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GELATO QUALITY CHARACTERISTICS MANUFACTURED FROM NATURAL INGREDIENTS

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Abstract. Ice cream is a highly complex food matrix that generally comprises a mixture of ingredients: air, water, milk fat, milk solids-not-fat, sweetener, stabilizer, emulsifier and flavoring agents. To improve the quality of ice cream, it is required to obtain the optimal formulation and processing parameters. To obtain a product with well-determined technological, organoleptic and physico-chemical properties is important to choose a right stabilizer. This paper presents quality indices of gelato manufactured from natural ingredients and the basic stabilizer, gelatin, is replaced in proportions of 25%, 50%, 75% and 100% with *spirulina*. The use of spirulina contributes to the improvement of the nutritional and biological value of the new product. With the increase of the spirulina concentrationin the product, the characteristics for the organoleptic indices, especially the natural green color are improved. The chemical composition of ice cream is improved, by increasing the iron content from 2.68 to 3.63. The addition of mineral salts with the increase of the spirulina content in gelato leads to the increase of the cryoscopic point of the finished product. The degree of beating, overrun, penetration's value increases and the viscosity values decreases.

Keywords: *dairy desert, ice cream, stabilizer, gelatin, spirulina, quality indices, nutritive value, biological value.*

Introduction

Ice cream industry has improved a lot in recently due to the consumer preference. Ice cream is a popular frozen dairy product and is made using milk, cream, milk powder, fat sugar, emulsifiers, stabilizers, fruits, nuts, candies, jams, plants, colouring, flavouring and sweetening agents, [1, 7]. For that reason, different types of ingredients including; fruits, fruit juice, herbs, probiotics and some other additives were used for the production of ice cream, [2, 3, 7]. These ingredients provide important nutritional and health benefits to the ice cream due to minerals, vitamins, fibers, antioxidants, natural colorants and flavours [4, 7]. Nowadays different types of ice creams are sold in markets and bakeries. Also, new types and formulations are desired to be found on markets by consumers, [5, 6, 7]. An ice cream-like product is gelato, from Italy, it means "frozen" and refers to a type of soft, dense,

low-fat ice cream, which has traditionally been made from milk, sugar and other fresh ingredients, such as fruit or nuts, [7]. It is important that small producers understand how to develop new ice cream mixes to meet changing customer demands. 'Balancing' the mix involves maintaining the correct balance between:

- Fat and sugar which controls the 'fattiness' of the product in the mouth.
- Water and solids which controls the texture or hardness/softness, [8].

Ice cream is a nutritious, healthful and relatively inexpensive food, supplies approximately 200 calories, 3.99 g protein, 0.31 g calcium, 0.10 g phosphorus, 0.14 mg iron, 548 IU vitamin A, 0.038 mg thiamine and 0.23 mg riboflavin (Arbuckle, 1986). The quality of ice cream depends upon the ingredients used; suitable stabilizer is the most important, [9]. Consumer acceptance of ice cream depends largely on its structure, textural quality, resistance to melting and flavor.

Examples of ice cream mixes are shown in table 1, [8].

Table 1

Ice cream mixes

Component	Low-fat ice creams %	Soft-frozen ice creams %	Hard ice cream		
			Standard brands	Premium brands	Super-premium brands
Fat	3.0 - 8.0	10.0 - 10.0	10.0 - 12.0	12.0 - 15.0	15.0 - 18.0
Milk Solids-not-fat	13.0 - 11.5	12.5 - 12.0	11.0 - 9.5	11.0 - 9.5	11.0 - 9.5
Sucrose	11.0 - 12	13.0 - 10.0	10.0 – 15.0	10.0 – 15.0	10.0 – 15.0
CSS	6.0 - 4.0	4.0 - 4.0	5.0 - 3.0	5.0 - 3.0	5.0 - 3.0
Stabilizer	0.35 - 0.15	0.35 - 0.15	0.35 - 0.15	0.35 - 0.15	0.35 - 0.15
Emulsifier	0.15 - 0.10	0.15 - 0.15	0.15 - 0.10	0.15 - 0.10	0.15 - 0.10
Water	66.3 - 63.7	64.0 - 63.7	64.0	62.0 - 60.0	<60.0
Total Solids	33.6 - 36.3	36.0 - 36.3	36.0	38.0 - 40.0	>40.0

