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EVALUATION OF SELECTED MICROBIOLOGICAL QUALITY PARAMETERS OF FRUIT MOUSSES

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Abstract: The changing pace of life, ways of spending free time, and the search for consumer products of specific nutritional properties force food producers to introduce products providing the expected nutritional value. The demand for low-processed food, ready for consumption and at the same time microbiologically safe, is linked to the growing nutritional awareness of consumers. Fruit mousses, intended both for child and for adult consumers, match this direction of convenience product market development. The purpose of this study was to evaluate selected microbiological characteristics of fruit mousses commercially available in the Tri-City of Poland. A total of 24 fruit mousse samples were tested, of varied compositions, made by 4 different producers. The total count of aerobic mesophilic bacteria and the count of filamentous fungi and yeasts were determined in the test material. The analyses were conducted by the traditional plate method, on the day of purchase and after being kept in cold storage for 24 hours, in accordance with the manufacturer's recommendations. A total of 12.5% of the mousse samples tested on the day of purchase failed to meet the microbiological purity criteria for aerobic mesophile and fungus TMC.

Keywords: fruit mousses, fruit preserves, microbiological quality.

1. INTRODUCTION

The valuable properties of fruit stem from many aspects, among which the most important are the presence of phenol compounds with antioxidant properties, numerous biologically active compounds whose presence in the diet involves potential pro-health effects, as well as prevention and treatment of certain lifestyle diseases [Gheribi 2011; Sembratowicz and Rusinek-Prystupa 2015; Pukszta and Platta 2017; Zielińska et al. 2017]. Fruit preserves, which are produced through processes that preserve many properties of the fresh material, may form a good source of easily assimilated vitamins, mineral salts, micro- and macroelements, antioxidants and other biologically active ingredients [Szajdek et al. 2007; Kluszczyńska and Sowińska 2014]. Such products include fruit mousses, which are a relatively new product on the Polish market. Data published in 2016 indicate that fruit mousse consumption was low (annual 49 g per capita), although considering the highly dynamic growth of this branch of the fruit processing industry, these results are likely to form a rising trend. Consumer surveys have shown that just over 90% of consumers declared they purchased fruit and vegetable mousses, and almost 30% consume these products multiple times a week, with 37% of children eating them once a day [http://www.sadyogrody.pl/przetworstwo/105….]. Fruit mousses may constitute one of the five portions (400 g) of fruits and vegetables, the consumption of which are recommended at 5 times a day by the World Health Organization (WHO) [WHO 2009; Płocharski 2016].

Fruit mousse ingredients are exclusively ripe, fresh, frozen or stored fruits subjected to fragmenting and grating, which result in a uniform thick product without inedible parts, i.e. seeds and cores. The production technology enables most of the properties of the fresh material to be preserved, although the microbiological quality of the end product is determined both by the microbiological purity of the raw material and by production hygiene standards [Nowicka, Wojdyło and Oszmiański 2014]. The microflora that most commonly contaminates fruits are bacteria resistant to environment acidification and acidotolerant fungi, both moulds and yeasts [Bonin, Bałdyga and Lipińska 2011]. *Micrococcus sp.* and *Bacillus sp.*, mainly originating from air, as well as *Pseudomonas sp*., *Alicyclobacillus sp*. and *Clostridium sp.* from soil are predominant among the bacteria [Sokołowska 2014]. Lactic acid and acetic acid bacteria frequently form the microflora that contaminate fermenting fruit, while yeasts most commonly belong to the *Kloeckera*, *Hanseniaspora*, *Debaryomyces* and *Rhodotorula* genera. Moulds dwelling on fruits are the most numerously represented by the *Alternaria*, *Aureobasidium, Cladosporium*, and *Rhizopus* genera [Kunicka 2004].

The demand for ready-made low-processed food, which is also microbiologically safe, is linked to the growing nutritional awareness of consumers. Fruit mousses, intended both for child and for adult consumers, match this direction of convenience product market development. Commission Regulation (EC) no. 1441/2007 of 5 December 2007 on microbiological criteria for foodstuffs has the requirement to meet food safety criteria, which includes the absence of *E. coli* and *Salmonella* bacteria in 25 g of fruit preserves [EC Regulation 2007]. However, more complete information concerning microbiological requirements for products can be obtained from the data included in the Regulation of the Minister of Health of 13 January 2003 on maximum chemical and biological contamination levels permissible in food, food ingredients, authorised additives, processing aids, and on food surfaces, which specifies the maximum permissible aerobic mesophilic bacteria and fungi counts [Regulation of the Minister of Health 2003; Sokołowska et al. 2011].

