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The use of acid whey for the production of yogurt-type fermented beverages

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Katarzyna Skryplonek

West Pomeranian University of Technology, Faculty of Food Sciences and Fisheries, Department of Dairy Technology and Food Storage, Papieża Pawła VI 3, 71-459 Szczecin, Poland

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Abstract

Acid whey is a by-product of cheese-making industry, which, in comparison to rennet whey, has less favourable processing properties and thus it is more difficult to utilize. The aim of the study was to evaluate the quality of yogurt-type fermented beverages based on acid whey. In the beverages production yogurt bacteria cultures *Streptococcus thermophilus* and *Lactobacillus delbruecki* ssp. *bulgaricus* (YO-MIX, Danisco, Denmark) were used. The production process included combining of pasteurized acid whey with UHT milk, unsweetened condensed milk or skimmed milk powder. Milk was incorporated to beverages in order to enrich casein content and obtain product with quality characteristics similar to fermented milk drinks. Moreover, the beverages were supplemented with oligofructose and whey protein concentrate WPC 35. The products were stored under refrigerated conditions (5±1°C) for 21 days. During the storage, an assessment of physicochemical properties and sensory characteristics was carried out. In addition, the beverages were evaluated in consumer preference test. The study showed, that by combining of acid whey with milk it is possible to obtain a products similar to yogurt, although their characteristics were influenced by the composition and storage time. During storage period, the acidity increased and acetaldehyde content decreased. Moreover the deterioration of sensory properties was observed. Consumer preference test indicated, that the best sensory properties had beverages from whey and condensed milk.

Key words: acid whey, fermented beverages, yogurt bacteria

Introduction

Yogurt is one of the most popular kind of milk fermented beverages with very significant position on the global market (Chandan, 2006). The high nutritional value, health promotion attributes as well as sensory properties make yogurt highly acceptable among consumers. Growing awareness of the need of balanced diet and openness to innovative products is the reason for which consumers have focused their interest to other types of fermented beverages, which are associated to health benefits. This trend is followed by continuous expansion of fermented beverages marked, what is demonstrated by the variety of new products launched every year. However, consumers are reluctant to accept products with sensory properties extremely different from traditional fermented milks (Yildiz, 2010). As a result, development of a high quality fermented beverages in which milk is substituted with whey is a challenge for the dairy industry.

Whey is a by-product of cheese production. It is estimated, that 33 % of the world milk production is used in cheese industry, and the volume of whey remaining during the production amounts about 85-90 % of milk volume. In 2010 the world whey production amounted about 165 million tonnes and 68 % was produced in European countries

*Corresponding author/Dopisni autor: katarzyna.skryplonek@zut.edu.pl

(Darade and Ghodake, 2012). Besides that, the global cheese, and consequently also whey, production increases for about 2 % per year (Dajnowiec and Zander, 2013). Whey contains about 50 % of milk solids, including almost 100 % of lactose and whey proteins and the majority of mineral compounds. Whey contains negligible amounts of casein, which forms the cheese curd and small quantities of milk fat. The average total solid content in whey is 6.7 % (FAO, 2013). Acid whey is a by-product of acid-coagulated cheese and casein manufacturing. In contrast to rennet whey, which remains after rennet coagulation, the pH of acid whey is distinctly lower than pH of milk. Moreover acid whey contains lower quantities of protein and greater amounts of minerals. Consequently, the acid whey is less suitable for processing than rennet equivalent and its utilization still remains a challenge especially for small dairy industries.

It is commonly known that whey has a high nutritional value and its consumption positively impacts the body functions (Khan et al., 2015). Whey proteins, calcium and other minerals and vitamins contribute to the beneficial effect on health. There is a growing body of evidence, that whey proteins and bioactive peptides play a crucial role in regulation of satiety and food intake as well as stimulation of muscle regeneration and immune defence enhancement. Moreover, whey ingredients such as minerals can significantly reduce blood pressure and act as antioxidants. Some whey components like lactoferrin and lysozyme have antimicrobial properties (Kassem, 2015; Khan et al., 2015). A range of researches indicated that whey proteins can reduce a risk of certain diseases, like cancer, cardiovascular disease and osteoporosis (Ha and Zemel, 2003).

