilisers profile

Ice cream is too fluffy and "hollow"

- Lack of total solids
- Lack of stabilisers
- Excessive use of emulsifiers
- Excessive air pressure in continuous barrel freezer

Coarse, rough, or icy texture

- Wrong balancing of the formula
- Insufficient LMS, sugars, total solids, or fat
- Freezing is performed at a slow rate, freezer malfunction
- Temperature fluctuation during storage or transport
- Lack of ageing of the mix
- Hardening not performed as quickly as necessary
- Thawing and re-freezing of the ice cream
- Ice cream is extracted from the freezer before completion of the cycle

Gummy, chewy body

- Excessive use of stabilisers
- Wrong stabilisers profile
- Lack of whipping/overrun

Watery ice cream

- Low-fat content
- Wrong stabilisers/emulsifiers profile

Sandy texture

- Excessive amount of lactose (or LMS)
- Fluctuation in storage temperature
- Hardening performed at a slow rate
- Excessive amounts of sucrose in the formula
- Pre-crystallisation of lactose in condensed milk

Fatty mouth feel

- Excessive amount of fat
- Lack of LMS
- Over beating resulting in fat churning
- Lack or defective homogenisation

Ice cream is spongy

- Wrong stabilisers; profile
- Excessive amount of egg yolk in recipe
- Wrong balancing of the formula

Ice cream is flaky and crumbly

- Lack of LMS
- Lack of total solids
- Lack of sugars (above all reducing sugars)
- Wrong recipe balancing

Weak and melty body

- Low % of total solids
- Excessive overrun
- Lack of fat
- Lack of stabilisers

Flavour Defects

Ice cream tastes eggy

- Excessive use of egg
- Poor quality of the eggs used
- Insufficient pasteurisation

Ice cream tastes artificial and unnatural

- Excessive use of synthetic aromas
- Poor quality of flavouring ingredient (above all, readymade pastes)

Ice cream tasting like cooked

- Excessive heat in pasteurisation
- Use of poor quality milk powder or evaporated milk

Acid, sour or rancid taste

- Poor ingredient (above all dairy or fruit)
- Spoilage of the mix by bacterial fermentation
- Incorrect cooling after pasteurisation and throughout the ageing
- Mix too old
- Lipolysis of butterfat due to poor temperature management

Ice cream is bitter

- Excessive use of artificial flavours like vanillin
- Defective dairy product

Ice cream has a weak, mild taste

- Lack of LMS
- Lack of sugars
- Insufficient use of aromatic pastes (hazelnut, cocoa, pistachio, etc.)
- pH value out of range

Oxidised, fishy, cardboard, paint, glue, or metallic tastes

- Wrong stabilisers or excessive use of it
- Some emulsifiers and stabilisers carry bad tastes
- Reaction of chemical substances with naturally occurring metal ions in milk

Ice cream is salty

- Excessive amount of LMS
- Use of whey products
- Excessive amount of salt where used (example: pistachio, or salted caramel)

Meltdown defects

Ice cream melts too quickly

- Lack of stabilisers or emulsifiers
- Excessive amount of sugars
- Lack of fat

Irregular curdy melting

- Protein denaturation due to excessively high pasteurisation or acidity
- Over churning in freezer

Ice cream does not melt in the mouth

- Excessive use of stabilisers/emulsifiers
- Excessive fat content
- Defective homogenisation

Colour defects

Ice cream has an unnatural colour

- Poor quality of flavouring pastes
- Excessive use of artificial colours
- Vanilla pastes added with fake yellow colours

Ice cream is grey

- Wrong pH while using fruit puree or berries
- Use of fruit pulps on non-white bases

The Recipes



Finally, the funniest and tastiest part. I have been writing the entire book and left this chapter for the end of the work thinking it would have been a humorous and relatively simple task.

I then realised that there are practically endless possible recipes and several different ways to classify them. I decided then to enclose some of my favourite recipes, some others I have developed over the years in the diverse environments I worked in, and some that I think you may find useful. I nonetheless believe that rather than just "take recipes" from here and there, the quintessential ice cream maker (whom I by now conceitedly believe I contributed to educating), should take pride in developing his own ones. Some of my recipes have been imperfect and broken balancing rules at times. Nevertheless, they are still mine.

When I go through my (dishevelled) pastry recipe book, I can still remember the precise moment each one of them was jotted down on tissue paper in the various pastry laboratories I had worked in. That being said, I am glad and proud to share with you my collection of recipes.

Disclaimer: I sometimes find it funny that to date, dogmas exist in ice cream balancing. Sometimes, it just seems that people in this sector keep on repeating "rules" passed over the generations of ice cream makers without actually asking the reasons behind them. A refulgent example of these "dogmas" is, in my opinion, the ratio at which sucrose can be replaced by other (simple) sugars. The elders have taught us that we cannot, for any reason, trespass the solemn threshold of 30% in sucrose replacement with, say, dextrose or inverted sugar. Going over this limit is heresy and the ice cream Gods might pour their anger on us if we dare to! Well, I feel compelled to bust this myth. Dextrose or glucose are sugars exactly like sucrose; they have their behaviours and characteristics but nothing can forbid me to use them in different ratios if needed and justified by the balance. Sucrose will remain the first source of sugar because it is inexpensive, practical, and easy to source, but not for other arcane religious reasons.

The major distinction I made is between milk-based ice creams and water-based sorbets.

Within these two categories, I then tried to group the recipes into families having common specific similarities. Some comments are added for a few recipes to give indications about specific characteristics or peculiarities.

White Creams



The white creams represent the base for most of the ice creams. They are the simplest recipes and act as a reference value when studying balancing and formulations.

White creams are generally made out of milk, cream, dry skimmed milk, and sugars. They can be easily aromatised by adding flavouring and aromatic pastes, paying attention although not to change the balance of the functional components. A well-balanced white cream can be surely frozen into ice cream by itself. In Italy, this is called "Fiordilatte", a very popular milky taste.

The general composition for white cream can include 6 – 11% of fat (buttermilk), 17 – 23% of sugars, and 10 – 11.5% of LMS.

The variegation possibilities are endless for these delicious milky ice creams. We can add any flavouring that does not significantly interfere with AFP and SP to turn this white base into something else special. Some examples of flavouring /variegation are:

- Coffee extract or soluble coffee
- Rose or violet aromatic paste
- Chocolate couverture scrambled into "Straciatella"
- Nuts, chocolate, candy, morsels, or cake solid inclusions
- Aromatic concentrated pastes designed for ice cream flavouring
- Aromatic pastes designed for variegation
- Jams and fruit compotes
- Crushed meringue

Preparing Ice Cream starting from a common "white mix"

Nowadays, I see an increasing number of specialised magazines and (obviously) manufacturers supporting the idea (and recommending) the common-based production system. In this scenario, the ice cream maker just has to prepare large amounts of a single white mix, either using premixed formulations or by mixing all the ingredients himself. Just before freezing it, they add the flavouring pastes.

In this case, if we are lucky, the ice cream maker will probably develop a somehow balanced white mix, and they will then proceed to unbalance it by adding very different ingredients (fat-based pastes, sugar-based-aromatic products, fruit puree, etc.).

This method is certainly quick and convenient, but it is clear that it doesn't keep in any account the single characteristic of each and any ingredient and related ice cream flavour.

I personally do not see the point in it. Having a small laboratory, old or new types of machinery does not change the game. I opened my first Pastry Shop producing ice creams at the age of 24 and, believe me, with no money. I had a custard-cream pasteuriser older than me and two small and, I would say ancient, batch freezers of tenth hand. Nonetheless, I ALWAYS strived to produce the best ice cream I possibly could, separately balancing all my recipes (some of which you can find in this manual marked as "Petit Four" the name of my first shop).

I then used to weigh, mix, pasteurise, cool down, and age every single recipe, storing them in plastic buckets in the under-counter fridges overnight before

freezing them. Small quantities and particularly sorbets can be EASILY cooked in a pot on a stove requiring just a few minutes.

Obviously, in certain cases, more than one flavour can be obtained by one single mix. For example, Fiordilatte, Stracciatella, Coffee, Violet, Rose, and others were obtained all by using the same white mix, because the flavouring ingredient did not have any interaction with the balancing.

Another example is the milk-based fruit mix; I was using the same recipe, and obtaining peach, strawberries, raspberries, or cantaloupe, and others just by adding the proper fruit puree before freezing.

If the idea of making artisanal ice cream is buying a full line of products from one manufacturer, mixing everything in one common mix as per instruction, and add different flavouring to it, this book can find little use and the brochure from the supplier of the product is more than enough.

Achieving a correct balance based on your tastes and needs is a practice that should be embraced by every artisan ice cream maker proud of their work, where they use their own recipes to create ice creams.

In the recipes that follow, I will include some formulations for a white common base, which, however, should be tried out and possibly re-balanced if different ingredients are added to obtain other flavours.

WHITE ICE CREAM BASE

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5%	60.00	0.21		5.40	5.61	270.00	43.00	
Cream 35%	16.00	5.60		0.96	6.56	48.00	8.00	
Dry Skimmed Milk	4.00			3.88	3.88	194.00	31.00	
Dextrose	2.50		2.30		2.30	414.00	166.00	
Inverted Sugar	2.00		1.40		1.40	266.00	182.00	
Sucrose	15.00		15.00		15.00	1,500.00	1,500.00	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	5.81	18.70	10.24	35.25			-11
%	100.0%	5.8	18.7	10.2	35.3	269	19	



FIORDILATTE ITALIAN ICE CREAM "PETIT FOUR" RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	60.00	2.10		5.40	7.50	270.00	43.20	
Cream 35 %	17.60	8.16		1.06	7.22	52.60	8.45	
Dried Skimmed milk	3.60			3.48	3.48	174.60	27.04	
Sucrose	13.20		13.20		13.20	1,320.00	1,320.00	
Dextrose	2.50		2.30		2.30	414.00	172.50	
Dry Glucose Syrup 38 DE	2.60		2.47		2.47	123.50	103.74	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.26	17.97	9.95	36.88			-11
%	100.0%	8.3	18	18	38.7	236	17	










It's a rich and delicious white cream ice cream, can be sold as it is or variegated with chocolate to obtain Stracciatella.

ESPRESSO ICE CREAM








 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	34.00	1.19		3.05	4.25	153.00	24.48	
Cream 35 %	22.00	7.70		1.32	9.02	66.00	10.56	
Dried Skimmed milk	6.00			5.92	5.92	291.00	46.56	
Sucrose	15.00		15.00		15.00	1,500.00	1,500.00	
Dextrose	2.50		2.30		2.30	414.00	172.50	
CSS 60 DE	2.00		1.60		1.60	96.00	80.00	
Espresso coffee	18.00							
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.89	19.90	10.20	38.49			-11
%	100.0%	8.9	19.9	10.2	38.5	252	16	












GELATO ALLA CREMA (ITALIAN EGG-CUSTARD) CHEAP RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	66.00	2.31		5.94	8.25	297.00	47.52	
Cream 35 %	5.00	1.75		0.30	2.05	15.00	2.40	
Dried Skimmed milk	4.00			3.88	3.88	194.00	31.04	
Sucrose	14.00		14.00		14.00	1,400.00	1,400.00	
Dextrose	2.00		1.84		1.84	331.20	138.00	
Inverted Sugar	1.00		0.72		0.72	93.50	135.80	
CSS 80 DE	1.50		1.20		1.20	72.00	60.00	
Egg Yolk	4.00	1.20			2.00			
Butter or Margarine	2.00	1.54			1.70			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	6.90	17.76	10.12	36.14			-11
%	100.0%	0.9	17.8	10.1	36.1	240	18	










GELATO ALLA CREMA (ITALIAN EGG-CUSTARD ICE CREAM)

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	55.00	1.93		4.95	6.88	247.50	39.60	
Cream 35 %	14.00	4.90		0.84	5.74	42.00	6.72	
Dried Skimmed milk	4.20			4.07	4.07	203.70	32.59	
Sucrose	12.80		12.80		12.80	1,280.00	1,280.00	
Dextrose	3.00		2.76		2.76	495.80	207.00	
CSS 60 DE	2.00		1.60		1.60	96.00	80.00	
Egg yolk	8.50	2.55			4.25			
Stabilizers / emulsifiers	0.50				0.50			
Total Kg	100.00	9.38	17.16	9.86	38.60			-11
%	100.0%	9.4	17.2	9.9	38.5	237	16	










GELATO ALLA CREMA (ITALIAN EGG-CUSTARD ICE CREAM) WITH CONDENSED MILK

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	54.00	1.89		4.86	6.75	243.00	38.88	
Cream 35 %	10.00	3.50		0.60	4.10	30.00	4.80	
Dried Skimmed milk	1.70			1.65	1.65	82.45	13.19	
Sucrose	9.50		9.50		9.50	950.00	950.00	
Dextrose	3.00		2.76		2.76	495.80	207.00	
CSS 60 DE	2.00		1.60		1.60	96.00	80.00	
Egg yolk	8.00	2.40			4.00			
Condensed Milk	11.30	1.02	4.86	2.49	8.36	495.90	398.72	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.81	18.72	9.60	39.22			-11
%	100.0%	8.8	18.7	9.6	39.2	233	17	










GELATO ALLA CREMA (ITALIAN EGG-CUSTARD) WITH CONDENSED MILK FOR RESTAURANT

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	48.00	1.68		4.32	8.00	216.00	34.56	
Cream 35 %	8.50	2.98		0.51	3.49	25.50	4.08	
Dried Skimmed milk	2.50			2.43	2.43	121.25	19.40	
Sucrose	7.00		7.00		7.00	700.00	700.00	
Dextrose	12.00		11.04		11.04	1,987.20	828.00	
Inverted Sugar	4.50		3.24		3.24	421.20	615.60	
Egg Yolk	8.00	2.40			4.00			
Condensed Milk	9.00	0.81	3.07	1.98	5.66	387.00	309.60	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	7.87	25.15	9.24	44.35			-18
%	100.0%	7.9	25.2	9.2	44.4	386	25	

ESPRESSO ICE CREAM "PETIT FOUR" RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	48.00	1.68		4.32	8.00	216.00	34.56	
Cream 35 %	28.00	9.80		1.68	11.48	84.00	13.44	
Dried Skimmed milk	5.00			4.85	4.85	242.50	38.80	
Sucrose	12.00		12.00		12.00	1,200.00	1,200.00	
Dextrose	3.55		3.36		3.36	804.44	251.95	
Inverted Sugar	1.00		0.72		0.72	93.60	136.90	
Dry Instant Coffe	1.20				1.20			
Rice Starch	0.75				0.75			
Stabilizers / Emulsifiers	0.40				0.40			
Total Kg	100.00	11.48	16.08	10.85	40.76			-11
%	100.0%	11.5	16.1	10.9	40.8	244	17	

ORIGINAL CARAMEL ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	41.00	1.44		3.69	513	164.50	29.52	
Cream 35 %	25.84	9.04		1.55	10.59	77.52	12.49	
Dried Skimmed milk	4.50			4.37	4.37	216.25	34.92	
Sucrose (dry caramelized)	16.00		16.00		16.00	1,600.00	1,600.00	
Dry Glucose Syrup 36 DE	5.00		4.75		4.75	237.50	199.50	
Egg Yolk	7.00	2.10			3.50			
Salt	0.16				0.16	16.00		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	12.58	20.75	9.61	44.99			-11
%	100.0%	12.6	20.8	9.6	45.0	233	19	

For this “real-deal” flavour, you first need to obtain a dry caramel by cooking the sucrose, deglaze with cream and milk, and then continue as usual in the pasteuriser.

TEA ICE CREAM










 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Tea Strong Infusion	46.00							
Cream 35 %	22.50	7.88		1.35	9.23	67.50	10.80	
Dried Skimmed milk	9.50			9.22	9.22	460.75	73.72	
Sucrose	15.00		15.00		15.00	1,500.00	1,500.00	
Dextrose	2.00		1.84		1.84	331.26	138.00	
CSS 60 DE	2.50		2.00		2.00	120.00	100.00	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	7.88	18.84	10.57	37.78			-11
%	100.0%	7.9	18.8	10.6	37.8	243	18	

RICE PUDDING ICE CREAM










 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	50.00	1.75		4.50	6.25	225.00	36.00	
Cream 35 %	19.00	6.65		1.14	7.79	57.00	9.12	
Dried Skimmed milk	3.00			2.91	2.91	145.50	23.29	
Sucrose	5.00		5.00		5.00	500.00	500.00	
Dextrose	3.50		3.22		3.22	579.80	241.50	
Inverted Sugar	9.00		5.46		6.48	842.40	1,231.20	
Rice	10.00				10.00			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.40	14.70	8.55	42.15			-11
%	100.0%	8.4	14.7	8.6	42.2	235	20	

You first need to cook the rice into a milk rice pudding. Then the remainder of recipe is cooked in a pasteuriser.








YOGURT ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	9.20	0.32		0.83	1.15	41.40	6.62	
Cream 35 %	12.00	4.20		0.72	4.92	36.00	5.76	
Dried Skimmed milk	3.30			3.20	3.20	160.05	25.61	
Sucrose	13.00		13.00		13.00	1,300.00	1,300.00	
Dextrose	3.00		2.75		2.76	496.80	207.00	
CSS 60 DE	3.00		2.40		2.40	144.00	120.00	
Full Fat Natural Yogurt	56.00	1.96		5.04	7.00	252.00	40.32	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	6.48	18.16	9.79	34.93			-11
%	100.0%	6.6	18.2	9.8	34.9	243	17	

YOGURT ICE CREAM "PETIT FOUR" RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Cream 35 %	13.50	4.73		0.81	5.54	40.50	6.48	
Dried Skimmed milk	2.00			1.94	1.94	97.00	15.52	
Sucrose	13.00		13.00		13.00	1,300.00	1,300.00	
Dextrose	1.80		1.66		1.66	298.06	124.20	
Inverted Sugar	2.60		1.87		1.87	243.36	355.68	
CSS 60 DE	1.30		1.04		1.04	62.40	52.00	
Dry Glucose Syrup 33 DE	1.30		1.24		1.24	61.75	51.87	
Full Fat Natural Yogurt	63.20	2.21		5.59	7.90	264.40	0.46	
Rice Starch	0.80				0.80			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	6.94	18.80	8.44	35.48			-11
%	100.0%	6.9	18.8	8.4	35.6	239	18	

YOGURT ICE CREAM FOR RESTAURANT

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	4.20	0.15		0.38	0.53	18.90	3.02	
Cream 35 %	12.00	4.20		0.72	4.92	35.00	5.76	
Dried Skimmed milk	3.30			3.20	3.20	150.05	25.61	
Sucrose	4.00		4.00		4.00	400.00	400.00	
Dextrose	14.00		12.88		12.88	2,318.40	956.00	
Inverted Sugar	7.00		5.04		5.04	655.20	957.60	
CSS 60 DE	1.00		0.90		0.80	48.00	40.00	
Full Fat Natural Yogurt	54.00	1.89		4.86	6.75	243.00	38.88	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	6.24	22.72	9.16	38.62			-18
%	100.0%	6.2	22.7	9.2	38.6	388	24	

WHITE ICE CREAM BASE FOR RESTAURANT

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 35 %	53.00	1.86		4.77	6.03	238.50	38.16	
Cream 35 %	14.50	5.05		0.87	5.95	43.50	6.86	
Dried Skimmed milk	4.00			3.88	3.88	194.00	31.04	
Sucrose	6.00		6.00		6.00	600.00	600.00	
Dextrose	10.00		9.20		8.20	1,658.00	690.00	
Inverted Sugar	12.00		8.64		8.64	1,123.20	1,641.60	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	6.93	23.84	9.52	40.79			-18
%	100.0%	6.9	23.8	9.5	40.8	386	30	

It's a convenient white base to be served at a lower temperature, can be used to develop any other flavour, and kept in regular deep freezers.

Ready Mixed Products

The composed ingredients for ice cream, or "semi-finished products for ice cream" are blends of ingredients in powder or paste that the ice cream maker can choose to use in making the blends, in their stabilisation, and in their flavouring.

These premixed products can be prepared "at home" by the ice cream maker himself to simplify the work or to standardize ingredients of difficult dosage. In the past it was common practice, for example, to prepare the so-called "premixed base" by mixing, for example, dextrose, natural stabiliser, milk powder, starches, etc. When preparing the "white base" it was simply a matter of adding milk, cream, and sugar according to a properly formulated recipe.

The increase in production volumes, the legislation in the field of hygiene and labelling, and, last but not least, the need to constantly adapt the product to the changing tastes of the consumer, led to the genesis of a specific industry for artisanal ice cream which has led to the creation of varied pre-measured and packaged products used for to directly prepare ice cream bases.

To date, premixed compound ingredients are ubiquitous. We can find them, in some form, in all artisan ice cream parlours in form of "ready-to-use bases", "stabilizing/emulsifying mixes" and "ready-made pastes". The pre-mixed bases and any stabilising/emulsifying premixes, designed to improve the functionality of the ice cream in some specific aspects such as dripping, spreadability, etc., are attributed to the continuous research of manufacturers in ice cream rheology.

Over the years, we have gone from simple mixtures of neutrals with dextrose and powdered milk to products containing fats (which can be simple, pre-emulsified, or fractionated, concerning the final result to be obtained), proteins (whipping agents, binders, emulsifiers), fibres (soluble, partially soluble), intensive sweeteners, flavours and so on. Research has also focused on giving answers to various intolerances (sugar-free bases, lactose-free bases) or following market trends, or also allowing particularly "clean" labels (free of additives, emulsifiers, artificial ingredients, vegan, nutritionally balanced, etc.).

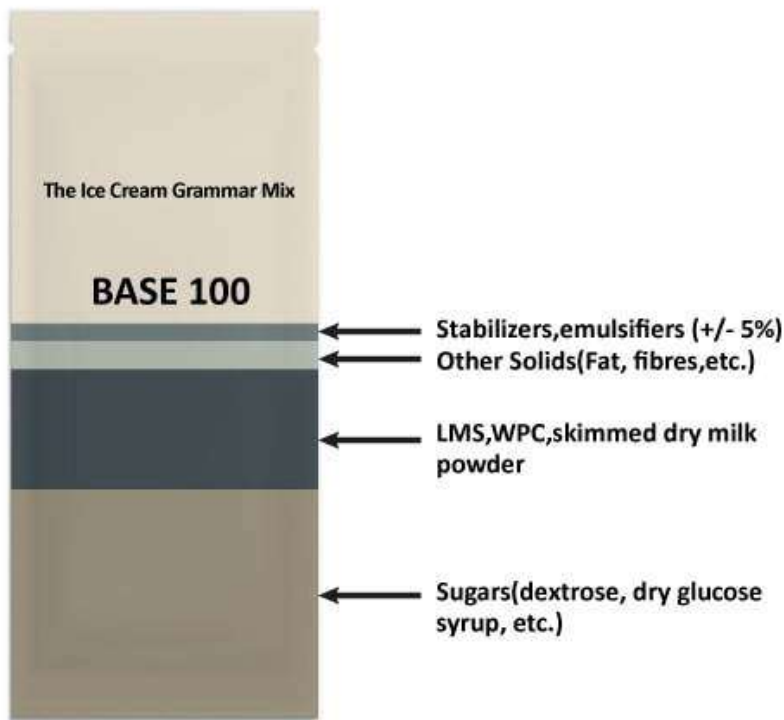
Like any other thing, pros and cons accompany the use of similar products.

Pros of using a ready-made ice cream base:

- Ease of use, quick operations
- Consistency in production
- Perfectly balanced mix at the best of the formula possibility
- The versatility of the base allowing variegation and flavouring
- Anyone without knowing the balancing rules can make ice cream

Cons of using ready-made ice cream base:

- Higher cost
- Utter homologation of all the products in laboratories using the same brand
- All (or most of) the flavours are developed on the same common base, neglecting proper balancing of each flavour
- Utter loss of pride in this profession. The artisan becomes (in my opinion) an "icer" instead of an Ice Cream Maker or Chef; he no longer makes ice cream, he is only freezing it!



General composition of an Ice cream powder base premix

Stabilisers and emulsifiers alone have a low dosage, usually between 0.3% and 0.5% of the mixture, therefore a few grams. On the other hand, a complete base, which we find in the 50gr, 100gr, 200gr, 300gr, and 400gr versions, is a pre-weighed mix composed of stabilisers and emulsifiers diluted and "ballasted" by sugars, proteins, milk powder, fibres, and other solids. The number in the base (base 50, base 100, base 300, etc.) is nothing more than the grams of that mix to be used for each kg of mix in an ice cream recipe. A hypothetically simple recipe might be 1 litre of milk, 100g of base 100, and 300g of sugar. Dosing pure stabilisers/emulsifiers can be trickier as you are more likely to make a mistake in measuring 3 or 4g than 300 or 400. An erroneous measurement can have tangible consequences for ice cream. The margin of error decreases significantly when handling bases.

An example of an average composition for a base 100 might be as follows:

Sugars	Fat	LMS	Other Solids	AFP
41%	1%	51%	7%	80

The remaining part of the mix is completed by following the instruction suggested by the manufacturer of the pre-mixed base.

This system is convenient where the laboratory offers limited space (or budget) for machinery like pasteurisers and ageing holding tanks, and it is, therefore, difficult to prepare many different bases for the different families of ice cream to be produced.

Pre-mixed ready-to-use products can be used for convenience, but I strongly believe that in any case, focus must be on balancing the single recipe to obtain the best from every single recipe and to produce a unique artisanal product we can be proud of.

The pre-mixed dry compound made "in-house"

A sometimes smart alternative to buying ready-made premix is to prepare them in-house.

The main advantages of the pre-mixed system are:

- The reduction of weighing operations by expediting the work during particular periods of the year.
- The minimisation of the possibility of error in the weighing of particular low dosage ingredients such as stabilisers and emulsifiers.
- The ability to customise the blend and choose the ingredients, while preserving the pride of craftsmanship.










In the table below is an example of a formulation for "home-made" dry premix. In this powder compound, all the required stabilisers and emulsifiers are present along with some milk proteins and simple sugars to bulk up.

The dosage in the ice cream mix recipe will be 120g per Kg in this case. The formulation of the recipe using dry premix is very simple; all we need to do is to use the last row and insert it in the recipe table, then complete as usual with the other ingredients.

Dry Premix Ingredients	Quantity	Sugars	Fat	LMS	Solids	AFP	SP
Skimmed Dry Milk	240	121	0	242	242	121	19
WPC	80	16	0	80	80	16	2
Dry Glucose Syrup 38 DE	235	223	0	0	223	111	93
Dextrose	235	216	0	0	216	388	162
Inulin	165	0	0	0	165	33	41
Stabilizers / Emulsifiers	45	0	0	0	45	0	0
TOTAL	1000	576	0	332	971	669	317








A simple example of the formulation can be the following white cream.

