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QUALITY EVALUATION OF TAKE HOME VANILLA ICE CREAM

Ice cream is a very popular dessert and is consumed usually during summer. Popularity of eating this cold, frozen sweet is slightly rising in Poland. Although impulse ice creams are consumed mostly in summer, family (take home) ice creams are popular and consumed during other seasons as well. One of the most popular tastes of this kind of ice cream is vanilla. Vanilla is a natural and expensive aroma and is often replaced by artificial vanillin. Therefore it causes different price of products including this flavouring, ice cream as well. What is important, the price of ice cream should stand for high quality of any product. That is why the aim of this study was to investigate this dependency and quality evaluation of selected vanilla ice cream. The study showed, that there was not ice cream which could fulfil the highest requirements and that high price does not always stand for high quality.

Keywords: ice cream, vanilla, quality evaluation.

INTRODUCTION

One of the products that are very popular, especially during the summer season, is ice cream. When purchasing, in addition to their attractive sensory, their price is very important, that is why family ice cream are the best combination of elements such as price, size and quality. This kind of ice cream is the perfect choice when buying for a family. According to Woźniak [12] vanilla flavour is the second favorite flavour of ice cream on the Polish market.

In the case of vanilla ice cream their taste is the most important, which can come from both synthetic flavours but also real vanilla, which could be in the form of: powdered sticks, extract the pieces and natural aroma. Their main role is to make vanilla ice creams proper taste. In addition, its consumption can have a positive effect on the human body, mainly due to its antioxidant properties that can be used in ice cream involving polyunsaturated fatty acids found in vegetable oils.

Ice cream with milk does not contain a lot of unsaturated fatty acids, their level may be increased by adding the vegetable oils rich in these fatty acids. These fats are essential to the proper functioning of the body, e.g. they reduce blood cholesterol, prevent hypertension, affect the normal condition of the skin. In addition, milk fat has a positive effect on the process of production of ice cream, facilitating aeration, giving a coherent and permanent consistency and contributing to an adequate flavour.

An important addition is the dry matter of non-fat milk, which raises the taste and positively affects the shape and texture of ice cream. The most important component is protein, which facilitates aeration and improves the viscosity of the mixture. The dry matter of non-fat milk has a high nutritional value, it contains all the necessary human amino acids, vitamin B₂, A, E and D and minerals such as calcium, phosphorus, potassium, magnesium and sodium. It is also a source of fat, including the essential fatty acids.

The addition of sweeteners plays an important role in increasing the viscosity of the ice-cream mixture, and lowering the freezing point, whereby a soft and smooth product is obtained at low temperature. Carbohydrates are primarily designed to add the appropriate sweetness. The use of additives such as stabilizers and emulsifiers, aims to improve the quality of ice cream, by shaping their structural features and give them a proper viscosity and reducing melting.

Ice milk - vanilla cream can also be classified as functional foods, because of the content of fiber, minerals, vitamins and the vanilla itself.

The aim of this study was to evaluate the effect of used addition of vanilla and its substitutes for sensory evaluation, especially on tastiness. Other basic quality characteristics of ice cream were determined.

1. CHARACTERISTICS OF VANILLA AND ITS SUBSTITUTES

Vanilla planifolia (*Vanilla planifolia* Andrews) is a species of tropical climbing plant belonging to the orchid family (Orchidaceae) *Vanilla* is epiphyte arboreal that achieves length to 25 meters in the wild, climbing over high tree branches and trunks, collecting nutrients from dead parts of the trees. The vanilla fruit is a narrow, half fleshy boll, reaching the length of 16–25 cm, with a shape similar to pod, called cane vanilla coloured matt brown or chocolate brown [1, 5, 10].

Properly collected, sorted and cleaned fruits are subjected to appropriate treatment, called formulation, that gives a characteristic, strong vanilla flavour and dark brown colour. Top quality taste and smell vanilla is subjected to treatment drying in the sun. The most important commercial species of vanilla known for its unique, pleasant odour, depending on the origin are Mexican vanilla, Bourbon, Tahiti and Moorish [6, 9]. This is due to vanillin, which is formed during the fermentation of unripe fruit, containing glycoside vanilla and glycoside vanilla alcohol. These compounds release vanillin in the process of enzymatic hydrolysis. Other compounds such as acid, vanilla, vanilla alcohol, esters of cinnamic acid, p-hydroxybenzoic aldehyde, alcohol and aldehyde and anise essential oil also have an influence on the distinctive and delicate scent of vanilla [11].