In the view of such valuable properties, whey and whey formulations are considered as appropriate ingredients of number of food products. Despite that, direct use of liquid acid whey is not common. Whey is proved to be a good medium for growth of yogurt bacteria (Galladro-Escamilla et al., 2007). Since whey facilitates the yogurt bacteria to survive in the gastrointestinal tract, fermented whey may beneficially influence gut microbiota (Kar and Misra, 1999). Despite the lack of casein and low total solids content, sensory properties of fermented whey are poor and watery in comparison to fermented milk. In order to improve textural characteristics, whey may be enriched with milk solids. The improvement of sensory as well as nutritional properties can be achieved by addition of oligofructose and whey protein concentrates (WPC) (Akalin et al., 2007). Oligofructose and inulin are fructooligosaccharids used in fermented dairy beverages production for improvement of texture, to retard liquid phase separation and to prevent syneresis. Due to a sweetish taste, those additives positively influence the product flavour (Nastaj and Gustaw, 2008). WPC are commonly used as additives incorporated into the products mainly due to their functional properties (water binding, gelling, emulsifying) but also because of valuable nutritional properties (Chavan et al., 2015).

The aim of the study was to assess the physicochemical and sensory characteristics of yogurt-type fermented beverages based on acid whey combined with milk, condensed milk or skimmed milk powder (SMP). Part of prepared beverages were additionally enriched with oligofructose and WPC 35. The quality properties of the products were evaluated during a 3-week refrigerated storage.

Material and methods

Materials

The yogurt-type fermented beverages were prepared from acid whey derived from dairy plant located in north-west Poland. Whey was obtained during industrial-scale semi-fat quark cheese production. The cheese was made from pasteurized milk with 0.8 % of fat. The steps of quark cheese production were as follows: addition of calcium chloride and lactic acid bacteria starter culture for direct vat inoculation (DVS), coagulation at 22-30 °C for 12-18 h, cutting and heating the curd, draining of whey, rinsing, moulding, pressing, packaging and storing at refrigerated conditions. The whey was subsequently transported to the laboratory of Dairy Technology and Food Storage Department and the beverages were prepared on the day of whey production. Other raw materials used in production were: sterilized in ultra high temperature (UHT) milk with 3.2 % fat content (OSM Wart-Milk, Poland); condensed unsweetened UHT milk with 7.5 % fat and 17.5 % non-fat milk solids; skimmed milk powder (SMP) with 0.2 % fat (both from SM

Gostyń, Poland). The additives used to enrich beverages were prebiotic oligofructose ORAFTI P95 (Beneo, Belgium) and whey protein concentrate WPC 35 with approximately 35 % of protein content (SM Spomlek, Poland). The fermentation of beverages was carried out by yogurt bacteria starter culture YO-MIX (Danisco, Denmark) consisted of *Streptococcus thermophilus* and *Lactobacillus delbruecki* ssp. *bulgaricus*.

Manufacture of beverages

The acid whey was submitted to thermal treatment at 72 °C for 10 min. Subsequently whey was enriched with oligofructose (B1), oligofructose and WPC 35 (B2) or SMP (B3). Then whey was mixed with milk in ratio whey: milk 1:1 (B1-B3), with milk and condensed milk in ratio whey: milk: condensed milk 2:1:1 (B4) or only with condensed milk in ratio whey: condensed milk 1:1. (B5) The composition of experimental beverages is presented in Table 1.

In the next stage, the mixtures were inoculated with 50 mL/L of starter culture, poured into PE-LD cups with 50 mL volume, tightly covered with aluminium foil and incubated at 42±1 °C for 3.5 h. The incubation was stopped when the curd was obtained. Then the beverages were cooled down and stored in refrigeration at 5±1 °C. The analyses were performed after 1, 4, 7, 14 and 21 days of the storage.

Whey analyses

The analysis of whey included assessment of following physicochemical characteristics: pH acidity, which was measured by pH-meter (model CP-411, Elmetron, Poland); titratable acidity expressed in % of lactic acid - by titration with 0.25 M NaOH solution; total solids content - by oven drying at 102 °C, density - by lactodensimeter (PN-A-86364:1996) and total protein content - by Kjeldahl method (PN-EN ISO 8968-1).

Beverages analyses

Physicochemical properties

The beverages were subjected to the evaluation of pH acidity (pH-meter model CP-411, Elmetron, Poland); titratable acidity in % of lactic acid; total solids by drying at 130 °C (PN-75/A-86130) and acetaldehyde content by diffusive method (Less and Jago, 1969).

Textural analysis

Texture profile analysis (TPA) was performed using texture analyzer TA.XT plus (Stable Micro System, Great Britain). The samples were penetrated with an aluminum cylindrical probe with diameter 20 mm. The trigger force was 1 G, penetration distance was 25 mm and test speed 5 m/s. The study was limited to analysis of the hardness as the crucial textural parameter of fermented milk beverages quality (Salvador and Fiszman 2004; Damin et al., 2009).

