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Effect of Vegetable Marrow (*Cucurbita pepo* L.) on Ice Cream Quality and Nutritive Value

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In the present study, the effect of adding vegetable marrow (VM) (control, 10, 15 and 20 % at concentrations) on the chemical, physicochemical and sensory of ice cream mixes were investigated. Also concentrations of some major and minor minerals were determined in ice creams. The chemical composition of ice creams were affected with vegetable marrow addition significantly ($p < 0.05$). The addition of vegetable marrow increased the viscosity, first dripping time and complete melting time of ice cream samples, but decreased the overrun value depending to vegetable marrow concentration. While Ca and P contents of ice creams decreased by increasing of added vegetable marrow, the K content increased. The addition of vegetable marrow did not affect statistically concentrations of minor elements such as Mn, Ni. But Fe and Zn contents of ice creams significantly increased at 15 and 20 % concentrations. In the result of sensorial analysis the ice creams with 10 and 15 % of vegetable marrow concentration were preferred by the panelists. This work showed vegetable marrow might be used as new variety in ice cream production, especially at 10 and 15 % concentrations of vegetable marrow.

Key Words: Ice cream, Vegetable marrow, *Cucurbita pepo* L., Mineral composition, Quality properties.

INTRODUCTION

Recently, nutraceuticals and functional foods have become popular. The awareness of consumers for healthier and functional food has led to the introduction in ice cream manufacture of certain materials with documented nutritional and physiological properties such as probiotics, lactic acid bacteria, dietary fibers, alternative sweeteners, natural antioxidants and low glycemic index sweeteners. So the researches have intended for increasing of nutritive values of ice cream. Ice cream is a valuable food with significant nutritive qualities and is well assimilated by the body. Therefore it is largely consumed by different age groups. Vegetables and fruits are accepted as functional foods due to phenolics contents. Therefore they are used commonly as an ingredient in ice-cream production. The number of studies about vegetables and fruits application in ice cream production increased recently[1-3].

Cucurbita L. species are an important vegetable crop in tropical and temperate regions. Morphologically, *C. pepo* displays a great diversity of types. The edible forms of these species can thus be grouped into eight morphotypes: Pumpkin, with round or nearly round fruits; Vegetable marrow (VM), with short, tapered and cylindrical-shaped fruits; Cocozelle, with long bulbous fruits; Zucchini, with uniformly cylindrical shaped fruits; Acorn, with furrowed, turbinate fruits; Scallop, with flat, scalloped fruits; Crookneck, with narrow, usually curved and warted, necked fruits and Straightneck, with short-necked or constricted fruits, usually warted[4]. It is brought up majority of *Cucurbita* L. species in Turkey due to suitability of climate. According to statistical data, annually Turkish's marrow production is 300000 tones[5]. The marrow is evaluated at different forms such as fresh and tinned in Turkey. The vegetable marrow contains 5-10 % dry matter and 90-95 % moisture. It compose of 1.2 % protein, 3.6-4.3 % carbohydrate, 19-25 mg vitamin C, 320-460 I.U vitamin A, 0.05 mg thiamine, 0.09 mg riboflavin, 1.0 mg niacin, 28 mg Ca, 30 mg P, 202 mg K, 0.5 mg Fe[6,7].

Ice cream is a highly complex food matrix, containing proteins, fat, sugars, air, minerals, *etc.* and countless interfaces between the different constituents[8]. Ice cream is accepted as milk product of high nutritional and caloric density. Although ice cream is rich in calories, it is poor in dietary fibers and some of natural antioxidants. The aim of this study is to investigate possibilities of using vegetable marrow as new variety in ice cream production and to determine effect of vegetable marrow (*Cucurbita pepo* L.) on ice cream quality.

EXPERIMENTAL

Cow's milk and cream were supplied by the Research and Application Farm of Ataturk University. Vegetable marrow was obtained from local markets. The marrows were washed, peeled and planed. Then they were cooked with its juice for 5 s. Sucrose, salep and emulsifier (mono- and di-glycerides) were obtained from local markets. Skim milk powder was supplied by Pinar Dairy Products Co. (Turkey).

Preparation of ice cream samples: Ice creams were made in the Pilot Plant of Food Engineering Department, Agriculture Faculty, Atatürk University. The fat ratio of cow milk was adjusted to 5 % with cream addition. The milk was divided into 4 equal parts of 3.5 kg. Then 15 % sucrose, 0.7 % salep (stabilizer), 0.25 % emulsifier (mono- and di-glycerides) and 3.75 % skim milk powder were added to each mix. The mixes were pasteurized using high temperature short time (HTST) at 81.5 ºC for 25 s and were rapidly cooled to 4 ºC and remained at constant temperature for 24 h to be aged. Then prepared marrows were added at three different concentrations (VM-10, VM-15 and VM-20). The mix without marrow was accepted as control (C). They were iced in ice cream machinery (-5 ºC) (Ugur Cooling Machineries Co., Nazilli Turkey) and hardened at -22 ºC for 1 day. Ice cream samples were produced in duplicate.

