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USE OF NATURAL SWEETENERS (MAPLE SYRUP) IN PRODUCTION OF LOW-FAT ICE CREAM

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Abstract

Ice cream is a popular frozen milk products worldwide. In the same time, maple syrup is one of the few products in the Middle East, Asia and Iraq, that has been used as a natural local substance instead of sucrose. This food product as health and nutritional benefits compared to sucrose. That's why this research aims to assess the extent to which maple syrup ratios differ in the physical, chemical, microbiological and sensory aspects of low-fat ice cream.

The chemical, physical and sensory characteristics of produced ice cream in our food science laboratory were evaluated**.** Samples were divided into 5 sections: Control sample (A) with 100% sucrose, Sample (B) with 75% sucrose and 25% maple syrup, Sample (C) with 50% sucrose and 50% maple syrup, Sample (D) with 25% sucrose and 75% maple syrup and Sample (E) with 100% maple syrup. Following parameters were examined: carbohydrates has been calculated via the (by the spectrometer), total solids (by the drying oven at 110 0C), fat (via the Gerber test), ash (furnace burning), and pH (by pH meter). Also were determined: basic specific weight of the product (by density vial), viscosity mixture ice cream (by viscosity meter), melt resistance (via loss, %), the length of the product's staying solid and overrun (using formulae: overrun = x100 [(W1 - W2) / W2], where W1 = weight of 250 mL of the mix and W2 = weight of 250 mL of ice cream). The sensory assessment it was done by panel test (25 participants who completed assessment of ice cream for: flavor, body and texture, color, and appearance).

Results showed decrease in total solids by increasing replacement of sucrose with maple syrup from 35.14 for (Sample A) to 31.29 for fully replaced sample (sample E). Similarly, carbohydrates also decreased to 20.73 in sample (E). Maple syrup contains organic acids, consequently, pH decreased to 4.92 in sample E. In contrast, ash percentage increased by increasing the substitution rate, from 0.91% in sample A, reaching 1.49% for the ice cream sample with a 100% substitution rate (Sample E). For the viscosity and specific weight, both decreased in most of the treatments compared to the control sample due to the decrease in the total solids rate. Melting resistance of the ice cream samples gradually decreased with the increase in the replacement percentage. Sensory assessment of ice cream samples obtained with different values between treatments, where sucrose replacement with maple syrup improves flavor, textures, color and appearance, especially for ice cream samples with an alternative rate of 50% and 100%.

The resulting ice cream by replacing maple syrup with sucrose led to a decrease in total solids, carbohydrates, pH, specific weight, viscosity, and melting resistance, while ash and excess ratio were improved, the values of the sensory properties of ice cream were improved, which is a result of used maple syrup recipes. Overall we can conclude that maple syrup is a promising replacement of sucrose in low-fat ice cream.

***Key words**: Ice cream, Skim milk, Maple syrup, Overrun, Sucrose.*

1. Introduction

The ice cream industry is increasingly booming around the world in order to achieve customer satisfaction especially in hot and humid climates. It becomes popular because of the taste of delicious ingredients. As a result, domestic and international dairy markets

have been positively affected [1].

The current competitive dairy market position will do more to meet consumer demands throughout the production and development of competitive new brands [2]. In addition, competition is also implemented to produce healthy products. Therefore, some food industries develop products with vital ingredients [3]. Dried fruit was added instead of skim milk led to increased viscosity, total solids, specific weight and pH for the ice cream product compared to the control sample [4].

In addition, phenolic compounds as well as antioxidant activity with ice cream containing grape juice residues were reported at different concentrations [5]. In a study on the effect of saleps obtained from different types of *Orchidaceae* on some physical and sensory properties of ice cream can affect the quality of melting ice cream, viscosity, glucomannan levels and starch levels [6].

In soy ice cream, it has been reported that replacing sucrose with maple syrup can decrease the freezing point as well as pH values. However, the specific weight increased [7].

In ice cream manufacturing, sucrose is the most common sweetener because of its flavoring effect, texture and stabilizer, a grouping factor that can control the size of the crystal and the freezing point [8]. However, many types of ice cream sweeteners including sucrose, converted sugar, maple syrup, malt syrup, corn sweeteners, and honey are used in the ice cream mix [9].

In a study, red palm olein (RPOL) and stabilizers, guar and xanthan gums were used in ice cream groups, all ice cream appeared in red and yellow due to the presence of RPOL, and color density was enhanced with stabilizers [10].

