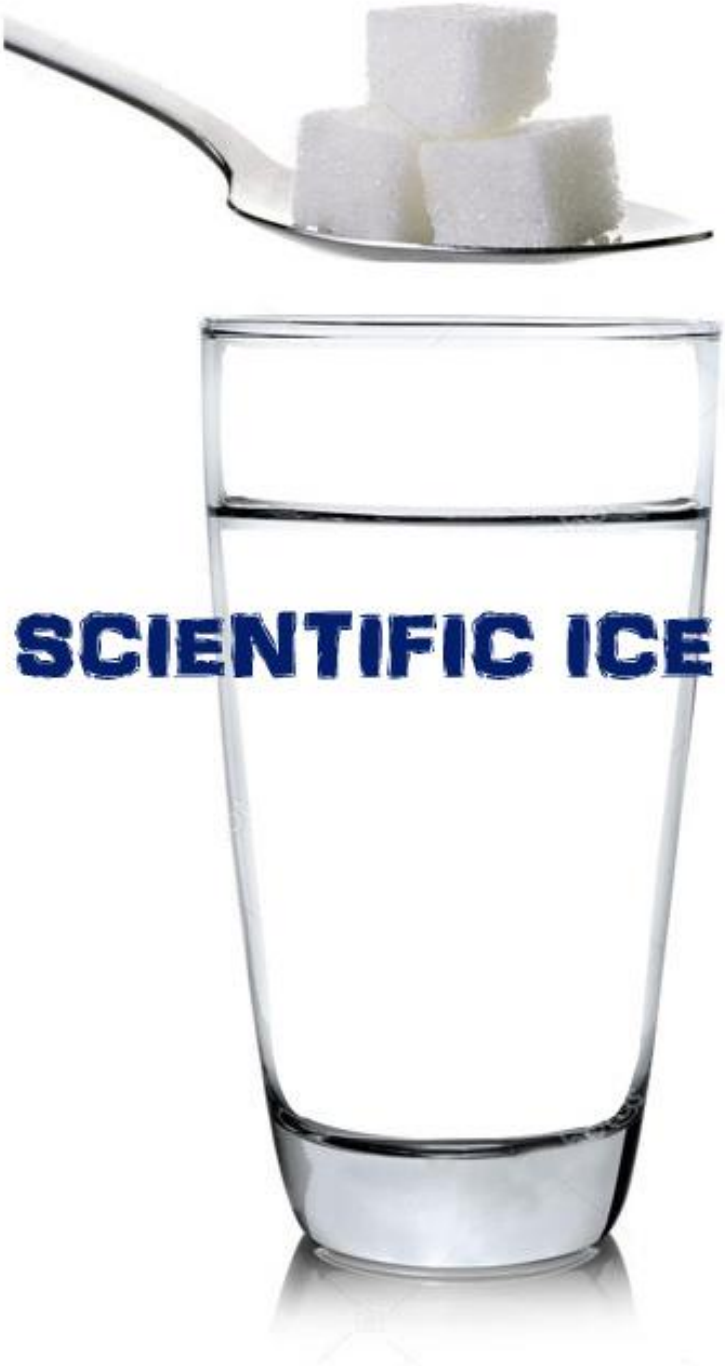

THE SCIENTIFIC ICE CREAM

Diego Celotto

THE SCIENTIFIC ICE CREAM

This short publication will expose the inaccuracies of the Science of Ice Cream, as it is currently presented, and, on the other hand, the Theory of Scientific Ice Cream, together with the properties that define it, based on an extensive scientific bibliography.

THE SCIENCE OF ICE CREAM TODAY

BALANCING

It has always been believed that in order to obtain a quality and well-structured Ice Cream, the quantities of Sugars, Fat, Milk Solids not Fat and Total Solids must be respected, according to certain values.
The so-called "balancing".
Nothing more false.
For 2 simple reasons.
The first is that there is no scientific text and publication, no expression or equation, even if only empirical, that relates the nutritional properties to the quality and structure of the Ice Cream.
The second is that the "balancing" does not take into any consideration the quantities of the 2 major components of the Ice Cream, the "real" responsible for its structure and sensory properties: the Air incorporated during the freezing process (Overrun), and the Ice present at negative temperatures.