**www.ice-cream-recipes.com*

Stabilizers are one such ingredient, which, in spite of the low level in the formulation, impart specific and important functions to the finished product, [10, 11].The basic purposes for using stabilizers in ice cream formulation are to increase mixture viscosity, prevent shrinkage and slow down moisture migration from ice cream during storage period, to reduce the rate of meltdown, to stabilize the mixture to prevent wheying off, to produce smoothness in body and texture, to help in suspension of flavoring particles, to allow easier pumping and more accurate filling during processing and finally to retard or reduce ice crystals and lactose crystal growth during storage, [10, 12, 13, 14]. So far many stabilizers have been used in the formulation of ice cream, but attempts to find new sources of hydrocolloids in order to create better quality ice cream have continued, [11, 14, 15, 16].

Spirulina can be used to improve the nutritional and functional particularities of ice cream, give the rich chemical composition and nutritional benefits for health.

Spirulina (*Arthrospira platensis*), is a blue-green microalgae, one of the oldest life forms on earth, which has helped produce oxygen for millions of years so that other forms of life can occur. The name comes from the spiral form of algae, being specific to freshwater lakes, although it can also be found in salt water sources [17].

Benefits of spirulina: [17, 18]:

- Contains 80% essential proteins and amino acids including γ-linoleic acid recognized for its anti-inflammatory effect.
- Spirulina contains ω-3, ω-6, ω-9 the highest weight being ω-3.
- It is extremely rich in chlorophyll which helps to eliminate toxins from the blood and helps to strengthen the immune system.
- Has a high concentration of easily assimilable iron.
- Spirulina contains vitamins B_1 (thiamine), B_2 (riboflavin), B_3 (niacin), B_6 (pyridoxine), B_9 (folicacid), vitamin C, vitamin D, vitamin A and vitamin E.
- It is also a good source of potassium, calcium, chromium, copper, iron and magnesium.
- The tests showed that Spirulina has an ORAC level (Oxygen Radical Absorption Capacity) of over 24,000, which is 4 times the ORAC score of blueberries. This score is used to measure antioxidant capacity and its concentration in different types of foods.
- Spirulina is high in calcium, having 26 times more calcium than in milk, being excellent for children, old people and pregnancy.
- The phosphorus content of spirulina makes it ideal for the regimen of tooth remineralization.
- Proteins from spirulina are easily assimilated with a utilization rate between 50-61%.
- Spirulina can counteract and remove heavy metals from organism.

Consumers are increasingly interested in the health benefits of foods and began to look beyond the basic nutritional benefits of food to the disease prevention and health enhancing compounds contained in many foods, [19, 20].

The purpose of the work is to replace the stabilizer used in the gelato manufacture with spirulina, depending on the spirulina amount used as stabilizer to be analyzed the change of the organoleptic characteristics and the variations of the physico-chemical and technological indices.

Materials and methods

Pasteurized milk, butter, cream, concentrated skimmed milk, milk powder corresponds to the normative requirements from Government Decision 158 regarding the approval of the Quality Requirements for milk and dairy products.

Crystal sugar from sugar beet, complies with the norms of the Technical regulation “Sugar. Production and marketing ”approved by Government Decision no. 774.

Eggs, corresponds to the norms of the Government Decision No. 1208 regarding the approval of the sanitary-veterinary Norm of the commercialization of eggs for human consumption.

Vanillin corresponds to the requirements presented in DECISION No. 229 for the approval of the Sanitary Regulation concerning the food additives.

Water, according to GD No. 934 regarding the establishment of the automated information system "The state register of natural mineral water, drinking water and bottled non-alcoholic beverages".

Vanillin, corresponds to the requirements presented in the DECISION No. 229 for the approval of the Health Regulation on food additives [5].

Gelatin, corresponds to the requirements of GOST 11293-89 “Gelatin. Technical conditions".

Spirulina (*Arthrospira platensis*), corresponds to the sanitary requirements according to DECISION No. 538 for the approval of the Health Regulation regarding food supplements.

