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DEVELOPMENT OF AN ACCEPTABLE PEANUT-BASED ICE CREAM FOR BULGARIAN CONSUMERS

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РАЗРАБОТКА МОРОЖЕНОГО НА ОСНОВЕ АРАХИСА, ПРИЕМЛЕМОГО ДЛЯ БОЛГАРСКИХ ПОТРЕБИТЕЛЕЙ

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Abstract. Ice cream, as a high energy and tasty dessert, is enjoyed by generations worldwide. So peanut, based alternative to this product would provide consumers with new and better choices that are healthy, tasty and nutritious to consume. This study evaluated general acceptability by means of consumer acceptance and purchase behavior of peanut-based vanilla flavored ice creams varying in peanut butter (5, 10, 15 and 20% w/w). Eighty consumers were recruited to participate in the ice cream acceptance test at the sensory lab of the Institute of Food Preservation and Quality. The selection criteria were the subjects had to consume ice cream or any flavoured ice-cream, ice-cream cakes, peanuts, peanut butter or any peanut flavoured food at least once in two weeks and be adults over 18 year of age with no food allergies. Consumers evaluated following a randomized block design four sample formulations for overall acceptance, appearance, color, sweetness, texture, flavor, peanut flavor and milk flavor. The panel rated peanut vanilla flavoured ice-cream treatment B (10% peanut butter) as the best product. It received the highest consumer ratings for overall acceptance, colour, sweetness, flavour, peanut flavour, and milk flavour. The formulation C (15% peanut butter) received similar consumer ratings for appearance and texture. Main differences were observed in appearance and texture for treatment A (5% peanut butter), flavour and peanut flavour for A&B, and milk flavour for treatment D (20% peanut butter).

The peanut vanilla flavoured ice-cream has a market potential and consumers that are looking for a nutritious flavored ice-cream alternative might opt to choose the frozen dessert similar to peanut ice-cream.

Key words: ice cream, peanuts, peanut butter, product development, consumer acceptance, frozen desserts.

Аннотация. Мороженое как высокоэнергетический и вкусный десерт пользуется многими поколениями во всем мире. Таким образом, альтернатива этому продукту, основанная на арахисе, предоставит потребителям новые и лучшие варианты, которые полезны для здоровья, вкусны и питательны. В этом исследовании оценивалась общая приемлемость с помощью потребительского признания и поведения при покупке мороженого на основе арахиса с ванильным вкусом, различающегося по содержанию арахисового масла (5, 10, 15 и 20% w/w). Восемьдесят потребителей были привлечены для участия в приемочных испытаниях мороженого в сенсорной лаборатории Института сохранения и качества пищевых продуктов. Критерии отбора заключались в том, что испытуемые должны были употреблять мороженое или любое ароматизированное мороженое, пирожные с мороженым, арахис, арахисовое масло или любую пищу со вкусом арахиса не реже одного раза в две недели и быть взрослыми старше 18 лет без пищевой аллергии. Потребители оценивали, следуя рандомизированному блочному дизайну, четыре образца рецептов по общему признанию, внешнему виду, цвету, сладости, текстуре, аромату, арахисовому вкусу и молочному вкусу. Группа оценила обработку мороженого В со вкусом арахиса и ванили (10% арахисового масла) как лучший продукт. Он получил самые высокие оценки потребителей по общему признанию, цвету, сладости, вкусу, арахису и молоку. Состав С (15% арахисового масла) получил аналогичные оценки потребителей по внешнему виду и текстуре. Основные различия наблюдались во внешнем виде и текстуре для обработки А (5% арахисового масла), вкуса и арахисового вкуса для А & В и молочного вкуса для обработки D (20% арахисового масла).

Мороженое со вкусом арахиса и ванили имеет рыночный потенциал, и потребители, которые ищут альтернативу питательному мороженому со вкусом, могут выбрать замороженный десерт, похожий на арахисовое мороженое.

Ключевые слова: мороженое, арахисовое масло, разработка продукта, потребительское восприятие, замороженные десерты.