Vanillin is otherwise 3-ethoxy-4-hydroxy-benzoic aldehyde. Depending on species vanillin content is about from 1.5 to 3%. The use of synthetic vanillin is influenced primarily by price, because kilogram of natural vanilla is several hundred times more expensive than artificially produced. Since 1874, there has been

a decline in production of natural vanilla to synthetic. Regardless of the flavour of natural vanilla is irreplaceable. Ethyl vanillin is produced more and more often. This is a compound that does not naturally occur in nature, but due to the low manufacturing costs and to 4 times stronger aroma is used in the food industry [4].

2. RESEARCH MATERIAL

Research material consisted of family ice cream of eight selected manufacturers of vanilla ice cream purchased in hyper- and supermarkets and in small shops. Ice cream from the premium segment, as well as the popular ice cream brand and private labels were selected for the study. Table 1 shows the characteristics of family ice cream selected for the study.

Table 1. Characteristics of family ice cream selected for the study

The manufacturer code	Product characteristics	Information about nutritional value	Capacity	Price	Price per liter
Producer 1	Ice cream from skimmed milk powder with the addition of palm oil and rape seed synthetic vanilla flavour	Lack of information	1000 ml	4.99	4.99
Producer 2	Vanilla ice cream with reconstituted skimmed milk and coconut oil with the addition of pieces of vanilla from Madagascar	given	800 ml	17.89	22.36
Producer 3	Vanilla ice cream with the addition of vanilla pods 0.01% and flavourings	given	1100 ml	6.99	15.44
Producer 4	Ice cream with vanilla flavour with 0.2% Bourbon vanilla extract and 0.05% of extracted minced vanilla pods.	given	1000 ml	5.99	5.99
Producer 5	Vanilla ice cream with powdered cane vanilla 0.08% and the natural aroma of vanilla	given	900 ml	6.99	7.77
Producer 6	Vanilla ice cream with vanilla stick, with added coconut fat, powdered vanilla pod and aroma	given	1100 ml	9.99	9.08
Producer 7	Vanilla ice cream with added coconut fat and minced extracted vanilla beans and flavours	given	1400 ml	8.9	6.42
Producer 8	Vanilla ice cream with 0.4% natural aroma of vanilla Bourbon and vanilla minced sticks	given	1250 ml	8.99	7.19

Source: own research.

Packaging condition all of vanilla ice cream was unharmed, without any damage. The inscriptions on the boxes were clear and legible. Majority of the packaging were made of a flexible plastic material with the exception of one brand of ice cream, which was made of a rigid paper. The examined samples of ice cream were given random numbers from 1–8.

3. METHODOLOGY OF RESEARCH

Test samples of ice cream were subjected to organoleptic evaluation, which was carried out by the team of ten evaluators fulfilling the requirements of the evaluation panels. Examination of organoleptic characteristics consisted of two steps: evaluation of taste and aroma with the use of polarization and the evaluation chart and a homogeneous and sandy consistency, spreadability and colour using the numerical scale. The appropriately prepared samples for organoleptic evaluation of taste and flavour of ice cream were tested by using a scale of 0 to 10 points with specially prepared graph polarity (own scheme based on PN-A-86431) [7].

Physicochemical tests were performed according to PN-67/A-86430 Milk and dairy products - ice cream - Methods of chemical research [8].

The following determinations were made:

- overrun (degree increment) - involving the determination of the percentage of air inside a given volume of ice cream,
- determination of melting using a method developed by the Central Laboratory of Refrigeration in Lodz [2],
- indication of the acidity of ice cream in Soxhlet-Henkel degrees,
- determining the fat content by Gerber method,
- determination of dry matter by drying at a temperature of 130°C,
- determination of total sugar content by the refractometric method using Abbe refractometer RL3.

In addition, the difference in colour and the degree of colour saturation was determined using a Minolta CR-400 colorimetry CIE lab method.

The colour coordinates of the CIELAB system are CIE L* (lightness, achromatic coordinate ranging from black to white), CIE a* (-a*=green, +a*=red) and CIE b* (-b*=blue, +b*=yellow). Parameter ΔE^*_{ab} indicates the difference between the different colours:

- 0 < ΔE < 1 – unnoticeable difference
- 1 < ΔE < 2 – noticeable difference, only for experienced observers,
- 2 < ΔE < 3.5 – noticeable difference for inexperienced observers,
- 3.5 < ΔE < 5 – noticeable difference in colour,
- 5 < ΔE – observer sees a clear difference of colour [3].