The potential application of stalk fibres carboxymethyl cellulose (SCMC) to low fat ice cream properties has been investigated, the low-fat ice cream produced using SCMC is comparable to low-fat ice cream produced using commercial carboxymethyl cellulose (CMC). This indicates the reliability of CMC extracted from oil palm empty fruit bunch (OPEFB) leg fibers to be applied in food [11].

Maple syrup is a famous North American ice cream sweetener naturally extracted from a tree (*Acer saccharum* L.) The main global producer of Maple is Quebec, Canada (~ 80%), [12]. Maple syrup is a highly consumed food product, including the carbohydrate composition of maple syrup mainly from sucrose (60 - 66%), glucose, fructose and polysaccharide [13, 14]. Minerals (K, Ca, Mg, Na, Mn, Al, Zn, I, etc.), vitamins (riboflavin, niacin, thiamine, etc.), amino acids (arginine, threonine, proline, etc.), organic acids (malic, fumaric acid etc.) are also found in maple syrup [15]. The color of maple syrup is mostly determined by the season harvested in maple sap from maple trees. Darker color of the resulting maple syrup is later in the season that maple sap is obtained. It has been reported that the size of sugar molecules leads to the dark color of maple syrup [16].

With all the benefits of sucrose as a local but it has to do with some health problems, such as obesity, dental erosion, blood pressure and increased glucose and insulin in the blood, it is particularly harmful to diabetes in addition to the other side of economic and technological issues today the use of various sugars as an alternative to sugar in ice cream and reduce sugar consumption [17].

Maple syrup is a good substance for human health. Because it contains a quantity of antioxidant compounds about 2% of its dry weight. Today, maple syrup is used as a local substance for breakfast [18].

The current study aims to assess the extent to which maple syrup ratios differ in the physical, chemical, microbiological and sensory aspects of low-fat ice cream, because maple syrup is one of the few products used in the Middle east, Asia and Iraq, that has been used as a natural local substance instead of sucrose, because its use has health and nutritional benefits compared to sucrose.

2. Materials and Methods

2.1 Materials

As materials for this research were used: fresh cow's milk with fat of 3% purchased from cow breeders, skimmed milk type (Regilit) of French origin, cream, fat 26%, yghurt of Turkish origin, maple syrup of Canadian origin purchased from the local market, stabilizer CMC of Dutch origin, original vanilla brand of Turkish origin, and sucrose from Thai origin.

2.1.1 Samples

The samples were divided into 5 sections as follows: control sample (a) - with 100% sucrose, sample (b) - with sucrose 75% and 25% maple syrup, sample (c) - with sucrose 50% and 50% maple syrup, sample (d) - with 25% sucrose and 75% maple syrup, and sample (e) - with 100% maple syrup.

2.1.2 Ice cream manufacturing

Making low-fat ice cream based on Marshall *et al*., [19], with modifications as shown in Table 1.

Table 1. Ice cream mixture ingredients (g)

Ingredient	Samples				
	A	B	C	D	E
Sugar (g)	80	60	40	20	0
Vanilla (g)	1.5	1.5	1.5	1.5	1.5
Powdered skim milk (g)	76	76	76	76	76
Cream 26% fat (g)	30	30	30	30	30
Fresh cow's milk (3% fat) (g)	310	310	310	310	310
Stabilizer (g)	2.5	2.5	2.5	2.5	2.5
Maple syrup (g)	0	20	40	60	80
Total (g)	500	500	500	500	500

2.2 Methods

2.2.1 Chemical analysis of ice cream

Carbohydrates, total solids, fats and ash were measured using the procedures outlined in [20]. pH values were determined using a glass pole and a wireless laboratory pH meter (HI 93 1400, Hanna Instruments).

2.2.2 Physical analysis of ice cream

Using a density vial, the basic specific weight of the product was carried out by the process reported in [21]. Viscosity mixture and ice cream melt resistance (loss %) designed according to Arbuckle [23]). The measurement system was used to assess ice cream overrun this formula: overrun = x 100 [(W1 - W2) / W2], where W1 = weight of 250 mL of the mix and W2 = weight of 250 mL of ice cream according to [22].

2.2.3 Sensory assessment

The sensory assessment was conducted as mentioned by Arbuckle, [23], with an adjustment. The color was evaluated instead of the melting properties of this because maple syrup is dark in color, with twenty-five participants who completed assessment of ice cream samples for: recorded flavor (from 45 points), body and texture (from 30 points), color (from 10 points) and appearance (from 15 points).