Introduction. The ice cream industry is very progressive with many new product introductions annually. Some of the current formulation trends in the industry include a growing interest in «reduced» or «no» claims for fat, calories, or sugar; the use of nutritionally functional additives (e. g., vitamins or minerals) or flavors showing added nutritional functionality (e. g., high in antioxidants); a renewed focus on frozen yogurt, particularly with probiotic cultures, although this represents a very small segment of the overall total market of frozen desserts; and formulations approved as kosher or halal compliant. Products are also marketed with a growing social awareness, including fair trade to primary

producers, organic products, environmental sustainability, and social responsibility by aligning products with particular social justice causes [1]

Ice cream, as a high energy and tasty dessert, is enjoyed by generations worldwide. It is estimated to be a good premium for the health for two hundred grams of butter cubes contains the entire daily intake of minerals and trace elements. A diet based on ice-cream helps correct figure. There are particular types of dietary ice-cream low in fat and sugar. Today is possible to buy an ice-cream designated for diabetic people. All this variety propagandizes ice-cream as a product of a healthy lifestyle. It was concluded from an Egyptian study [2, p. 133–137] that dried total milk proteinate

(from buffalo milk) could effectively replace skim milk protein in ice-cream mix up to a level of 50%. Polish scientists [3, p. 44–46] have investigated the possibility of partial or total replacement of dried skim milk by two new commercial high protein concentrates. Several cereals and legumes-based foods using peanuts as protein supplements have been developed to alleviate protein calories malnutrition problem. Peanut in the form of flour, protein isolates, and meal in a mixed product have been found to be very desirable from a sensory quality point of view. Peanut protein is deficient with respect to certain essential amino acids, but its true digestibility is comparable with that of animal protein [4, p. 165–177]. Butter is advocated as a valuable ingredient in ice-cream [5, p. 664] but various fat substitutes for ice-cream manufacturing such as milk fat being replaced by palm kernel fat were also discussed in some studies [6, p. 31; 7, p. 43]. American investigations [8, p. 39; 9, p. 51; 10, p. 16] highlighted the reported nutritional and anti-cancer properties of fruits and nuts and advance their use in ice-cream. Hence peanut based alternative to this product which is not yet commercially available in Bulgarian market would provide consumers with new and better choices that are healthy, tasty and nutritious to consume.

Objective. The objective of this study was to determine consumer acceptance of peanut-based vanilla flavoured ice cream formulations with varying level of peanut butter as well as their potential marketability.

Materials and method.

Samples. Peanut ice-cream base formula was prepared using 33.4% liquid reduced fat milk, 41.43% liquid reduced fat cream, 23.4% pure cane sugar, 1.75% vanilla flavour and 0.02% stabilizer. Treatments included added peanut butter concentrations of 5.0 [A], 10.0 [B], 15.0 [C] and 20.0% [D] to the basic formula. Vanilla flavor was chosen because it appeared to be the most popular ice cream flavor in many countries, including the United States, Canada, Germany, France, Italy, United Kingdom, and Japan [11].

Sample preparation. Peanut ice-cream was processed in the pilot plant two days before each test replication. All four treatments (A, B, C, & D) were processed identically. The product was double homogenized (first stage 82°C, 2500 psi;

second stage 72 °C & 1000 psi) and after cooling aged at 4°C in the fridge for 12 hours. Subsequently the mix was frozen to approximately – 25 °C through a scraped surface freezer while under shear («dynamic» freezing, which incorporates air and produces small, discrete air bubbles and ice crystals). Flavoring material (vanilla) was added after the dynamic freezing, followed by blast frizzling to the temperature of – 25 to – 30 °C and stored at –25 °C in the horizontal freezer (Figure 1).