WHITE ICE CREAM BASE WITH PREMIX 12%

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	56.00	1.96		5.04	7.00	252.00	40.32	
Cream 35 %	19.00	6.65		1.14	7.79	57.00	9.12	
Sucrose	13.00		13.00		13.00	1,300.00	1,300.00	
Dry Premix 12%	12.00		6.91	3.98	11.65	802.80	380.40	
Total Kg	100.00	8.61	19.91	10.16	39.44			-11
%	100.0%	8.6	19.9	10.2	39.4	241	17	

Another example of ice cream formulated using the “homemade” dry premix 12%. It is actually pretty easy to elaborate on the recipes with this method.

STRAWBERRY & CREAM ICE CREAM WITH PREMIX 12%

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	36.00	1.26		3.24	4.50	162.00	25.92	
Cream 35 %	20.00	7.00		1.20	8.20	60.00	9.60	
Sucrose	12.00		12.00		12.00	1,200.00	1,200.00	
Strawberry Purée 10%	20.00		2.00		2.40	230.00	230.00	
Dry Premix 12%	12.00		6.91	3.98	11.65	802.80	380.40	
Total Kg	100.00	8.26	20.91	8.42	38.75			-11
%	100.0%	8.3	20.9	8.4	38.8	24%	18	

Chocolate Ice Cream



Chocolate is an amazing material, and equally amazing ice creams can come from it. We can have milk, white or dark chocolate, pure cocoa mass, cocoa powder mono- origins chocolates, Gianduja, and many more. From chocolate, we can also obtain water-based "sorbetes" or vegan ice creams; the potential is endless. Chocolate ice cream can be made using actual chocolate (in all its variety), using a bitter paste or cocoa powder.

Using Chocolate

Balancing a chocolate ice cream recipe, however, requires a little extra attention. The chocolate ingredients bring components into the formula components that require difficult equilibration.

The main chocolate-related issue is hardness. No matter what type of chocolate we choose for our recipe, it will always make the resulting ice cream harder. This is ascribed to the nature of its composition. Chocolate is basically made up of three major components: Cocoa Butter, Sugar, and Cocoa Solids. Some chocolates may contain also milk powder or nut pastes.

The sugar contained in chocolate will be added to the sugar column together with the other sugar sources.

Cocoa Butter goes along with the other fat.

Cocoa Lean Solids, being basically fibre, will be added in the other solids column.

Well, unfortunately, this is not so easy. We must keep the hardening power of each type of chocolate we deal with into consideration. In fact, while it is true that sugar contained in chocolate will influence AFP and SP, the fat and solid will dramatically operate in the opposite direction and, when exposed at the freezing temperature, will dramatically stiffen the ice cream.

To be clear, a chocolate formula with an ST fixed at -11°C will be much harder than a white base with the same ST. We must, therefore, operate some change in the formula and be able to forecast its behaviours.

As far as I know, there is no scientifically defined system to predict the chocolate influence on the hardening of ice cream. However, it is relatively common practice to (approximately) determine the "hardening power" of chocolate and use this value as negative AFP to compensate for the stiffness it induces. Once again, this system is commonly used among professionals and many colleagues of mine, while others chose different systems just as valid. Many instead just don't bother to do any calculation about it and just add "some" extra sugar, particularly inverted sugar, to soften the product a tad. This method is surely fine, you can adjust the recipe trying by hit and miss until the fine-tuning is reached and you are happy with the texture and spoonability of the ice cream.

Nonetheless, I will try to explain an alternative system that should help forecast the behaviour of a chocolate ice cream "on paper".

The aim of this system is trying to determine how much each chocolate component can harden or soften the ice cream, proportion every single value for the ratio of the chocolate ingredients, and multiply this number for the amount of chocolate used. The number thus obtained will always be negative and treated as a normal AFP value. By simply adding the so obtained -AFP, we can easily forecast the ST of every chocolate mix.

To do so, we will adopt certain empiric approximations and use some fixed data as a "constant" to determine the Hardening Power of the chocolate components (cocoa butter and cocoa fibre).

This data has been obtained thanks to years of research and tests and we take them as "Ipse Dixit".

We know that:

The negative AFP of cocoa butter is -0.9 /g
The negative AFP of cocoa lean solids is -1.8 /g

We also need to know the precise composition of the chocolate we want to incorporate into the recipe in order to calculate its specific -AFP.

When buying chocolate of any kind we can easily notice it always states a % on the label.

This number indicates the % of cocoa-derived ingredients in this specific chocolate or couverture, the remaining part to get to 100% will be sugar. It will be sugar + milk powder for white or milk chocolate.

Therefore, a 70% dark chocolate will have 70% or more ingredients coming from cocoa (cocoa butter and cocoa liqueur) and 30% of sugar. In other words, 70g of this chocolate is made of cocoa ingredients while the remaining 30 is sugar.

However, this number does not tell us anything else. We cannot know how much of this 70g is cocoa butter and how much is cocoa lean solids. Luckily, some professional manufacturers nowadays tend to declare this ratio, thus making our job easier. If the repartition of cocoa components is not clearly stated, we can easily guess it by looking at the nutritional facts on the back of the package.

NUTRITIONAL INFORMATION PER 100 g:	
Energy	2350 kJ / 566 kcal
Fat	41 g
/ of which saturates	24 g
Carbohydrates	34 g
/ of which sugars	29 g
Protein	9,5 g
Salt	0,10 g

Pic. 89 Useful information can easily be obtained from chocolate nutritional fact labels

From this label, we can easily obtain all the information we need. In fact, we now know that 100g of this chocolate gives us:

- 41g of Cocoa Butter
- 29g of Sugars
- 30g (by subtraction) of other cocoa solids

We can now easily calculate our –AFP for this specific 70% dark chocolate as follows:

COMPONENT	G IN 100 G	SPECIFIC AFP	AFP
Sugar	29 g	1	29
Fat (Cocoa Butter)	41 g	-0,9	-36,9
Cocoa Lean Solids	30 g	-1,8	-54
		TOTAL AFP	-61,9

Before I am accused of wizardry, heresy, or quackery, let me clarify this once again:

Do remember that this is a rough approximation. Obviously, the cocoa butter and cocoa solids have no effect whatsoever on the water freezing, and using a negative AFP is just a shortcut trick to simplify the calculation of the mix. By hypothesising

a (bogus) negative AFP, we can only compensate for the texture by adding more sugar to obtain a softer finished product.





Now, we just have to insert this new “bogus –AFP” in the appropriate column after adding the chocolate to the recipe. Doing so will automatically increase the quantity of sugar needed to obtain the correct ice cream texture.

The same number can be obtained for any chocolate, for instance:

Milk chocolate:

 COMPONENT	 G IN 100 G	 SPECIFIC AFP	 AFP
Sugar (sucrose + Lactose)	50 g	1	50
Fat (Cocoa Butter + Milk-fat)	34 g	-0,9	-30,6
Cocoa Lean Solids	16 g	-1,8	-28,8
TOTAL AFP			-9,4

White chocolate:

 COMPONENT	 G IN 100 G	 SPECIFIC AFP	 AFP
Sugar (sucrose + Lactose)	55 g	1	55
Fat (Cocoa Butter + Milk-fat)	41 g	-0,9	-36,9
TOTAL AFP			18,1

We can notice that milk chocolate has a positive AFP as it comprises a lot of sugar and is devoid of cocoa lean solids. This means that white chocolate does not harden the ice cream but, instead, it lowers the mix’s freezing point. For this reason, we can choose to use this value as it is or to subdivide the white chocolate components (LMS, sugar, fat) and consider them separately.

In the milk chocolate, I approximated and neglected the LMS in the computation.

Once again, these approximate values merely provide a rough indication of the amount of sugar required to compensate for the hardness brought in by the cocoa materials.

When drawing up the calculation table for recipes with chocolate, fat, cocoa solids, sugar, and LMS, if present, they must be noted in the appropriate columns.

The amount of chocolate used in the recipe depends on factors like:

- Cost
- Personal taste
- Desired sweetness (the more chocolate we add, the more sugar we must add to compensate for the stiffness)
- Type of chocolate used
- Service temperature of the product

As a rule of thumb, we can consider an average of 15% of dark chocolate and up to 20% milk chocolate.

The fat brought in by the chocolate will force us to reduce (or even remove) the cream from the recipe. The freed space will be taken by the extra sugar and some milk necessary to dissolve it.

A good norm might be using both chocolate and cocoa powder to compensate for the extra sweetness.

CHOCOLATE ICE CREAM RICH RECIPE

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5 %	55.80	1.98		5.11	7.10	255.60	40.90	
Cream 35 %	5.00	1.75		0.30	2.05	15.00	2.40	
Dried Skimmed milk	3.20			3.10	3.10	155.20	24.83	
Sucrose	5.00		5.00		5.00	500.00	500.00	
Dextrose	11.50		10.58		10.58	1,904.40	793.50	
Inverted Sugar	4.00		2.88		2.88	374.40	547.20	
Chocolate 70%	14.00	5.74	4.06		14.00	-840.00	406.00	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	9.48	22.52	8.52	45.21			-11
	100.0%	9.5	22.5	8.5	45.2	236	23	

In the example above, we can see the negative AFP calculated by the spreadsheet for the 70% dark chocolate. To compensate for it, we had to go slightly above the "allowed" total solids.

Using Cocoa Powder

Things become much simplified when we use cocoa powder as an ingredient. We must remember the average composition of the cocoa powder. The most commonly used type of cocoa powder is the 22/24, these numbers mean that it contains between 22% and 24% of fat and the remaining 78 – 76% of lean cocoa solids.

When compiling the formula and deciding the amount of cocoa we want to include in our recipe, we must always refer to % of lean cocoa solids, aka pure cocoa, since they are the only ones bringing taste, aroma, and colour.

An average chocolate ice cream should contain at least 4-6% of pure cocoa (lean cocoa solids) to have a satisfactory taste and colour. Therefore, if our 100kg recipe requires 5kg of pure cocoa, the calculation will be as follows:

$$\frac{5.000g}{0,77} = 6.493 \text{ g of Cocoa 22 \ 24}$$





I approximate the content of lean solid to an average of 77%.

Needless to say, different types of cocoa powder are available in the market, which is why this calculation will be corrected according to the fat title in use. If for example, a 10/12 cocoa is used, the calculation will be:

$$\frac{5.000g}{0,89} = 5.617 \text{ g of Cocoa 10 \ 12}$$










Once again, the cocoa lean solid will make the product stiffer in the absence of sugar compensation. As we have done for the chocolate, we can easily guess a negative AFP for the cocoa powder and directly use it on our table.

Cocoa Powder 22/24:

 COMPONENT	 G IN 100 G	 SPECIFIC AFP	 AFP
Cocoa Lean Solids	77 g	-1,8	-42,8
Fat (Cocoa Butter + Milk Fat)	23 g	-0,9	-25,5
		TOTAL AFP	-68,3










Example recipe using cocoa powder: 22/24.

CHOCOLATE ICE CREAM WITH COCOA POWDER AND EGG YOLK










 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	49.00	1.72		4.41	6.13	229.50	35.28	
Cream 35 %	12.00	4.20		0.72	4.92	36.00	5.76	
Dried Skimmed milk	4.00			3.88	3.88	194.00	31.04	
Sucrose	14.00		14.00		14.00	1.400.00	1.400.00	
Dextrose	4.50		4.14		4.14	745.20	310.50	
Inverted Sugar	2.00		1.44		1.44	187.20	273.60	
Cocoa Powder	5.00	1.38			5.00	-408.80		
Egg Yolk	8.00	2.40			4.00			
Stabilizers / emulsifiers	0.50				0.50			
Total Kg	100.00	9.70	19.58	9.01	45.01			-11
%	100.0%	9.7	19.5	9.0	45.0	237	21	












CHOCOLATE ICE CREAM WITH COCOA POWDER (CHEAP VERSION)

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	62.60	2.39		5.63	7.83	281.70	45.07	
Dried Skimmed milk	4.00			3.88	3.88	194.00	31.04	
Sucrose	14.00		14.00		14.00	1.400.00	1.400.00	
Dextrose	3.40		3.13		3.13	563.04	234.60	
Inverted Sugar	4.00		2.88		2.88	374.40	547.20	
Cocoa Powder	4.50	1.04			4.50	-307.35		
Margarine	7.00	5.88			5.95			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	9.11	20.01	9.51	42.56			-11
%	100.0%	9.1	20.0	9.5	42.7	251	23	

CHOCOLATE ICE CREAM "PETIT FOUR" RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	13.00	0.63		1.62	2.25	81.00	12.96	
Cream 35 %	12.20	4.27		0.73	5.00	36.60	5.86	
Dried Skimmed milk	6.00			5.82	5.82	291.00	46.56	
Sucrose	11.00		11.00		11.00	1,100.00	1,100.00	
Dextrose	4.00		3.68		3.68	662.40	276.00	
Inverted Sugar	3.00		2.40		2.40	144.00	120.00	
Chocolate 70%	44.00		3.52		3.52	56.32	42.24	
Egg Yolk	1.00				1.00			
Cocoa Powder	0.80				0.80			
Rice Starch								
Stabilizers / Emulsifiers								
Total Kg	100.00	4.90	20.60	8.17	35.47			-11
%	100.0%	4.9	20.6	8.2	35.5	237	16	

MILK CHOCOLATE ICE CREAM










 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	66.30	1.97		5.07	7.04	263.35	40.54	
Cream 35 %	5.00	1.75		0.30	2.05	15.00	2.40	
Dried Skimmed Milk	3.20			3.10	3.10	155.20	24.83	
Sucrose	7.00		7.00		7.00	700.00	700.00	
Dextrose	6.00		5.52		5.52	993.60	414.00	
Inverted Sugar	6.00		4.32		4.32	591.60	820.80	
Milk Chocolate	16.00	5.44	8.00	1.12	16.00	-150.40	464.00	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	9.16	24.84	9.59	45.53			-11
%	100.0%	9.2	24.8	9.6	45.5	253	25	

WHITE CHOCOLATE ICE CREAM










INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5 %	62.00	2.17		5.58	7.75	279.00	44.64	
Cream 35 %	6.30	2.21		0.38	2.58	18.90	3.02	
Dried Skimmed Milk	2.20			2.13	2.13	106.70	0.17	
Sucrose	7.00		7.00		7.00	700.00	700.00	
Dextrose	6.00		5.52		5.52	992.60	414.00	
White Chocolate	15.00	6.15	7.50	2.25	15.00	375.00	435.00	
Casein	1.00				1.00			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	10.53	20.02	10.34	41.49			-11
%	100.0%	10.5	20.0	10.3	41.5	247	16	



WHITE CHOCOLATE ICE CREAM FOR RESTAURANT

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	53.00	1.86		4.77	6.63	238.50	38.16	
Cream 35 %	5.30	1.86		0.32	2.17	15.90	2.54	
Dried Skimmed Milk	2.20			2.13	2.13	106.70	17.07	
Dextrose	14.00		12.88		12.88	2,318.40	966.00	
Inverted Sugar	10.00		7.20		7.20	936.00	1,368.00	
White Chocolate	14.00	5.74	7.00	2.10	14.00	252.00	406.00	
Casein	1.00				1.00			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	9.50	27.08	9.32	46.51			-18
%	100.0%	9.5	27.1	9.3	46.5	387	28	

GIANDUJA ICE CREAM RICH RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	55.00	1.03		4.05	6.88	247.50	39.50	
Cream 35 %	7.30	2.56		0.44	2.99	21.90	3.50	
Dried Skimmed milk	3.00			2.91	2.91	145.50	23.28	
Sucrose	7.00		7.00		7.00	700.00	700.00	
Dextrose	5.00		4.60		4.60	928.00	345.00	
Inverted Sugar	10.00		7.20		7.20	936.00	1,368.00	
Hazelnut Paste	4.20	2.69			4.20	-294.00		
Cocoa Powder	3.00	0.69			3.00			
Egg Yolk	5.00	1.60			2.50			
Stabilizers / Emulsifiers	0.50							
Total Kg	100.00	9.36	18.80	8.30	41.78			-11
%	100.0%	9.4	18.8	8.3	41.5	238	25	

Nut Pastes



Nuts are delicious and versatile ingredients massively used in ice cream production. When dealing with these (and for that matter any other) ingredients, we have to keep in mind which functional ingredients they carry into the recipe.

All nuts and nut pastes have in common a high-fat content ranging from 40 to 65% (according to the type of nut), the rest is usually only fibre (other solids).

Some nut pastes may also contain sugar, for example nougat or praline, in this case, we will consider this element separately.

Similar to what happens with chocolate and cocoa, the high amount of fat and fibre contained in nut paste is prone to harden the ice cream. Once again, there is no simple but accurate method to calculate this hardening power, however, empiric tests have been held over the years leading to experimental data. We can now use these constants to "correct" the AFP and force the hardness to acceptable limits.

By multiplying the fat amount by the experimental constant, we will obtain a "bogus" negative AFP which we will then subtract from the AFP sum of the specific recipe, obtaining a higher amount of sugars in the recipe.

Once again, this is not a scientifically correct way, nor is it the only way possible to tackle this issue. Another approach may be to simply add the paste components in the appropriate columns and then correct the sugar profile afterwards. It is known that, for example, adding "some" inverted sugar "fixes" the hardness of nut ice creams; basically, we do the same thing, just in a more consistent way.

I will stick with this system to keep coherence with the one used while discussing chocolate and cocoa powder.




The constant we will use is based on the fat percentage of the nut paste we are using.

We know that:

The negative AFP of nut-fat butter is -1.1 /g

We also need to know the fat percentage of the paste we want to incorporate into the recipe in order to calculate its specific -AFP.

This information is usually stated on the product label, but, on average, we can consider the following general values.

 COMPONENT	 FAT	 -AFP
Hazelnut Paste	64	-70
Pistachio Paste	45	-50
Walnut Paste	68	-75
Peanut Butter	50	-55
Almon Paste	52	-57
Pine Nut Paste	69	-76
Sesame Paste	61	-67

Obviously, these numbers work only for 100% pure pastes. In the case of paste with a sugar content, the -ATP must be first added with the sugar AFP multiplied by the sugar %.

For example, let's consider a regular praline paste having 50% sugar and 50% hazelnut. Hazelnuts contain around 60% fat and 40% fibre. Therefore, the -AFP of this hazelnut praline paste will be calculated as follows:

COMPONENT	G IN 100 G	SPECIFIC AFP	AFP
Nut Fat	30	-1,1	-33
Sugar	50	1	50
		TOTAL AFP	17

In this case, we obtain a positive AFP, still lower than if we only considered the AFP for the sugar contained in the paste. In some cases, for example, some composed pastes or nougat pastes, the difference between sugar AFP and nut fat -AFP goes to almost 0, making for a "neutral" AFP, negligible in the count.

When balancing nut ice cream recipes, particular attention must be paid to the fat and total solids content.

Nut pastes carry a great amount of fat, therefore, as we have already seen in chocolate, the cream content must be lowered to make space for the dry fruit fat. As the total solids count rise (due to fat and fibre amount), it might be also required to lower the LMS %.

However, even if we know that the total solids in a recipe should never be above 45%, in the case of cocoa and nut pastes, I feel the need to emphasise the fact that a slight degree of flexibility can be accepted. We know that trespassing the "prohibited" threshold for total solid content might cause solubility problems and lead to sandiness and coarse texture but:

1. Adding cocoa powder or pure nut paste is not equivalent to adding any water-soluble substance, therefore we are not keeping the serum solution engaged.
2. The fibre portion of these ingredients, while hydrated, will remain suspended and not dissolved in the serum and therefore, not interfere with sugar solubility.
3. The fat portion of these ingredients will be emulsified and enmeshed in the ice cream matrix, again, which is why no engagement from the water will occur.

In conclusion, while it is important to consider all the range of parameters during the balancing of a recipe, we can sometimes make some little exception in case what we are after is the highest possible amount of nut paste.

HAZELNUT ICE CREAM

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5 %	24.00	0.84		2.16	3.00	108.00	17.28	
Water	34.50							
Dried Skimmed milk	7.00			6.78	6.78	339.50	54.32	
Sucrose	6.00		6.00		6.00	600.00	600.00	
Dextrose	5.00		4.60		4.60	828.00	345.00	
Inverted Sugar	13.00		9.36		9.36	1,216.80	1,778.40	
Hazelnut Paste	10.00	6.40			10.00	-700.00		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	7.24	19.96	8.95	40.25			-11
%	100.0%	7.2	20.0	9.0	40.3	239	28	



HAZELNUT ICE CREAM "PETIT FOUR" RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	60.25	2.11		5.42	7.53	271.13	43.38	
Dried Skimmed milk	2.10			2.04	2.04	101.85	16.30	
Sucrose	16.00		16.00		16.00	1,600.00	1,600.00	
Dextrose	4.50		4.14		4.14	745.20	310.50	
Inverted Sugar	5.00		3.60		3.60	468.00	684.00	
Hazelnut Paste	11.00	7.04			11.00	-770.00		
Rice Starch	0.75				0.75			
Stabilizers / Emulsifiers	0.40				0.40			
Total Kg	100.00	9.15	23.74	7.46	45.46			-11
%	100.0%	91	23.7	7.5	45.5	242	27	

HAZELNUT ICE CREAM WITH CONDENSED MILK

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	53.50	1.87		4.92	6.69	240.75	38.52	
Crém 35 %	5.00	1.75		0.30	2.05	15.00	2.40	
Dried Skimmed milk	3.00			2.91	2.91	145.50	23.28	
Sucrose	10.00		10.00		10.00	1,000.00	1,000.00	
Dextrose	1.00		0.92		0.92	185.80	98.00	
Inverted Sugar	6.00		4.32		4.32	561.60	829.60	
Hazelnut Paste	6.00	3.94			6.00	-420.00		
Condensed milk	15.00	1.35	8.45	3.30	11.10	645.00	477.30	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.81	21.69	11.33	44.49			-11
%	100.0%	8.8	21.7	11.3	44.5	235	24	

HAZELNUT ICE CREAM WITH EGG YOLK

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	67.00	2.00		5.13	7.13	255.50	41.04	
Dried Skimmed milk	4.00			3.88	3.88	194.00	31.04	
Sucrose	5.00		6.00		6.00	600.00	600.00	
Dextrose	5.00		4.60		4.60	828.00	345.00	
Inverted Sugar	14.00		10.08		10.08	1,310.40	1,915.20	
Hazelnut Paste	10.00	4.10			10.00	-700.00		
Egg Yolk	3.50	1.05			1.75			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	7.15	20.68	9.01	43.94			-11
%	100.0%	7.1	20.7	9.0	43.9	249	29	










HAZELNUT ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	57.50	2.01		5.18	7.19	258.75	41.40	
Dried Skimmed milk	4.00			3.88	3.88	194.00	31.04	
Sucrose	6.00		6.00		6.00	600.00	600.00	
Dextrose	5.00		4.60		4.60	828.00	345.00	
Inverted Sugar	15.00		10.80		10.80	1,404.00	2,052.00	
Hazelnut Paste	12.00	7.68			12.00	-840.00		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	9.69	21.40	9.06	44.97			-11
%	100.0%	9.7	21.4	9.1	45.0	244	31	

HAZELNUT ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	20.50	0.72		1.85	2.56	92.25	14.76	
Water	37.00							
Dried Skimmed milk	7.00			0.79	0.79	339.50	54.32	
Dextrose	18.50		17.02		17.02	3,063.60	1,276.50	
Inverted Sugar	12.00		8.64		8.64	1,123.20	1,641.60	
Hazelnut Paste	9.50	6.08			9.50	-665.00		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	6.80	25.66	8.64	45.01			-18
%	100.0%	6.8	25.7	8.6	45.0	335	80	

PISTACHIO ICE CREAM "PETIT FOUR" RECIPE










 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	60.25	2.11		5.42	7.53	271.13	43.38	
Cream 35 %	1.00	0.35		0.06	0.41	3.00	0.48	
Dried Skimmed milk	2.10			2.04	2.04	101.85	16.30	
Sucrose	16.00		16.00		16.00	1,800.00	1,600.00	
Dextrose	4.50		4.14		4.14	745.20	310.50	
Inverted Sugar	5.00		3.60		3.60	468.00	684.00	
Pistachio Paste	10.00	6.40			10.00	-700.00		
Rice Starch	0.75				0.75			
Stabilizers / Emulsifiers	0.40				0.40			
Total Kg	100.00	8.86	23.74	7.52	44.87			-11
%	100.0%	8.9	23.7	7.5	44.9	249	27	



PRALINÉE ICE CREAM

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5 %	55.00	1.93		4.95	6.86	247.50	39.80	
Cream 35 %	11.00	3.85		0.66	4.51	33.00	5.28	
Dried Skimmed milk	3.50			3.40	3.40	169.75	27.16	
Sucrose	8.00		8.00		8.00	800.00	800.00	
Dextrose	3.00		2.76		2.76	496.80	207.00	
Inverted Sugar	7.00		5.04		5.04	655.20	957.60	
Hazelnut Praline Paste	12.00	3.60	6.00	0.40	12.00		600.00	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	9.38	21.80	9.41	43.08			-11
%	100.0%	9.4	21.8	9.4	43.1	240	23	

NOUGAT ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	51.00	1.79		4.59	6.38	229.50	36.72	
Cream 35 %	12.50	4.38		0.75	5.13	37.50	6.00	
Dried Skimmed milk	4.00			3.88	3.88	194.00	31.04	
Sucrose	8.00		8.00		8.00	800.00	800.00	
Dextrse	1.00		0.92		0.92	165.80	69.00	
Honey	5.00		4.00		4.00	950.00	625.00	
Nugat Paste	10.00	3.00	4.00		10.00		400.00	
Egg Yolk	8.00	2.40			4.00			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	11.56	16.92	9.22	42.80			-11
%	100.0%	11.6	16.9	9.2	42.8	233	20	

The Fruit



With the word "fruit", we refer to an extremely vast array of ingredients. It is therefore very difficult to generalise while talking about fruit ice cream and sorbets. Some fruits are very sour, others are sweet, some are watery, and some are even fat or floury. It is clear that we need to divide the fruits into families to ease the handling of these ingredients in recipes.

When considering any kind of fruit, however, we need to know its sugar content and acidity. The sugar content is important because it will concur in the sugars, total solids, and AFP columns. The acidity is important to determine the fruit's compatibility with milk-based mixes, its degree of ripeness, and if it requires "help" in preserving its colour.