Sensory analysis

Sensory characteristics were evaluated in two separated test. One of them was a sensory evaluation during 3-week period of storage, performed by trained panellists and the other one was a consumer preference test performed only once, after 1 day of refrigerated storage of products. Sensory evaluation included assessment of appearance, consistency taste and smell of beverages and was performed using scoring method by panel of 6 trained assessors. Each of quality factors obtained the grade from 1 point (very poor quality) to 5 points (very good quality). The ideal product should have uniform and firm curd, without or with minimal whey separation, homogenous and thick consistency and clear and refreshing taste and smell which should combine the characteristics of whey and yogurt. The mean scores of each quality factor assessment were used to calcu-

Table 1. The composition of yogurt-type fermented beverages based on acid whey

Beverage variant	Main ingredients, ratio			Additives
	Whey	Milk	Condensed milk	
B1	1	1	-	oligofructose 20 g/L
B2	1	1	-	oligofructose 20 g/L, WPC 35 10 g/L
B3	1	1	-	SMP 50 g/L
B4	2	1	1	-
B5	1	-	1	-

late overall sensory quality of products. This quality indicator was calculated as a weighted average of the scores, where taste and smell had weights 0.30 each, consistency - 0.25 and appearance - 0.15. The weights reflect the influence of each factor on determination of overall product quality. The conditions of sensory analysis were in accordance with guidelines presented in Polish Standard (PN-ISO 6658:1998) and in work of Baryłko-Pikielna and Matuszewska (2009).

According to Castro et al. (2013), meeting the consumers' demands related with sensory properties is crucial factor to achieve commercial success while launching the new product on the market. That is why consumer preference test was performed. The number of randomly selected assessors was 44 and the test was performed in laboratory conditions, where each of the participants had separated place (Baryłko-Pikielna and Matuszewska, 2009). Coded samples were presented in PE-LD covered cups and the serving was 50 mL of each product. The test was performed after 1 day of refrigerated storage. Every consumer obtained individual set of samples served on tray. Participants were instructed to drink water between tasting the samples in order to clean the palate. The consumer test included 3 questions. In the first, participants were asked to rate the samples using 5-point hedonic scale, where 1 meant very bad and 5 - very good perception of the sample. Then panellists were asked how often they are willing to consume the products. For each of the sample they indicated if they would buy it often, sometimes or never. In the last part of the query, consumers selected one beverage which they like the most.

Statistical analysis

All analyses were performed in triplicate and in case of texture analysis, in 5 replicates. The results were statistically analysed at the significance level $p<0.05$ using Statistica StatSoft Software (StatSoft Inc., USA). The influence of the composition and storage time on the beverages' characteristics was evaluated by two-way analysis of variance (ANOVA). The mean values of the quality properties were compared by Tukey HSD test.

Results and discussion

Characterization of whey

The physicochemical properties of acid whey used in the production are showed in table 2. The protein content was higher than typical amount of 0.8 % indicated by FAO (2013). Sensory characteristics of whey were positively assessed. It possessed intensive and refreshing flavour, opaque appearance, light yellow-greenish colour, and was evaluated as a high quality raw material for the beverages production.

Physicochemical properties of whey-based fermented beverages

A number of studies confirmed that whey is good environment for lactic acid bacteria. In case of yogurt bacteria cultures (*Streptococcus thermophilus* and *Lactobacillus delbruecki* ssp. *bulgaricus*) their growth in whey is similar as in milk (Kar and Misra, 1999; Gallardo-Escamilla et al., 2007). Whey fermentation with yogurt bacteria leads to enhancement of its nutritional value by reduction of protein allergenicity and stimulation of bioactive peptides production (Pescuma et al., 2008). The physicochemical properties of five different types of whey-based yogurt-type fermented beverages prepared according to the formulations presented in Table 1, during 3-week refrigerated storage period, are shown in Table 3. The results of two-factor analysis of variance are presented in Table 4.

The results of a preliminary study (data not included) revealed that the content of milk in the recipe should amount at least 50 % in order to obtain products with optimal physicochemical and sensory characteristics. The same conclusion was drawn

Table 2. Characteristics of whey used in the beverages production

Characteristic	Value
Total solids content [%]	6.48±0.11
Protein content [%]	1.02±0.15
Density [g/cm^3]	1.025
Titratable acidity [% of lactic acid]	0.49±0.0
Active acidity [pH]	4.85±0.01

by Castro et al. (2013) who prepared fermented beverages from rennet whey combined with milk. The increase of milk solids, mainly casein content, strongly influenced the structure of casein curd and contributed to the improvement of textural properties of the product. Whey as a raw material with trace amounts of casein and low total solids content, decreases viscosity of the product and leads to a loose casein curd. Open structure and weaker interactions between casein micelles result in deteriorated water binding capacity and higher likelihood of syneresis (Almeida et al., 2008). According to Damin et al. (2009) and Marafon et al. (2011) a higher casein to whey proteins ratio enhances hardness and viscosity of fermented beverages. The results of hardness evaluation and sensory analysis confirmed that statement and beverages with greater amount of milk solids had harder texture, better consistency and were less vulnerable for liquid phase separation. The relation between the amount of milk in whey-based beverages and syneresis occurrence was stated also by González-Martínez et al. (2002), de Castro et al. (2009) and Castro et al. (2013).