Methods of analysis

Sensory quality assessment based on the score scale, ISO 6658: 2005 Sensory analysis - Methodology - General guidance.

Determination of titrable acidity - consists in neutralization of the acidic substances in milk with 0.1n NaOH (KOH) solution using phenolphthalein as indicator, according to ISO / TS 11869 and IDF / RM 150.

Determination of fat content by acid-butyrometric method - consists in the separation of the fat with the isoamyl alcohol by centrifuging the milk, previously mixed with sulfuric acid, according by SM EN ISO 1211: 2015.

Determination of milk protein content, consists in blocking the amyl groups of formic aldehyde proteins and releasing carboxylic groups, which are neutralized with 0.1n NaOH solution. Determine the amount of NaOH consumed at the second titration and multiply it by 1.94 and by 1.51 to determine the casein content, according to [21].

Determination of the viscosity, BROOKFIELD DV-III Ultra - the principle of operation is to drive a spindle (which is immersed in the test fluid) through a calibrated spring. The viscous drag of the fluid against the spindle is measured by the spring deflection. Spring deflection is measured with a rotary transducer. The measuring range of a DV-III (in centipoise) is determined by the rotational speed of the spindle, the size and shape of the spindle, the container the spindle is rotating in, and the full scale torque of the calibrated spring (BROOKFIELD DV-III Ultra, Guide Book).

Determination of the total dry matter content - at the initial stage of measurement, the device precisely determines the mass of object placed on its weighing pan. Following this, there is fast heating of the sample with halogen or IR lamps. This causes evaporation of humidity from the tested sample. While sampling, the moisture analyzer is continuously checking the decline of mass, and after calculation, it displays current indications on the display of the balance (MAC Humidity Analyzer, Radwag, Guide Book).

Determination of ash content - mineral residues resulting from the complete burning of the organic part of the sample and the determination of the weight of the ash mass fraction, according to [22].

Determination of iron content - measuring the color intensity of a bivalent iron complex compound solution with red orthophenanthroline, according to [23].

Determination of the beating degree of the finished product - neutralizing the foam formed with 1-2 diethyl ether, according to [21].

Results and discussions

Ice cream is a food, its recipe includes several of lactic or nonlactic ingredients, which during the technological process, especially freezing operation, allow to obtain the specific characteristics of the product.

The ice cream consists of a phase of proteins, sugars, mineral salts dispersed in frozen water, a phase of ice crystals, the phase of air bubbles, more or less evenly distributed in the mass of ice cream and a phase of emulsified fats globules.

Spirulina can be used to improve the nutritional and functional features of ice cream. Given the rich chemical composition, nutritional benefits for health, [24] and the functional

properties of spirulina, it is recommended to partially and even completely replace the amount of stabilizer used in the manufacture of ice cream according to the classic recipe. Table 2 shows the scheme for the replacement of the stabilizer - gelatin with spirulina.

Table 2

Gelato with *spirulina* assortment

Stabilizer	Control sample (Sc)	Sample 1 (S1)	Sample 2 (S2)	Sample 3 (S3)	Sample 4 (S4)
Gelatin, %	100	75	50	25	-
Spirulina, %	-	25	50	75	100

The characteristics of the sensory quality are the parameters appreciated by the consumers, being the most important factor in determining the acceptance of the food products.