As we can see from the table, fruits have roughly 10% sugar content on average, so we can infer that the remaining 90% will be mostly water and fibre. Fruit fibre is very important in ice cream, because, above all in sorbets, it gives body and structure to the product. In fact, in citrus sorbet (lemon, lime sorbet, etc.) the low % of solids, often causes collapsing, splitting, and separation of the liquids. In such sorbets, an integration of soluble fibre like inulin is recommended.





Red fruits are characterised by high acidity and intense colour. Their colour is sensitive to acidity changes, and this must be taken into account if we want, for instance, our strawberry to be red–pink instead of purplish.

Watery fruit is very bland in taste; their dosage will differ greatly from the other fruits. To obtain a strongly aromatic sorbet, some part of the water and sugar will be replaced by fruit juice/pulp.

Also, from fruit, we can prepare both milk-based ice cream and water-based sorbets.

Sorbets and fruit ice creams are very different products and require different attention.

Sorbets are made only with water, sugars, and fruit puree; basically, any fruit can be made into a sorbet given the correct balancing.

	 TYPE OF FRUIT	 SUGAR %	 PH	 SEASONALITY
RED FRUITS	Strawberry	8-10	3,5	April-July
	Raspberry	8-10	3,5	May-September
	Cherry	10-14	4	May-July
	Black berry	8-10	3,3	June-August
	Blueberry	7-9	3,5	June-August
	Red currant	7-9	3	June-August
CITRUSES	Lime	5-6	2,4	All Years
	Lemon	5-8	2,4	All years
	Passion Fruit	7-9	2,8	Tropical
	Tangerine	9-12	3,3	Nonember-March
	Orange	9-14	3,5	November-April
	Grapefruit	8-11	3	December-May
	Yuzu	5-8	2,4	Tropoical
WATERY FRUITS	Watermelon	6-8	4	June-September
	Cantaloupe	9-14	4	June-September
OTHER FRUITS	Peach	10-15	3,5	June-August
	Pear	10-14	4,2	All Years
	Apple	10-14	4,1	All Years
	Apricot	10-12	3,6	May-August
	Grapes	18-24	3,5	July-November
	Figs	12-25	5	June-August
	Banana	18-20	5	All Years
	Mango	12-15	4,5	Tropical
	Papaia	9-12	4	Tropical
	Pineapple	12-14	3,4	All Years
	Persimmon	10-15	4,5	October-January
	Plums	10-15	3,6	May-August

In fruit ice creams instead, we find also milk and cream, and as a result, proteins and fat. In these ice creams, the high acidity level of the fruit can pose a threat to

proteins and, if not handled properly, lead to denaturation of the latter with subsequent syneresis of the mix.

In fact, milk proteins, and in particular casein, the denaturation in pH is lower than 5, see the production of curd, yogurt, or cottage cheese as examples. However, this phenomenon is (providentially) limited at low temperatures below 2°C. The ice cream maker, when dealing with acid fruit ice creams, will have to take care when inserting the fruit puree at the very last minute or, even better, directly into the batch freezer right before the freezing process.

In ice cream where the acidity of the fruit is not an issue, such as banana, avocado, figs, persimmon, and others, the mix can be fully prepared more in advance without any problem.

Fruit can be used in various forms. Most commonly frozen fruit purees, fresh, frozen in pieces, or juices are used. On a less frequent basis, they are dried concentrated pastes, jams, or lyophilised forms.

Fresh Fruit



Fresh fruit is an amazing product; nutritious, tasty, and colourful. The ice cream maker can decide to use, for example, only or mostly local products to support the farming community and attract an aware clientele, or to use only seasonal fruit, obtaining the best technical performance from it at the best price.

Fresh fruit has several perks, along with some small inconveniences.

- When using fresh fruit, it is paramount to operate all the needful measures in order to reduce contamination.

Upon receiving, the fruit must be immediately decanted into a proper container, and the original cardboard boxes discharged.

Fresh fruit is then thoroughly washed with running water, then a specific fruit sanitiser is applied for the prescribed time. After this time fruit is carefully rinsed.

This is imperative because fruit in ice cream or sorbets does not undergo any pasteurisation, therefore microorganisms must be removed beforehand to prevent microbial contamination. Washing also removes potential pests and dirt (physical contaminations) and possible pesticide residues (chemical contaminations). Once washed, the fresh fruit can be processed and used in ice creams or sorbet, or can be portioned in sealed bags or containers and frozen for future use.

- Fresh fruit is, by definition, not constant. It's not available throughout the year but rather follows specific seasons, so should the related ice cream flavours.

Needless to say, the degree of ripeness and sweetness changes, thus varying the quality of the products produced with it. The ice cream maker must choose then between consistency or truth and fidelity to the seasonality of the product.

- Fresh fruit needs more time and labour to be processed, washed, peeled, winnowed, chopped, blended, etc.
- Lastly, fresh fruit is perishable. For this reason, frequent supplies are needed to ensure sufficient quality.

On the other hand, certain characteristics are not required to make ice cream or sorbets. The ice cream maker can obtain advantageous prices while buying second choice fruit (out of calibre or colour for example), as long as the taste is great.

- All these factors will be considered within the personal and commercial view of the business, the chef or ice cream maker desires to operate.

Frozen Fruit



- By using frozen fruit, we can save a lot of time and space. Frozen fruit arrives sanitised and washed, usually cut or chopped, in conveniently scaled sealed packages. No trimmings or wastage is made.
- While using frozen fruit ensures its availability throughout the year, it does not ensure consistency in taste, colour, or ripeness.
- Frozen fruit must be thawed out before being blended into the ice cream or sorbet mixture. However, this operation can sometimes be impractical or inconvenient.

Frozen Fruit Puree



Frozen fruit puree is, nowadays, the most popular source of fruit in ice cream production, and several manufacturers produce amazing quality and deliver great consistency in these products.

- Frozen fruit purees are constant and homogeneous in sugar content. The amount of sugar is titled and clearly stated on the package. Usually (depending on the brand), the producers standardise the sugar content at 10% making the balancing of the recipe easy and reliable.
- Using puree guarantees consistency in production all year around, making it possible to produce ice cream and sorbet from fruits not available during certain periods of the year or in certain geographic areas.
- Fruit purees are totally safe and pasteurised, which makes them the perfect ready-to-eat food ingredient to be added at any phase of ice cream production.
- Fruit purees are quick to use and extremely convenient. They are already finely processed, so no pieces, lumps, seeds, or dirt will slip into the product.
- They are great to optimise storage space and supply operations.

Lyophilised Fruit



Also known as Freeze-drying or cryodesiccation, lyophilisation is involved in getting the product frozen under negative pressure and subsequently getting the ice removed by sublimation. Due to the use of low temperatures in processing, it is seen that the quality of the rehydrated product remains excellent. At the same time, the original taste, colour, and shape of the product are perfectly maintained. This process was optimised by NASA to answer the need for safe, long-lasting, nutritious food for space missions. NASA also developed the Hazard Analysis Critical Control Point (HACCP) plan, which is widely used today to evaluate food material before, during, and after processing. With the combination of these and other innovations, NASA could provide safe and wholesome foods to their crews from freeze-dried meals.

Lyo-fruit contains little to no moisture; this unique characteristic makes for a perfect flavour booster. Adding a very small amount of lyo-fruit powder can greatly enhance the flavour of bland fruit or vegetables that would otherwise be too rich in moisture to be used in a high amount in the recipe. For instance, we can add some lyo-watermelon, or cantaloupe, or lychee to the recipe already containing the fresh version of the same fruit obtaining a strong but fully natural taste.

Lyo-fruit also does not alter all the vitamins of the fresh fruit and contains no preservatives.

We can safely infer that lyophilised fruit (and food in general) have only one advantage; the price is the only issue with this type of ingredient. Due to the very

high price of these ingredients, their use can be only complementary to other sources of (wet) fruit.

Fruit Juices



For some types of fruit, it is also possible (or necessary) to base the production on juice. This applies particularly to those fruit with lower fibre content, yielding a thinner juice instead of puree.

Juice can be extracted through various methods or even purchased ready-made. A typical example is citrus fruits (orange, lemon, etc.) that are normally bought whole and simply juiced in loco before commencing the production. It is possible to obtain other fruits by centrifugation or extraction using relatively inexpensive machinery. These can also include vegetables like celery, carrots, cucumber, ginger, turmeric, etc.

It is also quite common to purchase orange, lemon, or pineapple juices. When opting for these products, the ice cream maker must always select the ones without any added sugar, as we are aiming for fruit flavour and not sweetness, which we can easily and affordably provide ourselves.

Jams, concentrated paste, compotes



Endless fruit preparations, specifically designed for use in ice cream and sorbet production, are available in the market.

These pastes and compotes can contain a variable ratio of fruit/water/sugar.

Some are basically jams, where the fruit is simply cooked with sugars and sometimes stabilisers to prepare a "shelf-stable" ready to use product that can be added either directly in the mix and frozen together with the mix, or at extraction from the freezer to variegate a white base. I, for instance, prefer preparing my own lemon marmalade with only whole organic lemons, sugar, and pectin. If stored properly, this marmalade can last for extremely long periods. I then use it in a duly calculated proportion in my lemon sorbet to impart a "real taste" and texture to it. As you would have guessed by now, the result is amazing and unique.

When added within the mix, the sugar and solid content of these pastes must be included in the recipe calculation. However, when added after the dynamic freezing process, they are irrelevant in the count.

Other products are instead obtained by cooking the fruit under vacuum to concentrate it by removing water. The result is a dense and very aromatic paste

containing only fruit with little to no sugar added. The composition differs from a regular jam (and so will the cost), but the same rule applies; when added to the mix, those ingredients must be included in the calculation.

The “aromatic pastes” are obtained by blending natural and synthetic ingredients such as glucose syrup, chemical aromas, food colouring substances, concentrated fruit, sugars, thickeners, emulsifiers, etc. These products are designed to be added directly in the “white base” before freezing, and the manufacturer's instructions must be followed.

The Fruit Ice Creams



I personally find that some fruits are just perfect to be developed in milk-based ice creams, sometimes yielding better results than in sorbets. It is anyway a matter of personal taste, geographical costumes, and seasons.

Now that we have learned how to balance a white cream recipe while making ourselves aware of the fruit sugar and solid content, the compilation of these recipes is a very straightforward process.

As a rule of thumb, remember that:

- Sucrose and dextrose should be the primarily used sugars in these recipes
- Fat content is usually below 7% (but this is not written in stone)










- We will approximate overlapping the sugar content to the Total Solids
- We will also approximate both SP and AFP to 120 and 160, respectively, even though we know that fructose is slightly sweeter and anti-freezing; we do this because fruit does not contain only fructose, and anyhow, this approximation is more than acceptable.

Let's see some recipes for these delicious ice creams. Once again, I suggest some formulation for showcases at -11°C and others for restaurants or homes to be stored in a deep freezer at -18°C .


Do note that the type of fruit used in each recipe can be replaced with any other fruit with similar sugar content. So, for example, the strawberry recipe will perfectly work for raspberry, peach, plums, or blueberry as well. This implies you are only limited by your imagination!



BANANA ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	24.00	0.84		2.16	3.00	108.00	17.28	
Cream 35 %	22.50	7.88		1.35	9.23	67.50	10.80	
Dried Skimmed milk	6.00			5.82	5.82	291.00	46.56	
Sucrose	13.00		13.00		13.00	1,300.00	1,300.00	
Dextrose	4.00		3.68		3.68	662.40	276.00	
Ripe Banana	30.00		5.40		7.00	86.40	64.80	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.72	22.08	9.33	42.23			-11
%	100.0%	8.7	22.1	9.3	42.2	262	17	










BANANA ICE CREAM FOR RESTAURANT

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	19.00	0.67		1.71	2.38	85.50	13.68	
Cream 35 %	22.50	7.88		1.35	9.23	67.50	10.80	
Dried Skimmed milk	6.00			5.82	5.82	291.00	46.56	
Sucrose	4.00		4.00		4.00	400.00	400.00	
Dextrose	18.00		16.56		16.56	2,980.80	1,242.00	
Ripe Banana	30.00		5.40		7.00	86.40	64.80	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.54	25.96	8.88	46.48			-18
%	100.0%	8.5	26.0	8.9	46.5	391	18	

BLOOD ORANGE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	16.00	0.93		1.02	2.25	81.00	12.96	
Cream 35 %	12.20	4.27		0.73	5.00	36.60	5.86	
Dried Skimmed milk	5.00			5.82	5.82	291.00	46.55	
Sucrose	11.00		11.00		11.00	1,100.00	1,100.00	
Dextrose	4.00		3.68		3.68	652.40	276.00	
CSS 60 DE	3.00		2.40		2.40	144.00	120.00	
Blood Orange Juice Juice	44.00		3.52		3.52	56.32	42.24	
Corn Starch	1.00				1.00			
Stabilizers / Emulsifiers	0.80				0.80			
Total Kg	100.00	4.90	20.60	8.17	35.47			-11
%	100.0%	4.9	20.6	8.2	35.5	237	10	

CANTALOUPE ICE CREAM "PETIT FOUR" RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	36.70	1.28		3.30	4.59	165.15	26.42	
Cream 35 %	11.00	3.88		0.66	4.51	33.00	5.28	
Dried Skimmed milk	3.50			3.40	3.40	160.75	27.16	
Sucrose	15.00		15.00		15.00	1,500.00	1,500.00	
Dextrose	2.00		1.84		1.84	331.20	138.00	
CSS 60 DE	1.50		1.20		1.20	72.00	60.00	
Dry Glucose Syrup 38 DE	2.30		2.19		2.19	109.26	91.77	
Ripe Cantaloupe	27.00		3.24		3.24	51.84	38.88	
Rice Starch	0.50				0.50			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	5.13	23.47	7.36	36.96			-11
%	100.0%	5.1	23.5	7.4	37.0	243	19	

This is and remains one of my favourite recipes. I always believe in seasonality and quality. Back in the day, it was funny (sometimes difficult) to explain to my customers why strawberry wasn't available and cantaloupe was instead used in its place.

LEMON ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	40.00	1.40		3.60	5.00	180.00	28.80	
Cream 35 %	10.20	3.57		0.01	4.16	30.00	4.90	
Dried Skimmed milk	5.00			5.82	5.82	291.00	46.56	
Sucrose	13.00		13.00		13.00	1,300.00	1,300.00	
Dextrose	3.00		2.76		2.76	495.60	207.00	
CSS 60 DE	3.00		2.40		2.40	144.00	120.00	
Lemon Juice	24.00		1.92		1.92	30.72	23.04	
Stabilizers / Emulsifiers	0.80				0.80			
Total Kg	100.00	4.97	20.08	10.03	36.88			-11
%	100.0%	5.0	20.1	10.0	35.9	247	17	

PINEAPPLE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	16.00	0.53		1.35	1.88	67.50	10.80	
Cream 35 %	13.00	4.85		0.78	5.33	39.00	6.24	
Dried Skimmed milk	3.00			2.91	2.91	145.50	23.28	
Sucrose	12.00		12.00		12.00	1,200.00	1,200.00	
Dextrose	5.00		4.60		4.60	828.00	345.00	
Pineapple Puree 10%	51.20		5.12		5.12	81.92	61.44	
Stabilizers / Emulsifiers	0.80				0.80			
Total Kg	100.00	5.08	21.72	5.04	32.64			-11
%	100.0%	5.1	21.7	5.0	32.6	236	16	

STRAWBERRY ICE CREAM FOR RESTAURANT

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5 %	13.00	0.46		1.17	1.63	58.50	9.36	
Cream 35 %	10.90	3.82		0.65	4.47	32.70	5.23	
Dried Skimmed milk	8.00			7.76	7.76	388.00	62.08	
Sucrose	4.00		4.00		4.00	400.00	400.00	
Dextrose	16.00		16.56		16.56	2.980.80	1.242.00	
Strawberry Puree 10%	45.30		4.53		4.53	72.48	54.36	
Stabilizers / Emulsifiers	0.80				0.80			
Total Kg	100.00	4.27	25.09	9.58	39.74			-18
	100.0%	4.3	25.1	9.	39.7	393.	18	

STRAWBERRY ICE CREAM










INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5 %	15.00	0.56		1.44	2.00	72.00	11.52	
Cream 35 %	10.00	3.50		0.80	4.10	30.00	4.80	
Dried Skimmed milk	8.00			7.76	7.76	388.00	62.08	
Sucrose	10.00		10.00		10.00	1.000.00	1.000.00	
Dextrose	4.00		3.66		3.66	662.40	276.00	
Dry Glucose Syrup 36 DE	3.00		2.85		2.85	142.50	119.70	
Strawberry Puree 10%	48.20		4.82		4.82	77.12	57.84	
Stabilizers / Emulsifiers	0.80				0.80			
Total Kg	100.00	4.06	21.35	9.90	36.01			-11
%	100.0%	4.1	21.4	9.8	36.0	237	15	



TANGERINE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	20.00	0.70		1.80	2.50	90.00	14.40	
Cream 35 %	13.70	4.80		0.82	5.62	41.10	6.58	
Dried Skimmed milk	5.00			5.82	5.82	291.00	45.55	
Sucrose	12.00		12.00		12.00	1,200.00	1,200.00	
Dextrose	3.50		3.22		3.22	579.80	241.50	
CSS 60 DE	3.00		2.40		2.40	144.00	120.00	
Tangerine Juice	41.00		3.28		3.28	52.48	39.36	
Stabilizers / Emulsifiers	0.80				0.80			
Total Kg	100.00	5.50	20.90	8.44	35.04			-11
%	100.0%	5.5	20.9	8.4	35.5	240	17	

TANGERINE ICE CREAM FOR RESTAURANT

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	17.00	0.60		1.53	2.13	76.50	12.24	
Cream 35 %	13.70	4.80		0.82	5.62	41.10	6.58	
Dried Skimmed milk	5.00			5.82	5.82	291.00	45.55	
Sucrose	6.00		6.00		6.00	600.00	600.00	
Dextrose	16.50		15.18		15.18	2,732.40	1,138.50	
CSS 60 DE	3.00		2.40		2.40	144.00	120.00	
Tangerine Juice	37.00		2.96		2.96	47.36	35.52	
Stabilizers / Emulsifiers	0.80				0.80			
Total Kg	100.00	5.39	26.54	8.17	40.90			-18
%	100.0%	5.4	26.5	8.2	40.9	393	20	

The Fruit Sorbets



Fruit sorbets are light and refreshing alternatives to ice cream. Because they are made from just fruit, sugar, and water, they are an excellent choice for the hottest weather or areas.

A great sorbet should taste as the fruit does at its absolute best, which means using either fresh fruit at its peak or fruit purees of the best quality.

As mentioned before, while making fruit sorbets, only water, sugars and stabilisers undergo pasteurisation, while the fruit is always added later to the cold syrup. This is ascribed to more than one reason. First, it is simply not necessary to pasteurise the fruit; on the contrary, it would be an utter waste of time and energy. Second, the fruit quality would be negatively affected by the heat. Why then do we pasteurize the sugar mix? Well, we do so mostly because the hydrocolloids (stabilisers) need to be fully hydrated to perform their function correctly. Heating them is the only way to ensure their full dispersion and hydration. A second reason is to ensure the perfect dissolution of the sugars in water. This pasteurisation can be performed more or less at any temperature (lower pasteurisation or high pasteurisation), commonly, however, 80°C programs are used.

The production of water-based fruit sorbets consists then in preparing the syrup, pasteurising, cooling it, ageing it overnight, and then adding the appropriate amount of fruit puree just before the freezing process.

Depending on the volume of production, the number of flavours, and ultimately the ice cream makers' preferences, we can define two major ways to operate:

1. Prepare each sorbet recipe extemporaneously by scaling, mixing, pasteurizing, cooling, and freezing each different recipe. This system is more cumbersome and much more time-consuming. It is feasible only in small productions or where a combi-machine (pasteuriser/batch freezer) is used. The advantage of this system is the possibility to tailor the recipe to each different fruit with greater accuracy.
2. Prepare a large volume of "base sugar syrup" and only subsequently add to it the various fruit puree in small batches before freezing it. The sugar syrup will be properly balanced for a certain quantity of fruit puree to be added and will contain all the types of sugars and stabilisers. This method is extremely convenient, quicker, and simpler to handle. It is suited best to large operations and where standard batch freezers are used. Some purists (sometimes me with them) will say that this system cannot allow a proper formulation for every single fruit. Nonetheless, adjustments can be made on the ratio base syrup/fruit puree.

As a rule of thumb, we remember that:

- Almost all the stabilisers lose part of their efficiency in low pH. To compensate we will use a higher amount of them in the recipes.
- It's (almost) always a good idea to add some lemon juice to fruit sorbets. Lemon will enhance the fruit flavour and help protect it against oxidation. Usually anywhere between 30 and 50g per litre of the mix.
- Sucrose and dextrose will be the major sugars in these recipes. Sometimes glucose syrup is also used to improve the body given the low solid content typical of these products.
- When dealing with lemon, lime, and yuzu sorbets, the peculiarly low solid content makes them prone to the separation of the syrup during storage and exposition in the showcase and to collapsing. It is recommended to integrate the lack of solids with our friend, inulin. The latter, in fact, while not having any action on the AFP nor SP of the mix, gives it body and structure, dramatically improving stability and spoonability.

Let's see some possible fruit sorbet recipes.

Once again, the type of fruit used in each recipe can be replaced with any other fruit with similar sugar content. So, for example, the lemon recipes will perfectly work for yuzu, lime, or grapefruit, and so on.

LEMON SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	52.00					
Sucrose	19.00	19.00	19.00	1,900.00	1,900.00	
Dextrose	1.00	0.92	0.92	165.60	69.00	
Dry Glucose Syrup 38 DE	5.00	4.75	4.75	237.50	199.50	
Inulin	2.00		2.00	50.00	20.00	
Rice Starch	0.25		0.25			
Lemon Juice	20.00	1.60	1.60	25.60	19.20	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	26.27	29.27			-11
%	100.0%	26.3	29.3	238	22	

LEMON SORBET FOR RESTAURANT

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	40.00					
Sucrose	16.00	16.00	16.00	1,600.00	1,600.00	
Dextrose	12.00	11.04	11.04	1,987.20	828.00	
Dry Glucose Syrup 38 DE	4.00	3.80	3.80	190.00	159.60	
Inulin	2.00		2.00	50.00	20.00	
Rice Starch	0.25		0.25			
Lemon Juice	25.00	2.00	2.00	32.00	24.00	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	32.84	35.84			-18
%	100.0%	32.8	35.8	388	26	



BANANA SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	41.25		12.00	1,200.00	1,200.00	
Sucrose	12.00	12.00	5.52	993.60	414.00	
Dextrose	6.00	5.52	1.90	95.00	79.80	
Dry Glucose Syrup 38 DE	2.00	1.90	7.70	100.80	75.60	
Ripe Banana	35.00	6.30	0.24	3.84	2.88	
Lemon Juice	3.00	0.24	0.75			
Stabilizers / Emulsifiers	0.75					
Total Kg	100.00	25.96	28.11			-11
%	100.0%	26.0	28.1	239	18	

MANDARINE SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	25.00					
Sucrose	15.00	15.00	15.00	1,500.00	1,500.00	
Dextrose	4.00	3.68	3.68	662.40	276.00	
Dry Glucose Syrup 38 DE	2.00	1.90	1.90	95.00	79.80	
Inulin	1.25		1.25	31.25	12.50	
Mandarine Juice	50.00	4.50	5.00	72.00	54.00	
Lemon Juice	2.00	0.16	0.16	2.56	1.92	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	25.24	27.74			-11
%	100.0%	25.2	27.7	236	19	

PASSION FRUIT SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	52.00					
Sucrose	18.00	18.00	18.00	1,800.00	1,800.00	
Dextrose	2.25	2.07	2.07	372.60	155.25	
Dry Glucose Syrup 38 DE	5.00	4.75	4.75	237.50	199.50	
Inulin	2.00		2.00	50.00	20.00	
Rice Starch	1.00		1.00			
Passion Fruit Puree	19.00	1.52	1.52	24.32	18.24	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	26.34	30.09			-11
%	100.0%	26.3	30.1	248	22	

PEACH SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	37.25					
Sucrose	11.00	11.00	11.00	1,100.00	1,100.00	
Dextrose	6.00	5.52	5.52	993.60	414.00	
Dry Glucose Syrup 38 DE	4.00	3.80	3.80	190.00	159.60	
Peach Puree 10%	39.00	3.90	4.68	62.40	46.80	
Lemon Juice	2.00	0.16	0.16	2.56	1.92	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	24.38	25.91			-11
%	100.0%	24.4				

PISTACHIO AND ROSE SORBET

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Sucrose	15.00		15.00	15.00	1,500.00	1,500.00	
Water	52.75						
Dextrose	10.00		9.20	9.20	1,656.00	690.00	
CSS 60 DE	2.00		1.60	1.60	96.00	80.00	
Inulin	1.00			1.00	20.00	25.00	
salt	0.50			0.50	50.00		
Rose Water	6.00						
Pistachio Paste	12.00	7.68		12.00	-840.00		
Stabilizers / Emulsifiers	0.75			0.75			
Total Kg	100.00	7.68	25.80	40.05			-11
%	100.0%	7.7	25.8	40.1	248	23	



WATERMELON SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Sucrose	12.00	12.00	12.00	1,200.00	1,200.00	
Dextrose	6.00	5.52	5.52	993.60	414.00	
Dry Glucose Syrup 38 DE	4.00	3.80	3.80	190.00	159.60	
Ripe watermelon juice	73.00	7.30	7.30	116.80	87.60	
Rice Starch	1.25		1.25			
Lemon Juice	3.00	0.24	0.24	3.84	2.88	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	28.86	30.86			-11
%	100.0%	28.9	30.9	250	19	

RASPBERRY SORBET FOR RESTAURANT

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	34.00					
Sucrose	11.00	11.00	11.00	1,100.00	1,100.00	
Dextrose	16.50	15.18	15.18	2,732.40	1,138.50	
Dry Glucose Syrup 38 DE	2.00	1.90	1.90	95.00	79.80	
Raspberry Puree 10%	33.00	3.30	3.96	52.80	39.60	
Rice Starch	0.75		0.75			
Lemon Juice	2.00	0.16	0.16	2.56	1.92	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	31.54	33.70			-18
%	100.0%	31.5	33.7	398	24	



RASPBERRY SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	36.50					
Sucrose	13.00	13.00	13.00	1,300.00	1,300.00	
Dextrose	6.00	5.52	5.52	993.60	414.00	
Dry Glucose Syrup 38 DE	2.00	1.90	1.90	95.00	79.80	
Raspberry Puree 10%	39.00	3.90	4.68	62.40	46.80	
Rice Starch	0.75		0.75			
Lemon Juice	2.00	0.16	0.16	2.56	1.92	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	24.48	26.76			-11
%	100.0%	24.5	26.8	245	18	

YUZU SORBET

INGREDIENTS	QUANTITY KG	SUGARS	SOLIDS	AFP	SP	SERV. TEMP.
Water	52.00					
Sucrose	18.00	18.00	18.00	1,800.00	1,800.00	
Dextrose	2.25	2.07	2.07	372.60	155.25	
Dry Glucose Syrup 38 DE	5.00	4.75	4.75	237.50	199.50	
Inulin	2.00		2.00	50.00	20.00	
Lemon Juice	7.00	0.56	0.56	3.36	6.72	
Rice Starch	1.00		1.00			
Yuzu Juice	12.00	0.96	0.96	15.36	11.52	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	26.34	30.09			-11
%	100.0%	26.3	30.1	248	22	

Similar to the white cream base, as I previously mentioned, we can prepare a "common" sugar syrup and, only later, build the various fruit sorbets from it. This is a practical and quick system, in which large amounts of stabilised sugar syrup are prepared, pasteurised, and cooled to be stored in sealed containers in the chiller for up to 5 or 7 days. At the moment of freezing, the ice cream maker will weigh the proper dose of syrup, add to it the due amount of fruit puree and freeze the mix into sorbet. The reduction in time and labour still persuades many ice cream makers to use this system.