2.2.4 Statistical analysis

The SAS version statistical analysis system [24], was used to perform statistical analysis on the data collected. Duncan's multiple range tests were used to determine differences between means at 0.05 level [25].

3. Results and Discussion

3.1 The chemical composition ice cream

In Table 2 is presented chemical composition of the ice cream.

Total solids were much higher in the control sample than other samples the overall negative correlation was increased with maple syrup replacement. In fact, total solids in sucrose are higher than maple syrup [26].

Additionally, carbohydrates also decreased when replacing sucrose with maple syrup. Where sucrose is known to be rich in carbohydrates [27]. This makes the use of maple syrup more important than sucrose in ice cream production, which in turn gives a low carbohydrate product and thus low energy. The ash concentration was shown at 0.91% in the control sample compared to other treated samples, which are directly proportional to the increased maple replacement. This is likely due to the mineral salt content of the maple, which is about 5%. This is due to the importance of maple syrup, which contains appropriate concentrations of calcium, potassium, magnesium and other minerals that play an important role in the growth and construction of the body. Regarding percentage of fat, we didn't find any significant difference between samples. The results showed a decrease in pH by increasing maple syrup gradual replacement from 6.41 per control sample to 4.92 per 100% sample replacement (E). Maple syrup has been reported to contain organic acids in its composition [28]. This, in turn, shows the importance of maple syrup in giving a light sour taste in ice cream, which is considered desirable to the consumer.

Table 2. Chemical composition of the ice cream

Component	Samples				
	A	B	C	D	E
Total solids (TS) %	31.26 ± 1.009^{d}	32.65 ± 1.013^{c}	33.49 ± 1.015^{b}	34.74 ± 1.012^{ab}	35.14 ± 1.006^{a}
Carbohydrate %	20.73 ± 0.92^{c}	22.12 ± 0.94^{bc}	23.31 ± 0.94^{b}	23.69 ± 0.96^{a}	24.37 ± 0.92^{a}
Ash %	1.49 ± 0.08^{a}	1.38 ± 0.03^{ab}	1.24 ± 0.06^{b}	1.16 ± 0.04^{bc}	0.91 ± 0.04^{c}
Fat %	4.60 ± 0.126^{a}	4.61 ± 0.128^{a}	4.59 ± 0.129^{a}	4.60 ± 0.134^{a}	4.58 ± 0.125^{a}
pH	4.92 ± 0.081^{d}	5.27 ± 0.086^{cd}	5.76 ± 0.089^{c}	6.08 ± 0.092^{b}	6.41 ± 0.098^{a}

Legend: Different letters indicate significant differences within the row at ($P < 0.05$). (A) Control 100% sucrose, (B) 75% sucrose with 25% maple syrup, (C) 50% sucrose with 50% maple syrup, (D) 25% sucrose with 75% maple syrup, Sample (E) 100% maple syrup.

3.2 Physical analysis ice cream

According data in Table 3, a significantly specific weight also fell from 1.118 to 0.998 in samples A and E, respectively. The reason for this is that the density of sucrose is higher than maple. Similarly, ice cream viscosity has also decreased significantly between control and processing groups due to the low contents of total solids in the mixture. These results were consistent with Hasan *et al*., [4] and Sofjan and Hartel, [22]. Due to this decrease in viscosity, ice cream overrun increased significantly with the gradual replacement of the maple from 62.35 to 69.82 in samples A and E, respectively. The reverse relationship between viscosity and ice cream has been recorded [4]. Overrun is an important thing for the production of ice cream, which leads to an increase in size, and here highlights the importance of maple syrup in increasing the overrun of the resulting ice cream.

Ice cream melt resistance is defined as the relative weight loss of the main weight of the sample [7]. Table 3 shows a decrease in melt resistance affected by increased maple concentration replacement.

The results of this study were similar with the results of Khalil and Blassy, [29]. They found that the addition of date syrup concentrate (dibis) leads to a slight increase in melting values and a misrepresentation of ice cream resistance, improving shape stability and evaluating high-quality ice cream. Other effect factors, which are affected by the solubility range of ice cream are the quality and quantity of emulsifier polysorbate 80 [30]. In fact, ice cream cells are linked to air, where they can affect the rate of ice cream melt resistance. This makes the ice cream resulting from replacing maple syrup with sucrose more desirable to the consumer when eating, making it easier to melting in the mouth.