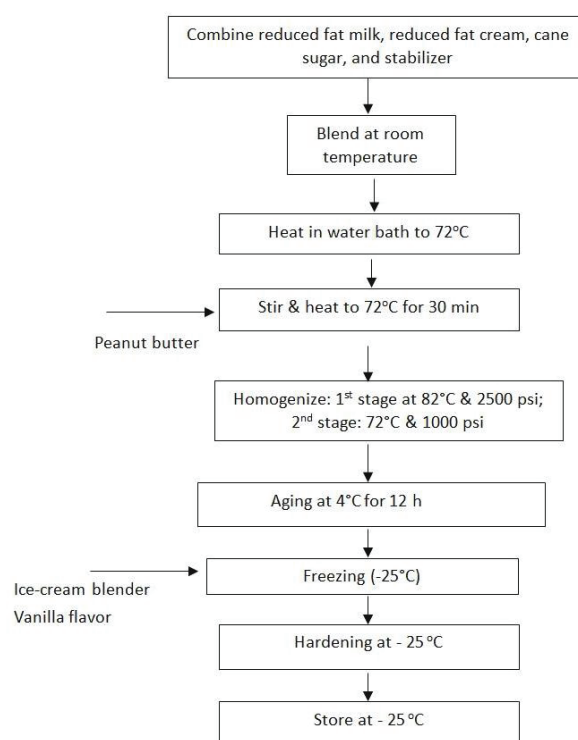


Figure 1. Pilot plant processing of peanut vanilla flavored ice-cream

Consumer sensory acceptance tests. Eighty consumers were recruited to participate in the ice cream acceptance test at the sensory lab of the Institute of Food Preservation and Quality. The selection criteria were that subjects had to consume ice cream or any flavoured ice-cream, ice-cream cakes, peanuts, peanut butter or any peanut flavoured food at least once in two weeks and be adults over 18 yr of age with no food allergies. The consumers received the samples in a monadic presentation. Twenty grams of peanut based vanilla ice cream at a temperature of –10 °C ± 2 °C was offered in plastic cups, coded with 3-digit numbers, together with a transparent plastic spoon [12, p. 1087–1094]. Participants used

a 9-point hedonic scale (dislike extremely to like extremely) to rate overall acceptance, appearance, color, sweetness, texture, flavor, peanut flavor and milk flavor, and intensity of roasted peanut, milk flavour as well as sweetness of the products. Consumers evaluated, and indicated their purchase intent for each sample using 9-point hedonic scale (extremely unlikely to extremely likely to purchase). Panelists evaluated samples using environmentally controlled partitioned booths illuminated with white incandescent light. All samples were presented in a balanced order using a randomized balanced block design of presentation. The subjects were instructed to rinse their mouths with distilled water between samples to avoid the «cold» carry-over effect [12, p. 1087–1094]. To prevent bias, no information about the samples was given to the consumers [13, p. 396–414].

Statistical analysis. Statistical analysis was carried out using STATISTICA software [14]. T-paired means test was used to determine each sensory attribute. Fisher’s Least Significance Difference (LSD) test was performed. Regression analysis (PROC REG) was used to calculate the

coefficient of correlation (R) and to develop prediction models for each dependent attribute based on independent peanut butter concentration as well as to determine the relation between sensory attributes and overall acceptance.

Results and Discussion

Consumer acceptance test. Consumer responses on acceptance questions. The mean consumer ratings for overall acceptance, appearance, color, sweetness, texture, flavor, peanut flavor, and milk flavour of peanut vanilla ice cream various formulations evaluated by 80 Bulgarian consumers as well as panelists’ willingness to purchase the products were determined (Table 1). The results showed that the treatment B had the highest mean ratings for all attributes evaluated in the consumer acceptance test, except for appearance and texture where the treatment containing 15% peanut butter (C) rated similarly, and for milk flavour where the ratings were close with treatment A.

The significant differences of the hedonic ratings for the sensory attributes and consumers’ purchasing behavior for peanut vanilla ice cream different formulations are presented in Table 1.

Table 1

Mean hedonic ratings and significant differences between means of peanut ice-cream samples and the panelists’ willingness to purchase

Samples	Overall acceptance	Appearance	Color	Sweet	Texture	Flavor	Peanut flavor	Milk flavor	Will to purchase
A (5%)	6.82A	6.68A	7.09A	6.77A	6.45A	6.91A	6.91A	7.36A	6.18A
B (10%)	7.23A	7.36B	7.41A	7.09A	7.45B	7.32A	7.09A	7.23A	6.91A
C (15%)	6.64A	7.23B	7.09A	6.77A	7.59B	6.68B	6.59B	6.59B	6.45A
D (20%)	6.54A	6.82B	6.68A	6.73A	7.18B	6.32B	6.32B	6.14BC	5.77B

Means in the same column not followed by the same letter are significantly different at p=0.05 as determined by t-paired means test.

Consumer purchase intent for samples. Treatment B showed the highest value (x=6.91) closely followed by treatment C (x=6.45, slightly likely) when consumers’ willingness to purchase peanut ice-cream was evaluated. There was no significant difference between the first three samples. Sample D was rated neither likely nor unlikely (x=5.77) to purchase the product. The significant differences of the hedonic ratings for

the sensory attributes and consumers’ purchasing behaviour for peanut ice-cream different formulations are presented in Table 1.