Ice cream analysis

Chemical and mineral analysis: Dry matter, fat, protein, ash, acidity (ºSH) and pH of ice-cream samples were determined as defined by Demirci and Gündüz[9] Mineral contents (Ca, K, Na, P, S, Mg, Fe, Mn, Zn, Ni) of ice cream samples were determined using an inductively couple plasma spectrophotometer (Perkin-Elmer, Optima 2100 DV, ICP/OES, Shelton, CT, USA) and following the method described by Güler[10]. Decomposition of samples was performed in a microwave oven (Berghof speed wave MWS-2, Eningen, Germany). For this purpose, about 0.5 g ice-cream sample was weighed into the digestion vessels. Concentrated nitric acid (10 mL) and after that, digestion was carried out to each sample at 210 ºC and 176 psi pressure for 10 min. After cooling, the carousels were removed from the oven, 30 % hydrogen peroxide (2 mL) was added to samples and then second digestion was applied at 195 ºC and 95 psi pressure for 5 min. The vessels were immediately closed after the addition of oxidants. At the end of the digestion process, the samples were diluted with distilled water to a suitable concentration and were filtered through Whatman No. 42 filter paper. All diluted digests were eventually analyzed by an Inductively couple plasma spectrophotometer (ICP-OES).

Physical measurements: Overrun was determined using a standard 100 mL cup, according to the equation [(volume of ice cream)-(volume of mix)/volume of mix × 100] given by Jimenez-Florez *et al.*[11]. First dripping and complete melting times were measured according to Güven and Karaca[12] 25 g of tempered samples were left to melt (at room temperature, 20 ºC) on a 0.2 cm wire mesh screen above a beaker. First dripping and complete melting times of samples were determined as seconds. The viscosities of the ice-creams were determined at 4 ºC using a digital Brookfield Viscometer, Model DV-II (Brookfield Engineering Labrotories, Stoughton, MA,USA)[13].

Sensory assessment: The sensory characteristics of the ice-cream were judged by 8 trained panelists using a score test. Hardened ice-cream samples were tested at a serving temperature of -10 ºC. The sensory characteristics were assessed on a scale from 1, for very poor, to 9, for excellent[14]. The panel assessors was an external panel of non-smokers who were very familiar with dairy products and were checked on the basis of sensory acuity and consistency.

Statistical analysis: All statistical analysis was performed on a computer running SAS for windows. Analysis of variance was performed using the routine Proc ANOVA. Significant treatment was separated using Duncan's multiple range test[15].

RESULTS AND DISCUSSION

The results of some physical, chemical analyses and mineral contents of milk and vegetable marrow are given in Table-1. The chemical composition of ice-cream samples is shown in Table-2. The dry-matter content of control sample was higher than other samples in significant levels ($p < 0.01$). The dry matter values of ice cream were decreased with the increase of vegetable marrow concentration. This condition might be originated from high moisture of vegetable marrow (Table-1). The highest fat ratio was determined in control sample. It was seen that addition of vegetable marrow was decreased fat values of ice-cream samples. The addition of vegetable marrow did not affect statistically protein ratios of samples. While the highest acidity value was determined in sample containing 20 % vegetable marrow, pH values of ice-cream samples were statistically similar. This situation might be due to pH of vegetable marrow (6.59).

TABLE-1
PHYSICAL, CHEMICAL PROPERTIES AND MINERAL CONTENTS OF MILK AND VEGETABLE MARROW

Parameters	Milk	Vegetable marrow
Dry matter (%)	11.99	15.19
Fat (%)	3.50	–
Protein (%)	3.41	–
Ash (%)	0.79	1.20
Acidity (%)	0.16	–
pH	6.66	6.59
	Minerals (mg/kg)	
Ca	1218.00	217.14
K	1347.00	3669.00
Na	351.00	37.29
P	872.30	510.65
S	215.40	274.00
Fe	13.99	68.76
Mg	96.77	302.45
Mn	0.108	0.944
Zn	48.46	85.69
Ni	0.340	0.438