3.3 Sensory properties assessment

The sensory qualities of ice cream are an important factor in attracting consumer attention and increasing overall acceptance of the product. It is possible to create extras and other colors allowed in the product in order to increase consumer attraction [31]. Sensory assessment of the samples is presented in Table 4.

The highest and best degree of taste was observed with a positive effect of treatment at the replacement level of 100% and the lowest degree in comparison treatment. There is a difference in flavor score among all treatments, and this may be due to the acidity of simple maple syrup. For the body and texture, the third sample where was a replacement level of 50%, had the highest values of 27 and the lowest degree in control sample. It may be due to increased homogeneity of the ice cream mixture as a result of the low level of total solids the maple syrup. As for the color of the ice cream, the replacement level of 50% achieved the

Table 3. Physical analysis ice cream

Variable	Samples				
	A	B	C	D	E
Specific weight	1.118 ± 0.012^{a}	1.088 ± 0.009^{a}	1.053 ± 0.013^{ab}	1.027 ± 0.018^{b}	0.998 ± 0.016^{c}
Viscosity (Pa x s)	11.46 ± 1.03^{a}	10.89 ± 1.01^{ab}	10.02 ± 1.03^{b}	9.56 ± 0.99^{bc}	8.84 ± 0.92^{c}
Over run %	62.35 ± 1.65^{d}	64.47 ± 1.81^{c}	66.15 ± 1.72^{bc}	67.91 ± 1.78^{b}	69.82 ± 1.92^{a}
Melting resistance %					
30 min.	9.81 ± 0.95^{e}	13.67 ± 0.96^{d}	$18.26\pm^{0.98c}$	$22.36\pm^{0.95b}$	$22.36\pm^{0.95b}$
45 min.	21.25 ± 0.85^{e}	28.28 ± 0.82^{d}	36.38 ± 0.89^{c}	47.93 ± 0.72^{b}	47.93 ± 0.72^{b}
60 min.	49.67 ± 1.05^{d}	54.70 ± 1.04^{c}	70.35 ± 1.01^{b}	80.25 ± 1.02^{a}	80.25 ± 1.02^{a}
90 min.	90.16 ± 1.12^{b}	95.57 ± 1.18^{a}	97.76 ± 1.15^{a}	Complete melt	Complete melt

Legend: Different letters indicate significant differences within the row at ($P < 0.05$). (A) Control 100% sucrose, (B) 75% sucrose with 25% maple syrup, (C) 50% sucrose with 50% maple syrup, (D) 25% sucrose with 75% maple syrup, Sample (E) 100% maple syrup.

Table 4. The points of the sensory assessment of the ice cream

Treatment	Samples				
	A	B	C	D	E
Flavour - 45 points	39 ± 0.5^{c}	41 ± 0.5^{b}	42 ± 0.5^{ab}	42 ± 1.0^{ab}	43 ± 1.5^{a}
Body and texture - 30 points	24 ± 0.5^{c}	24 ± 0.5^{c}	27 ± 0.5^{a}	26 ± 0.5^{ab}	25 ± 1.0^{b}
Color - 10 points	8 ± 0.5^{b}	8.5 ± 0.5^{ab}	9.5 ± 1.0^{a}	9 ± 0.5^{ab}	7 ± 0.5^{c}
Appearance - 15 points	10.5 ± 0.5^{c}	12 ± 0.5^{b}	12 ± 0.5^{b}	12.5 ± 1.0^{ab}	13 ± 1.0^{a}

Legend: Different letters indicate significant differences within the row at ($P < 0.05$). (A) Control 100% sucrose, (B) 75% sucrose with 25% maple syrup, (C) 50% sucrose with 50% maple syrup, (D) 25% sucrose with 75% maple syrup, Sample (E) 100% maple syrup.

highest rating compared to other samples, due to the dark color of the maple bar. This gave the desired color for the ice cream, but the increase in the replacement rate to 100% led to an unwanted dark-colored product. On the contrary, appearance values in ice cream samples increased by increasing the replacement rate.

4. Conclusions

- The resulting ice cream by replacing maple syrup with sucrose led to improvement of the resulting ice cream chemical properties, meaning: decrease in total solids, carbohydrates, pH, and increased ash concentration, while the concentration of fat made no significant difference between the samples.
- Physical analysis ice cream showed decrease in: specific weight, viscosity, and melting resistance, and increase in overrun values.
- Replacement process has improved the values of the sensory properties of ice cream, which is showing the importance of different maple syrup recipes.

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