Consumer ratings on intensity questions. The mean consumer ratings for intensity of roasted peanut, milk flavour and sweetness tend to be a bit more variable when compared to the descriptive panel data. Sweetness and roasted peanut intensity ratings, except treatment A for peanut flavour, exceeded 5 (neither like nor dislike or like slightly on the 9-point Hedonic scale) with an exception for treatment B for milk flavor intensity, x<5 (data not presented).

Effect of peanut butter concentration on sensory attributes ratings. Regression analysis (PROC REG) was used to calculate the coefficient of correlation (R) and to develop prediction models for each dependent attribute based on independent peanut butter concentration. The coefficient of correlation $R = 0.70$ indicated that a quadratic regression model could be used as the full model as follows:

$$y = ax^2 + bx + c,$$

where y is the response variable, e. g. sensory attributes; a , b and c are parameter estimates of peanut butter concentration, when a is its squared term ($a < 0$). Significant full models ($p < 0.05$) with R less than or equal to 0.70 were selected to test if reduced models could be used in place of full quadratic equation model to predict the response variable.

Regression models with a coefficient of correlation $R \geq 0.70$ and p -value < 0.05 were overall acceptance, appearance, colour, sweetness, texture, flavour, peanut flavour, and milk flavour as well as

willingness to purchase. The calculated F-values between the significant full and reduced models indicated that full quadratic equation model could be to predict the responses of sensory attribute ratings from the independent variable peanut butter concentration. These models were used to generate regression plot shown in Table 2.

Regression models developed to predict the responses of sensory attributes ratings from the independent variable level of peanut butter concentration indicated that $-4.35 < x < 23.75$ peanut butter resulted in an overall acceptance of 6. Optimum appearance was obtained with $1.58 < x < 23.95$ peanut butter, optimum colour was obtained with $-3.11 < x < 23.87$ peanut butter, optimum sweetness was obtained with $-5.03 < x < 27.59$ peanut butter and optimum texture was obtained with $3.35 < x < 24.96$ peanut butter. For having a rating of 6 for flavor, peanut flavor and milk flavor peanut butter concentration used should be $-2.71 < x < 21.45$; $-7.32 < x < 22.23$ and $-22.64 < x < 20.77$, respectively.

Table 2

Regression analysis of the sensory attribute variables in the four Peanut Ice-Cream formulations and coefficient of correlation (R; R²)

Sensory attribute	Model ¹	(R, R ²)
Overall		
liking	$= 6.5275 + 0.0989*x - 0.0051*x^2$	0.70; 0.60; $-4.355444955 < x < 23.74760181$, $9.696078431 = 9.696078431$
Appearance		
	$= 5.5875 + 0.2783*x - 0.0109*x^2$	0.97; 0.95; $1.579986713 < x < 23.95212337$, $12.76605504 = 12.76605504$
Color	$= 6.5425 + 0.1515*x - 0.0073*x^2$	0.97; 0.94; $-3.113700090 < x < 23.86712474$, $0.0022119 = 0.0022119$
Sweetness	$= 6.5 + 0.0812*x - 0.0036*x^2$	0.70; 0.69; $-5.034093987 < x < 27.58964954$, $11.27777777 = 11.27777777$
Texture	$= 4.8225 + 0.3991*x - 0.0141*x^2$	0.99; 0.99; $3.345904823 < x < 24.95905971$, $14.15248226 = 14.15248226$
Flavor	$= 6.4475 + 0.1443*x - 0.0077*x^2$	0.91; 0.83; $-2.709448636 < x < 21.44970837$, $9.370129870 = 9.370129870$
Peanut		
flavor	$= 6.7325 + 0.0671*x - 0.0045*x^2$	0.93; 0.88; $-7.321558046 < x < 22.23266915$, $7.455555555 = 7.455555555$
Milk flavor	$= 7.505 - 0.006*x - 0.0032*x^2$	0.98; 0.97; $-22.64444373 < x < 20.76944373$, $-0.9375 = -0.9375$
Willingness to		
purchase	$= 4.9875 + 0.3187*x - 0.0141*x^2$	0.96; 0.93; $3.823882207 < x < 18.77895467$, $11.30141843 = 11.30141843$

¹ A quadratic regression model is used as the full model as follows:

$$y = ax^2 + bx + c,$$

where y is the response variable, e. g. sensory attributes; a , b and c are parameter estimates of peanut butter concentration, when a is its squared term ($a < 0$, hyperbolic function).

