SCIENTIFIC METHODOLOGY FOR ANALYSIS AND DESIGN OF A GELATO

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INTRODUCTION

The Food Technologists have always been trying to identify the perfect formula for an aerated product, such as Gelato, in order to predict its "structure", consistent, creamy and dry (that is, with a limited concentration of water in a liquid form), based on the percentage values of Sugars, Fat and Protein of the initial starting mix.

This method, called "nutritional balance", unfortunately, has proved to be the most unreliable and wrong possible, given that there is no law or scientific expression that connects "nutrition" to "structure". There is no correlation nor recognized experimental results.

Furthermore, Gelato, at the display case temperature (in general, at -12°C), has 2 other important components which are NEVER taken into consideration by the "nutritional balance": the air incorporated during the mixing and freezing phases (called **Overrun**), and **Ice**, for the solidification of part of the total water, due to the lowering of the temperature below the cryoscopic point of the mix.

Other "pseudo-scientific" systems have also been proposed, which have tried to predict the chemical-physical characteristics of an Gelato on the basis of certain properties of the initial liquid mixture, but they have all failed negatively due to the ineffectiveness of the proposed solutions.

Two above all: the WCI (Water Control Index) Theory of researchers Bruce Tharp and Steven Young, and that of Unilever's Ice Content, concerning, respectively, the "mobility" and "quantity" of free water in Gelato.

WHY THE BALANCE

The term "balancing" means the development and creation of a recipe whose ingredients, mixed according to certain quantities, and subjected to freezing and whipping, lead to the production of a Gelato with optimal characteristics of consistency, creaminess, and dryness.

A brief introduction.

Both the Industrial and Artisanal Gelato are burdened by a basic misunderstanding.

The one that "by equaling the percentages of sugars, fat and protein of a gelato mix to a specific range of values, the so-called '**nutritional balance**', you will get a structured Gelato in terms of consistency, creaminess, and dryness".

Nothing more fake. And we have already mentioned why.

In addition, the structure of a Gelato with "nutritional balance" is not determined objectively, for example through a scientific evaluation, but according to the extemporaneous considerations of a technician. And that the same structure cannot be equally reproduced in a Gelato that has a different food composition.

Putting aside the unreliable "nutritional balance", what we now propose to do is to predict, in a rigorous and scientific way, the "quality" of the structure of a Gelato, obtained from a mixture of which Ingredients and Quantities are known.

The evaluation of the qualities of consistency, creaminess, and dryness of a Gelato, at certain Temperature and Overrun values, is assigned to two exclusive scientific functions: the **Creaminess Index** and the **Dryness**.

The first function (IdC) represents a complex algorithm that includes all the contributions to the structure deriving from the Freezing Temperature of the Gelato and from the percentages of Ice, Fat and Total Solids.

The Dryness, on the other hand, represents the percentage ratio between Ice and Total Water.

In consideration of these two functions, we will therefore speak of "**structural balance**" of a Gelato, at the values indicated of Temperature and Overrun.

STRUCTURAL BALANCE

"Balancing is predicting what will happen."

The aim of obtaining a structured Gelato leads us to turn our attention to the values of the "Creaminess Index" and "Dryness" functions, and to the initial Temperature and Overrun settings.

The theory of "structural balancing", and related functions, is derived from twenty-year analytical studies and experimental observations on vast databases of industrial and artisanal products.

The results obtained lead us to affirm, indisputably, that for any combination of Temperature and Overrun, a structured Gelato, for the functions involved, will present these ranges of values:

Creaminess Index = 59 ÷ 61

Dryness = 79 ÷ 81 %

For values outside the listed ranges, the Gelato will be structured according to a subjective evaluation.

Given the complexity of the functions, in relation to the variables involved, for the calculation of the values of the Creaminess and Dryness Index, we will use the **FREEZY PLUS** Software for the Analysis of a Gelato, and the **GELATO CREATOR** Software will be used, for the Designing a Gelato, both available on the Articagel.it

GELATO ANALYSIS

For a Gelato, subjected to Analysis, the initial inputs in **FREEZY PLUS** are those relating to the **Temperature** at which it must be examined (in relation to this, the structural functions vary), and to the "most probable" **Overrun value,** derived from historical data, on which the Creaminess Index depends.