The stabilised sugar syrup for sorbets can have various concentrations. The concentration of the sugar syrups can be expressed in different ways such as % of sugars per kg or Bè° or Brix°. The Bè° and Brix° are measured by a refractometer or densimeter. However, since we are the ones who put a given amount of sugar in this syrup, I truly find it completely useless and self-congratulatory to use such units in the day-to-day ice cream-making routine. I sincerely think that using the percentage of sugars used in the syrup recipe will do the trick brilliantly, without the need to use alchemical instruments or sorcery guess measure of units.

I, therefore, propose an example of a 50% sugar syrup, which I believe to be the most common and convenient to be used.

BASIC SUGAR SYRUP 50 % FOR SORBETS

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	40.00					
Sucrose	35.00	35.00	35.00	3,500.00	3,500.00	
Dextrose	5.40	4.97	4.97	894.24	372.60	
CSS 60 DE	12.50	10.00	10.00	600.00	500.00	
Inulin	6.50		6.50	130.00	162.50	
Stabilizers / Emulsifiers	0.60		0.60			
Total Kg	100.00	49.97	57.07			-23
%	100.0%	50.0	57.1	512	45	

Here, an example of sorbet formulated using the 50% stabilised sugar syrups is illustrated.

FRUIT SORBET WITH SUGAR SYRUP

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	15.00					
Lemon Juice	5.00	0.40	0.50	40.00	40.00	
Sugar Syrup 50%	40.00	20.00	22.80	2,048.00	17,600.00	
Fruit Puree 10% Sugar	40.00	4.00	4.80	400.00	400.00	
Total Kg	100.00	24.40	28.10			-11
%	100.0%	24.4	28.1	249	180	

The Alcohol in Ice Cream



Alcoholic ice cream is a "thorny" issue on a technical level, which has always given ice cream makers a hard time. In addition to the difficulty of making ice cream with

alcoholic components, there are also stimulating possibilities that the use of alcoholic beverages, even valuable ones, as ingredients provide us with.

It is not easy to make a liquor or wine ice cream containing enough alcohol to impart the needed flavour without changing the temperature and texture associated with other ice creams.

First, we must learn about the characteristics and behaviours of alcohol and the effect it has on ice cream to act accordingly in its recipe.

First of all, let's examine what alcohol does in ice creams.

- As we all know, alcohol is a strong anti-freezing substance. Its presence drastically lowers the mix's temperature and has a high AFP.
- It does not influence the sweetness so no SP has to be taken into account for this element.
- It denaturates the proteins, all of them, causing destabilisation and syneresis. When dealing with alcoholic ice cream, the protein content must be higher than usual to compensate for the loss for denaturation.
- Alcohol is also prone to "attack" the stabilisers making them less effective. Proper stabilisation must be able to neutralise this effect.

The next question now is: "So, how do we modify the recipe to make it work?"

Well, first we should identify the maximum amount of alcohol an average formula can "safely" take.

This is predicated on many factors, the most important of which are the service temperature and the type of spirits we use. In most cases, these type of ice creams will be served in restaurants and therefore they will be stored in freezers at -18°C. However, it is not uncommon nowadays to find wine or spirit flavours in ice cream parlours. Naturally, it is much easier to formulate the recipe for lower temperature than for the standard -11°C.

It is also very important to define the source of alcohol. Whisky, Vodka, Limoncello, and wine have obviously deeply diverse characteristics.

When examining an alcoholic beverage as a potential ice cream ingredient we must know its alcohol % and, if present, the sugar content.

On average, it is safe to say that we can obtain a good quality of ice cream with the 2 – 3 % of pure alcohol (ethanol) in the mix, or 20 – 30g per kg of mix.

Now, all we need to do is to divide this amount by the alcohol content of the chosen beverage.

For example:

If we want to make a red wine ice cream with 2.5% of alcohol and we are using a Cabernet with 14% of ethanol content, the count will be:

$$\frac{25g \text{ di alcohol per kg}}{14 \%} \times 100 = 178 g \text{ of wine per Kg}$$

In case we instead opt for something a tad more "extreme" and decide to make a Tequila ice cream: Tequila alcohol content 40%, the amount required in the mix 3%

$$\frac{30g \text{ di alcohol per kg}}{40 \%} \times 100 = 75 g \text{ of Tequila per Kg}$$

So far everything is easy, now, all we have to do is find the AFP of the alcohol, and we are all set. Well, almost. In this case, there is a large gap between the theory behind the freezing point depression of alcohol in an aqueous solution and the reality of the ice cream.

Why?

The AFP of a substance is usually measured in a theoretical condition, in which the alcohol, in this case, remains free in a water solution and therefore capable of playing its full action on the freezing point depression.

Ice cream and sorbet mixes, unfortunately, are all but easily predictable nor is there a simple solution. In any ice cream mix, there is a vast array of components besides water that the alcohol can interact with. In fact, the alcohol interacts with basically everything in the mix; it binds with fats and hydrocolloids and denaturates the milk, fruits and egg proteins, etc.

The magnitude of these interactions is not easily definable and largely depends on the characteristics of the recipe. For example, a very fat and protein-rich recipe will "keep the alcohol busy" so that its AFP won't be so remarkable. On the other hand, a sorbet, containing no fat or proteins, will be more severely affected by the action of the alcohol.

This is why decades of study and experimentation are fundamental for achieving reliable results, even when it comes to complex approaches such as that of alcohol in ice cream.

Through experience, we now know that it is possible to assign a different AFP whether we are talking of ice cream or sorbets. This, certainly, is not a scientific approach but (as many other approximations) is good enough to make ice cream.

In ice cream, the alcohol AFP can be approximated at 300, which means that 100g of alcohol will lower the freezing point as much as 300g of sucrose.

In water sorbets, the alcohol AFP shows to be around 500, thus implying that 100g of pure ethanol will have the same effect on depressing the freezing temperature as 500g of sucrose.

That being said, one is advised to keep the alcohol content generally lower in sorbets while slightly more forgiving dosing can be supported in rich ice creams. Inexorably, these numbers give us a base to start the calculation, as once we have the ice cream in the showcase, we will observe its stability and structure to correct the recipe if and where needed.

Other recommendations when using alcoholic ingredients are:










- Strongly graded alcoholic beverages should be added last when the freezing process is almost completed in the batch freezer
- Beer and wine can be added directly to the mix before freezing
- Alcohol can also be added before pasteurisation or cooked with some of the ingredients like, for instance, when making zabaglione (eggnog) or Malaga ice cream. If a Marsala wine zabaglione is produced, on an egg basis, it will be preferable to add the marsala wine in part of the sugar and eggs, then cook it at 85°C before adding milk and the remaining ingredients.

BEER ICE CREAM

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Cream 35 %	30.00	10.50		1.80	12.30	90.00	14.40	
Dried Skimmed milk	7.00			6.79	6.79	339.50	54.32	
Sucrose	8.25		8.25		8.25	825.00	825.00	
Honey	2.00		1.44		1.44	187.20	273.60	
CSS 50 DE	3.00		2.40		2.40	144.00	120.00	
Dry Glucose Syrup 38 DE	1.00		0.95		0.95	47.50	39.90	
Beer	45.00					810.00		
Inulin	3.00				3.00	75.00		
Stabilizers / Emulsifiers	0.75				0.75			
Total Kg	100.00	10.50	13.04	8.59	35.88			-11
%	100.0%	10.5	13.0	8.6	35.9	262	13	










RED WINE ICE CREAM









 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	40.85	1.43		3.68	5.11	183.83	29.41	
Cream 35 %	22.00	7.70		1.32	9.02	68.00	10.58	
Dried Skimmed milk	6.40			6.21	6.21	310.40	48.66	
Sucrose	8.00		8.00		8.00	800.00	600.00	
Dextrose	1.00		0.92		0.92	105.80	69.00	
CSS 60 DE	3.00		2.40		2.40	144.00	120.00	
Dry Glucose Syrup 38 DE	2.00		1.90		1.90	95.00	79.80	
Red Wine	16.00					720.00		
Stabilizers / Emulsifiers	0.75				0.75	29.41		
Total Kg	100.00	9.13	13.22	11.20	34.30			-11
%	100.0%	9.1	13.22	11.2	34.3	248	12	



STRAWBERRIES AND PROSECCO SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	40.25			900.00		
Sucrose	9.00	9.00	9.00	96.00	900.00	
CSS 60 DE	2.00	1.60	1.60	237.50	80.00	
Dry Glucose Syrup 38 DE	5.00	4.75	4.75	1,000.00	199.50	
Prosecco Wine	20.00			216.00		
Strawberry Puree 10%	18.00	1.80	2.16	75.00	216.00	
Inulin	3.00		3.00		36.00	
Rice Starch	2.00		2.00			
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	17.15	23.26			-11
%	100.0%	17.2	23.3	252	14	

RED WINE AND PEACH SORBET

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	41.75	10.50					
Sucrose	9.50		9.50	9.50	950.00	950.00	
CSS 60 DE	2.00		1.60	1.60	96.00	80.00	
Dry Glucose Syrup 38 DE	5.00		4.75	4.75	237.50	199.50	
Red Wine	15.00				900.00		
Peach Puree 10%	21.00		2.10	2.52	252.00	252.00	
Inulin	3.00			3.00	75.00	36.00	
Rice Starch	2.00			2.00			
Stabilizers / Emulsifiers	0.75			0.75			
Total Kg	100.00	17.95	8.59	24.12			-11
%	100.0%	18.0	8.6	24.1	251	15	

SPARKLING SWEET WINE SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	37.25					
Sucrose	9.00	9.00	9.00	900.00	900.00	
CSS 60 DE	2.00	1.60	1.60	96.00	80.00	
Dry Glucose Syrup 38 DE	3.00	2.85	2.85	142.50	110.70	
Sparkling Sweet Wine	43.00	4.30	4.30	1,290.00	430.00	
Inulin	3.00		3.00	75.00	36.00	
Rice Starch	2.00		2.00			
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	17.75	23.50			-11
%	100.0%	17.8	23.5	250	16	

WHISKY ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	44.20	155		3.68	5.53	198.90	31.62	
Cream 35 %	29.00	10.15		1.74	11.89	87.00	13.92	
Dried Skimmed milk	6.00			5.82	5.82	201.00	46.56	
Sucrose	10.50		10.50		10.50	1,050.00	1,050.00	
Dry Glucose Syrup 38 DE	1.00		0.95		0.95	47.50	39.90	
Whisky	7.00					840.00		
Rice Starch	1.55							
Stabilizers / Emulsifiers	0.75				0.75			
Total Kg	100.00	11.70	11.45	11.54	35.44			-11
%	100.0%	11.7	11.5	11.5	35.4	251	12	



ZABAGLIONE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	41.00	1.44		3.68	5.13	184.50	29.52	
Cream 35 %	14.25	4.88		0.86	5.84	42.75	6.84	
Dried Skimmed milk	6.00			5.82	5.82	291.00	46.56	
Sucrose	11.00		11.00		11.00	1,100.00	1,100.00	
CSS 60 DE	3.00		2.40		2.40	144.00	120.00	
Dry Glucose Syrup 38 DE	1.00		0.95		0.95	47.50	39.90	
Marsala Wine (dry)	10.00					630.00		
Rice Starch	1.00				1.00			
Egg Yolk	12.00	3.60			6.00			
Stabilizers / Emulsifiers	0.75				0.75			
Total Kg	100.00	10.02	14.35	10.37	38.89			-11
%	100.0%	10.0	14.4	10.4	39.3	244	13	

The Savoury Ice Cream



Savoury ice cream is not a new concept, but it has never taken off. Weird ice cream flavours may still be used to impress in the molecular gastronomy scene, but it is pretty rare to see them in parlours. Savoury ice cream is having a shot now because people have stopped viewing it as an alternative dessert and are now seeing it as something in its own right; a snack, a starter, or the perfect combination to refresh other courses. The global dissemination of new flavours and food culture fusion has done the rest.

The application of these flavours is clearly the doing of restaurants rather than the gelateria showcase. They can be used to accompany soups, appetisers, game dishes, fish, etc.

The formulation of salted ice cream is, to me, quite interesting. For the composition of these recipes, we can tap into a myriad of different ingredients, while considering the entire architecture of the dish they are intended for.

When building this type of recipe, we have to keep in mind:

- The sweetness must be kept as low as possible, while some sugar is still needed to lower the freezing point of the mix
- There will be salt, either from the ingredient or added. This will help us in increasing the AFP (AFP of salt is 100)
- LMS should be kept up to the top amount allowed. This note is important because we “need” so much body, but also must take advantage of the lactose AFP. Since the amount of sugar is pretty low, we can take the risk of using all the lactose allowed, knowing that it will dissolve in the available water. Things are clearly different in the case of savoury sorbets
- Proper emulsifier must be used to ensure the appropriate whipping of fat ingredients
- Fat content depends on the ingredients which can be close to 0 in vegetable sorbets and up to 15% in fatty ingredients like salmon, cheese, or foie gras
- The main sugar used in these flavours will be dextrose due to its high AFP when compared with the relatively low SP
- When using each and every ingredient we must –as usual- know their composition (fat, salt, LMS) and insert them in the respective columns
- Also, in this case, ingredients like maltodextrins or inulin will help us fill up the (potential) lack of solids








 INGREDIENT	 % fat	 % SUGARS	 % LMS	 % SOLIDS	 % SALT	 AFP
Bell Peppers	/	1	/	3	/	1
Tomatoes	/	3	/	15	/	2
Carrots	/	5	/	10	/	3
Avocado	15	6	/	40	/	8
Permesan Cheese	30	/	44	72	1,5	1,5
Gorgonzola Cheese	30	/	28	70	2	2
Smoked Salmon	14	/	/	75	5	5
Fois Gras	44	/	/	70	1	1
Goat Cheese	30	2	22	65	2	2

In the table above, we can find some reference standard parameters to help us compile the calculation table.

Usually, these ice creams are prepared extemporaneously in small batches, after being mixed and pasteurised in a pot on induction or stove. For this reason, I will write these recipes based on 1kg instead of 100kg.

Again, this is an extremely limited selection of recipes I personally have a liking for, but the fantasy of the Chefs and the visceral dexterity of the ice cream maker will make for surprising and mouth-watering products.

BELL PEPPER SORBET










 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	34.25					
Dextrose	12.5	11.50	11.50	2,070.00	862.50	
Dry Glucose Syrup 38 DE	3.00	2.85	2.85	142.50	119.70	
Bell Pepper Juice	43.00	0.43	1.29	0.43	5.16	
Salt	1.00		1.00	100.00		
Rice Starch	1.50		1.50			
Inulin	3.00		3.00	75.00		
Lemon Juice	1.00	0.08	0.08	1.28	0.96	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	14.86	21.97			-11
%	100.0%	14.9	22.0	239	10	

CARROT SORBET










 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	36.75					
Dextrose	13.00	11.96	11.96	2,152.80	897.00	
Dry Glucose Syrup 38 DE	3.00	2.85	2.85	142.50	119.70	
Carrots Puree	43.00	2.58	4.30	7.74	30.96	
Salt	1.00		1.00	100.00		
Rice Starch	1.50		1.50			
Lemon Juice	1.00	0.08	0.08	1.28	0.96	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	17.47	22.44			-11
%	100.0%	17.5	22.4	240	10	












COOKED CARROT ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	30.00	1.05		2.70	3.75	135.00	21.60	
Cream 35 %	29.00	10.15		1.74	11.89	87.00	13.92	
Dried Skimmed milk	5.00			4.85	4.85	242.50	38.90	
Dextrose	8.00		7.36		7.36	1,324.80	552.00	
Honey	1.00		0.72		0.72	93.60	136.60	
Dry Glucose Syrup 38 DE	7.00		6.65		6.65	332.50	279.30	
Cooked Carrot Puree	18.50		1.11		1.85	146.00		
Salt	1.00				1.00	100.00		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	11.20	15.84	8.29	38.57			-11
%	100.0%	11.2	15.8	8.3	38.5	246	10	









FOIE GRAS ICE CREAM

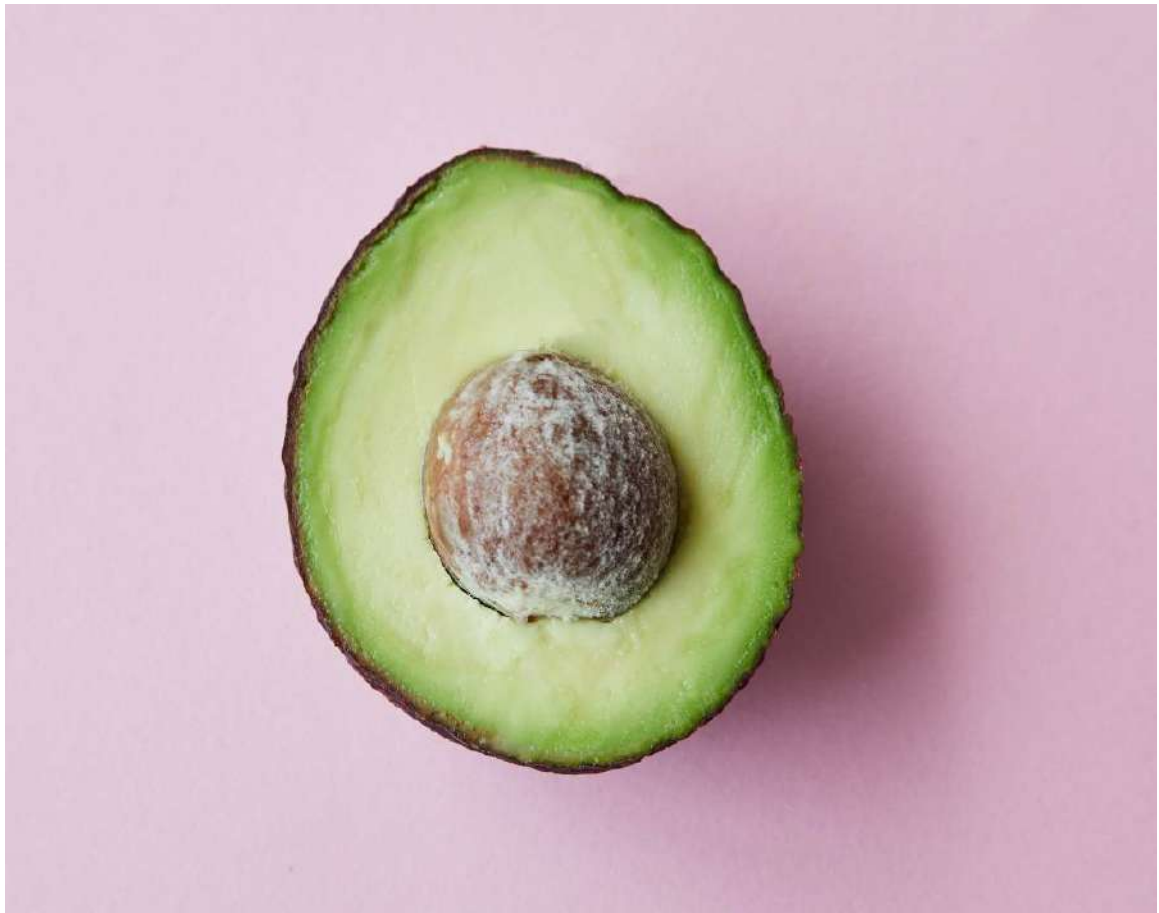
 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	66.00	1.96		5.04	7.00	252.00	40.32	
Cream 35 %	13.00	4.55		0.78	5.33	39.00	5.24	
Dried Skimmed milk	4.50			4.37	4.37	218.25	34.92	
Dextrose	5.50		5.06		5.06	910.80	379.50	
Honey	2.50		1.80		1.80	234.00	342.00	
Dry Glucose Syrup 36 DE	4.00		3.80		3.80	190.00	159.60	
Foie Gras	10.00	4.40			7.00	100.00		
Salt	2.00				2.00	200.00		
Cognac	2.00					180.00		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	10.91	10.66	10.19	36.96			-11
%	100.0%	10.9	10.7	10.2	36.9	232	10	

GORGONZOLA ICE CREAM










 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	65.00	130,685.50		4.95	130,690.46	247.50	39.80	
Cream 35 %	13.00	4.55		0.78	5.33	39.00	8.24	
Dried Skimmed milk	3.00			2.91	2.91	145.50	23.28	
Dextrose	7.00		6.44		6.44	1,159.20	493.00	
Honey	1.50		1.08		1.08	140.40	205.20	
CSS 60 DE	1.50		1.20		1.20	72.00	60.00	
Dry Glucose Syrup 38 DE	3.00		2.85		2.85	142.50	119.70	
Gorgonzola Cheese	14.00	4.20		3.92	9.80	280.00		
Salt	1.50				1.50	150.00		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	10.68	11.57	12.56	38.49			-11
%	100.0%	10.7	11.6	12.6	38.5	238	9	

GUACAMOLE ICE CREAM










 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	36.00	1.33		3.42	4.75	171.00	27.36	
Cream 35 %	10.00	3.50		0.60	4.10	30.00	4.80	
Dried Skimmed milk	4.00			3.88	3.88	194.00	31.04	
Sucrose	0.50		0.50		0.50	50.00	50.00	
Dextrose	8.00		7.36		7.36	1,324.80	552.00	
Dry Glucose Syrup 38 DE	7.00		6.65		6.65	332.50	278.30	
Avocado Pulp	20.00	3.00	1.20		8.00	150.00		
Salt	1.00				1.00	100.00		
Onion Puree	3.00		0.06		0.24	6.00		
Lime Juice	8.00				0.64	64.00		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	7.83	16.41	7.90	37.62			-11
%	100.0%	7.8	16.4	7.9	37.6	243	9	



PARMESAN CHEESE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	44.00	1.54		3.96	5.50	198.00	31.66	
Cream 35 %	13.00	4.55		0.78	5.33	90.00	6.24	
Dextrose	16.50		15.18		15.18	2.732.40	1.138.50	
Honey	4.00		2.88		2.88	374.40	547.20	
Dry Glucose Syrup 38 DE	6.00		5.70		5.70	285.00	238.40	
Parmesan Cheese	15.00	4.50		6.50	10.80	225.00		
Salt	1.00				1.00	100.00		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	10.59	23.76	11.34	48.89			-11
%	100.0%	10.6	23.8	11.3	48.9	395	20	

SMOKED SALMON ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	47.50	1.66		4.28	5.94	213.75	34.20	
Cream 35 %	13.00	4.55		0.78	5.33	39.00	6.24	
Dried Skimmed milk	3.00			2.91	2.91	145.50	23.28	
Sucrose	1.00		1.00		1.00	100.00	100.00	
Dextrose	14.00		12.88		12.88	2,318.40	996.00	
Dry Glucose Syrup 38 DE	7.00		6.65		6.65	332.50	279.30	
Smoked Salmon	13.00	1.82			9.75	650.00		
Salt	1.00				1.00	100.00		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.03	20.53	7.97	45.96			-18
%	100.0%	8.0	20.5	8.0	46.0	390	14	

TOMATO SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	36.50		12.01	2,161.08	900.45	
Dextrose	13.05	12.01	2.85	142.50	119.70	
Dry Glucose Syrup 38 DE	3.00	2.85	4.80	3.60	14.40	
Tomato Juice	40.00	1.20	1.20	120.00		
Salt	1.20		1.50			
Rice Starch	1.50		0.32	5.12	3.84	
Lemon Juice	4.00	0.32	0.75			
Stabilizers / Emulsifiers	0.75					
Total Kg	100.00	16.38	23.43			-11
%	100.0%	16.4	23.4	243	10	

Dietetic Ice Cream

Sugar-free and fat-free ice cream is a fashion theme that hides several pitfalls: what are the technical possibilities for those who make their ice cream from raw materials? What does the legislation say in terms of labelling? And, above all, what should be the ice cream maker's approach?

Ice cream, being a rich source of fat, protein, and carbohydrate, innately entails significant caloric value. The caloric value of a good average ice cream is approximately 250-350 kcal/100g. The awareness of consumers for healthier and lighter foods has led to the development of new technologies and ingredients for the manufacture of such products.

The successful development of good quality dietetic foods depends on the imitation of organoleptic properties of the equivalent standard products. Consequently, the development of a completely new formulation is often required to obtain acceptable dietetic frozen desserts for the consumers.

Labelling and Regulations

Although ice cream accommodates a gamut of ingredients, the Standards of Identity in the U.S. Code of Federal Regulations (CFR), section 21 CFR 135.110 for ice cream specifies a particular quantity of milk solids, air, and milk fats. Any product that claims to be an ice cream must comprise at least 20% total solids, 10% milk fat, and other provisions for bulky ingredients, for example, weighing a minimum of 4.5 pounds/gallon, of which total solids must account for 1.6 pounds. Here, total solids denote the various components of protein, fat and sugar, etc. in the preparation of ice creams.

Besides, ice cream also consists of optional ingredients specified by the Code of Federal Regulations, such as optional hydrolyzed milk proteins, dairy ingredients, caseinates, whey, stabilizers, and acidity. Some terms must adhere to the FDA norms to be displayed on labels. For example, any product with a label of 'reduced fat' means that the fat content must be a minimum of 25% less as compared to a particular product, regardless of the brand. Similarly, the fat content in a 'light ice cream' must have 33% fewer calories or 50% less fat than popular brands' products.