Table 3. Physicochemical characteristics of whey-based fermented beverages during refrigerated storage

Product	Time of storage [days]				
	1	4	7	14	21
			pH acidity		
B1	4.48±0.01^{a}	4.48±0.03^{a}	4.43±0.01^{a}	4.26±0.01^{b}	4.13±0.04^{b}
B2	4.50±0.01^{a}	4.61±0.02^{b}	4.44±0.01^{a}	4.23±0.01^{a}	4.05±0.03^{a}
B3	4.54±0.01^{b}	4.71±0.02^{c}	4.65±0.01^{b}	4.50±0.01^{c}	4.18±0.02^{b}
B4	4.75±0.01^{c}	4.75±0.03^{c}	4.68±0.02^{bc}	4.49±0.01^{c}	4.37±0.01^{c}
B5	4.94±0.01^{d}	4.87±0.01^{d}	4.70±0.01^{c}	4.53±0.01^{d}	4.36±0.01^{c}
			Titratable acidity [% of lactic acid]		
B1	0.614±0.005^{a}	0.614±0.005^{a}	0.639±0.000^{a}	0.664±0.005^{a}	0.702±0.009^{a}
B2	0.648±0.000^{b}	0.646±0.005^{b}	0.677±0.005^{b}	0.713±0.005^{b}	0.731±0.005^{b}
B3	0.889±0.005^{e}	0.857±0.005^{d}	0.866±0.005^{d}	0.893±0.010^{d}	0.934±0.005^{d}
B4	0.731±0.005^{c}	0.754±0.005^{c}	0.756±0.000^{c}	0.808±0.005^{c}	0.835±0.005^{c}
B5	0.803±0.005^{d}	0.862±0.005^{d}	0.916±0.005^{e}	0.992±0.005^{e}	1.037±0.005^{e}
			Total solids [%]		
B1	10.52±0.28^{a}	10.50±0.03^{a}	10.23±0.05^{a}	10.71±0.09^{a}	10.38±0.31^{a}
B2	11.05±0.22^{b}	11.16±0.06^{b}	10.76±0.09^{b}	11.32±0.22^{b}	10.97±0.05^{b}
B3	12.75±0.09^{d}	12.67±0.16^{d}	12.16±0.10^{d}	12.59±0.06^{d}	12.27±0.15^{c}
B4	11.95±0.03^{c}	11.97±0.12^{c}	11.39±0.13^{c}	11.87±0.05^{c}	11.75±0.27^{c}
B5	15.36±0.07^{e}	15.20±0.11^{e}	14.82±0.09^{e}	15.39±0.10^{e}	15.06±0.13^{d}
			Hardness [N]		
B1	0.145±0.009^{a}	0.146±0.018^{ab}	0.115±0.024^{a}	0.144±0.029^{ab}	0.142±0.015^{ab}
B2	0.141±0.012^{a}	0.135±0.011^{a}	0.139±0.010^{a}	0.138±0.007^{a}	0.136±0.017^{a}
B3	0.184±0.029^{ab}	0.176±0.005^{bc}	0.196±0.016^{b}	0.194±0.038^{c}	0.198±0.036^{ab}
B4	0.156±0.021^{a}	0.169±0.013^{abc}	0.151±0.007^{a}	0.172±0.013^{ab}	0.163±0.028^{ab}
B5	0.210±0.024^{b}	0.196±0.014^{c}	0.208±0.007^{b}	0.186±0.016^{b}	0.222±0.026^{b}
			Acetaldehyde content [ppm]		
B1	1.742±0.060^{a}	1.307±0.043^{a}	1.310±0.029^{ab}	0.908±0.117^{bc}	0.676±0.017^{bc}
B2	1.660±0.031^{a}	1.483±0.048^{a}	1.408±0.049^{b}	0.644±0.049^{a}	0.641±0.041^{ab}
B3	2.055±0.059^{b}	1.922±0.028^{b}	1.774±0.081^{c}	1.174±0.035^{d}	0.890±0.055^{d}
B4	1.801±0.031^{a}	1.500±0.077^{a}	1.401±0.067^{b}	1.014±0.019^{cd}	0.750±0.045^{c}
B5	2.020±0.070^{b}	1.515±0.085^{a}	1.174±0.067^{a}	0.777±0.044^{ab}	0.558±0.024^{a}