4. RESULTS

According to PN-A-86431: 1999 Milk and milk products - ice cream requirements and test quality factors, i.e.: taste and odour should be characteristic for added flavour additives.[7]

In terms of flavour ice cream from Producer 8 were rated as the best and received an assessment of 7.7, slightly lower rated were Producer 3 ice cream – 7.6. The worst rated ice cream with vanilla flavour were those from Producer 1 company, which obtained given a result of 5.2. Producer 8, Producer 3 and Producer 7 ice cream characterized most noticeable taste of vanilla. Similarly, the highest rating of the smell of vanilla received ice cream of Producer 3. The remaining ice cream were assessed from 5.0 to 5.3, with the exception of ice cream of Producer 2, which was assigned the lowest rating. As regards of sweet smell and taste the highest score got Producer 3 vanilla ice cream, the taste of which rated up to 8.7. In contrast, the least sweet ice cream turned out to Producer 4 and ice cream of Producer 1. Almost all ice creams were characterized by the same sweet scent, but among them in this context the lowest rated ice cream were those offered by Producer 5 and Producer 8. Again ice cream from Producer 8 and Producer 3 had the highest score of dairy taste and smell. Producer 2 ice cream had the lowest rate among all brands. Table 2 shows the results of organoleptic evaluation of vanilla ice cream and ice cream with vanilla flavour.

Table 2. A comparison of average ratings of selected quality parameters of family ice cream (from 1 – the lowest to 6 – the highest rate)

Producer	The quality discriminant											
	Vanilla taste	Sweet taste	Milky taste	Artificial taste	Watery taste	Strange taste	Vanilla odour	Sweet odour	Milky odour	Artificial odour	Strange odour	Tastiness
1	4.5	6.5	6.0	5.1	5.1	1.8	5.1	5.3	5.7	4.7	2.0	5.2
2	5.9	7.1	4.5	4.6	3.1	2.4	4.5	5.3	4.6	4.6	2.5	6.0
3	7.6	8.7	6.1	3.1	3.6	1.4	6.6	6.1	5.7	3.0	1.1	7.6
4	5.5	6.4	6.2	4.3	1.8	1.2	5.2	5.3	5.1	3.3	1.5	5.5
5	4.6	6.9	6.1	3.9	1.7	1.0	5.1	4.9	5.2	3.9	1.2	6.8
6	5.8	8.0	5.4	3.2	2.8	0.8	5.0	5.3	5.0	2.6	1.6	5.7
7	7.2	7.4	5.9	2.7	1.6	0.9	5.3	5.1	4.5	2.9	1.3	6.6
8	7.3	7.6	6.3	2.8	2.1	0.6	5.2	4.9	5.9	3.1	0.6	7.7

Source: own research.

Research showed that vanilla flavour in ice cream from Producer 1 and Producer 2 characterized the most artificial taste and smell. The least perceptible artificial flavour occurred in ice cream from Producer 8 and Producer 7, and artificial odour had ice cream from Producer 6 and Producer 7. In evaluation of watery taste the highest score obtained ice cream from Producer 1, and the lowest from Producer 7, Producer 5 and 4. It was found that the best vanilla, sweet and milky flavour and taste had ice cream from Producer 3, Producer 8 and Producer 7 out of the eight analysed ice cream brands. The lowest rated ice cream were those from Producer 2 and 1. They were characterized by the strongest artificial taste and smell. The rest of the ice creams were rated average. Table 3 shows the obtained results of the comparison of consistency, spreadability and colour of vanilla ice cream.

Table 3. A comparison of average assessments of quality parameters selected brands of family ice cream

Producer	The quality discriminant			
	Uniform consistency	Smooth consistency	Melting in mouth	Creamy colour
1	3.7	3.6	4.2	2.7
2	4.2	4.6	4.4	3.9
3	4.3	4.5	4.3	3.8
4	4.0	3.9	3.9	3.3
5	3.7	3.9	4.0	4.7
6	4.5	4.9	4.4	2.0
7	4.3	4.2	3.9	3.7
8	4.2	4.4	3.5	3.7

Source: own research.

Vanilla ice cream from Producer 6 had the most uniform and smooth consistency. Ice cream from Producer 6 and Producer 2 dissolved in the mouth easiest, but much worse rated ice cream of Producer 8. Ice cream from Producer 1 characterized the worst uniform and smooth consistency. The rest of ice creams ranged assessment of 4 and above.