The viscosity affects greatly characteristics of ice cream mix. Therefore, viscosity measurement is important to measure the effect of vegetable marrow on characteristics of ice cream mixes. It could be seen that the addition of vegetable marrow significantly ($p < 0.01$) affected the viscosity behaviour of ice-cream samples (Fig. 1). The viscosity of ice cream increased significantly by the addition of vegetable marrow, especially compared to control samples. The viscosity values were 5687, 7154 and 7880 cp with the addition of vegetable marrow at 10, 15 and 20 % concentrations, respectively. This increase of viscosity might be originated from the components such as pectin contained in vegetable marrow. These results were in

TABLE-2
SOME CHEMICAL PROPERTIES OF ICE CREAM SAMPLES

Parameters	C	VM 10	VM 15	VM 20
Dry matter (%)	29.01 ± 0.07[a]	27.78 ± 0.06[bc]	27.97 ± 0.05[b]	27.70 ± 0.23[c]
Fat (%)	4.47 ± 0.05[a]	3.75 ± 0.19[b]	3.92 ± 0.37[b]	3.90 ± 0.34[b]
Protein (%)	5.70 ± 0.20[a]	5.35 ± 0.42[a]	5.70 ± 0.19[a]	5.32 ± 0.42[a]
Ash (%)	0.835 ± 0.01[b]	0.899 ± 0.01[a]	0.913 ± 0.02[a]	0.912 ± 0.00[a]
Acidity (SH)	9.90 ± 0.30[c]	10.35 ± 0.43[c]	11.12 ± 0.22[b]	11.78 ± 0.15[a]
pH	6.25 ± 0.04[a]	6.28 ± 0.01[a]	6.25 ± 0.01[a]	6.24 ± 0.01[a]

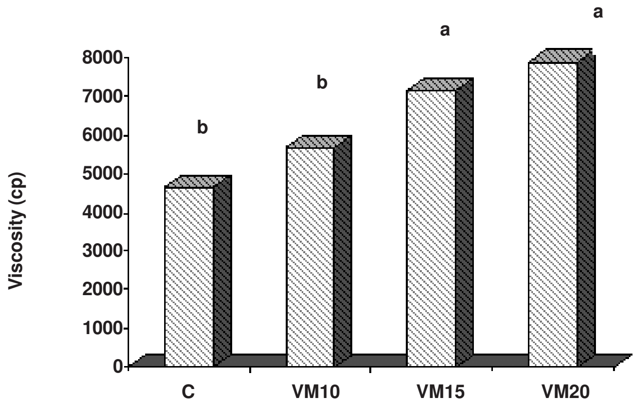

Fig. 1. Viscosity values of ice creams containing VM and control C: control (without vegetable marrow) VM10: vegetable marrow at 10 % concentration. VM15: Vegetable marrow at 15 % concentration. VM20: vegetable marrow at 20 % concentration

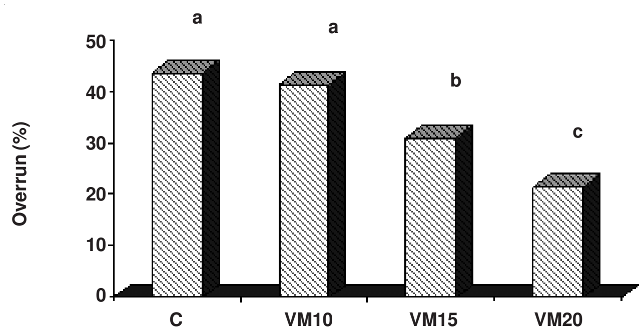

Fig. 2. Overrun values of ice creams containing VM and control C: control (without vegetable marrow) VM10: vegetable marrow at 10 % concentration. VM15: vegetable marrow at 15 % concentration. VM20: vegetable marrow at 20 % concentration

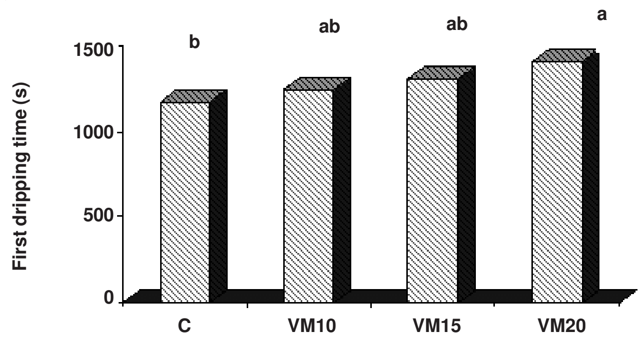

Fig. 3. First dripping times of ice creams containing VM and control C: control (without vegetable marrow). VM10: vegetable marrow at 10 % concentration. VM15: vegetable marrow at 15 % concentration. VM20: vegetable marrow at 20 % concentration

agreement with Hwang *et al.*[1], who indicated the addition of grape wine lees increased the viscosity of ice cream dose dependent circumstance. El-Samahy *et al.*[2], reported that increase of viscosity in ice cream containing concentrated cactus pear pulp might due to the effect of many factors such complexes which could be formed during aging between the components like pectin and sugars. It is also known that pectic components are utilized as gel forming ajan and thickening in food industry[16].