Considering the above, a study was undertaken to evaluate selected microbiological characteristics of fruit mousses commercially available in the Tri-City.

2. MATERIAL AND METHODS

The test material consisted of 24 samples (n = 24) of fruit mousses originating from retail chains in the Tri-City. The microbiological analysis was conducted on mousses of varied composition, obtained from 4 manufacturers. In this report they are identified using the symbols A (n = 8), B (n = 5), C (n = 5) and D (n = 6). Samples A and B were intended for adult consumers, while C and D were dedicated for child consumers. According to the manufacturer's declaration on product packaging, the composition of sample A contained: apple, strawberry, mango, passion fruit, banana and apricot, while sample B contained: apple, apricot and peach. The composition of mousse C, intended for children, contained: apple, guava, banana, pear, blueberry, mango, and passion fruit, while sample D contained: apple, mango, peach, banana, pear and strawberry. Total aerobic mesophilic bacteria count (TMC) on a Merck nutrient agar substrate, and fibrous fungi and yeast count on Merck YGC substrate with chloramphenicol, were determined from test material obtained from different retail centres. Aerobic mesophiles were incubated at 30°C for 72 hours, while fungi at 25°C for 120 hours. Microbiological tests were performed in 2 repetitions using the traditional plate method in accordance with current methodology standards [PN-A-75052-05:1990; PN-EN 1132:1999; PN-EN ISO 4833:2004; PN-EN ISO 7218:2008].

All microbiological tests were performed on samples with an expiry date longer than one year. The analyses were conducted on the day the purchased products were transported to the laboratory, and after 24 hours of storing the product in cold storage (temp. 6 ±1°C), in accordance with the information stated by the manufacturer on the product packaging. The pH values were also determined for the test material using a Hanna Instruments pH meter. Active acidity assays were performed on every test product on the day of opening and after 24 hours of cold storage. The results were analysed using elements of descriptive statistics, i.e. mean values and standard deviation, using an Excel 2010 spreadsheet.

An analysis of the data presented in Table 1 indicates that the test results within the samples from a single manufacturer were inconsistent, which may mean some instability in the production process. The test fruit mousse samples from all manufacturers were characterised by a total aerobic mesophilic bacteria count within the range 0 to log 4.86 cfu in 1 ml (Tab. 1). The highest TMC values were found in samples from manufacturer A, both on test day 1 (mean value log 1.75 log cfu/ml) and after 24 hours of cold storage (log 1.64 cfu/ml) (Tab.1).

3. RESULTS

Table 1. Population of aerobic mesophilic bacteria in the test fruit mousse samples [log cfu/g]

Samples	Test day	N	N_0	M	Min	Max	SD
A	0	8	3	1.75	0	4.86	1.70
	After 24 h	8	2	1.64	0	4.18	1.37
B	0	5	0	2.01	1.30	2.30	0.76
	After 24 h	5	1	1.18	0	2.30	0.76
C	0	5	4	0.46	0	2.30	0.92
	After 24 h	5	3	0.82	0	2.34	1.02
D	0	6	3	1.26	0	3.58	1.37
	After 24 h	6	2	1.07	0	1.65	0.79

N – number of samples, N_0 – number of samples where no presence of aerobic mesophilic bacteria was found, M – arithmetic mean, Min – minimum value, Max – maximum value, SD – standard deviation.

Source: original studies.

An absence of total aerobic mesophile count was observed in almost 40% of samples from manufacturer A on test day 1, while after 24 hours of cold storage these microorganisms were found to be absent in one in four samples. On the other hand, samples from manufacturer C were characterised by the lowest counts of aerobic mesophilic bacteria, which on test day 1 was at the level of log 0.46 and log 0.82 cfu/ml after a day of cold storage. All analysed samples of mousses from manufacturer B showed the presence of aerobic mesophiles on test day 1 (mean value of log 2.01 cfu/ml), while after the period at cold storage temperatures, a slight drop in the number of these microorganisms was noted (log 1.18 cfu/ml), with aerobic mesophiles being absent in only 1 sample. 50% of the samples from manufacturer D were characterised by an absence of aerobic mesophilic bacteria on test day 1, while after the cold storage period, a drop in the count of these microorganisms was observed.