The terms "few calories," 'low calorie' or 'low source of calories,' could be used in labelling food items, barring those specified in 101.13(l) as well as products falling under the main dish category as long as:

- A) The product features a reference amount in excess of 30g consumer customarily or over two tablespoons while also disallowing over 40 calories/reference amount 2;
- B) Its calorie content per customarily consumed reference amount is 25% lower as compared to a food that is referenced appropriately.

Sugar content claims

Terms like 'no sugar,' 'sugar-free,' or 'zero sugar' denote products with negligible/trivial/insignificant sources of sugar, implying that consumers can expect that these terms refer to foods that are devoid of artificial sweeteners or added sugars, and, by extension, are lower in calories. This means that except for this section's paragraph (c) (2), such terms must not be applied to labels unless:

- (i) The sugar component is less than 0.5g/customarily consumed reference (or per label serving), as per 101.9(c) (6)(ii), or, less than 0.5g per labelled serving if it is the main dish or meal product; and
- (ii) There is no sugar component in an ingredient that consumers typically understand unless such precedes an asterisk denoting the statement underneath the ingredients' list, stating 'adds a trivial amount of sugar,' or "a negligible amount of sugar;

Terms like 'no sugar added' are only allowed in these cases:

- (i) In the packaging or processing, no sugars/any ingredient containing sugar that functionally replaces added sugars are added; and
- (ii) There is no ingredient that contains added sugar in the form of jelly, jams, and concentrated fruit juice;
- (iii) There has been no hike in the sugar content beyond what is pre-existing in the use of ingredients means like enzymes, barring cases where the processes' desired impact is not to raise the sugar content of the food. content.

In the UK, according to the Food Labelling Regulations 1996 which came into force on 1st July 1996, ice cream is regulated as follows:

The description "dietary" or "dietetic".	Is not applicable to any food except for specific nutritional purposes (does not include foods designed for healthy young children and infants that— (a) specifically prepared for a group of individuals with impaired metabolism or digestive process due to their innate physiological condition
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The description "ice cream".	Is not applicable to any food except a frozen product that contains at least 2.5% milk protein and 5% fat (not mandatorily in natural
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proportions); which is derived by exposing an emulsion of sugar/fats/milk solids (includes sweeteners allowed by the Sweeteners in Food Regulations 1995) to heat treatment with or without adding other substances or to eventual freezing and evaporation after adding water.

The description "dairy ice cream"

Is not applicable to any food the one that meets the conditions concerning the ice cream description's application (as long as the minimum fat content of 5% is specified); which does not contain any fat barring milk fat or those added in the form of emulsifiers, stabilizers, flavouring or ingredients like eggs.

In Europe, REGULATION (EC) No 1924/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL (20 December 2006) regulates ice cream labelling on health/nutritional claims. Similarly, the COMMISSION REGULATION (EU) No 1047/2012 of 8 November 2012 amending Regulation (EC) No 1924/2006 is also responsible for regulating/overseeing nutrition claims.

Here, I list an extract of the regulation; obviously, before making any decision about the production of such products, the ice cream maker must carry out a thorough investigation regarding all the laws and regulations on this delicate matter.

(21) Council Directive 89/398/EEC of 3 May 1989 concerning the approximation of the Member States' laws deals with conditions for claims like 'gluten-free' or 'lactose-free specifically with regard to consumers suffering from specific disorders. Moreover, the Directive adds that food products for consumption denote their feasibility for consumption by these individuals only if they meet the conditions applicable for such statements. Member States are liable to take pertinent steps unless conditions are specified at a community level.

(22) A scientific evaluation meeting the highest possible standard of scrutiny must be conducted before authorizing health claims in the community; these evaluations must be carried by the EFSA.

Nutrition claims and conditions applying to them

LOW ENERGY

No claim for a low energy food can be made unless the product contains over 40 kcal/100g for solids/over 20kcal/100ml for liquids. The limit of 4kcal/portion is applicable to equivalent sweetening properties of one teaspoon of sucrose (6g of sucrose).

ENERGY-FREE

No claim for energy-free food can be made unless the product contains less than 4 kcal/100ml. As far as table-top sweeteners are concerned, the above limit with equivalent sweetening properties (6g of sucrose) is applicable

ENERGY-REDUCED

No claim for an energy-reduced food can be made unless the energy value is lowered by a minimum of 30% accompanied by a measure of characteristic(s) that lower the total energy value of a food.

LOW-FAT

No claim for low-fat food can be made unless a product does not contain over 3g of fat/100g (for solids) or 1.5g of fat/100ml for liquids.

FAT-FREE

No claim for fat-free food can be made unless a product does not contain over 0.5g of fat/100g or 100ml. Claims specifying 'X % fat-free' are disallowed.

LOW-SATURATED FAT

No claim for low-saturated fat food must be made if the total quantity of trans-fatty acids and saturated fatty acids in the product goes past 1.5g/100g (for solids) or 0.75g/100ml as far as liquids are concerned. In all cases, the total of the aforementioned acids must not exceed 10% of energy.

SATURATED FAT-FREE

No claim for saturated-free food can be made if the total quantity of trans-fatty acids and saturated fatty acids does not go past 0/1g of saturated fat/100g or 100ml.

LOW SUGAR

No claim for low-sugar food can be made if the product comprises over 5g of sugar/100g and 2.5g of sugar/100ml for solids and liquids, respectively.

SUGAR-FREE

No claim for low-sugar free food can be made if the product comprises over 0.5g of sugar/100g or 100ml.

WITH NO ADDED SUGAR

No claim for with no added sugar food can be made if the product consists of any added mono/disaccharides or other foods utilised for sweetening properties. If the food contains naturally present sugars, the label must include 'CONTAINS NATURALLY OCCURRING SUGARS'.

LOW SODIUM/SALT

No claim for low salt/sodium food can be made if the product contains over 0.12g of sodium, or the equivalent value for salt, per 100ml or 100g. For waters, this value must not go past 2mg of sodium/100 ml except natural mineral waters that fall within the purview of Directive 80/777/EEC.

VERY LOW SODIUM/SALT

No claim for very low salt/sodium food can be made if a product contains over 0.04g of sodium, or the equivalent value for salt, per 100g/100ml. The rule is also applicable for other waters and mineral waters.

SODIUM-FREE or SALT-FREE

No claim for very sodium/salt-free food can be made if a product comprises over 0.005g of sodium or the equivalent value for salt, per 100g.

SOURCE OF FIBRE

No claim for a fibre source food can be made if a product comprises less than 3g of fibre/100g or 1/5g of fibre/100kcal.

HIGH FIBRE

No claim for a high-fibre food can be made if a product does not contain a minimum of 3g of fibre/100kcal

SOURCE OF PROTEIN

No claim for a food with a protein source can be made if the protein does not account for a minimum of 12% of the food's energy value.

HIGH PROTEIN

No claim for a high-protein food can be made if the protein does not account for at least 20% of the food's energy value.

SOURCE OF (NAME OF VITAMIN/S) AND/OR (NAME OF MINERAL/S)

No claim of a food with a source of minerals/vitamin/s can be made if the product does not comprise a significant quantity specified in the Annex to Directive 90/496/EEC/the amount specified by Article 7 of Regulation (EC) No 1925/2006 of the European Parliament and of the Council of 20 December 2006 that specifically pertains to adding substances like minerals and vitamins to foods.

HIGH (NAME OF VITAMIN/S) AND/OR (NAME OF MINERAL/S)

No claim for food being high in mineral/s or vitamin/s can be made if a product does not comprise at least two times the value of the source

CONTAINS (NAME OF THE NUTRIENT OR OTHER SUBSTANCE)

No claim for a food containing a particular nutrient or other substances can be made (that are not specified in the Regulation) if a product does not adhere to all pertinent provisions of the aforementioned Regulation, especially Article 5. The conditions of 'source of' claims would be applicable to minerals and vitamins.

INCREASED (NAME OF THE NUTRIENT)

No claim mentioning the presence of at least one nutrient except minerals/vitamins in increased quantity can be made if a product does not fulfil the conditions for the 'source of' claim and the content is a minimum of 30% higher than a product.

REDUCED (NAME OF THE NUTRIENT)

No claim for any reduced nutrients can be made unless the percentage of content is a minimum of 30 % lower than a comparable product, barring micronutrients where a difference of 10% in reference values defined in Council Directive 90/496/EEC would be suitable for sodium, or a difference of 25% would be suitable for the equivalent value of salt.

LIGHT/LITE

No claim for a product being 'light' can be made if a product does not meet the conditions specified for the term 'reduced'. In addition, this claim will include an indication of the various attributes that render a food 'lite' or 'light.'

NATURALLY/NATURAL

In case a food is found to naturally fulfil the condition(s) specified in the Annex concerning a nutritional claim, it is acceptable to use the term 'naturally/ natural' as a prefix.

Formulations of Sugar-Reduced Ice Creams



Sugar, obviously, contributes to the sweetness in ice cream. Also, sugars are well known to lower the freezing point of the mix determining the hardness and texture of the frozen dessert. In order to produce ice cream with a sufficiently low calorie load or compatible with a diabetic's diet, we need to drastically reduce or even remove sugars from the mix. When replacing sucrose with a non-nutritive intense sweetener, the required dose is measurable in ppm immediately leading to a huge lack of total solids. To "fill-up" the solids void, it is common to use low calorie bulking agents like polydextrose, maltodextrins, inulin, etc. Our mix still cannot work even with the correct total solid level. The anti-freezing power of sugar cannot be replaced by these ingredients. At a typical drawing temperature of -6°C , the sugar-free mixture would have twice the amount of frozen water as a regular ice cream, rendering the product hard and icy. To maximise the freezing point depression and reduce the hardness of the ice cream, various polyols such as sorbitol, lactitol, glycerol, erythritol, etc. are used. Sorbitol and erythritol are widely

used in frozen desserts for diabetics as a replacement for sugar as they can lower the freezing point of the mix and make the ice cream scoopable/softer.

Carbohydrate-based bulking agents such as maltodextrin, inulin, and polydextrose are used in reduced fat and sugar ice cream formulation in combination with aspartame, acesulfame, sucralose, or other intense sweeteners compensating the SP.

Whey protein concentrate (WPC) is often included in such ice cream mix formulations for its contribution to a pleasant taste and texture.

As we know Erythritol is a polyol, an additive, with the identification number E968, the European Commission, in 2006, included it in the list of food additives. Erythritol has a molecular weight of about 122 Dalton, which means that it is comparable to that of dextrose having a relative sweetness of about 60%, compared to sucrose and an anti-freezing power value higher than dextrose. In addition, the erythritol has other perks:

- Almost no calorie intake
- Glycemic index equal to 1, therefore extremely low
- Absence of bitter aftertaste, typical of sugar alcohols
- Reduced irritation towards the intestinal mucosae

The need to have a bulk ingredient such as inulin or fibre oligosaccharides must also be considered when formulating the recipe with the use of erythritol. In addition, there is the possibility of using another interesting sugar for the ice cream maker; trehalose. Trehalose has an SP of 45 and PAC 91. This means that it gives solids and lowers the freezing point without adding too much sweetness. However, trehalose is a full-fledged sugar so it is not compatible with diabetic or sugar-free recipes.

In conclusion, to obtain a good final result when replacing the sugars in an ice cream mix, the balance needs to include:

- A bulk agent to give body and solids
- A polyol to lower the freezing point
- An intensive sweetener to correct the sweetness
- Fibre to improve the body structure







With a balanced mix of these ingredients, a low glycemic index product can be obtained, which can also be consumed by those who do not suffer from particular diseases.

Glycemic Index: The glycemic index (abbreviated: GI) measures the ability of a certain food to raise blood sugar after a meal compared to a reference standard which is pure glucose. The glycemic index is indicated with a number from 0 to 100. Pure glucose has a maximum GI of 100.

Foods with a GI = or <35 have a low GI and can be consumed without problems. These are foods that do not give problems to those who are diabetic and are suitable for those who want to lose weight.

Foods with a GI between 35 and 50 are considered with moderate GI and can be eaten freely by those who want to keep their weight stable, while they are to be avoided in the case of diabetes if you are keen to have your blood sugar under control and lose weight.










Foods that have a high GI (which is = or > 50) should be avoided if you are diabetic and want to lose weight. By all others, they can be eaten in moderation and occasionally.

 INGREDIENT	 GLYCEMIC INDEX	 % SOLIDS	 AFP	 SP	 KCAL/100 G
Trehalose	72	100	91	45	400
Fructose	20	100	190	140	400
Inulin	0	100	25	20	208
Isomalt	10	100	100	50	200
Erythritol	0	100	260	70	0
Xylitol	12	100	190	100	240
Sorbitol	4	100	190	60	240
Maltitol	53	100	100	80	240
Polydextrose	7	100	25	25	100
Maltodextrine	100	95	35	15	200
Tagatose	0	100	190	92	150
Glycerol	5	0	370	60	240
Sucralose	0	100	/	60000	0
Cellulose Microcrystalline	0	100	0	0	0










In the above table, we can see the standard parameters of the most commonly used sugar replacements. When compiling the balancing table, we will use, as usual, AFP and SP and solids. The calories and the glycemic index are to guide the choice under the commercial destination of the ice cream we aim to produce. Reduced sugar or sugar-free ice cream can be aimed at calorie control and at achieving a diabetic diet.

I will suggest some reduced-sugar ice cream recipes, however, keep in mind that brilliant ready-balanced bases and mixes are available in the market. The manufacturer has already taken the burden of balancing and assembling a recipe capable to deliver effective sugar reduction, taste, texture, and compliance to the laws and regulations in this complex field.

SUGAR-FREE WHITE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	64.47	2.20		5.80	8.05	290.12	48.42	
Cream 35 %	15.00	5.25		0.90	6.15	45.00	7.20	
Dried Skimmed milk	5.50			5.34	5.34	265.75	42.68	
Polydextrose	2.00				2.00	50.00	50.00	
Glycerol	1.00				1.00	370.00	60.00	
Erythritol	1.00				1.00	260.00	80.00	
Inulin	3.00				3.00	75.00	80.00	
Sorbitol	6.00				6.00	1140.00	360.00	
Maltitol	0.50				0.50	50.00	40.00	
Microcrystalline Cellulose	0.75				0.75			
Sucralose	0.02				0.02		1,200.00	
Aspartame/Acesulfame	0.01				0.01		300.00	
Stabilizers / Emulsifiers	0.75				0.75			
Total Kg	100.00	7.51	0.00	12.04	34.57			-12
%	100.0%	7.5	0.0	12.0	34.8	255	22	

SUGAR-FREE WHITE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	53.48	1.87		4.81	6.69	240.66	38.51	
Cream 35 %	15.00	5.25		0.90	6.15	45.00	7.20	
Dried Skimmed milk	6.00			5.82	5.82	291.00	46.56	
Polydextrose	13.00				13.00	325.00	325.00	
Glycerol	2.00				2.00	740.00	120.00	
Erythritol	2.00				2.00	520.00	160.00	
Inulin	4.50				4.50	112.50	90.00	
Maltitol	0.50				0.50	50.00	40.00	
Isomalt	2.00				2.00	200.00	100.00	
Microcrystalline Cellulose	0.75				0.75			
Sucralose	0.02				0.02		1,200.00	
Stabilizers / Emulsifiers	0.75				0.75			
Total Kg	100.00	7.12	0.00	11.53	44.18			-11
%	100.0%	7.1	0.0	11.5	44.2	252	21	

SUGAR-FREE CUSTARD ICE CREAM

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5 %	57.98	2.03		5.22	7.25	260.91	41.75	
Cream 35 %	12.00	4.20		0.72	4.92	36.00	5.76	
Dried Skimmed milk	5.50			5.34	5.34	266.75	42.68	
Glycerol	1.00		0.50		1.00	370.00	60.00	
Inulin	4.00		7.36		4.00	100.00	80.00	
Sorbitol	6.00		6.85		6.00	1080.00	360.00	
Maltitol	4.00		1.20		4.00	400.00	320.00	
Isomalt	2.00				2.00	200.00	100.00	
Microcrystalline Cellulose	0.75		0.06		0.75			
Egg Yolk	6.00	1.80	0.64		3.00			
Sucralose	0.01				0.01		600.00	
Aspartame / Acesulfame K	0.01				0.01		300.00	
Stabilizers / Emulsifiers	0.75				0.75			
Total Kg	100.00	8.03	0.00	11.27	39.02			-12
%	100.0%	8.0	0.0	11.3	39.0	271	19	

LOW SUGAR \ HIGH PROTEIN ICE CREAM

INGREDIENTS	QUANTITY KG	KCAL PER 100 gr	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.	PROTEINS
Milk 3,5 %	56.38		1.80		4.89	6.80	244.62	39.10		2.45
Cream 35 %	5.00		1.75		0.30	2.05	15.00	2.40		0.15
Dried Skimmed milk	2.00				1.94	1.94	97.00	15.52		0.97
Glycerol	1.00					1.00	370.00	60.00		
Inulin	2.00					2.00	50.00	10.00		
Sorbitol	1.00					1.00	180.00	60.00		
Maltitol	1.00					1.00	100.00	80.00		
MPI	5.00		0.33	0.25	4.73	4.70	25.00	4.00		4.48
WPC80	5.00		0.25	0.20	4.70	4.80	20.00	3.20		4.00
MCC89	5.00		0.15	0.05	4.55	4.55	5.00	0.80		4.48
Erythritol	4.00					3.50	1100.00	280.00		
Polydextrose	3.00					2.70	122	1.66		
Sucrose	4.00			4.00		4.00	400.00	400.00		
Isomalt	1.50					1.50	150.00	75.00		
Microcrystalline Cellulose	0.50					0.50				
Egg Yolk	4.00		1.20			2.00				0.19
Sucralose	0.01					0.01		800.00		
Aspartame / Acesulfame K	0.01					0.01		300.00		
Salt	0.00					0.00	60.00			
Guar Gum	0.12					0.12				
Corraganenan	0.15					0.15				
Sumc 6-20 glycerides of fatty acids	0.20					0.20				
Propylenglycole monoester	0.20					0.20				
Carob Bean Gum	0.15					0.15			Proteins %	10.71
Total Kg	100.00		5.33	4.50	21.17	45.89			-13	
%	100.0%	212.0	5.4	4.5	21.1	45.9	264	153		

Formulations of Fat-Reduced Ice Creams



Removing the fat from an ice cream recipe is instead a slightly simpler task. Theoretically, by simply using fat-free ingredients and removing the fatty components (egg yolk, chocolate, nuts pastes, etc.), the resulting ice cream is going to be fat-free, or anyway, with very low-fat content. However, it will not be as creamy and pleasant as the full-fat one. Fat, as we very well know, is responsible for developing a three-dimensional structure while freezing in agitation, and imparts unique characteristics to the frozen dessert. Therefore, while removing fat has a little impact on the freezing behaviour of the mix, the impact on texture and mouthfeel is great and the ice cream maker must compensate for it. It can be inferred that as fat is removed from the recipe, other ingredients must be brought in to keep the solid / water ratio within a reasonable range.

It is pretty easy to formulate a reduced-fat or “light” ice cream with a fat content reduced down to around 4%. This result can be achieved by just re-proportioning regular ingredients, basically removing cream, yolk, chocolate, etc.

On the other hand, reaching lower concentrations of fat below 4% requires the need to resource some sort of fat replacement.

Fat-emulating substances can come from a variety of component categories. We may have carbohydrate fat replacement, protein fat replacement, or even fat-based fat replacement (yes, I know it sounds weird).

Some examples of these substances are:

Carbohydrate-based fat replacement

They provide solids contributing to bulk up the formula. They increase the viscosity and bind water to help control the ice crystals’ growth.

- Modified and Microcrystalline Cellulose 0.5 – 2 %
- Starches and Modified Starches 1 – 2 %
- Dextrins and Cycle-dextrins 0.01 – 0.3 %
- Maltodextrins (5 – 36 DE) 1 – 5 %
- Polydextrose 2 – 15 %

Protein-based fat replacement

They have a colloidal function, bind water, and give creaminess.

- Whey proteins concentrated (any amount depending on the lactose content)
- Egg white powder 1 – 4 %

Fat based fat replacement

Typically, these products are not purely added by the artisanal ice cream maker; rather they are included in pre-mixed compounds to be used as a ready-made fat replacement at the dose suggested by the manufacturer. They are still fat, which is why their use, even if required at a very low concentration, only allows the production of “reduced-fat” or “light” frozen desserts.

- Mono and Diacylglycerols MDAG 0,3 – 1 %










After obtaining a correct balancing of the functional ingredient in the recipe, the flavouring must also be considered carefully.

Butterfat has a characteristic and pleasant taste; its removal allows other less favorable tastes to emerge, especially skimmed dry milk and glucose syrups. Moreover, several aromas are conveyed by fat. When fat is removed, all the other flavouring becomes dull and bland, imposing a higher dosage in the recipe to compensate. Often, chemical aromas are either used pure or within syrup-based aromatic pastes. Caramel, coffee, and butterscotch are often used in fat-reduced products because their taste will prevail over the mix.

Defatted cocoa powder can be used as long as the fat carried by this ingredient in the mix does not trespass the stipulated threshold.

Chemical aromas like milk, cream, vanilla, nuts, and butterscotch are commonly used.

FAT-FREE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Skimmed Milk 0,1%	50.50	0.06		5.27	5.32	263.25	42.12	
Dried Skimmed milk	4.00			3.88	3.89	194.00	31.04	
Sucrose	13.00		13.00		13.00	1300.00	1300.00	
Dextrose	0.50		0.46		0.46	82.80	34.50	
CSS 60 DE	5.50		4.40		4.40	264.00	220.00	
Inulin	4.00				4.00	100.00	100.00	
Maltodextrine 10 DE	6.00				5.70	85.50	52.70	
Polydextrose	4.00				4.00	100.00	20.00	
WPC 80%	3.00	0.12		2.40	2.85	27.00	4.32	
Microcrystalline Cellulose	1.00				1.00			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	0.18	17.86	11.55	45.11			-11
%	100.0%	0.2	17.9	11.5	45.1	242	18	

Plant-Based Formulation



Plant-based protein ice creams are increasingly emerging as the preferred alternatives for those who are allergic to egg or dairy protein, while also attracting those who do not want to include animal products in their diet for various reasons. Nowadays, vegan consumers are increasingly seeking frozen, dairy-free desserts without compromising on the ice cream's texture and creamy mouthfeel. Until recently, such consumers could merely opt for sorbets in ice cream parlours (artisanal) to satiate their desire for something sweet while complying with their dietary restrictions. This explains the growing popularity of vegan ice creams.

Manufacturers are also seemingly increasingly accepting frozen desserts to supplant rudimentary nutrition to lower the hazard of various health ailments/diseases thus increasing their foothold in a market that is becoming health conscious.

There is a marked differentiation in the regulation of frozen dairy and plant-based desserts. The market for frozen dessert formulations (dairy-based) which do not comply with this standard fall under the category of frozen desserts. However, there is a paucity of published information on the science of such ice creams.

The non-dairy frozen dessert formulation has been fixed on an empirical basis so far. Unlike the recognised science of conventional ice cream, this category requires a more scientific examination of the interactions between the ingredients. Manufacturers of technological ingredients are developing new products and researching this complex and new sector. As of today, the composition of plant-based formulations is not defined by any specific regulations, allowing great flexibility to use unique and sometimes unusual functional ingredients. Fat sources include emulsions such as margarine, coconut cream, oils, or shortening. Plant solids may be derived from a wide array of plants like nuts, grains, fruits, and seeds. Plant solids non-fat (PSNF) can be brought into the recipe with other ingredients like nut butter or plant-based beverages. However, they are more often added to formulations in more convenient and consistent dry concentrated powders such as pea protein concentrate, soy protein isolate, rice, or pumpkin seed protein powders.

Now, you will probably be wondering: "ok, what do we put in these recipes then?" Well, we now need to emulate the behaviours of the original thing while sourcing all the functional ingredients within the vegetable realm.

In our formulation we will, as usual, need:

- A source of fat
- A source of proteins
- A properly designed sugars profile
- The right amount of solids

The major issue will be to obtain consistency in the very valuable composition of the vegetable ingredient. This is essential to predict the properties of the recipe.

The variability in the composition of vegetable ingredients can influence several characteristics of the product. It is difficult to standardize plant-based butter, beverages, and creams, which is why they should not be used as the foundation of a plant-based formulae.

- The freezing point depression will be varying along with the fluctuations in sugar composition (for example different vegetable beverages)
- Different fats profile can influence the whippability and hardness
- The difference in solids and starch content will greatly change the viscosity of the mix after pasteurisation
- The taste and flavour can be affected by "alien" off-notes deriving from vegetable ingredients

It is important to completely revisit the formulations of desserts to substitute protein and milk fat so as to emulate the feel/taste of ice creams. Due to the difference in the properties of plant proteins and milk proteins, it is not easy to make non-dairy vegetable substitutions.

We have already explained the huge importance that milk protein and milk fat have on the development of the body and structure. Their unique interaction leads, in regular dairy-based ice cream, to partial coalescence, stabilising the product and giving it the typical smoothness and texture. By contrast, vegetable proteins and fats do not develop such delicate interactions. As a result, when swapping suppliers of protein, dairy-alternative ice cream producers must alter their formulation.

Moreover, the egg proteins are also missing in plant-based ice creams and with them, the emulsifying properties of the egg yolk lecithin are also missing. In vegan ice creams, mono-/diglycerides, as well as acetylated diglycerides, function appropriately as emulsifiers. PS 80 is also employed successfully.

Vegetable Solids Non-Fat (PSNF)

These components can be sourced from a variety of ingredients, provided the ice cream maker knows the precise composition of those. These components can be derived from legumes, seeds, nuts, grains, roots, or fruits. Soy, pea, hemp, potato, chia, canola, faba, coconut, cashew, oat, rice, flax, avocado, and pumpkin are the most common.

They can come under different forms such as pastes, butter, liquid suspensions ("alternative milk"), or in powder forms like flour or isolated proteins.

Fats and Oils

Similar to the PSNF, are derived from several different sources. They are divided into two categories: solid fats and liquid oil. In plant-based ice cream formulations, a ratio 70 / 30% is usually recommended to obtain the best scoopability and mouthfeel.

Common sources of pure fat are palm, palm kernel, cotton, coconut, soy, peanut, canola, cashew, avocado, cocoa butter, flax, sunflower, safflower, almond, etc. Fats can also be carried in by pastes and butter like peanut butter, hazelnut, pistachio, sesame or walnuts pastes.

Other components

We also find other components that are commonly used in regular ice cream and frozen desserts.

