APARATURA
BADAWCZA I DYDAKTYCZNA

Cohesiveness and firmness of fermented milk with an increased proportion of whey proteins

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ABSTRACT:

Milk fermentation process can be controlled not only by the choice of a type and dose of characteristic microflora, but also by altering the composition of the processed milk. The scope and dynamics of milk souring process affect many physical characteristics of finished products. Most frequently is refers to changes of rheological characteristics, including parameters of the texture. The material for studies was processed milk, which composition was modified by the addition of skimmed powdered milk and whey protein concentrate thus increasing the dry substance from 11 to 16, 21 and 26%. The obtained results revealed that parameters of the fermented milk's texture can be freely modified by changing the composition of processed milk. The higher content of dry substance the greater consistency and firmness of fermented milk were obtained. Regardless of the dry substance content, the greater share of whey proteins the higher firmness of fermented milk was observed. A similar trend was noted by measuring the consistency.

Spoistość i zwięzłość mleka fermentowanego o zwiększonym udziale białek serwatkowych

Słowa kluczowe: mleko fermentowane, koncentraty białek serwatkowych, tekstura

STRESZCZENIE:

Proces fermentacji mleka można kontrolować nie tylko poprzez dobór rodzaju i dawki mikroflory charakterystycznej, ale także poprzez zmianę składu mleka przerobowego. Zakres i dynamika procesu ukwaszania mleka mają wpływ na wiele cech fizycznych gotowych produktów. Najczęściej dotyczy to zmian cech reologicznych, w tym i parametrów tekstury. Materiałem do badań było mleko przerobowe, którego skład modyfikowano poprzez dodatek odtłuszczonego mleka w proszku oraz koncentratu białek serwatkowych, zwiększając tym samym suchą substancję z 11 do 16, 21 i 26%. Otrzymane wyniki pozwoliły stwierdzić, że parametry tekstury mleka fermentowanego można dowolnie modyfikować poprzez zmianę składu mleka przerobowego. Konsystencja oraz zwięzłość mleka fermentowanego były tym większe, im większa była zawartość suchej substancji. Niezależnie od zawartości suchej substancji, im większy był udział białek serwatkowych, tym mleko fermentowane było bardziej zwięzłe. Podobny kierunek zauważono mierząc konsystencję.

1. INTRODUCTION

The content and type of milk proteins allow controlling the fermentation process, but it also has a certain effect on the texture's parameters such as: firmness, consistency, cohesiveness or viscosity index. The type and amount of proteins also determines a health-promoting value of fermented milk. It becomes important when entering skimmed powdered milk, whey protein concentrates or other concentrates of fractionated milk [1]. It is important in shaping a profile of fermented milk's texture to determine the ratio of whey proteins to casein proteins. Casein micelles contribute to increase the firmness and reduced secretion of whey [2]. Fermented milk is a product, which protein content must not be less than 2.7% [3].

The important trend became the enrichment of food products in bioactive peptides. Milk proteins have a high nutritional and biological value. They participate in the construction of muscles, reduce fat tissue and affect the correct functioning of the digestive system. Milk proteins are also used to control the body weight. The main attention is focused on whey proteins, which are an additive to athletes and also for the production of innovative dairy products in the form of isolates and concentrates [4]. Whey proteins can serve as a substitute for fat and also they increase the viscosity and firmness [5, 6].

Evaluation of the texture of fermented milk with an increased proportion of proteins is a major determinant of its quality, because fermented milk must meet the expectations of the consumer. Consumer estimates the product in a sensory way and he mainly draws attention to its texture and other parameters of the texture [7]. The texture of fermented milk is a complex and multidimensional feature, which allows describing the structure and rheological properties of the food product. It can be evaluated in an instrumental or sensory way. Instrumental measurement reproduces the characteristics, which were sensorily measured, without having an impact of the personal abilities of consumers. This is an objective measurement, which allows obtaining precise results.

2. EXPERIMENTAL PART

The experimental material was fermented milk with the following proportion of dry substance: 16, 21 and 26%. It was obtained by the addition of skimmed powdered milk (SPM) or whey protein concentrate (WPC 80) (Tab. 1) to milk. The milk contained 1.5% of fat. In order to initiate the fermentation, a starter culture with *Streptococcus thermophilus* and probiotic strains *Lactobacillus acidophilus* and *Bifidobacterium animalis ssp. lactis* under the trade name Lyofast SAB 440B (Sacco, Poland) in the amount of 40 u.a.·100^{-1} liters of processed milk were used. Fermentation was carried out at 37°C until obtaining pH of the curd 4.45.