AFP

The other parameter that is considered "unsuitable" to explain Ice Cream is the AFP (acronym for Anti-Freezing Power), a mathematical "artifice".
Chemically, the AFP is nothing more than the Sucrose Equivalent of an Ice Cream.
In simple terms, with the AFP, it is assumed that all the Ingredients present in the Ice Cream become a single ingredient (Sucrose) dissolved in Water. A more easily manageable system than a set of different Ingredients in aqueous solution.
Apart from the confusion generated between Relative and Absolute AFP, also in this case there is no scientific literature that correlates the AFP to the quality and structure of an Ice Cream.
Furthermore, as in the case of "balancing", the AFP does not consider the Overrun and the Ice present in the Ice Cream at a given temperature

SPO

The SPO (acronym for Sweetingr POwer) is, in other words, the Relative Sweetness of an Ice Cream, calculated according to a sensory scale with the Sweetness of Sucrose set equal to 100.
Unfortunately, the calculated SPO does not give an effective value to the sweet sensation of an Ice Cream, as it remains constant at any temperature at which the Ice Cream is placed (from 0 to - 25 ° C and above), without taking into account the presence of the Ice (coldness), of the Mineral salts (salinity), of the Organic Acids of Fruit (Sourness) and of the Overrun (volume of air), which contribute to a perception of Sweetness of the Ice Cream lower than that calculated in a mathematical way.

EVALUATIONS

To confirm what has just been written, consider two perfectly identical formulations for Ice Cream, with the same percentages of nutritional properties, therefore the same "balancing", and the same AFP and SPO.

	WHITE BASE	g	kg
1	Milk, whole	750,000	576,923
2	Milk, skimmed (powder)	50,000	38,462
3	Butter	50,000	38,462
4	Cream (35% fat)	150,000	115,385
5	Sucrose	200,000	153,846
6	Syrup, Glucose 42DE	100,000	76,923
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
		1300,000	1000,000

INPUT		
Overrun	%	15,00
Temperature	°C	-11,00

ANALYSIS		
Sugars	%	18,09
Fat	%	9,47
Milk Solids not Fat	%	9,24
Total Solids	%	40,24
Total Water	%	59,76

AFP (Sucrose Equivalent)		25,95
AFP Absolute		43,43

Freezing Point	°C	-2,74
Dryness [Ice=47,38]	%	79,28
Creaminess Index		56,88

Perceived Sweetness [RS=19,41]		14,89
Coldness		46,91
Sandiness [Lactose=5,34]	%	43,17

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	WHITE BASE	g	kg
1	Milk, whole	750,000	576,923
2	Milk, skimmed (powder)	50,000	38,462
3	Butter	50,000	38,462
4	Cream (35% fat)	150,000	115,385
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6	Syrup, Glucose 42DE	100,000	76,923
7			
8			
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10			
11			
12			
13			
14			
15			
16			
17			
18			
		1300,000	1000,000

INPUT		
Overrun	%	35,00
Temperature	°C	-14,00

ANALYSIS		
Sugars	%	18,09
Fat	%	9,47
Milk Solids not Fat	%	9,24
Total Solids	%	40,24
Total Water	%	59,76

AFP (Sucrose Equivalent)		25,95
AFP Absolute		43,43

Freezing Point	°C	-2,74
Dryness [Ice=48,92]	%	81,87
Creaminess Index		62,12

Perceived Sweetness [RS=19,41]		12,44
Coldness		44,60
Sandiness [Lactose=5,34]	%	49,33

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The two Ice Creams, even though they are the same in formulation, have different structural and sensory properties.
This is evident considering that the Overruns and the Temperatures at which the ice creams are placed, and the consequent volumes of Air and the quantities of Ice present, are different.