Therefore, by entering the Ingredients and the relative Quantities for any Recipe, you will obtain this screen:

GELATO	g	kg
1 Milk, whole	750,000	750,000
2 Milk, skimmed (powder)	50,000	50,000
3 Butter	80,000	80,000
4 Sugar, Sucrose	120,000	120,000
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
	1000,000	1000,000

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

ANALYSIS		
Sugars	%	18,46
Fat	%	9,52
Protein	%	4,33
Total Solids	%	32,80
Total Water	%	67,20

Sucrose Equivalent (AFP)	20,62
Sucrose Equivalent Absolute	30,69

Freezing Point	°C	-1,89
Dryness [Ice content=54,94]	%	81,77 =
Creaminess Index		58,24 =

Perceived Sweetness [RS=15,00]	9,13
Coldness [ΔQ=202,01 kJ/kg]	49,06
Sandiness [Lactose=6,46] %	52,73

Aroma	%	0,00
Intensity		0,00

The Creaminess Index and the Dryness values, determined automatically by the Software, immediately provide us with an indication whether a Gelato, at that given Temperature and with that Overrun, it will appear "structured" or not.

If the values are outside of what is expected (see **STRUCTURAL BALANCE**), the recipe (Ingredients and Quantity) will have to be varied until the values of the two functions are included in the indicated ranges.

It should be remembered that, without prejudice to the Temperature and Overrun values, by adding Water to the recipe, in a measure of 5 ÷7 % (for example, 50 grams), the Creaminess Index value decreases (-), while that of Dryness increases (+), compared to the initial values:

GELATO	g	kg
1 Milk, whole	750,000	714,286
2 Milk, skimmed (powder)	50,000	47,619
3 Butter	80,000	76,190
4 Sugar, Sucrose	120,000	114,286
5		
6 Water	50,000	47,619
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
	1050,000	1000,000

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

ANALYSIS		
Sugars	%	17,58
Fat	%	9,06
Protein	%	4,12
Total Solids	%	31,24
Total Water	%	68,76

Sucrose Equivalent (AFP)		19,64
Sucrose Equivalent Absolute		28,56

Freezing Point	°C	-1,75
Dryness [Ice content=56,29]	%	81,86 +
Creaminess Index		57,29 -

Perceived Sweetness [RS=14,29]		8,58
Coldness [ΔQ=207,67 kJ/kg]		50,09
Sandiness [Lactose=6,15]	%	49,34

Aroma	%	0,00
Intensity		0,00

While, by adding Sucrose or Dextrose to the recipe, in a measure of 2 ÷5% (for example, 30 grams of 1000 total grams), the value of the Creaminess Index increases (+), while that of Dryness decreases, always with respect to the initial values (-) :

GELATO	g	kg
1 Milk, whole	750,000	728,155
2 Milk, skimmed (powder)	50,000	48,544
3 Butter	80,000	77,670
4 Sugar, Sucrose	120,000	116,505
5		
6		
7 Sugar, Dextrose monohydrate	30,000	29,126
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
	1030,000	1000,000

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

ANALYSIS		
Sugars	%	20,57
Fat	%	9,24
Protein	%	4,20
Total Solids	%	34,50
Total Water	%	65,50

Sucrose Equivalent (AFP)		25,06
Sucrose Equivalent Absolute		38,26

Freezing Point	°C	-2,39
Dryness [Ice content=53,32]	%	81,40 -
Creaminess Index		59,47 +

Perceived Sweetness [RS=16,68]		10,41
Coldness [ΔQ=191,17 kJ/kg]		47,00
Sandiness [Lactose=6,27]	%	51,49

Aroma	%	0,00
Intensity		0,00

Instead, by adding a nutritional component that does not bind water, i.e. complex carbohydrate, fat, protein and fibre, in the amount of 3 ÷5 % (for example, 30 grams of 1000 total grams), the value of Dryness remains constant (=) (however, with a decrease in the total % of Ice), while that relating to the Creaminess Index undergoes a significant increase (+):