Sugars, flavouring ingredients, stabilisers, and emulsifiers are the same used in standard ice cream, as long as they are 100% plant-based. Typically, the sweetness of the water-soluble bulking agents in plant-based mixes is very similar to that of dairy mixes. However, while considering the amount/type of proteins, oils, and fats to be used, it may be necessary to use an unusually high amount of sweeteners/bulking agents to balance the remaining mix to attain the intended freezing performance, as well as eating quality without compromising on the element of sweetness.

The use of stabilisers and hydrocolloids might sometimes depend on the composition of the plant-based ingredients. Some ingredients contain a high quantity of starch that, once pasteurised, thickens dramatically increasing the mix viscosity. In other cases, instead, a proper stabiliser profile can improve mouthfeel, stability, and texture.

In this table, some commonly used plant-based protein sources used in this type of frozen dessert are shown.

PRODUCT	PSNF %	FAT %	SUGAR %	SOLID %
Defatted Soy Flour	50	1	12	95
Pumpkin Seeds Proteins	60	1	0	95
Rice Isolated Proteins	80	1	0	95
Cashew Butter	20	50	4	95
Isolated Pea Proteins	80	1	0	95

This data will be used in compiling of recipe balancing table. However, these are just reference numbers, a myriad of amazing ready-to-use products can be bought in the market, and manufacturer indication must be followed to obtain the best results.

In the table below, some examples of the variegate behaviours of different plant-based proteins are shown. In preparing plant protein ice cream, parameters like the ice cream’s texture and mouthfeel are paramount to replicate the eating experience associated with a normal ice cream. The plant proteins’ molecular structures are drastically dissimilar to those found in dairy proteins. For this reason, many technical challenges could be observed during the formulation of plant protein ice creams. There is variation in the interaction between the protein structures of dairy/non-dairy sources, which is why the viscosity level is higher in vegan/non-dairy formulation caused by the presence of starch and the lack of non-fat milk solids.

After replacing milk proteins, the mouthfeel and flavour of vegan or plant-based ice creams become prominent. However, using an appropriate blend of vegetable protein sources allows a pleasant outcome in sensorial evaluation.

Extensive tests and adherence to the manufacturer’s indications are the key to achieving a good quality product.

 TYPE OF PROTEIN	 TYPICAL TASTE	 % OF VISCOSITY INCREASE IN PASTEURIZATION
Rice Proteins	Sweet, nutty powdery	2
Faba Proteins	Cereal, clean, viscous, beany	300
Soy Proteins	Nutty, Clean, beany, viscous	-20
Pea Proteins	Nutty, cereal, beany, viscous	20
Milk Proteins	Milky, paper, sweet	-25

Once the perfect balance of functional components has been achieved, the base mix must be flavoured to give a nice taste and mouthfeel that is not created by the absence of dairy components.

The choice is almost endless. The ice cream maker can now free their fantasy to use any (vegetable), which means it is possible to enhance the taste and flavour of the frozen dessert.

The flavouring of plant-based frozen ice cream can be achieved using, among others:









- Fruit puree, fresh or lyo
- Fruit jams, marmalade, compote
- Nut pastes, nut butters, and pralines (no milk)

- Dried fruit and dried nut powders
- Chemical aromas
- Aromatic paste concentrates
- Cocoa and vegan dark chocolate
- Vanilla or other vegetable extracts
- Inclusion of vegan cookies, meringue, marshmallows, or other vegan baked goods
- Caramel
- Etc.








VEGAN ICE CREAM BASE

INGREDIENTS	QUANTITY KG	FATS	SUGARS	PSNF	SOLIDS	AFP	SP	SERV. TEMP.
Oat Milk 5 % fat	67.80	3.39	4.75	2.03	5.42	474.60	474.60	
Coconut Oil	8.00	8.00			8.00			
Peas Isolated Proteins	3.00	0.03		2.40	2.85			
Sucrose	12.00		12.00		12.00	1,200.00	1,200.00	
Dextrose	3.70		3.40		3.40	612.72	255.30	
CSS 60 DE	4.50		3.60		3.60	216.00	180.00	
Mono-Diglycerides fatty acid	0.30				0.30			
PS 80	0.20				0.20			
Stabilizers	0.50				0.50			
Total Kg	100.00	11.42	23.75	4.43	36.28			-11
%	100.0%	11.4	23.8	4.4	36.3	250	21	

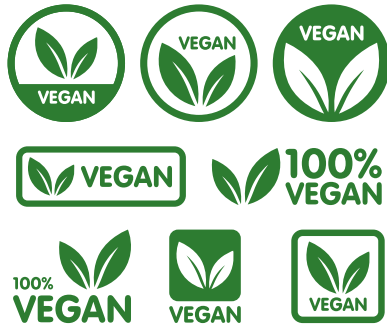
VEGAN COCONUT ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 PSNF	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Coconut Milk 5 % fat	65.10	3.26	4.56	1.95	5.21	455.70	455.70	
Dehydrated coconut milk	5.00	3.10		0.60	4.75			
Coconut Oil	2.00	2.00			2.00			
Peas Isolated Proteins	2.00	0.02		1.60	1.90			
Sucrose	6.00		6.00		6.00	600.00	600.00	
Dextrose	8.00		7.36		7.36	1,324.80	552.00	
Coconut Dry	8.00	2.80			2.80			
Dry Glucose Syrup 38 DE	3.00		2.85		2.85	142.50	119.70	
Mono-Diglycerides fatty acid	0.30				0.30			
PS 80	0.15				0.15			
Stabilizers	0.45				0.45			
Total Kg	100.00	11.18	20.77	4.15	33.77			-11
%	100.0%	11.2	20.8	4.2	33.8	252	17	

VEGAN CHOCOLATE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 PSNF	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Oat Milk 5 % fat	61.80	3.09	4.33	1.85	4.94	432.60	432.60	
Coconut Oil	6.00	6.00			6.00			
Peas Isolated Proteins	3.00	0.03		2.40	2.85			
Sucrose	12.00		12.00		12.00	1,200.00	1,200.00	
Dextrose	5.70		5.24		5.24	943.92	393.30	
CSS 80 DE	4.50		3.60		3.60	216.00	180.00	
Cocoa Powder 20 /22	6.00	1.38			6.00	-409.80		
Mono-Diglycerides fatty acid	0.30				0.30			
PS 80	0.20				0.20			
Stabilizers	0.50				0.50			
Total Kg	100.00	10.50	25.17	4.25	41.64			-11
%	100.0%	10.5	25.	4.3	41.8	238	22	

Keep in mind also...



There are several vegan trademarks in the UK. The USA and Europe have different standards which the food must meet when their logo is displayed. In the UK and EU, terminology such as “vegan” or “vegetarian” had not been clearly defined by law. In the UK, however, the *Protection from Unfair Trading Regulations 2008* forbids any good containing animal product ingredients from being called “vegan”.

When adding a declaration like this, the manufacturer or artisanal ice cream maker must be backed up by independent certifying organisations like *The Vegan Society Trademark*, an international standard that comes under the purview of the Vegan Society.

Via their regulations, food producers are allowed to use the term ‘may contain’ on packaging, as well as labels to signify the possibility of contact with animal products during the manufacturing. Having said that, they encourage manufacturers to reduce cross-contamination to the greatest extent possible.

You must consult with these types of organisations before adding any claim on the product and registering the label.

Granita

The Sicilian granita is the symbol of summer, a fresh indulgence with a unique taste and amazing simplicity: only water, caster sugar, and fruit are needed. According to tradition, granita must be enjoyed together with another mythical delight of Sicilian gastronomy: the brioche with "tuppo", in a fantastic, still alive symbiosis.



Granita is profoundly different from any other frozen dessert we have been studying so far. This kind of slush develops no overrun or creamy texture. Above all, we want the ice crystals to be as big as possible in the granita. For all these reasons, granita is a special and extremely simple preparation, falling in between water ice, a sorbet, and a frozen beverage.

The production of gratina does not require particular skills and is extremely inexpensive. Therefore, ice cream makers should consider including this extraordinary product in their catalogue of products.

The showcase/holding freezer is the only thing that must be paid attention to, as it cannot be stored together with ice creams but instead needs a different temperature.

As I said, only three ingredients are required for this product; water, fruit, and sucrose. No glucose, no dextrose, no inverted sugar, or other exotic ingredients are necessary.

The preparation, in a similar way to sorbets, can follow two systems:

- Preparation of the sugar syrup in large batches and adding fruit puree/juice when freezing the batches
- Preparation of each batch starting from weighing to freezing

Probably the first method is the most common and the quickest. I will therefore explain this, but the differences in this product are minimal.

The most commonly used basic sugar syrup for any granita is the 60% one. In this case, 100 litres of the syrup will contain 40kg of water and 60kg of sucrose.

This syrup, once cooled, can be kept in the fridge for prolonged periods, as long as it is kept in sealed containers.

At the moment of preparation of the granita, the ice cream maker will simply mix the proper ratio of syrup/fruit juice or puree and freeze the mix.

The general composition for granita requires between 17.5 and 21% of sugar; it is, therefore, clear that knowing the sugar title of the fruit used is essential to balance this ratio.

When using fruit juices or purees titled in sugar (i.e. 10%), this task is straightforward and the balancing is easy/consistent.

On the other hand, when using fresh fruit (as is usually done in Italy for the production of this dessert), we cannot be sure of its actual sugar content.

In this case (and dare I say, only in this case), the measurement can be empirical and done on the final mix that will then be possibly adjusted.

Actual sugar measurement can be undertaken by two systems: The densitometer or the refractometer.

The densitometer Baumè



The hydrometer, also called hydrometer or Baumè, is used for measuring the relative density of liquids based on the concept of buoyancy. These instruments are usually calibrated and graduated with one or more scales such as specific weights. The most useful scale for granita will be 0 - 30 or 0 - 50. A densitometer consists of a floating sealed hollow glass tube, a ballast for stability as well as a narrow stem with graduations for reading the measurement. The mixture to be tested is poured into a tall, narrow container, often a cylinder, and the hydrometer is gently lowered into the liquid until it floats freely. The point where the surface of the liquid touches the stem of the hydrometer reads the relative density.

The Brix refractometer



Nowadays, the most common and easy way to determine the sugar content in a mix is probably the refractometer. This pocket-sized, light-weighted device measures the index of refraction of a light source through the sample and gives us the solid content of this sample, in our case sugar. The ice cream maker will simply place a drop of the mix on the sampling area, point the device to a light source (the sun for example) and look into the instrument as if it was a spyglass. A line will appear in corresponding graduated scale indicating the sugar content of the sample. The refractometers usually yield the result in ° Brix. The °Brix is named after Adolf Brix, measures of the concentration of sugar in solution expressed as the % by weight of sugar in solution at a specified temperature.

1.8° Brix = 1° Baumé (Bè). As a result, we will have 20°C:

17° Brix = 17% sugar = 9.4° Bè

18° Brix = 18% sugar = 10° Bè

19° Brix = 19% sugar = 10.5° Bè

20° Brix = 20% sugar = 11.1° Bè

21° Brix = 21% sugar = 11.6° Bè

22° Brix = 22% sugar = 12.2° Bè

The Freezing Methods

Once the mix is ready and calibrated, it must be frozen. Unlike ice cream and sorbets, for granita, we want to slowly lower the temperature of the mix to promote the growth of large ice crystals.

Traditionally, the granita has been produced via static freezing. The artisan simply pours the mix into the iconic metal cylinders that are then placed into the negative well-counter to freeze. There, the freezing takes place over several hours and every now and then, the ice cream maker scrapes the ice formed on the sides of the container, mixing it with a long spatula.

Excellent results are also obtained using the vertical batch freezer with no agitation. However, these machineries are hardly used in modern laboratories today.

It's instead much more common to prepare the granita with other horizontal batch freezers which, nowadays, come equipped with digital programs specifically designed to produce granita.

The same mix can be successfully frozen in a slush machine. Those simple devices allow, with only one piece of equipment, the production of the slush and to hold it cold, thus optimising the costs and the space consumption related to this product. Not surprisingly, the use of such devices is considered heretic by the purist artisans from the south of Italy, while continuing to uphold the original granita tradition.



ALMOND GRANITA

 INGREDIENT	 QUANTITY	 SUGARS
Sugar Syrup 60%	1.65	0.99
Sweet Almond Paste 50%	2	1
Water	6.35	
TOTALS	10	1.99

COFFEE GRANITA

 INGREDIENT	 QUANTITY	 SUGARS
Sugar Syrup 60%	3.4	2.04
Water	6.35	
Dry Instant Coffe	0.25	
TOTALS	10	2.04

LEMON GRANITA

 INGREDIENT	 QUANTITY	 SUGARS
Sugar Syrup 60%	2.4	1.44
Lemon Marmalade	0.8	0.56
Water	4	
Lemon Juice	2.8	
TOTALS	10	2

REAL COFFEE GRANITA

 INGREDIENT	 QUANTITY	 SUGARS
Sucrose	2	2
Espresso Coffee	8	
TOTALS	10	2

STRAWBERRY GRANITA

 INGREDIENT	 QUANTITY	 SUGARS
Sugar Syrup 60%	3	1.8
Water	4.5	
Strawberry Puree 10%	2	0.2
Lemon Juice	0.5	
TOTALS	10	2

COCOA GRANITA

 INGREDIENTS	 QUANTITY KG	 SUGAR KG
Sugar Syrup 60%	3.4	2.04
Milk	5	
Water	1.1	
Cocoa Powder	0.5	
Total	10	2.04

SWEET FRUITS GRANITA

 INGREDIENT	 QUANTITY	 SUGARS
Sugar Syrup 60%	2.4	1.44
Sweet Fruit Puree	2	0.36
Water	5	
Lemon Juice	0.6	
TOTALS	10	1.8



Icicles and Moulded Stick Ice Creams



In this chapter, I refer to all these frozen products containing a stick for hand-holding. The production procedure is simple, the decorations are endless, and there is no product waste. Ice cream on a stick must have a creamy consistency, without air, be as tasty and fresh as artisanal, and be 100% genuine ice cream. Cream ice creams have the same ingredients as normal ice cream, only the production method changes. They can be prepared in a manner to achieve any taste, and it is also possible to surprise your customers with ice creams covered and decorated in some of the most creative ways.

Fruit popsicles, on the other hand, are made with a few simple ingredients: fruit, water, and sugars. This means that the product has negligible production costs but can attract a lot of demand, especially in the hottest months.

Water ice bars are produced by quiescently freezing a mixture similar to the one used for sorbets in proper moulds. After partial freezing, as the mix starts to crystallize, a wooden stick is inserted in the middle point of the product which subsequently undergoes complete freezing at a low temperature (-25°C / -35°C). Multiple deposits and freezing cycles allow the production of water ice bars with the stratification of horizontal colours.

Moulded ice creams are instead made with a mixture very similar to the one used in regular gelato, without overrun. In this production, the mix might or might not undergo partial dynamic freezing/whipping in the continuous or batch freezer before being poured/injected into the moulds. In this case as well, a wooden stick is inserted as the mix starts hardening and a complete freezing process follows. Often these products are then coated, usually with a fat-based chocolate concoction.

In case the ice cream maker opts for a semi-whipped/batch-frozen mixture, the density at the moment of extraction moment must be carefully monitored. If the ice cream mix does not freeze sufficiently, it will turn into a liquid and can be easily poured into the moulds, but the result will be icier and sometimes harder. If the batch-freezing process is too extended, the resulting ice cream will be too creamy and difficult to pour into the moulds, especially when this operation is performed manually for small productions.



Pic. 90 Model Mister Art device for the injection of semi-frozen mix in the icicles moulds. Photo courtesy of © Carpigiani

Brilliantly designed pieces of equipment are now available to prepare semi-whipped/frozen moulded ice cream. The above picture shows the example of an extremely compact device capable of pasteurising, cooling down, partially freezing, and whipping the mix for these products. The machine then pumps the semi-frozen mix via a narrow pointed nozzle, eventually reaching the bottom part of the icicle mould.

The recipe formulation does not require any particular attention besides a lower AFP. Both water ice bars and stick ice cream must have a pretty low percentage of liquid water when consumed. An AFP around 175 - 190, and a predicted service temperature of -8° / -9° , usually works well.

The hardening in the mould can be performed in various ways. Small productions should opt for air-cooled systems and metal or silicon moulds. These freezers can also be accessed from above to simplify the loading operation.



When using horizontal plastic or silicon moulds, the ice cream must be fully frozen and whipped. Regular ice creams (often small amounts of leftover or quantity are insufficient in filling up a new container) are used, provided a lower temperature of conservation is set in the showcase.

In laboratories with a larger scale of production, liquid-cooled bath machineries should be preferred due to their ability to achieve faster, more reliable, and consistent production.



Pic. 91 Blast freezer with loading from above specially designed for the production of ice cream sticks. Model Fantastick. Photo courtesy of © Carpigiani



FRUIT WATER ICE BARS

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	55.00					
Sucrose	15.00	15.00	15.00	1,500.00	1,500.00	
Dry Glucose Syrup 38 DE	4.25	4.04	4.04	201.88	169.58	
Fruit Puree 10%	17.00	1.70	2.04	27.20	20.40	
Flavouring	2.00					
Lemon Juice	6.00	0.48	0.48	7.68	5.76	
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	21.22	22.31			-8
%	100.0%	21.2	22.3	174	17	

WHITE STICK ICE CREAM

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5 %	58.00	2.03		5.22	7.25	261.00	41.76	
Cream 35 %	20.00	7.00		1.20	8.20	60.00	9.00	
Dried Skimmed milk	5.00			4.85	4.65	242.50	38.80	
Sucrose	9.00		9.00		9.00	900.00	900.00	
Dry Glucose Syrup 38 DE	7.50		7.13		7.13	358.25	299.25	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	9.03	16.13	11.27	36.93			-8
%	100.0%	9.0	16.1	11.3	36.9	192	13	

TOFFE FUDGE BARS

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5 %	56.50	1.98		5.09	7.06	254.25	40.68	
Cream 35 %	10.00	3.50		0.60	4.10	30.00	4.80	
Dried Skimmed milk	5.00			4.85	4.85	242.50	38.80	
Sucrose	10.00		10.00		10.00	1000.00	1000.00	
Dry Glucose Syrup 38 DE	5.00		4.75		4.75	237.50	199.50	
Toffee Aromatic Paste	8.00		4.80		5.60	432.00	432.00	
Cocoa powder 22/24	5.00	1.15			5.00	-341.50		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	6.63	19.55	10.54	41.86			-8
%	100.0%	6.6	19.6	10.5	41.9	185	17	

Chocolate coating



Often icicles and, above all, moulded ice cream on sticks are coated with chocolate. This not only makes them more delicious and visually appealing but also protects them and helps them retain their shape if exposed to thermic shock or temperature fluctuations.

Consistently achieving the rewarding sensation of chocolatey crunch, the cocoa flavour is deliciously offsetting, and achieving this balanced sweetness is rather complicated.

The chocolate mixture used for the coating (aka enrobing), must fulfil various technical prerequisites.

- Must have a pleasant and real chocolate taste
- Must solidify quickly on the frozen product
- Must readily melt in the mouth without leaving fatty or waxy sensations
- Must be fluid to allow a thin layer of coating on the ice cream
- Must be flexible enough to absorb shocks and impacts (transportation, storing...)
- Must be crunchy when bitten and not soft or elastic

This is mainly attributed to the specific properties of confectionery fats like the uniquely hard cocoa butter which melts in the mouth at 35°C (95°F) despite being hard and brittle below 30°C (86°F).

However, it is pretty clear that chocolate alone cannot achieve these results. Other ingredients must also be mixed in the coating concoction.

The total fat content should be above 60% to attain a thin layer as well as the short time of crystallisation.

To begin with, a fluid chocolate couverture (white, dark, or milk), should be chosen as the base.

To impart flexibility and crack resistance to the formulation, it is prudent to use an oil with a high content of lauric acid. Coconut oil and PKO are perfect for this scope in a percentage between 12 and 15%.

Both palm kernel fat and coconut oils are comparatively brittle and hard after cooling. In addition, a mix containing only chocolate and such oils might be prone to smearing. To counter these issues and improve plasticity, a common suggestion is to add 8-10% of a non-lauric liquid oil (peanut, sunflower, or rapeseed oil). Alternatively, I highly recommend the addition of 5 - 6% of anhydrous milk fat.

In milk and white chocolate, the additional milk fat content increases softness and plasticity and reduces shrinkage during crystallisation. However, due to the variability in the composition of these types of chocolates, the viscosity should be tested and adjusted with the addition of coconut oil, peanut oil, and anhydrous butterfat.

In order to obtain a thin and even chocolate coating, we would do well to remember that several factors are involved in this ostensibly simple operation. The colder the ice cream will be, the thicker the coating and vice versa. Also, a longer immersion time would lead to a thicker coat. The moisture is deleterious for chocolate, the ice

cream must be coated immediately after being removed from the blast freezer without sitting at room temperature to avoid condensation.

When using very low-temperature ice cream sticks, the coating mixture temperature must be risen to some degree to obtain a thin layer.

©Pacojet



Even though it can do much, much more, the ©Pacojet is usually elucidated as a princely, high-tech, Swiss-made ice cream maker. It's about the size of a coffee bean machine, so it can easily fit on a residential kitchen counter or in any small restaurant kitchen. Over time, a real cult has developed around this fancy piece of equipment and it seems that nowadays every single starred restaurant MUST have one... at least.

Here, I will be unable to expound on the full potentiality of this brilliant device. Recipes, indications, and the Chef's experience are shared on the company website: www.pacojet.com. I will instead focus on its use to make frozen desserts like "ice cream" and "sorbet". However, it is important to keep in mind that a specific name (ice cream, gelato, sorbet, etc.) might not be associated with such products, but fall in the generic "frozen dessert" nomenclature in accordance with the local legislation.

To approach the preparation of frozen desserts with the ©Pacojet, we must forget everything we have learned so far about ice cream.

The ©Pacojet turns the ice cream-making process inside out using a finely calibrated mechanism and pure brute power. So, by dynamically freezing the mix in some sort of device that removes heat while slowly agitating it, the process starts with static freezing of the mixture. Once the mix is frozen, it is processed in the machine where

sharpened blades turn at a very high speed to achieve an extremely fine cream. The ice crystals do not pose a challenge because they also get reduced in size during processing. Obviously, this kind of production does not consider the partial coalescence of fat or sugar balancing to control the AFP. However, none of this matters because the ice cream produced with the ©Pacojet is not supposed to last, be stored, or exposed in showcases. The machine only allows the production of very small-sized batches, making for a quick service product ideal for restaurants. This consideration assumes even greater significance in the context of savoury ice creams. Not being constrained by the sugar balancing rules, the Chef can reach more "extreme" recipes with even lower sugar content, thus making a real "salty" ice cream out of every possible ingredient.

Another extremely convenient feature of this machine is the over-pressure. It is in fact possible to process the frozen products while a positive pressure is created in the sealed container. This, of course, allows a significant increase in overrun, above all, in "unbalanced" recipes which would be impossible to freeze in standard ice cream machinery.

For sweet ice cream or sorbets, the process commences with frozen fruit, or with a purposely prepared frozen mixture that might include milk, cream, sugar, stabiliser, eggs, fruit, etc.

The frozen product is then inserted into the stainless steel processing cup and undergoes processing in the machine.

The processing cycle can also be repeated two or three times in order to improve the overrun and obtain a fluffier result.

The ingredients needed for a single batch can also be pre-weighted and mixed in spare metal cups and frozen. At the time of service, all it will take is a few minutes (or seconds) to turn this frozen batch into ice cream, with perfect spoonability ideal for obtaining quenelles.

If the processing is made under positive pressure, a significantly greater overrun is obtained, leading, if desired, to airy, light mousses as well.

All in all, this machine makes for a great resource in operation requiring small extemporaneous production of a variety of different preparations, but that does not need to store them.

I will include some recipes I find helpful or that I like for this device. In those recipes, however, I did not use the same standard table with basic components because, as I mentioned before, these products do not follow the standard rules we have learned so far.



Pic. 92 ©Pacojet 2 Plus. Photo courtesy of © Pacojet AG

The recipes for this device are way more "forgiving", allowing basically everyone, even without a clue about ice cream balancing, to prepare a dignified short service frozen dessert.

All of that being said, I must highlight that any ice cream recipe we have seen so far will work just brilliantly for the processing in the ©Pacojet. A small batch of the mixture will be cooked, cooled, and frozen in the stainless steel ©Pacojet cup, ready to be turned into ice cream.

Furthermore, an array of machinery with similar specs from different brands are now available in the market. They are capable of performing in a similar fashion.

Chocolate Ice Cream

250 g of Milk
200 g of Cream
100 g of Sugar
80 g of Egg-Yolk
Vanilla
22 g of Cocoa Powder
140 g of 70% Chocolate

Mix all the ingredients, bring to 85°C, cool down and place in the Pacojet cup. Freeze and process twice.

Vanilla Ice Cream

250 g of Milk
160 g of Cream
100 g of Sugar
80 g of Egg-Yolk
Vanilla Beans
20 g of Honey
25 g of Milk Powder

Mix all the ingredients, bring to 85°C, cool down and place in the Pacojet cup. Freeze and process twice.



Strawberries Ice Cream

320 g of Cream
100 g of Sugar
430 g of Strawberries
20 g of Dextrose
20 g of Milk Powder

Mix all the ingredients, bring to 85°C, cool down and place in the Pacojet cup. Freeze and process twice.

Hazelnut/Pistachio Ice Cream

250 g of Milk
150 g of Cream
100 g of Sugar
80 g of Egg-Yolk
20 g of Milk Powder
100 g of Roasted Nuts

Mix all the ingredients, bring to 85°C, cool down and place in the PacoJet cup. Freeze and process twice.

Yogurt and Rosemary Ice Cream

500 g of Full-Fat Yogurt
200 g of Cream
100 g of Sugar
15 g of Fresh Rosemary
20 g of Milk Powder
30 g of Honey

Mix all the ingredients, bring to 85°C, cool down, remove the rosemary or leave few fresh leaves only. Place in the PacoJet cup. Freeze and process twice.

Fennel and Lime Sorbet

150 g of Fennel
90 g of Lime Juice
100 g of Sugar
2 g of Stabilizer
140 g of Water

Mix water, stabilizer and sugar, bring to 85°C, cool down and place in the Pacojet cup. Add the remaining ingredients and freeze. Process twice.

Conclusion

It does not matter how old we are, what our job title might be, or the scale of our operations; keeping ourselves updated and open-minded to assimilate knowledge must be our constant aim as Chefs. There is very little limit to the scope, depth, and breadth of one's knowledge. I believe that as artisans, we owe the best proficiency we can get in our field of expertise to our customers. In the world of ice cream, new technologies, ingredients, techniques, and machinery are being constantly introduced, and we cannot afford to look the other way.