Different structural and sensory properties also occur when two formulations have **the same percentages of nutritional properties ("balancing"):**

	WHITE BASE	g	kg
1	Milk, whole	750,000	576,923
2	Milk, skimmed (powder)	50,000	38,462
3	Butter	50,000	38,462
4	Cream (35% fat)	150,000	115,385
5	Sucrose	200,000	153,846
6	Syrup, Glucose 42DE	100,000	76,923
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
		1300,000	1000,000

ANALYSIS		
Sugars	%	18,09
Fat	%	9,47
Milk Solids not Fat	%	9,24

Freezing Point	°C	-2,74
Dryness [Ice=48,48]	%	81,13
Creaminess Index		62,45

Perceived Sweetness [RS=19,41]		12,52
Coldness		43,20
Sandiness [Lactose=5,34]	%	47,40

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	COCOA BASE	g	kg
1	Water	650,000	500,000
2	Cocoa (powder)	189,500	145,769
3	Milk, Proteins (powder)	120,000	92,308
4	Oil, Coconut	43,500	33,462
5	Syrup, Fructose 42%	297,000	228,462
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
		1300,000	1000,000

ANALYSIS		
Sugars	%	18,09
Fat	%	9,46
Milk Solids not Fat	%	9,23

Freezing Point	°C	-4,01
Dryness [Ice=43,67]	%	80,02
Creaminess Index		65,63

Perceived Sweetness [RS=19,54]		12,70
Coldness		36,90
Sandiness [Lactose=0,00]	%	0,00

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or, even when two formulations have **the same Absolute AFP** (in the examples shown, MIX 1 and MIX 2, it is "simplified" considering only the contribution of the Sugars):

	MIX 1	g	kg
1	Water	910,000	910,000
2	Sucrose	390,000	390,000
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
		1300,000	1000,000

AFP Absolute		42,86
Freezing Point	°C	-2,70
Dryness [Ice=56,81]	%	81,16
Creaminess Index		57,92
Perceived Sweetness [RS=30,00]		20,21
Coldness		49,62
Sandiness [Lactose=0,00]	%	0,00

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	MIX 2	g	kg
1	Water	1060,700	1060,700
2	Dextrose	239,300	239,300
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
		1300,000	1000,000

AFP Absolute		42,87
Freezing Point	°C	-2,70
Dryness [Ice=66,22]	%	81,16
Creaminess Index		50,95
Perceived Sweetness [RS=14,73]		8,72
Coldness		52,21
Sandiness [Lactose=0,00]	%	0,00

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STRUCTURAL AND SENSORY PROPERTIES

To identify an Ice Cream, whether its structural (Dryness, Creaminess, etc.) or sensory (Coldness, etc.) properties, there is no scale determined by measurable quantities.
They are properties evaluated by subjective sensations, unrepeatable judgments, especially after some time and without a unique and unequivocal description.
What is the visual perception of a dry Ice Cream? Will it be possible to obtain the same perception for other Ice Creams? If so, in what way?
Or, how can you describe the feeling of cold when tasting an Ice Cream? And will that feeling be the same if you taste the same Ice Cream after months? If so, how can this be determined?
These are just some of the questions that can be asked about the properties of the Ice Cream.
It is a great limitation of the Ice Cream. Until now never solved.

THE THEORY OF SCIENTIFIC ICE CREAM

The properties of Scientific Ice Cream can be divided into three classes:
- nutritional: Sugars, Fat, Milk Solids not Fat, Total Solids and Total Water;
- structural: Freezing Point, Ice, Dryness and Creaminess Index;
- sensorial: Relative Sweetness, Perceived Sweetness, Coldness, Lactose and Sandiness.

As written in the previous notes, the "balancing" does not contribute anything to the quality and structure of the Ice Cream.
Only the quality of the Sugars will have to be taken into account, for the Sweetness, the links with Water and the Freezing Process, and the Fat and Protein, for the formation of Overrun and the stabilization of the air bubbles formed.