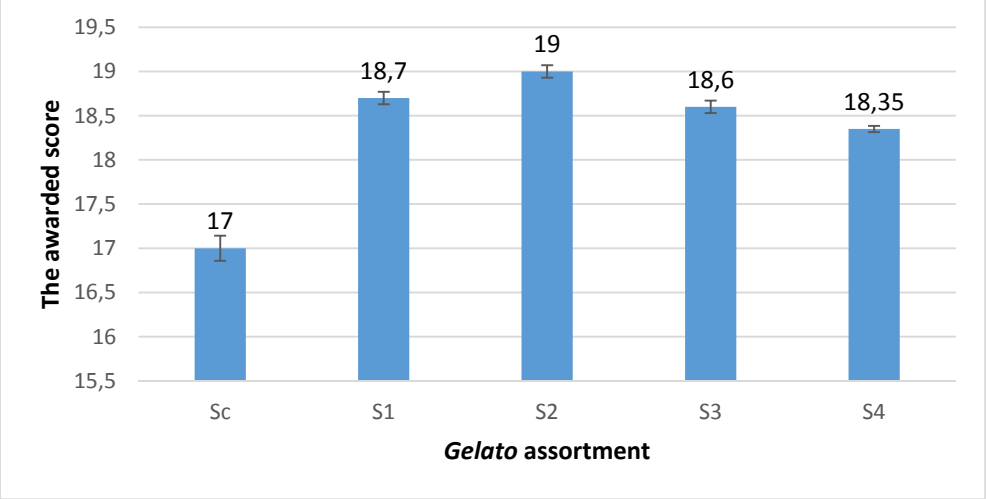

Figure. 1. The total point saverage of the gelato with spirulina.

The sensory qualities (appearance, color, taste, smell) of the gelato assortments were assessed according to the rating scale, presented in the sensory analysis paper: 5 = very good, 4 = good, 3 = satisfactory, 2 = unsatisfactory, 1 = bad, 0 = very bad. The mean scores of the sensory analysis were passed in the Results centralization data sheet.

Total average score (Pt) is calculated based on weighted average scores (Pmp).

The results of the sensory evaluation are shown in figure 1. With the exception of the control sample, the entire gelato assortment was rated as "very good" and characterized as follows: "Product with pleasant, specific, well-defined sensory characteristics, does not present any noticeable defects".

The quality control sample was regarded as "satisfactory" and characterized as follows: "The product has poorly defined sensory properties, but also small defects", due to which the product is at the minimum level allowed by the normative documents.

The physico-chemical indicators results presented in table 3 show a slight increase in the dry matter content from 47.01% to 49.75% in the sample 4 and protein (from 4.46% control sample to 5.04% in the sample where the stabilizer was replaced with 100% spirulina) due to the nutrient supply by spirulina. The amount of fat has virtually the same value for all investigated gelato samples.

Milk is a poor source of iron, so replacing the gelatin stabilizer with spirulina has a beneficial impact on filling the iron content in ice cream.

Table 3

Physico-chemical indices of *Gelato*

Sample	Chemical composition (%)		
	Dry matter	Protein	Fat
Sc	47,01±0,014	4,46±0,007	10,5±0,035
S1	49,04±0,007	4,65±0,035	10,2±0,07
S2	49,54±0,028	4,85±0,035	10,5±0,035
S3	49,61±0,028	4,95±0,021	10,5±0,042
S4	49,75±0,035	5,04±0,007	10,5±0,07

Henrickson (2009) reports high iron content in spirulina, considering the spread of anemia among the population, especially among children, an important group of ice cream consumers. In comparison, iron sulphate as an iron supplements may pose a toxicity problem. Cereals are also high in iron, but they contain phytic acid which limits its bioavailability. In the case of spirulina, the bioavailability of iron has been demonstrated in vivo, without presenting any health risks. Thus, replacing the basic stabilizer with spirulina has beneficial nutritional effects by fortifying the gelato with iron (Figure 2 and 3), [24, 25].

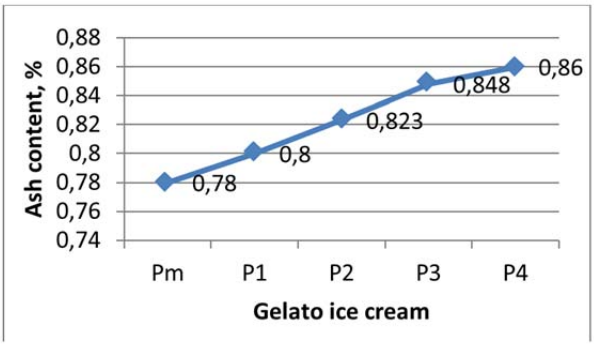

Figure 2. The effect of using spirulina on the ash content in gelato.