GELATO	g	kg
1 Milk, whole	750,000	728,155
2 Milk, skimmed (powder)	50,000	48,544
3 Butter	80,000	77,670
4 Sugar, Sucrose	120,000	116,505
5		
6		
7		
8 Fibre	30,000	29,126
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
	1030,000	1000,000	⇦

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

ANALYSIS		
Sugars	%	17,92
Fat	%	9,24
Protein	%	4,20
Total Solids	%	34,76
Total Water	%	65,24

Sucrose Equivalent (AFP)	20,17
Sucrose Equivalent Absolute	30,91

Freezing Point	°C	-1,90
Dryness [Ice content=53,34]	%	81,76 =
Creaminess Index		59,24 +

Perceived Sweetness [RS=14,56]	8,84
Coldness [ΔQ=197,18 kJ/kg]	48,18
Sandiness [Lactose=6,27]	%	52,70

Aroma	%	0,00 ⇦
Intensity		0,00

Finally, having verified that after these operations, a "structured Gelato" is achieved, the recipe obtained can be used as a "standard" for the production of any line of Gelato, Industrial and Artisanal, of different tastes and shapes, equally structured.

The term "design" means the development and creation of a recipe whose Ingredients and Quantities, mixed and subjected to freezing and whipping, lead to the production of a Gelato with specific Creaminess and Dryness Index values, a given Temperature and with a defined Overrun.

Even if there are more constraints to respect, paradoxically, the Design is much easier to implement than the Analysis, and the consequent "structural balancing", of a Gelato.

Let's hypothesize that a Gelato has an Overrun of 35% at a Temperature of -12°C.

We also establish that the Creaminess Index and the Dryness of the Gelato, at the pre-set Temperature and Overrun values, are, respectively, equal to 60.00 and 80.00% (the median values of the ranges reported in **STRUCTURAL BALANCE**).

And that the Ingredients chosen are:

- Whole Milk

- Skimmed milk powder

- Milk protein powder (Protein)

- Cream (35% fat)

- Butter

- Dextrose

- Sucrose

- Fibre

The **GELATO CREATOR** software, will automatically insert next to each Ingredient selected, the relative Quantities, finally obtaining a **structured Gelato** according to the pre-established TARGET:

PRODUCT	Pz	g
1 Milk, whole		68,251
2 Milk, skimmed (powder)	5,000	22,750
3 Cream (35% fat)		59,151
4 Butter		54,601
5 Sucrose	1,000	4,550
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16 Dextrose	-----	148,384
17 Protein	-----	57,320
18 Fibre	-----	40,000 ⇦
W Water	-----	544,993
	6,000	1000,000 ⇦

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TARGET		
Overrun	%	35,00 ⇦
Temperature	°C	-12,00 ⇦
Dryness	%	80,00 ⇦
Creaminess Index		60,00 ⇦

ANALYSIS		
Freezing Point	°C	-3,08
Dryness [Ice content=51,95]	%	79,96
Creaminess Index		60,19
Sugars	%	17,11
Fat	%	6,82
Protein	%	6,95
Total Solids	%	35,03
Total Water	%	64,97

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The "reorganization" of the recipe, again by GELATO CREATOR, therefore, leads to:

PRODUCT	g	g
1 Milk, whole	68,251	68,251
2 Milk, skimmed (powder)	22,750	22,750
3 Cream (35% fat)	59,151	59,151
4 Butter	54,601	54,601
5 Sucrose	4,550	4,550
6 Dextrose	148,384	148,384
7 Protein	57,320	57,320
8 Fibre	40,000	40,000
9 Water	544,993	544,993
10		
11		
12		
13		
14		
15		
16	-----	
17	-----	
18	-----	⇦
W	-----	
	1000,000	1000,000 ⇦

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TARGET		
Overrun	%	35,00 ⇦
Temperature	°C	-12,00 ⇦
Dryness	%	0,00 ⇦
Creaminess Index		0,00 ⇦

ACTIVE

ANALYSIS			
Freezing Point	°C	-3,08	
Dryness [Ice content=51,95]	%	79,96	80,00
Creaminess Index		60,19	60,00
Sugars	%	17,11	
Fat	%	6,82	
Protein	%	6,95	
Total Solids	%	35,03	
Total Water	%	64,97	

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QED