The structure of the Ice Cream, on the other hand, depends on 3 fundamental properties: Ice, Dryness and Creaminess Index.
By respecting the recommended reference values for these properties, the Ice Cream will remain qualitatively superior and structurally stable over time.

Furthermore, the Scientific Ice Cream has the prerogative and importance of having numerically coded the different structural and sensory properties of the Ice Cream, making them usable and reproducible in a unique way among the professionals in the Sector.
If, before, to determine the properties of an Ice Cream, distinctive elements were used, such as: dry, creamy, sweet, cold, and all the related gradations, with the Scientific Ice Cream there is, instead, a "numerical value" to describe each property of the Ice Cream taken into consideration, regardless of sensory perceptions and process conditions (chemical, physical and nutritional).

PROPERTIES

Assuming that the Ice Cream has a given Overrun and is placed at a defined Temperature, the Scientific Ice Cream is characterized by the following properties (the reference values in brackets):

Freezing Point (-2.75 ÷ -3.25 °C)
It is the temperature at which the first ice crystal begins to form.
Important for two reasons.
The first is that it provides an indication of how the Ice Cream will appear in the refrigerator showcase: hard if the HP is above -2.75 ° C, soft if the HP is below -3.25 ° C.
Furthermore, it is a fundamental component in the equation for calculating Ice at a given temperature.

Ice (48 ÷ 52 %)
It is the percentage of Free (frozen) Water present at a set temperature.

Dryness (78 ÷ 82 %)
It is the percentage of Ice compared to the amount of Total Water present at a set temperature.

Creaminess Index (58 ÷ 62)
It is a mathematical algorithm that indicates the Creaminess of the Ice Cream (at a given Overrun and at a set Temperature) as a function of Ice, Bound Water and Total Solids present.

Relative Sweetness (DR)
It is the sum of the individual Sweetness of the Ingredients, each calculated for its own contribution to the Formula, with reference to the Sweetness of Sucrose set equal to 100.

Perceived Sweetness (10 ÷ 16)
It is a mathematical algorithm that indicates the perception of Sweetness of the Ice Cream (at a given Overrun and at a set Temperature) as a function of Organic Acids, Salts, Ice, Bound Water and Total Solids present, with reference to the Sweetness of Sucrose set equal to 100 (Relative Sweetness).

Coldness (48 ÷ 52)
It is a mathematical algorithm that transforms the amount of heat needed to decrease the temperature of 10 ml of Ice Cream to + 5 ° C (at a given Overrun and at a set Temperature) in a numeric value.

Lactose
It is the percentage of Lactose present (it does not change even by changing the Overrun and Temperature).

Sandiness (≤ 80 %)
It is a mathematical algorithm that indicates the probability of the presence of crystallized Lactose, at a given temperature.

INPUT		
Overrun	%	35,00
Temperature	°C	-13,00

ANALYSIS		
Sugars	%	18,09
Fat	%	9,47
Milk Solids not Fat	%	9,24
Total Solids	%	40,24
Total Water	%	59,76

AFP (Sucrose Equivalent)		25,95
AFP Absolute		43,43

Freezing Point	°C	-2,74
Dryness [Ice=48,48]	%	81,13
Creaminess Index		62,45

Perceived Sweetness [RS=19,41]		12,52
Coldness		43,20
Sandiness [Lactose=5,34]	%	47,40

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AUTHOR'S NOTE

The algorithms used in the Scientific Ice Cream have not been made public nor have they been granted to third parties.
The only forms in which the algorithms are reported in original are in the "FREEZY", "FreezerLabel" and "REVERSO" Software (http://www.articagel.it), which can be purchased by contacting the email: articagel@libero.it
Any references or uses of proprietary names mentioned in this publication must be considered falsified.

The **Teory of Scientific Ice Cream** is open to further study.
Therefore, please refer to the Articagel website (http://www.articagel.it) for the Courses in programming.

Diego Celotto

think scientific