Model significance at $\alpha = 0.05$ level was determined using the calculated F-ratio

The optimum range for peanut butter concentration for willingness to purchase should correspond to $3.82 < x < 18.78$. (Figure 2). The prediction models indicated that above the level of 9.69 of peanut butter concentration for overall acceptance, 12.77 for appearance, 10.38 for color, 11.27 for sweetness, 14.15 for texture, 9.37 for flavor, 7.45 and 0.94 for peanut and milk flavour respectively consumer acceptance decreases. Above a level of 11.30 for peanut butter concentration, willingness to purchase diminishes smoothly (Figure 2).

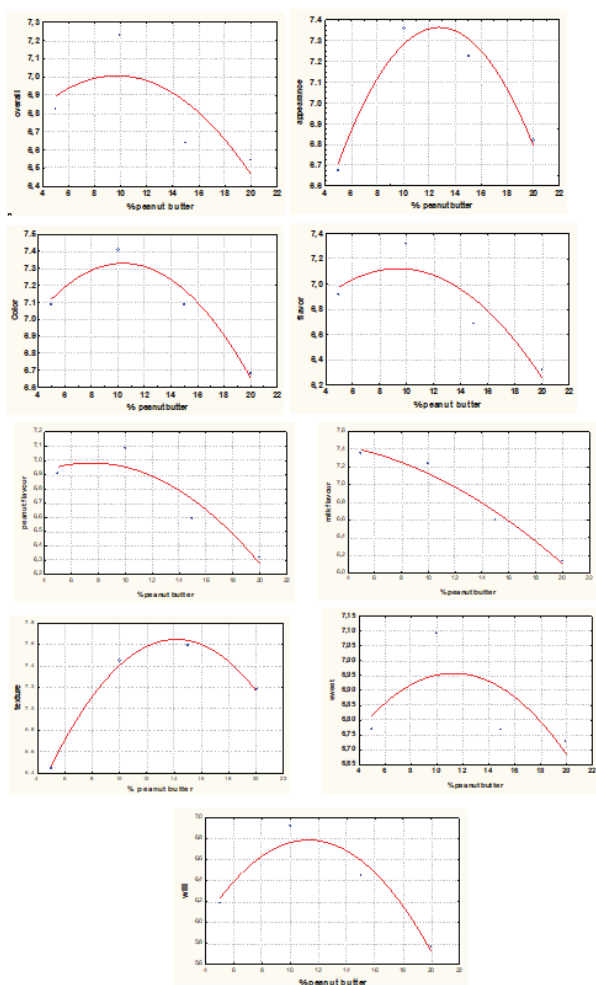


Figure 2. Regression lines showing effect of peanut butter concentration on hedonic ratings for overall acceptance, appearance, colour, sweetness, texture, flavour, peanut and milk flavour as well as consumers' willingness to purchase.

Relationship between overall acceptance and sensory attributes. There was a relatively strong relationship between overall acceptance and sensory attributes ($R=0.80$). The coefficient of multiple regressions between overall acceptance and sensory attributes (Table 3) showed appearance, texture and flavour significantly affected overall acceptance.

Table 3

Regression coefficients between overall acceptance and sensory attributes

Parameter	Overall acceptance estimate
Intercept	1.83**
Appearance	0.36**
Colour	0.18 ns
Sweetness	0.07 ns
Texture	-0.28*
Flavour	0.26**
Peanut flavour	0.04 ns
Milk flavour	-0.10 ns

*=significant at 0.01, **=significant at 0.05, ns=non-significant.

Conclusions. The results indicated that all of the sample formulations produced high consumer acceptance rating ($x>6$). The formulation with 10% added peanut butter had the highest value ($x>7.0$) except for appearance and texture where the treatment containing 15% peanut butter rated similarly. The 5% treatment produced the lowest rating on appearance and texture ($x=6.68$; $x=6.45$) but showed the highest value for milk flavor ($x=7.36$). The formulation with 20% added peanut butter resulted the lowest on every attribute, except for appearance and texture ($x=6.82$; $x=7.18$). Treatments with 5 and 15% of peanut butter had the same ratings for color and sweetness $x=7.09$ and $x=6.77$. A relatively strong relationship ($R=0.80$) between overall acceptance and certain sensory attributes was found. The coefficient of multiple regressions between overall acceptance and sensory attributes) showed appearance, texture and flavour significantly affected overall acceptance.

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