The measurement of cohesiveness and firmness in comparison to other parameters of the texture was performed with the use of TA.XT plus texturometer from Stable Micro Systems Company (UK, Surrey) – compatible with the Texture Exponent E32 (version 4.0.9.0) software. The sample was placed inside a cylinder with an internal diameter Ø=50 mm (75% of filling). The measurement was carried out with the use of the backward extrusion technique, which involves the compression and return in a single cycle. Parameters of the test were as follows: Pre-Test Speed: 1.0 $mm \cdot s^{-1}$, mandrel immersion speed (Test Speed): 1.0 $mm \cdot s^{-1}$, Post-Test Speed: 10.0 $mm \cdot s^{1}$, weight of the load: 10 g.

3. RESULTS AND THEIR DISCUSSION

Measurement of texture's parameters clearly indicated a significant impact of a type of the used protein. Fermented milk with whey protein concentrate was characterized by a greater firmness, consistency and viscosity index than fermented milk with the skimmed powdered milk.

The highest cohesiveness was observed in fermented milk containing 149.3 $g \cdot kg^{-1}$ of proteins, 82.2% of which were whey proteins. At the same time, the same sample had the highest viscosity index. On the other hand, the greatest firmness was observed in fermented milk with a content of dry substance of 26%, prepared with the participation of whey protein concentrate WPC 80.

Sandoval-Castilla et al. claim that the texture depends on rheological properties of the product and a very significant impact has the type of a utilized additive, including whey protein concentrates [8]. Firmness and consistency of fermented milk with the participation of whey protein concentrate is greater than in case of milk produced with the participation of skimmed powdered milk at the same level of dry substance. Salvador and Fiszman additionally found that a significant impact on the firmness of fermented milk also has the time of its cooling storage [7]. Cohesiveness of fermented milk, regardless of the content of dry substance, was higher than while using whey protein concentrate. Viscosity index parameter had statically significant differences in the degree of increasing the dry substance with the use of whey protein concentrate WPC 80. According to Bhullar, the addition of whey protein concentrates as a method of increasing the dry substance causes the increase of the viscosity index [9]. In contrast, Marafon et al. found that the viscosity of fermented milk enriched with skimmed powdered milk has a higher viscosity than the fermented milk with the addition of whey protein concentrate [10].

4. CONCLUSION

Yogurt texture parameters can be freely changed by the modification of the processed milk's composition via adding of whey protein concentrates or skimmed powdered milk. Consistency and firmness of fermented milk were greater along with the higher content of dry substance. The use of whey protein concentrate WPC 80, more than skimmed powdered milk, increases the cohesiveness and viscosity of fermented milk with a dry substance from 16 to 26%.

Table 1 Quantitative and qualitative participation of proteins in fermented milk

Fermented milk with the participation of	Content		Share in the total amount of protein (%)	
	Dry substance (%)	Protein in total ($g \cdot kg^{-1}$)	Casein proteins	Whey proteins
SPM	16	57.90	68.4	31.6
	21	82.30	55.5	44.5
	26	119.00	54.0	46.0
WPC 80	16	67.60	39.9	60.1
	21	108.90	24.7	75.3
	26	149.30	17.8	82.2

*SPM – skimmed powdered milk (94.3%, including 35.1% of protein);
WPC 80 – whey protein concentrate (95.2 %, including 79.4% of protein)

Table 2 Parameters of the texture in fermented milk with a different density by the addition of whey protein concentrate or skimmed powdered milk (instrumentally measured)

Texture parameters	Type of sample*	Content of dry substance (%)		
		16	21	26
Firmness (g)	**A**	40.069^{aA}	42.288^{aA}	68.404^{aB}
	B	47.153^{bA}	58.244^{bB}	107.615^{bC}
Consistency (g·s)	**A**	955.082^{aA}	1013.849^{aA}	1799.704^{aB}
	B	1175.392^{bA}	1452.179^{bB}	2718.493^{bC}
Cohesiveness (g)	**A**	-16.529^{aA}	-18.604^{aA}	-59.460^{aB}
	B	-23.183^{bA}	-42.502^{bB}	-117.990^{bC}
Viscosity index (g**·s**)	**A**	-24.114^{aA}	-23.4^{aA}	-147.624^{aB}
	B	-35.705^{bA}	-103.93^{bB}	-277.399^{bC}

*A – skimmed powdered milk (SPM); B – whey protein concentrate WPC 80

a-b: various small letters in columns for the same examined characteristic and for the same level of dry substance's compaction mean a statistically significant influence of the type of used protein

A-C: various capital letters in rows for the same examined feature and for the same type of used additive mean a statistically important impact of the level of dry substance's compaction

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