The microbiological criteria applicable to foodstuffs, included in the Regulation of the Minister of Health of 13 January 2003 on the maximum chemical and biological contamination levels permissible in food, food ingredients, authorised additives, processing aids, or on food surface, specify the aerobic mesophilic TMC at 10^2 to $5x10^2$ cfu/ml of the product. 25% of the sample A fruit mousses exceeded these microbe limits on test day 1, while after 24 h of cold storage, this value dropped to 12.5%. Samples of fruit mousses from manufacturers B and C met the criteria specified in the above legal acts, while among mousse samples from manufacturer D, only one test sample exceeded the aerobic mesophile limits on test day 1 (log 3.58 cfu/ml). The varied multiplication of microorganisms during product storage after their opening is related to the microorganism growth phases.

However, fluctuations in the rate of these changes occur under the effects of external environment effects, time and storage conditions, as well as loss of product sterility. In their microbiological quality tests of products for children, Drożdż et al. [2014] demonstrated much higher levels of both aerobic mesophile TMC and fibrous fungi contamination. The fruit paste desserts they analysed were characterised by the presence of a total aerobic mesophile count of approx. log 1.75 cfu/g on the day of opening, and log 1.95 cfu/g after a storage period [Drożdż et al. 2014].

Table 2. Population of fibrous fungi and yeasts in the test fruit mousse samples [log cfu/g]

Samples	Test day	N	N_0	M	Min	Max	SD
A	0	8	7	0.38	0	3	0.99
	After 24 h	8	6	0.38	0	2.04	0.71
B	0	5	1	0.72	0	1.60	0.63
	After 24 h	5	2	1.02	0	1.60	0.56
C	0	5	5	0	0	0	0
	After 24 h	5	4	0.26	0	1.30	0.52
D	0	6	6	0	0	0	0
	After 24 h	6	6	0	0	0	0

N – number of samples, N_0 – number of samples where no presence of aerobic mesophilic bacteria was found, M – arithmetic mean, Min – minimum value, Max – maximum value, SD – standard deviation.

Source: original studies.

Based on the data summarised in Table 2, it was concluded that the highest maximum fungi count occurred in fruit mousses from manufacturer A on the first day of sample testing (log 3 cfu/ml), and after 24 hours in cold storage a drop by 1 logarithmic cycle in the count of these microorganisms was observed. Fruit mousse samples from manufacturer B showed fungus contamination at levels from 0 to log 1.60 cfu/ml, and after the cold storage period their counts reduced slightly. Mousse samples from manufacturer D were characterised by an absence of fungi, both on test day 1 and after the cold storage period. Among the mousse samples from manufacturer C, only one test sample exhibited the presence of fungi at the level of log. 1.3 cfu/ml. Tests conducted by Drożdż et al. [2014] demonstrated a significantly higher level of fibrous fungi contamination in fruit mousses for children, both on the day of opening (log 1.70 cfu/g) and after a storage period (log 2.11 cfu/g) [Drożdż et al. 2014]. The requirements of the Regulation of the Minister of Health concerning the fibrous fungi and yeast counts in fruit preserves, which include mousses, specify the limit at below $5x10^1$ cfu in 1 ml. Among the mousse samples from manufacturer A, the permissible fungi count was found to be exceeded significantly (log 3 cfu/ml) on test day 1 and after 24 hours of cold storage (log 2.04 cfu/ml). A total of 60% of the mousse samples from manufacturer B exhibited a fibrous fungi contamination at the start of the test, although the permissible count of these microorganisms was exceeded in two mousse samples. The fibrous fungi and yeast contamination levels for mousse samples concerned manufacturers C and D to the least extent, with none of the test samples exceeding the microbe limits.