The profession of the artisan ice cream maker, as any other hand-crafting job, cannot be chosen only or for sake of profit. While it is important to maintain the profitability of a business, at the end of the day, passion and pride should always guide our hands.

As the markets get increasingly globalised, people are becoming finicky about choosing quality food. The huge trademarks and manufacturers that boomed in the '80s and '90s with cheap and industrial products are now sharing the market with small artisanal and local productions, aimed at evincing the attention of increasingly aware consumers.

The ice cream sector is, in my opinion, thriving and capable of offering both professional satisfaction and rich profit to those who invest in quality.

Hopefully, those who want to undertake and succeed in entrepreneurial activity in this sector will be able to understand the real value of the quality and the urgency of being true to the highest professional and ethical standards.

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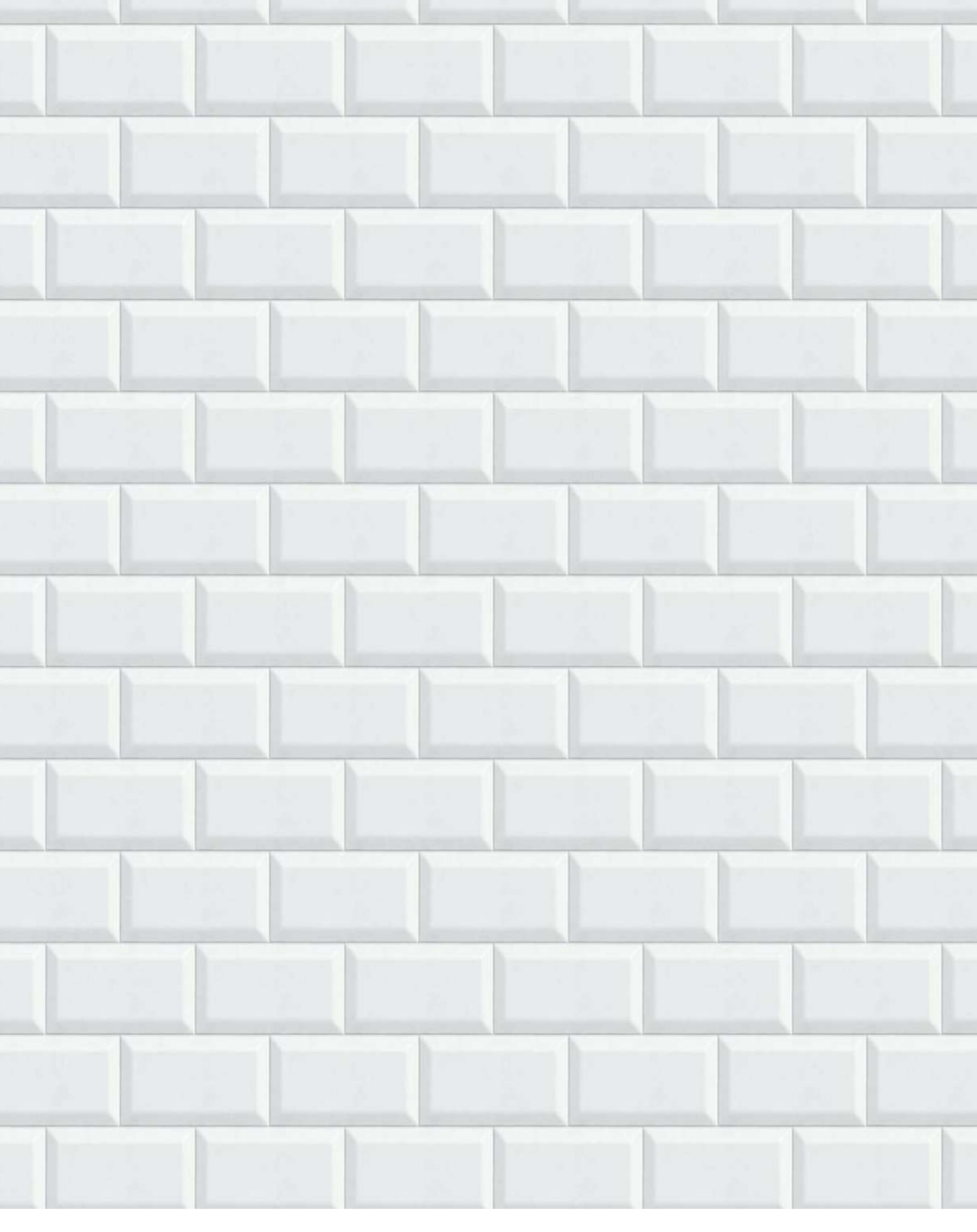
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FIORDILATTE ITALIAN ICE CREAM "PETIT FOUR" RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	60.00	2.10		5.40	7.50	270.00	43.20	
Cream 35 %	17.60	8.16		1.06	7.22	52.60	8.45	
Dried Skimmed milk	3.60			3.48	3.48	174.60	27.04	
Sucrose	13.20		13.20		13.20	1,320.00	1,320.00	
Dextrose	2.50		2.30		2.30	414.00	172.50	
Dry Glucose Syrup 38 DE	2.60		2.47		2.47	123.50	103.74	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.26	17.97	9.95	36.88			-11
%	100.0%	8.3	18	18	38.7	236	17	










It's a rich and delicious white cream ice cream, can be sold as it is or variegated with chocolate to obtain Stracciatella.

ESPRESSO ICE CREAM







 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	34.00	1.19		3.05	4.25	153.00	24.48	
Cream 35 %	22.00	7.70		1.32	9.02	66.00	10.56	
Dried Skimmed milk	6.00			5.92	5.92	291.00	46.56	
Sucrose	15.00		15.00		15.00	1,500.00	1,500.00	
Dextrose	2.50		2.30		2.30	414.00	172.50	
CSS 60 DE	2.00		1.60		1.60	96.00	80.00	
Espresso coffee	18.00							
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.89	19.90	10.20	38.49			-11
%	100.0%	8.9	19.9	10.2	38.5	252	16	












GELATO ALLA CREMA (ITALIAN EGG-CUSTARD) CHEAP RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	66.00	2.31		5.94	8.25	297.00	47.52	
Cream 35 %	5.00	1.75		0.30	2.05	15.00	2.40	
Dried Skimmed milk	4.00			3.88	3.88	194.00	31.04	
Sucrose	14.00		14.00		14.00	1,400.00	1,400.00	
Dextrose	2.00		1.84		1.84	331.20	138.00	
Inverted Sugar	1.00		0.72		0.72	93.50	135.80	
CSS 80 DE	1.50		1.20		1.20	72.00	60.00	
Egg Yolk	4.00	1.20			2.00			
Butter or Margarine	2.00	1.54			1.70			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	6.90	17.76	10.12	36.14			-11
%	100.0%	0.9	17.8	10.1	36.1	240	18	










GELATO ALLA CREMA (ITALIAN EGG-CUSTARD ICE CREAM)

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	55.00	1.93		4.95	6.88	247.50	39.60	
Cream 35 %	14.00	4.90		0.84	5.74	42.00	6.72	
Dried Skimmed milk	4.20			4.07	4.07	203.70	32.59	
Sucrose	12.80		12.80		12.80	1,280.00	1,280.00	
Dextrose	3.00		2.76		2.76	495.80	207.00	
CSS 60 DE	2.00		1.60		1.60	96.00	80.00	
Egg yolk	8.50	2.55			4.25			
Stabilizers / emulsifiers	0.50				0.50			
Total Kg	100.00	9.38	17.16	9.86	38.60			-11
%	100.0%	9.4	17.2	9.9	38.5	237	16	










GELATO ALLA CREMA (ITALIAN EGG-CUSTARD ICE CREAM) WITH CONDENSED MILK

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	54.00	1.89		4.86	6.75	243.00	38.88	
Cream 35 %	10.00	3.50		0.60	4.10	30.00	4.80	
Dried Skimmed milk	1.70			1.65	1.65	82.45	13.19	
Sucrose	9.50		9.50		9.50	950.00	950.00	
Dextrose	3.00		2.76		2.76	495.80	207.00	
CSS 60 DE	2.00		1.60		1.60	96.00	80.00	
Egg yolk	8.00	2.40			4.00			
Condensed Milk	11.30	1.02	4.86	2.49	8.36	495.90	398.72	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.81	18.72	9.60	39.22			-11
%	100.0%	8.8	18.7	9.6	39.2	233	17	










GELATO ALLA CREMA (ITALIAN EGG-CUSTARD) WITH CONDENSED MILK FOR RESTAURANT

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	48.00	1.68		4.32	8.00	216.00	34.56	
Cream 35 %	8.50	2.98		0.51	3.49	25.50	4.08	
Dried Skimmed milk	2.50			2.43	2.43	121.25	19.40	
Sucrose	7.00		7.00		7.00	700.00	700.00	
Dextrose	12.00		11.04		11.04	1,987.20	828.00	
Inverted Sugar	4.50		3.24		3.24	421.20	615.60	
Egg Yolk	8.00	2.40			4.00			
Condensed Milk	9.00	0.81	3.07	1.98	5.66	387.00	309.60	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	7.87	25.15	9.24	44.35			-18
%	100.0%	7.9	25.2	9.2	44.4	386	25	

ESPRESSO ICE CREAM "PETIT FOUR" RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	48.00	1.68		4.32	8.00	216.00	34.56	
Cream 35 %	28.00	9.80		1.68	11.48	84.00	13.44	
Dried Skimmed milk	5.00			4.85	4.85	242.50	38.80	
Sucrose	12.00		12.00		12.00	1,200.00	1,200.00	
Dextrose	3.55		3.36		3.36	804.44	251.95	
Inverted Sugar	1.00		0.72		0.72	93.60	136.90	
Dry Instant Coffe	1.20				1.20			
Rice Starch	0.75				0.75			
Stabilizers / Emulsifiers	0.40				0.40			
Total Kg	100.00	11.48	16.08	10.85	40.76			-11
%	100.0%	11.5	16.1	10.9	40.8	244	17	

ORIGINAL CARAMEL ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	41.00	1.44		3.69	513	164.50	29.52	
Cream 35 %	25.84	9.04		1.55	10.59	77.52	12.49	
Dried Skimmed milk	4.50			4.37	4.37	216.25	34.92	
Sucrose (dry caramelized)	16.00		16.00		16.00	1,600.00	1,600.00	
Dry Glucose Syrup 36 DE	5.00		4.75		4.75	237.50	199.50	
Egg Yolk	7.00	2.10			3.50			
Salt	0.16				0.16	16.00		
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	12.58	20.75	9.61	44.99			-11
%	100.0%	12.6	20.8	9.6	45.0	233	19	

For this “real-deal” flavour, you first need to obtain a dry caramel by cooking the sucrose, deglaze with cream and milk, and then continue as usual in the pasteuriser.

TEA ICE CREAM










 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Tea Strong Infusion	46.00							
Cream 35 %	22.50	7.88		1.35	9.23	67.50	10.80	
Dried Skimmed milk	9.50			9.22	9.22	460.75	73.72	
Sucrose	15.00		15.00		15.00	1,500.00	1,500.00	
Dextrose	2.00		1.84		1.84	331.26	138.00	
CSS 60 DE	2.50		2.00		2.00	120.00	100.00	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	7.88	18.84	10.57	37.78			-11
%	100.0%	7.9	18.8	10.6	37.8	243	18	

RICE PUDDING ICE CREAM










 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	50.00	1.75		4.50	6.25	225.00	36.00	
Cream 35 %	19.00	6.65		1.14	7.79	57.00	9.12	
Dried Skimmed milk	3.00			2.91	2.91	145.50	23.29	
Sucrose	5.00		5.00		5.00	500.00	500.00	
Dextrose	3.50		3.22		3.22	579.80	241.50	
Inverted Sugar	9.00		5.46		6.48	842.40	1,231.20	
Rice	10.00				10.00			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.40	14.70	8.55	42.15			-11
%	100.0%	8.4	14.7	8.6	42.2	235	20	

You first need to cook the rice into a milk rice pudding. Then the remainder of recipe is cooked in a pasteuriser.

YOGURT ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	9.20	0.32		0.83	1.15	41.40	6.62	
Cream 35 %	12.00	4.20		0.72	4.92	36.00	5.76	
Dried Skimmed milk	3.30			3.20	3.20	160.05	25.61	
Sucrose	13.00		13.00		13.00	1,300.00	1,300.00	
Dextrose	3.00		2.75		2.76	496.80	207.00	
CSS 60 DE	3.00		2.40		2.40	144.00	120.00	
Full Fat Natural Yogurt	56.00	1.96		5.04	7.00	252.00	40.32	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	6.48	18.16	9.79	34.93			-11
%	100.0%	6.6	18.2	9.8	34.9	243	17	

YOGURT ICE CREAM "PETIT FOUR" RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Cream 35 %	13.50	4.73		0.81	5.54	40.50	6.48	
Dried Skimmed milk	2.00			1.94	1.94	97.00	15.52	
Sucrose	13.00		13.00		13.00	1,300.00	1,300.00	
Dextrose	1.80		1.66		1.66	298.06	124.20	
Inverted Sugar	2.60		1.87		1.87	243.36	355.68	
CSS 60 DE	1.30		1.04		1.04	62.40	52.00	
Dry Glucose Syrup 33 DE	1.30		1.24		1.24	61.75	51.87	
Full Fat Natural Yogurt	63.20	2.21		5.59	7.90	264.40	0.46	
Rice Starch	0.80				0.80			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	6.94	18.80	8.44	35.48			-11
%	100.0%	6.9	18.8	8.4	35.6	239	18	

YOGURT ICE CREAM FOR RESTAURANT

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	4.20	0.15		0.38	0.53	18.90	3.02	
Cream 35 %	12.00	4.20		0.72	4.92	35.00	5.76	
Dried Skimmed milk	3.30			3.20	3.20	150.05	25.61	
Sucrose	4.00		4.00		4.00	400.00	400.00	
Dextrose	14.00		12.88		12.88	2,318.40	956.00	
Inverted Sugar	7.00		5.04		5.04	655.20	957.60	
CSS 60 DE	1.00		0.90		0.80	48.00	40.00	
Full Fat Natural Yogurt	54.00	1.89		4.86	6.75	243.00	38.88	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	6.24	22.72	9.16	38.62			-18
%	100.0%	6.2	22.7	9.2	38.6	388	24	

Nonetheless, I will try to explain an alternative system that should help forecast the behaviour of a chocolate ice cream "on paper".

The aim of this system is trying to determine how much each chocolate component can harden or soften the ice cream, proportion every single value for the ratio of the chocolate ingredients, and multiply this number for the amount of chocolate used. The number thus obtained will always be negative and treated as a normal AFP value. By simply adding the so obtained -AFP, we can easily forecast the ST of every chocolate mix.

To do so, we will adopt certain empiric approximations and use some fixed data as a "constant" to determine the Hardening Power of the chocolate components (cocoa butter and cocoa fibre).

This data has been obtained thanks to years of research and tests and we take them as "Ipse Dixit".

We know that:

The negative AFP of cocoa butter is -0.9 /g
The negative AFP of cocoa lean solids is -1.8 /g

We also need to know the precise composition of the chocolate we want to incorporate into the recipe in order to calculate its specific -AFP.

When buying chocolate of any kind we can easily notice it always states a % on the label.

This number indicates the % of cocoa-derived ingredients in this specific chocolate or couverture, the remaining part to get to 100% will be sugar. It will be sugar + milk powder for white or milk chocolate.

Therefore, a 70% dark chocolate will have 70% or more ingredients coming from cocoa (cocoa butter and cocoa liqueur) and 30% of sugar. In other words, 70g of this chocolate is made of cocoa ingredients while the remaining 30 is sugar.

However, this number does not tell us anything else. We cannot know how much of this 70g is cocoa butter and how much is cocoa lean solids. Luckily, some professional manufacturers nowadays tend to declare this ratio, thus making our job easier. If the repartition of cocoa components is not clearly stated, we can easily guess it by looking at the nutritional facts on the back of the package.

NUTRITIONAL INFORMATION PER 100 g:	
Energy	2350 kJ / 566 kcal
Fat	41 g
/ of which saturates	24 g
Carbohydrates	34 g
/ of which sugars	29 g
Protein	9,5 g
Salt	0,10 g

Pic. 89 Useful information can easily be obtained from chocolate nutritional fact labels

From this label, we can easily obtain all the information we need. In fact, we now know that 100g of this chocolate gives us:

- 41g of Cocoa Butter
- 29g of Sugars
- 30g (by subtraction) of other cocoa solids

We can now easily calculate our –AFP for this specific 70% dark chocolate as follows:

COMPONENT	G IN 100 G	SPECIFIC AFP	AFP
Sugar	29 g	1	29
Fat (Cocoa Butter)	41 g	-0,9	-36,9
Cocoa Lean Solids	30 g	-1,8	-54
		TOTAL AFP	-61,9

Before I am accused of wizardry, heresy, or quackery, let me clarify this once again:

Do remember that this is a rough approximation. Obviously, the cocoa butter and cocoa solids have no effect whatsoever on the water freezing, and using a negative AFP is just a shortcut trick to simplify the calculation of the mix. By hypothesising

a (bogus) negative AFP, we can only compensate for the texture by adding more sugar to obtain a softer finished product.





Now, we just have to insert this new “bogus –AFP” in the appropriate column after adding the chocolate to the recipe. Doing so will automatically increase the quantity of sugar needed to obtain the correct ice cream texture.

The same number can be obtained for any chocolate, for instance:

Milk chocolate:

 COMPONENT	 G IN 100 G	 SPECIFIC AFP	 AFP
Sugar (sucrose + Lactose)	50 g	1	50
Fat (Cocoa Butter + Milk-fat)	34 g	-0,9	-30,6
Cocoa Lean Solids	16 g	-1,8	-28,8
TOTAL AFP			-9,4

White chocolate:

 COMPONENT	 G IN 100 G	 SPECIFIC AFP	 AFP
Sugar (sucrose + Lactose)	55 g	1	55
Fat (Cocoa Butter + Milk-fat)	41 g	-0,9	-36,9
TOTAL AFP			18,1

We can notice that milk chocolate has a positive AFP as it comprises a lot of sugar and is devoid of cocoa lean solids. This means that white chocolate does not harden the ice cream but, instead, it lowers the mix’s freezing point. For this reason, we can choose to use this value as it is or to subdivide the white chocolate components (LMS, sugar, fat) and consider them separately.

In the milk chocolate, I approximated and neglected the LMS in the computation.

Once again, these approximate values merely provide a rough indication of the amount of sugar required to compensate for the hardness brought in by the cocoa materials.

When drawing up the calculation table for recipes with chocolate, fat, cocoa solids, sugar, and LMS, if present, they must be noted in the appropriate columns.

The amount of chocolate used in the recipe depends on factors like:

- Cost
- Personal taste
- Desired sweetness (the more chocolate we add, the more sugar we must add to compensate for the stiffness)
- Type of chocolate used
- Service temperature of the product

As a rule of thumb, we can consider an average of 15% of dark chocolate and up to 20% milk chocolate.

The fat brought in by the chocolate will force us to reduce (or even remove) the cream from the recipe. The freed space will be taken by the extra sugar and some milk necessary to dissolve it.

A good norm might be using both chocolate and cocoa powder to compensate for the extra sweetness.

CHOCOLATE ICE CREAM RICH RECIPE

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5 %	55.80	1.98		5.11	7.10	255.60	40.90	
Cream 35 %	5.00	1.75		0.30	2.05	15.00	2.40	
Dried Skimmed milk	3.20			3.10	3.10	155.20	24.83	
Sucrose	5.00		5.00		5.00	500.00	500.00	
Dextrose	11.50		10.58		10.58	1,904.40	793.50	
Inverted Sugar	4.00		2.88		2.88	374.40	547.20	
Chocolate 70%	14.00	5.74	4.06		14.00	-840.00	406.00	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	9.48	22.52	8.52	45.21			-11
	100.0%	9.5	22.5	8.5	45.2	236	23	

In the example above, we can see the negative AFP calculated by the spreadsheet for the 70% dark chocolate. To compensate for it, we had to go slightly above the "allowed" total solids.

Using Cocoa Powder

Things become much simplified when we use cocoa powder as an ingredient. We must remember the average composition of the cocoa powder. The most commonly used type of cocoa powder is the 22/24, these numbers mean that it contains between 22% and 24% of fat and the remaining 78 – 76% of lean cocoa solids.

When compiling the formula and deciding the amount of cocoa we want to include in our recipe, we must always refer to % of lean cocoa solids, aka pure cocoa, since they are the only ones bringing taste, aroma, and colour.

An average chocolate ice cream should contain at least 4-6% of pure cocoa (lean cocoa solids) to have a satisfactory taste and colour. Therefore, if our 100kg recipe requires 5kg of pure cocoa, the calculation will be as follows:

$$\frac{5.000g}{0,77} = 6.493 \text{ g of Cocoa 22 \ 24}$$





I approximate the content of lean solid to an average of 77%.

Needless to say, different types of cocoa powder are available in the market, which is why this calculation will be corrected according to the fat title in use. If for example, a 10/12 cocoa is used, the calculation will be:

$$\frac{5.000g}{0,89} = 5.617 \text{ g of Cocoa 10 \ 12}$$










Once again, the cocoa lean solid will make the product stiffer in the absence of sugar compensation. As we have done for the chocolate, we can easily guess a negative AFP for the cocoa powder and directly use it on our table.

Cocoa Powder 22/24:

 COMPONENT	 G IN 100 G	 SPECIFIC AFP	 AFP
Cocoa Lean Solids	77 g	-1,8	-42,8
Fat (Cocoa Butter + Milk Fat)	23 g	-0,9	-25,5
		TOTAL AFP	-68,3






Example recipe using cocoa powder: 22/24.

CHOCOLATE ICE CREAM WITH COCOA POWDER AND EGG YOLK

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	49.00	1.72		4.41	6.13	229.50	35.28	
Cream 35 %	12.00	4.20		0.72	4.92	36.00	5.76	
Dried Skimmed milk	4.00			3.88	3.88	194.00	31.04	
Sucrose	14.00		14.00		14.00	1.400.00	1.400.00	
Dextrose	4.50		4.14		4.14	745.20	310.50	
Inverted Sugar	2.00		1.44		1.44	187.20	273.60	
Cocoa Powder	5.00	1.38			5.00	-408.80		
Egg Yolk	8.00	2.40			4.00			
Stabilizers / emulsifiers	0.50				0.50			
Total Kg	100.00	9.70	19.58	9.01	45.01			-11
%	100.0%	9.7	19.5	9.0	45.0	237	21	



CHOCOLATE ICE CREAM WITH COCOA POWDER (CHEAP VERSION)

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	62.60	2.39		5.63	7.83	281.70	45.07	
Dried Skimmed milk	4.00			3.88	3.88	194.00	31.04	
Sucrose	14.00		14.00		14.00	1.400.00	1.400.00	
Dextrose	3.40		3.13		3.13	563.04	234.60	
Inverted Sugar	4.00		2.88		2.88	374.40	547.20	
Cocoa Powder	4.50	1.04			4.50	-307.35		
Margarine	7.00	5.88			5.95			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	9.11	20.01	9.51	42.56			-11
%	100.0%	9.1	20.0	9.5	42.7	251	23	

The Fruit



With the word "fruit", we refer to an extremely vast array of ingredients. It is therefore very difficult to generalise while talking about fruit ice cream and sorbets. Some fruits are very sour, others are sweet, some are watery, and some are even fat or floury. It is clear that we need to divide the fruits into families to ease the handling of these ingredients in recipes.

When considering any kind of fruit, however, we need to know its sugar content and acidity. The sugar content is important because it will concur in the sugars, total solids, and AFP columns. The acidity is important to determine the fruit's compatibility with milk-based mixes, its degree of ripeness, and if it requires "help" in preserving its colour.

As we can see from the table, fruits have roughly 10% sugar content on average, so we can infer that the remaining 90% will be mostly water and fibre. Fruit fibre is very important in ice cream, because, above all in sorbets, it gives body and structure to the product. In fact, in citrus sorbet (lemon, lime sorbet, etc.) the low % of solids, often causes collapsing, splitting, and separation of the liquids. In such sorbets, an integration of soluble fibre like inulin is recommended.





Red fruits are characterised by high acidity and intense colour. Their colour is sensitive to acidity changes, and this must be taken into account if we want, for instance, our strawberry to be red–pink instead of purplish.

Watery fruit is very bland in taste; their dosage will differ greatly from the other fruits. To obtain a strongly aromatic sorbet, some part of the water and sugar will be replaced by fruit juice/pulp.

Also, from fruit, we can prepare both milk-based ice cream and water-based sorbets.

Sorbets and fruit ice creams are very different products and require different attention.

Sorbets are made only with water, sugars, and fruit puree; basically, any fruit can be made into a sorbet given the correct balancing.

	 TYPE OF FRUIT	 SUGAR %	 PH	 SEASONALITY
RED FRUITS	Strawberry	8-10	3,5	April-July
	Raspberry	8-10	3,5	May-September
	Cherry	10-14	4	May-July
	Black berry	8-10	3,3	June-August
	Blueberry	7-9	3,5	June-August
	Red currant	7-9	3	June-August
CITRUSES	Lime	5-6	2,4	All Years
	Lemon	5-8	2,4	All years
	Passion Fruit	7-9	2,8	Tropical
	Tangerine	9-12	3,3	Nonember-March
	Orange	9-14	3,5	November-April
	Grapefruit	8-11	3	December-May
	Yuzu	5-8	2,4	Tropoical
WATERY FRUITS	Watermelon	6-8	4	June-September
	Cantaloupe	9-14	4	June-September
OTHER FRUITS	Peach	10-15	3,5	June-August
	Pear	10-14	4,2	All Years
	Apple	10-14	4,1	All Years
	Apricot	10-12	3,6	May-August
	Grapes	18-24	3,5	July-November
	Figs	12-25	5	June-August
	Banana	18-20	5	All Years
	Mango	12-15	4,5	Tropical
	Papaia	9-12	4	Tropical
	Pineapple	12-14	3,4	All Years
	Persimmon	10-15	4,5	October-January
	Plums	10-15	3,6	May-August

In fruit ice creams instead, we find also milk and cream, and as a result, proteins and fat. In these ice creams, the high acidity level of the fruit can pose a threat to

proteins and, if not handled properly, lead to denaturation of the latter with subsequent syneresis of the mix.