Different letters in superscript indicate statistically significant differences ($p<0.05$) among mean values in columns

Acidity is an important indicator of fermented beverages quality. The pH of all tested beverages decreased gradually during the storage time. Only in case of B1 and B4 beverages, increase between the 1st and 4th day of storage was observed. The beverages from whey and milk (B1 and B2) were characterized by lower values of pH during storage, while products containing condensed milk (B5 and B4) had higher pH values. The titratable acidity presented as the percentage of lactic acid also increased during storage. In contrast to pH, the beverages with condensed milk addition (B5 and B4) had higher titratable acidity than other products. These results are consistent with the total solid content of beverages. The increase of total solids content by implementation of milk or WPC caused the increase of titratable acidity of the beverages. Such findings could be explained by the fact, that milk proteins and minerals shape titratable acidity of dairy products. Lower pH value of samples with higher content of milk solids is a consequence of buffering capacity of milk (Akalin et al., 2007; Marafon et al., 2011). Comparing samples B1 and B2 which differed only in addition of 50 g/L WPC 35 it could be noticed that whey protein addition did not stabilize pH of product. pH values of both products constantly decreased between the 4th and the 21st day of storage. Consequently, the amount of incorporated whey proteins was obviously too low to prolong the product durability. Post-acidification during the storage period is typical for fermented dairy beverages and is affected by temperature and bacteria strain properties (Antunes et al., 2005). The increase of the acidity of whey-based fermented beverages was observed also by Almeida et al. (2008, 2009), Castro et al. (2009) and Pescuma et al. (2010).

Table 4. Results of two-factor analysis of variance of physicochemical properties of whey-based fermented beverages

Indicator	Factor	p value	test F
Hardness	Time of storage	0.4215	2.463
	Type of beverage	0.0000*	2.463
	Interactions	0.1283	1.746
Acetaldehyde content	Time of storage	0.0000*	2.557
	Type of beverage	0.0000*	2.557
	Interactions	0.0000*	1.850
Titratable acidity	Time of storage	0.0000*	2.557
	Type of beverage	0.0000*	2.557
	Interactions	0.0000*	1.850
Active acidity	Time of storage	0.0000*	2.557
	Type of beverage	0.0000*	2.557
	Interactions	0.0000*	1.850
Total solids content	Time of storage	0.0000*	2.557
	Type of beverage	0.0000*	2.557
	Interactions	0.3423	1.850

*statistically significant differences (level of significance $p<0.05$)

Hardness of experimental beverages depended only on product composition and did not change significantly during storage (Table 4). Similar to titratable acidity, the increase of total solids caused an increase of products' hardness. The highest hardness had product from whey and condensed milk (B5) and the lowest hardness had products from whey and milk (B1 and B2). According to the literature, WPC are additives improving the texture and mouthfeel of fermented dairy beverages. The use of WPC as replacements of milk powder in fermented dairy beverages production was investigated by Akalin et al. (2007), Damin et al. (2009) and Marafon et al. (2011). In all of the quoted studies, WPC positively affected the texture of products. However, our results showed that WPC 35 addition did not significantly influence the hardness of whey-based beverages. It was presumably due to too small quantity of WPC 35 to cause this effect.

Acetaldehyde is one of the major aroma components of yogurt. The flavour intensity as well as the profile of aroma compounds are influenced by product composition, bacterial strain characteristics and conditions during fermentation and storage of fermented beverages. Acetaldehyde is synthesized mainly by *L. delbruecki* ssp. *bulgaricus*, and the role of *S. termophilus* is minor (Beshkova et al., 1998). The minimal level of acetaldehyde detectable by human sense of smell is 0.415 ppm (Less and Jago, 1978). There are two pathways of acetaldehyde synthesis, in which either lactose or amino acid threonine act as a substrate (Zourari et al., 1992). Both of these components are present in whey, and as reported Magalhães et al. (2011), the production of acetaldehyde may be performed at the same level as in case of milk fermentation. Gallardo-Escamilla et al. (2005) stated that the replacement of milk with whey does not affect the capacity of yogurt bacteria to produce aroma compounds.