Analysis of the results of organoleptic evaluation of selected brands of ice cream showed the ice cream from Producer 8, Producer 7, and Producer 3 are preferably evaluated in terms of flavour and the rest of the organoleptic evaluation of positive traits such as vanilla, milky flavour and taste and sweetness. Ice cream with vanilla flavour from Producer 1 and Producer 2 were rated the worst. Comparing the uniformity and smoothness of texture and melting in the mouth on a scale of 1 to 5 ice cream from Producers 6, 3, 2 and 7 were rated highest. In terms of creamy colour ice cream from Producer 5 were rated highest and ice cream from Producer 5 got the lowest score.

Ice cream from Producer 6 (350%) and Producer 8 (315%), characterized the biggest overrun while the smallest was reached by the ice cream from Producer 3 (104%). The higher overrun of ice cream, the less ice-cream mixture content, and more air in the package. Overrun of ice cream by Polish standards should not exceed 130%. Ice creams of such overrun are compact, but they might be too hard for the consumer. The tested ice creams exceed the value specified in the standard slightly ice cream of Producer 5 or several times products of Producer 7, 6 or 8. Ice cream that has an overrun of more than 200% may be inappropriate consistency resembling snow. Results of overrun studies are shown in Table 4.

Table 4. Comparison of overrun of selected ice cream

Producer	1	2	3	4	5	6	7	8
Overrun [%]	207	197	104	200	145	350	285	315

Source: own research.

In the assessment of overrun only vanilla ice cream from Producer 3 did not exceed the specified in the standard suggested maximum overrun. This feature of other brands of ice cream was significantly higher than this value (130%). However, when assessing the resistance to melting this ice cream came out to be the worst, because the leak was the fastest and biggest. The highest melting resistance had ice cream from Producer 2.

Ice cream from Producer 3 had the highest acidity (10°SH), ice cream made by Producer 5 characterized slightly smaller acidity (8,7°SH). The research shows that the lowest acidity - 4,1°SH characterized ice cream of Producer 6. Table 5 shows the results of determination of acidity, fat and sugar content compared to the content declared by producers.

Table 5. Comparison of selected quality features of examined vanilla ice cream

Producer	Acidity [°SH]	Fat content determined/ declared [%]	Sugar content determined/ declared [%]
1	6.9	16.0 / -	20.9 / -
2	7.7	17.3 / 7.0	30.9 / 27.0
3	10.0	32.0 / 15.8	29.9 / 25.8
4	5.9	21.3 / 12.0	27.9 / 25.0
5	8.7	23.5 / 7.1	23.9 / 23.9
6	4.1	24.0 / 12.4	23.9 / 21.0
7	5.2	21.7 / 9.0	25.9 / 24.0
8	5.4	31.7 / 11.9	26.9 / 26.1

Source: own research.

Comparing the percentage of fat content obtained in the research and declared by the manufacturer clear difference was noticed. The results obtained using Gerber method are twice higher than the declarations of manufacturers shown on the packaging. Table 5 shows the ice cream with a high fat content; the highest in the products from Producer 3 and 8, and the lowest from the Producer 1.

The highest content of total sugars had vanilla ice cream from Producer 2 and 3. The research showed that ice cream with vanilla flavour from Producer 1 contained the least sugar content, up to 10% less than the ice cream of Producers 2 and 3. Producers' 7 and 8 ice cream had an average sugar content. Comparing the percentage of sugars content obtained by the refractometric method, and declared by the manufacturer only 5 Producer's ice cream reached the same value. The rest of investigated family ice cream had higher content of this component than declared despite ice cream from Producer 1, which did not provide information about their nutritional value.

The percentage of fat and sugars content were compared with the manufacturer's declaration. In both cases, the product of the Producer 1 did not have the nutritional information on the packaging. When the total amount of sugars in ice cream was slightly higher than declared by manufacturer, then there was evaluated twice the difference between the results obtained and the manufacturer's declaration in fat content.

When evaluating the acidity and the content of dry matter during the drying at a temperature of 130°C there were compared the highest and lowest value for the ice cream data. Ice cream from Producer 6 characterized by the highest dry matter content, and also the lowest acidity. Meanwhile, the ice cream of Producer 1 had the lowest dry matter content, and ice cream of Producer 3 had the highest acidity.