Overrun is related to the amount of air incorporated during the manufacturing process. This feature defines the structure of the final product, since the presence of air gives the ice-cream an agreeable light texture and influences the physical properties of melting and hardness of the final product[17,18]. Although vegetable marrow addition significantly was decreased the overrun of ice cream at 15 and 20 % concentrations, 10 % concentration did not cause significant change in the overrun of ice cream (Fig. 2). Since the viscosity of ice cream increased with vegetable marrow, it was possible that less air was incorporated in the ice cream mix with vegetable marrow during batch freezing, which resulted in lower overrun than for control (without marrow). El-Samahy *et al.*[2], reported that the decrement of overrun in ice cream containing concentrated cactus pear pulp might be attributed to increment of mix's viscosity which extremely affects on whipping rate of mixes. Hwang *et al.*[1], reported that the overrun values of ice cream samples were decreased significantly by the addition of grape wine lees.

As seen in Fig. 3, the first dripping times of ice creams containing vegetable marrow were prolonged significantly compared to control. While the highest first dripping time (1410 s) was determined in ice cream containing 20 % vegetable marrow, there was no statistically difference between 10 and 15 % vegetable marrow concentrations. The addition of vegetable marrow was statistically affected the complete melting times of ice creams. The ice creams with vegetable marrow melted in longer time compared to control. Also complete melting times increased with vegetable marrow addition (Fig. 4). This may be originated from some components situated in marrow, which have the ability to absorb water. It was reported that the addition of hydrocolloid stabilizers or polysaccharides to ice cream reduced the melting rate[19,20]. Akin *et al.*[13], reported that inulin retarded melting in ice cream due to its ability to reduce the free movement of water molecules.

Certain inorganic elements are essential for growth and performance. Those needed in substantial amounts, calcium, phosphorus, magnesium, sodium, potassium and sulfur, are termed major minerals. Those needed in small amounts, copper, cobalt, iodine, manganase, fluorine, molybdenum and selenium, are termed trace minerals[21]. The concentrations of selected

TABLE-3
CONCENTRATIONS OF MAJOR MINERALS IN ICE CREAM SAMPLES

Major minerals (mg/kg)	C	VM 10	VM 15	VM 20
Ca	1832.50 ± 28.99[a]	1174.50 ± 79.90[b]	1024.00 ± 4.24[b]	1053.75 ± 141.77[b]
K	1666.50 ± 58.68[c]	1618.50 ± 25.45[c]	1813.00 ± 87.67[b]	2240 ± 28.99[a]
Na	560.15 ± 19.44[a]	494.05 ± 9.68[ab]	408.40 ± 5.09[b]	441.40 ± 69.72[b]
P	1335.50 ± 36.06[a]	989.65 ± 9.54[b]	862.35 ± 36.69[c]	910.55 ± 48.15[bc]
S	963.25 ± 29.20[a]	706.95 ± 105.85[b]	528.65 ± 35.42[bc]	490.00 ± 67.59[c]
Mg	162.25 ± 12.51[a]	134.25 ± 28.35[a]	135.10 ± 3.95[a]	143.65 ± 11.38[a]

TABLE-4
CONCENTRATIONS OF MINOR MINERALS IN ICE CREAM SAMPLES

Minor minerals (mg/kg)	C	VM 10	VM 15	VM 20
Fe	11.78 ± 3.16[b]	21.97 ± 3.95[b]	84.14 ± 6.98[a]	130.65 ± 37.83[a]
Mn	0.302 ± 0.03[a]	0.315 ± 0.09[a]	0.522 ± 0.20[a]	0.513 ± 0.16[a]
Zn	54.54 ± 19.82[b]	37.95 ± 6.94[b]	203.37 ± 30.29[a]	213.98 ± 60.54[a]
Ni	0.68 ± 0.58[a]	0.22 ± 0.04[a]	0.98 ± 1.29[a]	0.88 ± 0.30[a]