The results of our study showed, that the content of this compound in all analysed samples was low and dropped rapidly during the storage period. After one day of storage, the acetaldehyde content amounted 1.660-2.055 ppm and after 3 weeks of storage it declined to 0.558-0.890 ppm. However, the decrease in aroma compound content during refrigerated storage is a typical phenomenon for fermented dairy beverages (Beshkova et al., 1998; Guven et al., 2005). During the entire storage period, the content of acetaldehyde was positively affected by SMP addition and product B3 had distinctly the highest amount of this aroma compound. In contrast to our findings, Isleten and Karagul-Yuceer (2008) examined aroma compounds in yogurt, and did not find a relation between acetaldehyde content and milk powder addition. Analysing the literature, it could be noticed, that the content of acetaldehyde measured in whey-based yogurt-type beverages was much lower in comparison to the results obtained by other authors. The levels of acetaldehyde in yogurt reported by different authors were inconsistent. Beshkova et al. (1998) reported the range of 14-17 ppm and the ranges stated by Guven et al. (2005) were 7-9 ppm. These results showed that the acetaldehyde content is a parameter which varies considerably among products. Since consumers mostly prefer yogurts with mild aroma, it may be assumed that commercial yogurt bacteria strains have weak capacity of acetaldehyde synthesis.

Sensory characteristics of whey-based fermented beverages

The results of sensory characteristics evaluation of beverages during a 3-week refrigerated storage are presented in Fig. 1.

The evaluation performed by trained panellists showed that all of the tested beverages had a good sensory properties and the overall sensory quality exceeded 4 points at 1-5-point scale. The quality of beverages slightly decreased during the storage period, which was associated to the increase of sour taste and decrease of flavour intensity. According to de Castro et al. (2009), the deterioration of sensory characteristics of whey-based fermented beverages is connected with the increase of titratable acidity during the storage period.

The appearance and consistency of the products were stable during the storage. The most liquid consistency had the beverage B1 with the less content of total solids and the minimal syneresis. Sample B2 was additionally fortified with WPC 35 and was characterised by loose consistency but without syneresis occurrence. Products with milk and skimmed milk powder (B3), milk and condensed milk (B4) and solely condensed milk (B5) were more creamy, but the whey flavour was less intensive. The least intensive whey flavour was detected in the sample B3. Beverages B1 and B2 had a pleasant, sweetish taste most probably due to a 20 g/L addition of oligo-

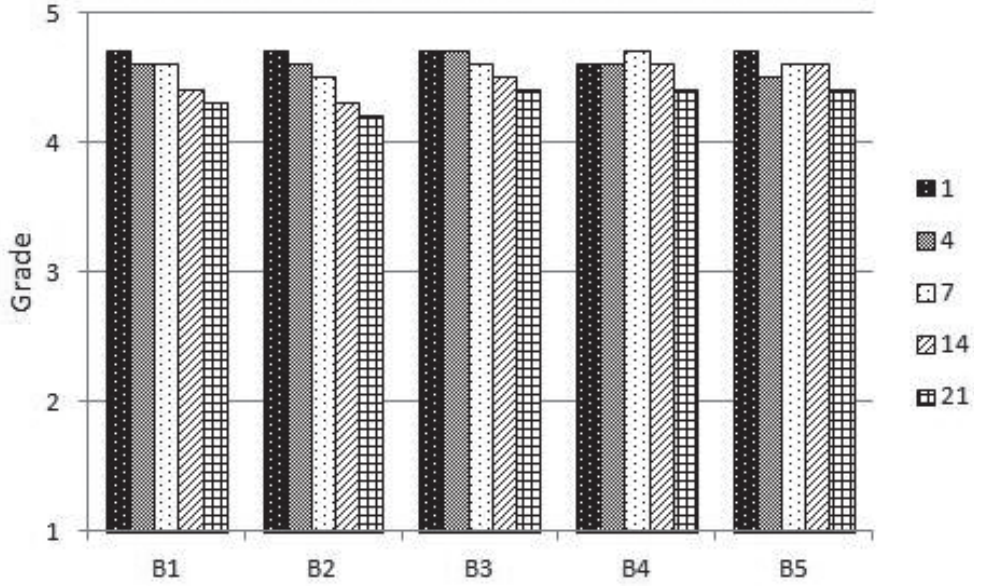

Figure 1. Overall sensory quality of whey-based fermented beverages during storage

fructose. Nastaj and Gustaw (2008) also reported a positive influence of oligofructose on sensory properties of yogurts. The use of oligofructose in whey-based fermented beverages was studied by de Castro et al. (2009), although they did not report the effect of oligofructose on sensory properties of the products. Comparing samples B1 with B2 which differed in WPC 35 addition, the panellists noticed that WPC 35 incorporation caused an improvement in consistency. On the other hand, WPC might have influenced the flavour of beverages, which in case of sample with added WPC 35 was assessed as less intense. Negative impact of WPC on the taste of fermented beverages was reported also by Damin et al. (2009) and was an outcome of bitter taste of whey proteins.