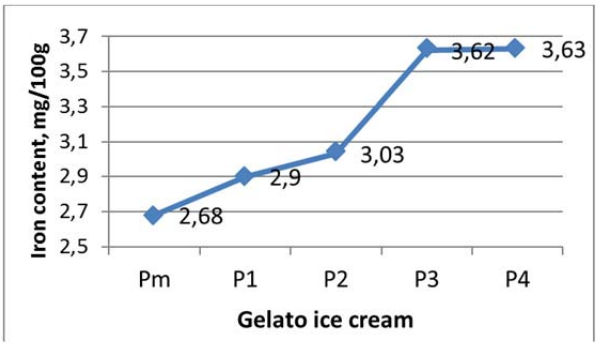

Figure 3. The effect of using spirulina on the iron content of gelato.

The natural acidity of the ice cream mix is made up of milk proteins, mineral substances and dissolved gases [10]. With the increase of the skimmed dry substance in milk, the titrable acidity in milk also increases due to the buffering capacity of proteins, phosphates, citrates, lactates and other components. The increase in the acidity of the gelato can be attributed to the chemical composition of spirulina, a value that actually increases with the concentration of spirulina [24]. The addition of spirulina supplements the protein and mineral salts content, which leads to increased acidity of the manufactured product. The results are shown in table 4. Viscosity is a physical property of ice cream that contributes to maintaining the components in a homogeneous phase. As the spirulina content increases, the viscosity of the product decreases. Usually, the stabilizers used in the ice cream manufacture have the tendency to increase the viscosity of the ice cream, but the spirulina has an inverse proportional effect, possibly due to the high capacity of water binding and the capacity of gelation in water, in order to improve the consistency of the manufactured product, to reduce the ice crystals growth during storage condition [10]. The air is incorporated into the ice cream mix during the freezing operation. The speed with which the air is incorporated into the ice cream mix is largely attributed to the mass part of the solid substance including additives, stabilizers and emulsifiers [26].

Table 4

Physical properties values of *Gelato*

Sample	pH	Titrable acidity (°T)	Viscosity, mPas
Sc	7,05±0,007	16±0,070	3360±3,535
S1	6, 94±0,007	17±0,070	2400±3,535
S2	6,70±0,070	18±0,070	2400±7,071
S3	6,78±0,014	18±0,141	1760±7,071
S4	6,73±0,049	19±0,035	1920±3,535

The results of the experiment (table 5) show that with the increase of the spirulina content in the gelato, the degree of beat increases from 18.75% for the control sample to 27.2% in the sample with 100% added spirulina. The increase of the overrun with the increase of the spirulina content in the end product may be due to the active interaction properties on the surface of the proteins and fats contained in spirulina. Spirulina has the emulsification capacity of 1.13 ml fat / g protein, the stability of the foam of 27% [26, 10], parameters that also contribute to the increase of the beat degree of gelato with spirulina.

The increase of the freezing point with the increase of the spirulina concentration in gelato is attributed to the high content of mineral salts contained in spirulina [28].

Table 5

Technological parameters values of the *Gelato*

Product	Overrun (%)	Beat degree (%)	Freezing point (°C)
Pm	18,7±0,007	28,0±0,707	-7,3±0,070
P1	20,6±0,014	30,0±0,353	-9,2±0,141
P2	23,4±0,028	31,6±0,424	-9,2±0,035
P3	26,0±0,035	32,0±0,424	-9,4±0,035
P4	27,2±0,014	32,0±0,353	-9,6±0,035

Gelato hardness was determined using the penetrometer. The results show that using the spirulina stabilizer contributes to the increase of the penetration value and to the decrease of the hardness of the gelato respectively. These values are directly proportional to the gelato overrun. The higher is overrun, which coincides with the higher amount of stabilizer - spirulina, the finer, softer will be the gelato, respectively the higher penetration degree and the lower hardness [29].

Conclusions

Replacing gelatin with spirulina, as a stabilizer, allows to obtain a product with high quality index values and increased biological value because spirulina is a microalgae rich in proteins, amino acids, polyunsaturated fatty acids, a wide spectrum of mineral salts, vitamins, has high water binding capacity, gelling in water. The results of the sensory analysis showed that the assortment of gelato with spirulina was appreciated as "very good" and characterized as follows: "Product with pleasant, specific, well-defined sensory properties, it does not present any noticeable defects". The replacement of the gelatin with spirulina, even in the samples with total substitution, allowed to obtain an attractive, tasty product with high qualifications for both physical-chemical and technological indices.

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