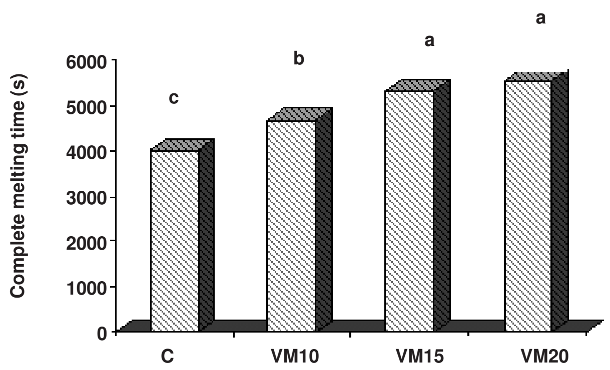

Fig. 4. Complete melting times of ice creams containing VM and control C: control (without vegetable marrow). VM10: vegetable marrow at 10 % concentration. VM15: vegetable marrow at 15 % concentration. VM20: vegetable marrow at 20 % concentration

elements such as Ca, K, Na, P, S, Mg, Fe, Mn, Zn and Ni in ice cream samples are shown at Tables 3 and 4. The addition of vegetable marrow was decreased significantly Ca and P contents of ice creams compared to control. This situation is not surprised because milk and its products are among the richest sources of Ca and P. While Na contents of ice cream samples were decreased with vegetable marrow, potassium contents of ice cream were increased statistically. It is known dietary potassium may play a role in decreasing blood pressure and is involved in nerve function, muscle control and blood pressure. Increasing potassium in the diet may protect against hypertension in people who are sensitive to high levels of sodium. The increase in K contents may due to high K concentration of vegetable marrow. As seen in Table-1, the K concentration of vegetable marrow was about 2.5 fold as compared to milk. The sulfur content was decreased by the addition vegetable marrow. The addition of vegetable marrow did not affect statistically concentrations of minor elements such as Mn, Ni (Table-4). Although vegetable marrow significantly increased Fe and Zn contents of ice creams at 15 and 20 % concentrations, vegetable marrow at 10 % concentration did not cause to significant change.

The organoleptic characteristics of ice cream shows in Table-5. There was no significant difference ($p > 0.05$) existed for the acceptance level of colour, texture and aroma attributes among all the ice cream samples. However, gumming structure and resistance to melting, especially the formulated samples of VM 15 and VM 20 were significantly ($p < 0.05$) higher as compared to the control. The addition of vegetable marrow increased the gumming structure and resistance to melting scores. The panelists reported that ice creams containing vegetable marrow had more viscous structure according to control. This might be originated that some components contained in vegetable marrow increased consistence of ice cream mix. The sample with 10 % level was very close to the control sample organoleptically. The resultant ice cream with substitution levels 10 and 15 % of vegetable marrow were preferred by the panelist.

Conclusion

The addition of vegetable marrow affected significantly chemical, physical, sensory characteristics and mineral composition of ice creams. Increasing vegetable marrow concentration led to products with better physical properties. The addition of vegetable marrow improved viscosity, first dripping and complete melting times. The ice cream with high vegetable marrow contents also showed unpleasant effects, such as the decrease of Ca and P. This unwanted effect was minor at 10 % vegetable marrow concentration. However, the addition of

TABLE-5
ORGANOLEPTIC CHARACTERISTICS OF ICE CREAM SAMPLES

Organoleptic characteristic	C	VM 10	VM 15	VM 20
Colour	8.12 ± 0.17[a]	8.00 ± 0.00[a]	8.19 ± 0.09[a]	7.62 ± 0.36[a]
Gumming structure	7.06 ± 0.08[b]	6.81 ± 0.26[b]	7.85 ± 0.11[a]	7.66 ± 0.00[a]
Texture	6.87 ± 0.00[a]	6.87 ± 0.17[a]	7.26 ± 0.09[a]	7.19 ± 0.39[a]
Flavor	7.37 ± 0.17[a]	7.45 ± 0.28[a]	7.43 ± 0.26[a]	7.00 ± 0.00[a]
Resistance to melting	6.81 ± 0.26[b]	7.12 ± 0.17[ab]	7.60 ± 0.07[a]	7.58 ± 0.11[a]
Overall acceptability	7.37 ± 0.17[a]	7.12 ± 0.17[a]	7.25 ± 0.35[a]	6.81 ± 0.26[b]

vegetable marrow increased significantly K, Fe and Zn contents of ice creams compared to control. In terms of sensorial, ice creams with vegetable marrow generally were approved by the panelists, especially at 10 and 15 % concentrations. Therefore, vegetable marrow may be used a value-added ingredient in ice cream industry to enhance the physico-chemical and nutritional properties.

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