Consumer preference test of whey-based fermented beverages

Besides the analysis conducted with the participation of panellists, also consumer assessment was performed. In contrast to the previous test, it was performed only after one day from the production. The aim of this stage of the study was to recognize a consumers' estimation of products, which did not necessarily reflect the evaluation performed by trained panellists. Consumers in their judgments of food products are subjective and product perception corresponded with their individual taste and habits. Consumer preferences influences the crucial factors during the purchasing decision and indicates the real chance of newly introduced product to maintain on the highly competitive fermented beverages market (Castro et al., 2013). For that reason, this kind of examination is one of the stages of development and implementation of new food products (Krasnowska and Salejda, 2008).

The first question of the inquiry was to rate the samples using a 5-point hedonic scale, the results of this part of test are presented in Fig. 2.

None of the beverage samples obtained a very good mean grade, however three beverages (B4, B5 and B1) were assessed as good. Despite the lower susceptibility to syneresis, sample B2 obtained lower grades than sample B1, which was most probably caused by the influence of WPC on the product's flavour. The products with condensed milk (B5 and B4) were graded higher than samples with uncondensed milk (B1 and B2). However, product with uncondensed milk (B3) obtained the lowest grades among consumers despite the high total solid content. According to the consumers' explanations whey flavour in sample B3 was less distinct and the taste of milk powder was detectable.

The consumer assessment indicated that key characteristics, which shape the opinion about the product are consistency and taste. According to Damin et al. (2009) and Lee and Lucey (2010), both of these factors are positively connected with the total solid content in the beverage.

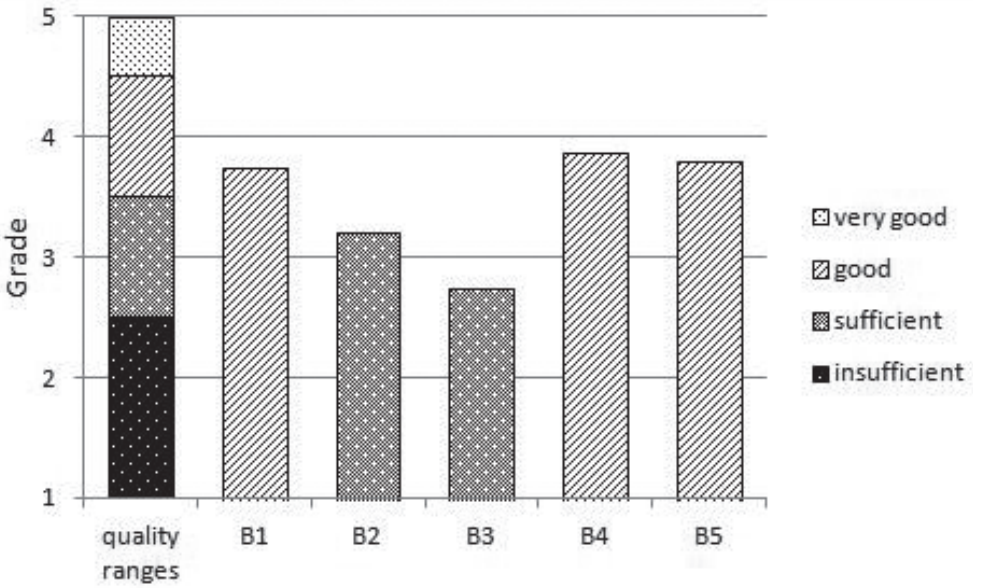

Figure 2. Customer assessment of whey-based fermented beverages

In the second question the participants were asked to indicate how often they would be willing to consume each beverage (Fig. 3), by choosing one out of three possible options (often, sometimes or never). The majority of consumers were ready to often consume beverage B5 which was followed by beverages B4 and B1. In case of the product B2, most participants indicated that they would consume it only sometimes and most consumers weren't willing to consume product B3 at all.

In the last part of the query, consumers were asked to select one beverage which they like the most. Among 44 participants who took the test, 15 (34.1 %) indicated product B5, while beverages B1 and B4 were chosen by 13 persons (29.5 %) each. 3 consumers selected the beverage B2 to be the most suitable for them, and beverage B3 was not selected by any of the respondents.