In fact, milk proteins, and in particular casein, the denaturation in pH is lower than 5, see the production of curd, yogurt, or cottage cheese as examples. However, this phenomenon is (providentially) limited at low temperatures below 2°C. The ice cream maker, when dealing with acid fruit ice creams, will have to take care when inserting the fruit puree at the very last minute or, even better, directly into the batch freezer right before the freezing process.

In ice cream where the acidity of the fruit is not an issue, such as banana, avocado, figs, persimmon, and others, the mix can be fully prepared more in advance without any problem.

Fruit can be used in various forms. Most commonly frozen fruit purees, fresh, frozen in pieces, or juices are used. On a less frequent basis, they are dried concentrated pastes, jams, or lyophilised forms.

Fresh Fruit



Fresh fruit is an amazing product; nutritious, tasty, and colourful. The ice cream maker can decide to use, for example, only or mostly local products to support the farming community and attract an aware clientele, or to use only seasonal fruit, obtaining the best technical performance from it at the best price.

Fresh fruit has several perks, along with some small inconveniences.

- When using fresh fruit, it is paramount to operate all the needful measures in order to reduce contamination.

Upon receiving, the fruit must be immediately decanted into a proper container, and the original cardboard boxes discharged.

Fresh fruit is then thoroughly washed with running water, then a specific fruit sanitiser is applied for the prescribed time. After this time fruit is carefully rinsed.

This is imperative because fruit in ice cream or sorbets does not undergo any pasteurisation, therefore microorganisms must be removed beforehand to prevent microbial contamination. Washing also removes potential pests and dirt (physical contaminations) and possible pesticide residues (chemical contaminations). Once washed, the fresh fruit can be processed and used in ice creams or sorbet, or can be portioned in sealed bags or containers and frozen for future use.

- Fresh fruit is, by definition, not constant. It's not available throughout the year but rather follows specific seasons, so should the related ice cream flavours.

Needless to say, the degree of ripeness and sweetness changes, thus varying the quality of the products produced with it. The ice cream maker must choose then between consistency or truth and fidelity to the seasonality of the product.

- Fresh fruit needs more time and labour to be processed, washed, peeled, winnowed, chopped, blended, etc.
- Lastly, fresh fruit is perishable. For this reason, frequent supplies are needed to ensure sufficient quality.

On the other hand, certain characteristics are not required to make ice cream or sorbets. The ice cream maker can obtain advantageous prices while buying second choice fruit (out of calibre or colour for example), as long as the taste is great.

- All these factors will be considered within the personal and commercial view of the business, the chef or ice cream maker desires to operate.

Frozen Fruit



- By using frozen fruit, we can save a lot of time and space. Frozen fruit arrives sanitised and washed, usually cut or chopped, in conveniently scaled sealed packages. No trimmings or wastage is made.
- While using frozen fruit ensures its availability throughout the year, it does not ensure consistency in taste, colour, or ripeness.
- Frozen fruit must be thawed out before being blended into the ice cream or sorbet mixture. However, this operation can sometimes be impractical or inconvenient.

Frozen Fruit Puree



Frozen fruit puree is, nowadays, the most popular source of fruit in ice cream production, and several manufacturers produce amazing quality and deliver great consistency in these products.

- Frozen fruit purees are constant and homogeneous in sugar content. The amount of sugar is titled and clearly stated on the package. Usually (depending on the brand), the producers standardise the sugar content at 10% making the balancing of the recipe easy and reliable.
- Using puree guarantees consistency in production all year around, making it possible to produce ice cream and sorbet from fruits not available during certain periods of the year or in certain geographic areas.
- Fruit purees are totally safe and pasteurised, which makes them the perfect ready-to-eat food ingredient to be added at any phase of ice cream production.
- Fruit purees are quick to use and extremely convenient. They are already finely processed, so no pieces, lumps, seeds, or dirt will slip into the product.
- They are great to optimise storage space and supply operations.

Lyophilised Fruit



Also known as Freeze-drying or cryodesiccation, lyophilisation is involved in getting the product frozen under negative pressure and subsequently getting the ice removed by sublimation. Due to the use of low temperatures in processing, it is seen that the quality of the rehydrated product remains excellent. At the same time, the original taste, colour, and shape of the product are perfectly maintained. This process was optimised by NASA to answer the need for safe, long-lasting, nutritious food for space missions. NASA also developed the Hazard Analysis Critical Control Point (HACCP) plan, which is widely used today to evaluate food material before, during, and after processing. With the combination of these and other innovations, NASA could provide safe and wholesome foods to their crews from freeze-dried meals.

Lyo-fruit contains little to no moisture; this unique characteristic makes for a perfect flavour booster. Adding a very small amount of lyo-fruit powder can greatly enhance the flavour of bland fruit or vegetables that would otherwise be too rich in moisture to be used in a high amount in the recipe. For instance, we can add some lyo-watermelon, or cantaloupe, or lychee to the recipe already containing the fresh version of the same fruit obtaining a strong but fully natural taste.

Lyo-fruit also does not alter all the vitamins of the fresh fruit and contains no preservatives.

We can safely infer that lyophilised fruit (and food in general) have only one advantage; the price is the only issue with this type of ingredient. Due to the very

high price of these ingredients, their use can be only complementary to other sources of (wet) fruit.

Fruit Juices



For some types of fruit, it is also possible (or necessary) to base the production on juice. This applies particularly to those fruit with lower fibre content, yielding a thinner juice instead of puree.

Juice can be extracted through various methods or even purchased ready-made. A typical example is citrus fruits (orange, lemon, etc.) that are normally bought whole and simply juiced in loco before commencing the production. It is possible to obtain other fruits by centrifugation or extraction using relatively inexpensive machinery. These can also include vegetables like celery, carrots, cucumber, ginger, turmeric, etc.

It is also quite common to purchase orange, lemon, or pineapple juices. When opting for these products, the ice cream maker must always select the ones without any added sugar, as we are aiming for fruit flavour and not sweetness, which we can easily and affordably provide ourselves.

Jams, concentrated paste, compotes



Endless fruit preparations, specifically designed for use in ice cream and sorbet production, are available in the market.

These pastes and compotes can contain a variable ratio of fruit/water/sugar.

Some are basically jams, where the fruit is simply cooked with sugars and sometimes stabilisers to prepare a "shelf-stable" ready to use product that can be added either directly in the mix and frozen together with the mix, or at extraction from the freezer to variegate a white base. I, for instance, prefer preparing my own lemon marmalade with only whole organic lemons, sugar, and pectin. If stored properly, this marmalade can last for extremely long periods. I then use it in a duly calculated proportion in my lemon sorbet to impart a "real taste" and texture to it. As you would have guessed by now, the result is amazing and unique.

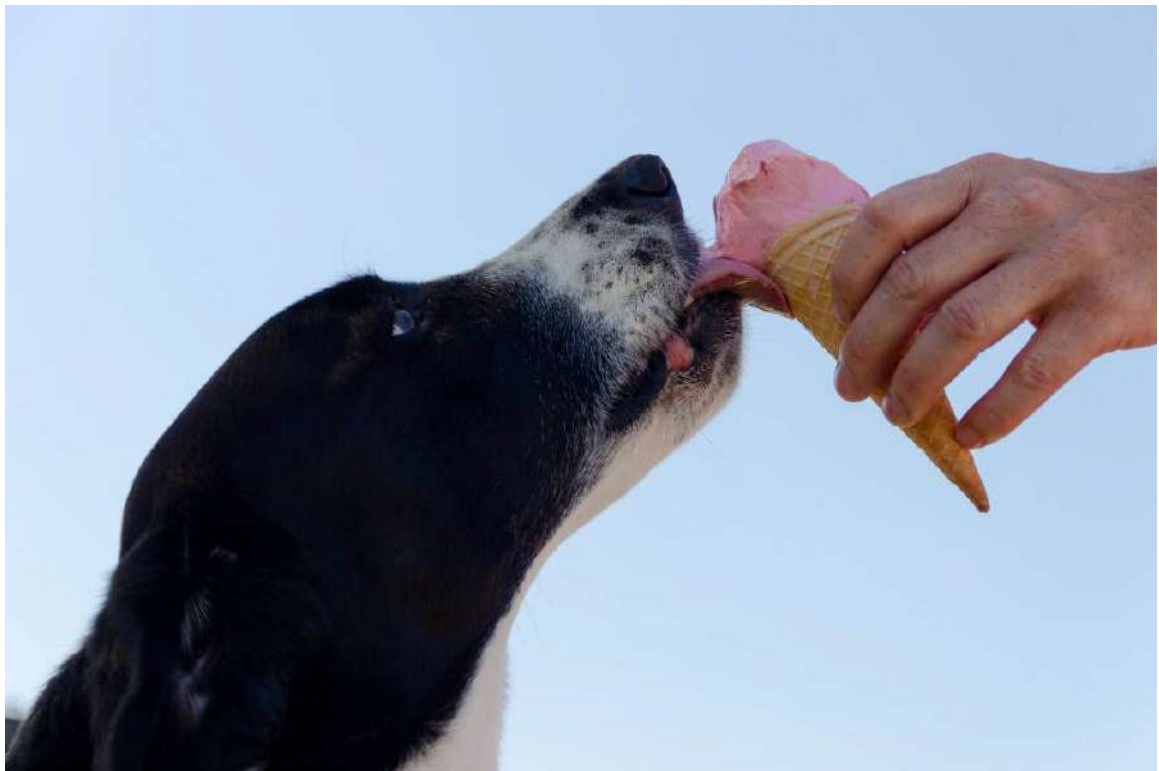
When added within the mix, the sugar and solid content of these pastes must be included in the recipe calculation. However, when added after the dynamic freezing process, they are irrelevant in the count.

Other products are instead obtained by cooking the fruit under vacuum to concentrate it by removing water. The result is a dense and very aromatic paste

containing only fruit with little to no sugar added. The composition differs from a regular jam (and so will the cost), but the same rule applies; when added to the mix, those ingredients must be included in the calculation.

The “aromatic pastes” are obtained by blending natural and synthetic ingredients such as glucose syrup, chemical aromas, food colouring substances, concentrated fruit, sugars, thickeners, emulsifiers, etc. These products are designed to be added directly in the “white base” before freezing, and the manufacturer's instructions must be followed.

The Fruit Ice Creams



I personally find that some fruits are just perfect to be developed in milk-based ice creams, sometimes yielding better results than in sorbets. It is anyway a matter of personal taste, geographical costumes, and seasons.

Now that we have learned how to balance a white cream recipe while making ourselves aware of the fruit sugar and solid content, the compilation of these recipes is a very straightforward process.

As a rule of thumb, remember that:

- Sucrose and dextrose should be the primarily used sugars in these recipes
- Fat content is usually below 7% (but this is not written in stone)










- We will approximate overlapping the sugar content to the Total Solids
- We will also approximate both SP and AFP to 120 and 160, respectively, even though we know that fructose is slightly sweeter and anti-freezing; we do this because fruit does not contain only fructose, and anyhow, this approximation is more than acceptable.

Let's see some recipes for these delicious ice creams. Once again, I suggest some formulation for showcases at -11°C and others for restaurants or homes to be stored in a deep freezer at -18°C .

Do note that the type of fruit used in each recipe can be replaced with any other fruit with similar sugar content. So, for example, the strawberry recipe will perfectly work for raspberry, peach, plums, or blueberry as well. This implies you are only limited by your imagination!












BANANA ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	24.00	0.84		2.16	3.00	108.00	17.28	
Cream 35 %	22.50	7.88		1.35	9.23	67.50	10.80	
Dried Skimmed milk	6.00			5.82	5.82	291.00	46.56	
Sucrose	13.00		13.00		13.00	1,300.00	1,300.00	
Dextrose	4.00		3.68		3.68	662.40	276.00	
Ripe Banana	30.00		5.40		7.00	86.40	64.80	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.72	22.08	9.33	42.23			-11
%	100.0%	8.7	22.1	9.3	42.2	262	17	










BANANA ICE CREAM FOR RESTAURANT

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	19.00	0.67		1.71	2.38	85.50	13.68	
Cream 35 %	22.50	7.88		1.35	9.23	67.50	10.80	
Dried Skimmed milk	6.00			5.82	5.82	291.00	46.56	
Sucrose	4.00		4.00		4.00	400.00	400.00	
Dextrose	18.00		16.56		16.56	2,980.80	1,242.00	
Ripe Banana	30.00		5.40		7.00	86.40	64.80	
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	8.54	25.96	8.88	46.48			-18
%	100.0%	8.5	26.0	8.9	46.5	391	18	

BLOOD ORANGE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	16.00	0.93		1.02	2.25	81.00	12.96	
Cream 35 %	12.20	4.27		0.73	5.00	36.60	5.86	
Dried Skimmed milk	5.00			5.82	5.82	291.00	46.55	
Sucrose	11.00		11.00		11.00	1,100.00	1,100.00	
Dextrose	4.00		3.68		3.68	652.40	276.00	
CSS 60 DE	3.00		2.40		2.40	144.00	120.00	
Blood Orange Juice Juice	44.00		3.52		3.52	56.32	42.24	
Corn Starch	1.00				1.00			
Stabilizers / Emulsifiers	0.80				0.80			
Total Kg	100.00	4.90	20.60	8.17	35.47			-11
%	100.0%	4.9	20.6	8.2	35.5	237	10	










CANTALOUPE ICE CREAM "PETIT FOUR" RECIPE

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3.5 %	36.70	1.28		3.30	4.59	165.15	26.42	
Cream 35 %	11.00	3.88		0.66	4.51	33.00	5.28	
Dried Skimmed milk	3.50			3.40	3.40	169.75	27.16	
Sucrose	15.00		15.00		15.00	1,500.00	1,500.00	
Dextrose	2.00		1.84		1.84	331.20	138.00	
CSS 60 DE	1.50		1.20		1.20	72.00	60.00	
Dry Glucose Syrup 38 DE	2.30		2.19		2.19	109.26	91.77	
Ripe Cantaloupe	27.00		3.24		3.24	51.84	38.88	
Rice Starch	0.50				0.50			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	5.13	23.47	7.36	36.96			-11
%	100.0%	5.1	23.5	7.4	37.0	243	19	

This is and remains one of my favourite recipes. I always believe in seasonality and quality. Back in the das, it was funny (sometimes difficult) to explain to my customers why strawberry wasn't available and cantaloupe was instead used in its place.










RED WINE ICE CREAM









 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	40.85	1.43		3.68	5.11	183.83	29.41	
Cream 35 %	22.00	7.70		1.32	9.02	68.00	10.58	
Dried Skimmed milk	6.40			6.21	6.21	310.40	48.66	
Sucrose	8.00		8.00		8.00	800.00	600.00	
Dextrose	1.00		0.92		0.92	105.80	69.00	
CSS 60 DE	3.00		2.40		2.40	144.00	120.00	
Dry Glucose Syrup 38 DE	2.00		1.90		1.90	95.00	79.80	
Red Wine	16.00					720.00		
Stabilizers / Emulsifiers	0.75				0.75	29.41		
Total Kg	100.00	9.13	13.22	11.20	34.30			-11
%	100.0%	9.1	13.22	11.2	34.3	248	12	



STRAWBERRIES AND PROSECCO SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	40.25			900.00		
Sucrose	9.00	9.00	9.00	96.00	900.00	
CSS 60 DE	2.00	1.60	1.60	237.50	80.00	
Dry Glucose Syrup 38 DE	5.00	4.75	4.75	1,000.00	199.50	
Prosecco Wine	20.00			216.00		
Strawberry Puree 10%	18.00	1.80	2.16	75.00	216.00	
Inulin	3.00		3.00		36.00	
Rice Starch	2.00		2.00			
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	17.15	23.26			-11
%	100.0%	17.2	23.3	252	14	

RED WINE AND PEACH SORBET

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	41.75	10.50					
Sucrose	9.50		9.50	9.50	950.00	950.00	
CSS 60 DE	2.00		1.60	1.60	96.00	80.00	
Dry Glucose Syrup 38 DE	5.00		4.75	4.75	237.50	199.50	
Red Wine	15.00				900.00		
Peach Puree 10%	21.00		2.10	2.52	252.00	252.00	
Inulin	3.00			3.00	75.00	36.00	
Rice Starch	2.00			2.00			
Stabilizers / Emulsifiers	0.75			0.75			
Total Kg	100.00	17.95	8.59	24.12			-11
%	100.0%	18.0	8.6	24.1	251	15	










SPARKLING SWEET WINE SORBET

 INGREDIENTS	 QUANTITY KG	 SUGARS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Water	37.25					
Sucrose	9.00	9.00	9.00	900.00	900.00	
CSS 60 DE	2.00	1.60	1.60	96.00	80.00	
Dry Glucose Syrup 38 DE	3.00	2.85	2.85	142.50	110.70	
Sparkling Sweet Wine	43.00	4.30	4.30	1,290.00	430.00	
Inulin	3.00		3.00	75.00	36.00	
Rice Starch	2.00		2.00			
Stabilizers / Emulsifiers	0.75		0.75			
Total Kg	100.00	17.75	23.50			-11
%	100.0%	17.8	23.5	250	16	










WHISKY ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	44.20	155		3.68	5.53	198.90	31.62	
Cream 35 %	29.00	10.15		1.74	11.89	87.00	13.92	
Dried Skimmed milk	6.00			5.82	5.82	201.00	46.56	
Sucrose	10.50		10.50		10.50	1,050.00	1,050.00	
Dry Glucose Syrup 38 DE	1.00		0.95		0.95	47.50	39.90	
Whisky	7.00					840.00		
Rice Starch	1.55							
Stabilizers / Emulsifiers	0.75				0.75			
Total Kg	100.00	11.70	11.45	11.54	35.44			-11
%	100.0%	11.7	11.5	11.5	35.4	251	12	

SUGAR-FREE WHITE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	64.47	2.20		5.80	8.05	290.12	48.42	
Cream 35 %	15.00	5.25		0.90	6.15	45.00	7.20	
Dried Skimmed milk	5.50			5.34	5.34	265.75	42.68	
Polydextrose	2.00				2.00	50.00	50.00	
Glycerol	1.00				1.00	370.00	60.00	
Erythritol	1.00				1.00	260.00	80.00	
Inulin	3.00				3.00	75.00	80.00	
Sorbitol	6.00				6.00	1140.00	360.00	
Maltitol	0.50				0.50	50.00	40.00	
Microcrystalline Cellulose	0.75				0.75			
Sucralose	0.02				0.02		1,200.00	
Aspartame/Acesulfame	0.01				0.01		300.00	
Stabilizers / Emulsifiers	0.75				0.75			
Total Kg	100.00	7.51	0.00	12.04	34.57			-12
%	100.0%	7.5	0.0	12.0	34.6	255	22	

SUGAR-FREE WHITE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Milk 3,5 %	53.48	1.87		4.81	6.69	240.66	38.51	
Cream 35 %	15.00	5.25		0.90	6.15	45.00	7.20	
Dried Skimmed milk	6.00			5.82	5.82	291.00	46.56	
Polydextrose	13.00				13.00	325.00	325.00	
Glycerol	2.00				2.00	740.00	120.00	
Erythritol	2.00				2.00	520.00	160.00	
Inulin	4.50				4.50	112.50	90.00	
Maltitol	0.50				0.50	50.00	40.00	
Isomalt	2.00				2.00	200.00	100.00	
Microcrystalline Cellulose	0.75				0.75			
Sucralose	0.02				0.02		1,200.00	
Stabilizers / Emulsifiers	0.75				0.75			
Total Kg	100.00	7.12	0.00	11.53	44.18			-11
%	100.0%	7.1	0.0	11.5	44.2	252	21	

SUGAR-FREE CUSTARD ICE CREAM

INGREDIENTS	QUANTITY KG	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.
Milk 3,5 %	57.98	2.03		5.22	7.25	260.91	41.75	
Cream 35 %	12.00	4.20		0.72	4.92	36.00	5.76	
Dried Skimmed milk	5.50			5.34	5.34	266.75	42.68	
Glycerol	1.00		0.50		1.00	370.00	60.00	
Inulin	4.00		7.36		4.00	100.00	80.00	
Sorbitol	6.00		6.85		6.00	1080.00	360.00	
Maltitol	4.00		1.20		4.00	400.00	320.00	
Isomalt	2.00				2.00	200.00	100.00	
Microcrystalline Cellulose	0.75		0.06		0.75			
Egg Yolk	6.00	1.80	0.64		3.00			
Sucralose	0.01				0.01		600.00	
Aspartame / Acesulfame K	0.01				0.01		300.00	
Stabilizers / Emulsifiers	0.75				0.75			
Total Kg	100.00	8.03	0.00	11.27	39.02			-12
%	100.0%	8.0	0.0	11.3	39.0	271	19	

LOW SUGAR \ HIGH PROTEIN ICE CREAM

INGREDIENTS	QUANTITY KG	KCAL PER 100 gr	FATS	SUGARS	LMS	SOLIDS	AFP	SP	SERV. TEMP.	PROTEINS
Milk 3,5 %	56.38		1.80		4.89	6.80	244.62	39.10		2.45
Cream 35 %	5.00		1.75		0.30	2.05	15.00	2.40		0.15
Dried Skimmed milk	2.00				1.94	1.94	97.00	15.52		0.97
Glycerol	1.00					1.00	370.00	60.00		
Inulin	2.00					2.00	50.00	10.00		
Sorbitol	1.00					1.00	180.00	60.00		
Maltitol	1.00					1.00	100.00	80.00		
MPI	5.00		0.33	0.25	4.73	4.70	25.00	4.00		4.48
WPC80	5.00		0.25	0.20	4.70	4.80	20.00	3.20		4.00
MCC89	5.00		0.15	0.05	4.55	4.55	5.00	0.80		4.48
Erythritol	4.00					3.50	1100.00	280.00		
Polydextrose	3.00					2.70	122	1.66		
Sucrose	4.00			4.00		4.00	400.00	400.00		
Isomalt	1.50					1.50	150.00	75.00		
Microcrystalline Cellulose	0.50					0.50				
Egg Yolk	4.00		1.20			2.00				0.19
Sucralose	0.01					0.01		800.00		
Aspartame / Acesulfame K	0.01					0.01		300.00		
Salt	0.00					0.00	60.00			
Guar Gum	0.12					0.12				
Corraganenan	0.15					0.15				
Sumc 6. 20-glyceride of the fatty acids	0.20					0.20				
Propylenglycole monoester	0.20					0.20				
Carob Bean Gum	0.15					0.15			Proteins %	10.71
Total Kg	100.00		5.33	4.60	21.1	45.89			-13	
%	100.0%	212.0	5.4	4.5	21	45.9	264	153		

Formulations of Fat-Reduced Ice Creams



Removing the fat from an ice cream recipe is instead a slightly simpler task. Theoretically, by simply using fat-free ingredients and removing the fatty components (egg yolk, chocolate, nuts pastes, etc.), the resulting ice cream is going to be fat-free, or anyway, with very low-fat content. However, it will not be as creamy and pleasant as the full-fat one. Fat, as we very well know, is responsible for developing a three-dimensional structure while freezing in agitation, and imparts unique characteristics to the frozen dessert. Therefore, while removing fat has a little impact on the freezing behaviour of the mix, the impact on texture and mouthfeel is great and the ice cream maker must compensate for it. It can be inferred that as fat is removed from the recipe, other ingredients must be brought in to keep the solid / water ratio within a reasonable range.

It is pretty easy to formulate a reduced-fat or “light” ice cream with a fat content reduced down to around 4%. This result can be achieved by just re-proportioning regular ingredients, basically removing cream, yolk, chocolate, etc.

On the other hand, reaching lower concentrations of fat below 4% requires the need to resource some sort of fat replacement.

Fat-emulating substances can come from a variety of component categories. We may have carbohydrate fat replacement, protein fat replacement, or even fat-based fat replacement (yes, I know it sounds weird).

Some examples of these substances are:

Carbohydrate-based fat replacement

They provide solids contributing to bulk up the formula. They increase the viscosity and bind water to help control the ice crystals’ growth.

- Modified and Microcrystalline Cellulose 0.5 – 2 %
- Starches and Modified Starches 1 – 2 %
- Dextrins and Cycle-dextrins 0.01 – 0.3 %
- Maltodextrins (5 – 36 DE) 1 – 5 %
- Polydextrose 2 – 15 %

Protein-based fat replacement

They have a colloidal function, bind water, and give creaminess.

- Whey proteins concentrated (any amount depending on the lactose content)
- Egg white powder 1 – 4 %

Fat based fat replacement

Typically, these products are not purely added by the artisanal ice cream maker; rather they are included in pre-mixed compounds to be used as a ready-made fat replacement at the dose suggested by the manufacturer. They are still fat, which is why their use, even if required at a very low concentration, only allows the production of “reduced-fat” or “light” frozen desserts.

- Mono and Diacylglycerols MDAG 0,3 – 1 %










After obtaining a correct balancing of the functional ingredient in the recipe, the flavouring must also be considered carefully.

Butterfat has a characteristic and pleasant taste; its removal allows other less favorable tastes to emerge, especially skimmed dry milk and glucose syrups. Moreover, several aromas are conveyed by fat. When fat is removed, all the other flavouring becomes dull and bland, imposing a higher dosage in the recipe to compensate. Often, chemical aromas are either used pure or within syrup-based aromatic pastes. Caramel, coffee, and butterscotch are often used in fat-reduced products because their taste will prevail over the mix.

Defatted cocoa powder can be used as long as the fat carried by this ingredient in the mix does not trespass the stipulated threshold.

Chemical aromas like milk, cream, vanilla, nuts, and butterscotch are commonly used.

FAT-FREE ICE CREAM

 INGREDIENTS	 QUANTITY KG	 FATS	 SUGARS	 LMS	 SOLIDS	 AFP	 SP	 SERV. TEMP.
Skimmed Milk 0,1%	50.50	0.06		5.27	5.32	263.25	42.12	
Dried Skimmed milk	4.00			3.88	3.89	194.00	31.04	
Sucrose	13.00		13.00		13.00	1300.00	1300.00	
Dextrose	0.50		0.46		0.46	82.80	34.50	
CSS 60 DE	5.50		4.40		4.40	264.00	220.00	
Inulin	4.00				4.00	100.00	100.00	
Maltodextrine 10 DE	6.00				5.70	85.50	52.70	
Polydextrose	4.00				4.00	100.00	20.00	
WPC 80%	3.00	0.12		2.40	2.85	27.00	4.32	
Microcrystalline Cellulose	1.00				1.00			
Stabilizers / Emulsifiers	0.50				0.50			
Total Kg	100.00	0.18	17.86	11.55	45.11			-11
%	100.0%	0.2	17.9	11.5	45.1	242	18	

Plant-Based Formulation



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