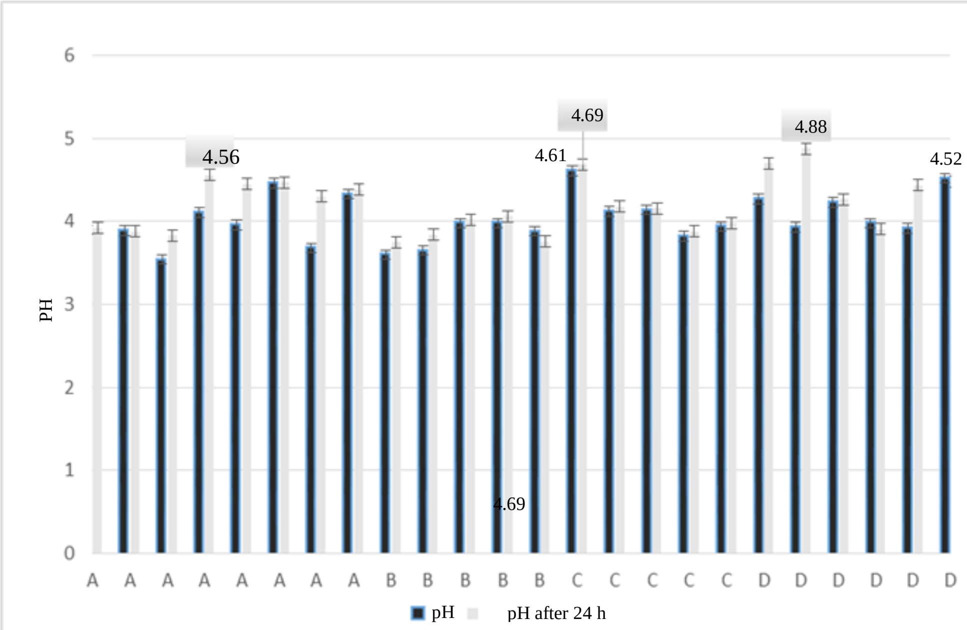

Fig. 1. pH values in the test fruit mousse samples on test day 1 and after 24 hours of cold storage

Source: original studies.

The test material was also analysed for pH values, both on the test day 1 and after the cold storage period. This parameter was analysed due to the significant impact of environmental acidity on fungi population growth. The test mousse samples were characterised by a pH within the 3.54–4.88 range, and in the case of 5 mousses, these values slightly exceeded the levels provided for in the Regulation of the Minister of Health of 2003, which were used as limits for the selected microbiological properties. The data presented in Figure 1 indicate that only four fruit mousses showed a drop in pH after 24 hours of cold storage. The change in this value by 0.01 to 0.12 was detected in mousses from manufacturers A and B, and in 2 samples from manufacturer D which contained banana and peach in addition to apple. In the mousse samples from manufacturers A and B, there was no increase in the number of fibrous fungi and yeast counts, while in the samples of mousses intended for children, these microbes were absent. In the other samples, an increase in pH by 0.01 to 0.95 was observed. The highest increase was found in a sample from manufacturer D, where fungi were absent, while on test day 1 the highest aerobic mesophile count (log 3.58 cfu/ml) in mousses for children was noted.

The mousse samples where aerobic mesophilic microorganism levels were exceeded included 2 samples intended for adult consumers and 1 sample intended for child consumers. The composition of these mousses included strawberry and peach, in addition to apple. On the other hand, fibrous fungi and yeast counts were only exceeded in mousses for adult consumers, which other than apple contained strawberry and peach.

Table 3. The number of samples that failed to meet the requirements for test microbiological characteristic counts, including pH values for all test fruit mousses

	Aerobic mesophilic bacteria count in log cfu/ml		**Fungi count in log cfu/ml**		**pH value**	
	On purchase day	**After 24 h**	**On purchase day**	**After 24 h**	**On purchase day**	**After 24 h**
Range	Ab - 4.86	Ab - 4.18	Ab - 3	Ab - 2.04	3.54-4.61	3.75-4.88
Medium	1.42	1.23	0.23	0.30	4.02	4.20
% of samples that failed to meet requirements	**12.5**	**4.2**	**12.5**	**4.2**	-	-

Source: original studies.

4. CONCLUSION

A total of 12.5% of the mousse samples tested on the day of purchase failed to meet the microbiological purity criteria for aerobic mesophile and fungus TMC.

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