Conclusions

The results of the study showed that by combining acid whey with milk it is possible to obtain products with characteristics similar to yogurt, although their properties were influenced by the composition and storage period. Due to the good sensory properties of the beverages, it could be presumed that they should meet the consumer's demands and find a place on the marked. Nowadays consumers are more conscious on the need of proper and balanced diet in wellbeing. For that reason, yogurt and other fermented dairy beverages as products connected with health lifestyle are integral part of a diet (Chavan et al., 2015). Moreover, consumers seek for innovative, functional products, with high nutritional value and natural, high quality ingredients. These demands may be met by products containing whey and whey preparations. Rich nutritional composition and growing body of evidence of health benefits cause a growing interest in whey as a novel food. Due to a specific salty flavour unprocessed whey is not appreciated by consumers, but the use of fresh acid whey for high quality yogurt-type fermented beverages production may be considered as a good method of its utilization. This approach is beneficial for dairy industry since it does not require expensive processing steps and the production process is analogical to those of the traditional yogurt. The production of evaluated beverages should be especially attractive to small dairy factories, because it solves the problem with acid whey utilization and simultaneously does not require substantial financial expenditures for implementation of production process.

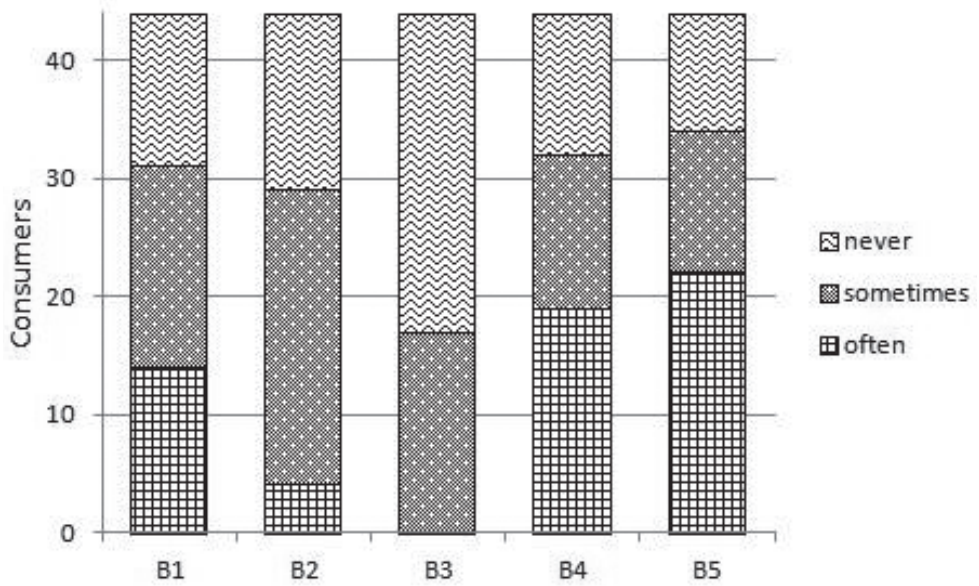

Figure 3. Declared frequency of whey-based fermented beverages intake

Upotreba kisele sirutke za proizvodnju fermentiranih napitaka nalik jogurtu

Sažetak

Kisela sirutka je sporedni proizvod sirarske industrije i u usporedbi sa slatkom sirutkom manje je pogodna za daljnju preradu, stoga ju je i teže iskoristiti. Cilj ovog rada bio je utvrditi kvalitetu fermentiranog napitka proizvedenog od kisele sirutke primjenom jogurtne kulture *Streptococcus thermophilus* i *Lactobacillus delbruecki* ssp. *bulgaricus* (YO-MIX, Danisco, Denmark). Proizvodni proces uključivao je miješanje kisele sirutke s UHT mlijekom, nezaslađenim kondenziranim mlijekom ili obranim mlijekom u prahu. Mlijeko se dodavalo u svrhu obogaćivanja sirutke kazeinom kako bi se dobili napici slični fermentiranom mlijeku. Napici su obogaćivani dodatkom oligofruktoze i koncentrata proteina sirutke WPC 35. Proizvodi su čuvani na hladnom (5±1 °C) tijekom 21 dan, pri čemu su im utvrđivana fizikalno-kemijska i senzorska svojstva. Osim toga, na svim je napicima proveden i test prihvatljivosti od strane potrošača. Dobiveni rezultati pokazali su da je miješanjem kisele sirutke i mlijeka moguće proizvesti napitke slične jogurtu, iako je na njihova svojstva znatno utjecao sastav i duljina skladištenja. Tijekom skladištenja povećavala se kiselost, a snižavala koncentracija acetaldehida. U testovima prihvatljivosti od strane potrošača najbolje je bio ocijenjen napitak na bazi sirutke i kondenziranog mlijeka.

Ključne riječi: kisela sirutka, fermentirani napici, jogurtna kultura

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