On the basis of the studies, the difference in the colour of selected brands of family ice cream was determined. The colour difference for ice cream made by Producer 8 and 6 an average observer could not see. Comparing the ice cream from Producer 8 and Producer 1, Producer 6 and Producer 1 and ice cream manufactured by Producer 3 and 4 only an experienced observer can notice the difference in colour. Between $2 < \Delta E < 3.5$ there is a noticeable difference for inexperienced observers in ice from Producer 4 and 2. Comparing the other brands of ice cream selected for this research, the observer sees noticeable and very clear difference of colour. The results of determination of the degree of colour difference and saturation of the examined ice cream are shown in Table 6.

Table 6. Determination of the degree of colour difference ΔE of examined ice cream

Producer	1	2	3	4	5	6	7	8
1		6.01	5.17	5.30	10.12	1.66	5.28	1.64
2	6.01		4.47	3.47	7.42	4.35	8.50	4.26
3	5.17	4.47		1.37	4.99	4.60	9.95	4.52
4	5.30	3.47	1.37		5.06	4.58	9.84	4.75
5	10.12	7.42	4.99	5.06		9.44	13.18	9.33
6	1.66	4.35	4.60	4.58	9.44		5.58	0.40
7	5.28	8.50	9.95	9.84	13.18	5.58		5.52
8	1.64	4.26	4.52	4.75	9.33	0.40	5.52	

Source: own research.

Selected ice cream brands had similar brightness within the range from 71.0 to 78.0. Ice cream from Producer 7 had the highest value of L^* , slightly less value of brightness had ice cream from Producer 1, while ice cream of Producer 5 had the lowest brightness. Parameter $+a^*$, indicating the green colour was specified only for ice cream of Producer 2. The other ice cream were characterized by a low level $-a^*$ expressing a shade of green. Value $+b^*$ sets the saturation of yellow. Therefore Table 7 shows that the highest saturation is observed in ice cream from Producer 5, and the lowest from Producer 7. The results of parameters of colour saturation and brightness are shown in Table 7.

Table 7. Comparison of the brightness and colour saturation of examined ice cream

Producer	L^*	a^*	b^*
1	77.37	-2.88	15.76
2	74.0	1.55	17.59
3	74.63	-2.11	20.08
4	73.71	-1.45	19.31
5	71.31	-1.57	23.76
6	76.92	-1.34	16.17
7	77.82	-1.57	10.67
8	76.57	-1.48	16.05

L^* – brightness
 a^* i b^* – colour saturation
 ΔE^*ab – colour difference

Source: own research.

When analyzing the colour of the tested family ice cream the saturation of the colour yellow with the pointer +b was compared. Ice cream from Producer 5 had the highest value, and Producer's 7 ice cream – the lowest. Hence the highest degree of brightness was assigned to ice cream made by Producer 7, and the lowest to Producer's 5 ice cream.

In the range $0 < \Delta E < 1$ indicating unnoticeable colour difference were ice cream from Producer 6 and from Producer 8. The biggest difference in the colour of all the ice cream assigned desserts made by Producer 5 and 1.

The results of ice cream melting are presented in Table. 8. Research showed that high resistance to melting had the ice cream from Producer 2, 7 and 8.

Table 8. Comparison of ice cream melting

Producer	Leak volume after 60 min [ml]	Ice cream resistance to melting
1	3.5	Middle
2	0.0	High
3	23.0	Low
4	3.5	Middle
5	12.4	Low
6	3.3	Middle
7	1.5	High
8	2.3	High

Source: own research.

Ice cream made by Producer 6, 4 and 1 had average resistance to melting. Ice cream from Producer 3 and 5 melted faster than 60 minutes. The leak was 23 ml for ice cream Producer's 3 and 12.4 ml for ice cream from Producer 5, therefore, they had the lowest resistance to melting.

CONCLUSIONS

In conclusion, this commodity assessment showed that there were not ice creams that could fulfill all requirements for ice creams given in suitable norm PN-A/86431 [7].

The highest rate was reached by ice creams of Producer 8, and then of Producers 4 and 6, the lowest was obtained by ice creams of Producers 1 and 3. It indicates that the best quality ice creams were these with natural vanilla extracts, pods and flavour addition. The worse ice creams contained synthetic vanilla flavour.

Neither brand, nor product popularity or price cannot guarantee high quality of ice creams. Researched products differed also in prices. The most expensive ice creams taken to our research got average range, and the highest quality characterized those with average price. High price does not always follow high quality.

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