SENSORY PROPERTIES AND ACCEPTABILITY OF KOMBUCHA FERMENTED MILK DRINK

ORIGINAL SCIENTIFIC ARTICLE

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ABSTRACT:
Kombucha, as a non-traditional starter, is successfully used for the fermentation of milk in order to obtain a liquid fermented milk product. Fermented milk products have a pleasant, slightly sour taste that are created by the fermentation of milk under the influence of starter cultures (lactic acid bacteria), lactic and other acids are produced, which are responsible for the refreshing taste and aroma of the product. In this way, products with new organoleptic properties are obtained. The aim of the work was to examine the sensory properties and acceptability of a fermented milk drinkduring storage for 14 days using the tea mushroom Kombucha as a non-traditional starter culture and inoculum, which were obtained by inoculating the fungus on black tea and milk, depending on the starter culture and sweetener used. Two sweeteners, sucrose and meadow honey, were used as a carbon source. The obtained results were compared with the control sample, produced with the lyophilized culture Lyofast Y 452 E. The results of the research showed that the fermented milk drinksamples obtained by fermentation with Kombucha possess unique sensory properties with a mixture of sweet and sour notes. The acceptability of the produced samples of kombucha fermented milk drinkis high.Keywords: fermented milk drink, syneresis, kombucha, sweeteners.

KEYWORDS: sensory properties, acceptability, Kombucha, fermented milk drink

INTRODUCTION

Kombucha is a traditional fermented drinkwith a history spanning thousands of years, first appearing in the East. Recently, this drinkhas become more popular in Western civilization. Kombucha is produced by aerobic fermentation of black tea (green tea can also be used) and white sugar by a combination of bacteria and yeast, known as a symbiotic culture of bacteria and yeast (SCOBY). The yeast converts sucrose into ethanol (in addition to organic acids and carbon dioxide), which acetic acid bacteria convert into acetaldehyde and acetic acid [1]. Kombucha consists of a multifaceted microbial ecosystem of complex interactions. In kombucha, a complex community of bacteria and yeast initiates the fermentation of a starter tea (plain black or green tea with sugar), forming a biofilm-like gelatinous structure that covers the liquid for several weeks. This occurs through several fermentation stages characterized by cooperation and competition between microbes in the kombucha solution. Yeast biomass is a source of the enzyme invertase, which allows yeasts and bacteria to metabolize sugar. The bacteria form a surface biofilm that can act as a means of protection from external influences, microbial storage, and increased access to oxygen for the microbes within it [2].

Kombucha is a traditional tea drink(with low alcohol content) fermented by a symbiotic community of acetic acid bacteria (*Acetobacteraceae*) and osmophilic yeasts [3,4]. Consumption of drinks produced with these microorganisms has been associated with numerous health benefits, such as antimicrobial, antioxidant, anticancer, and antidiabetic properties [4,5] and are often called functional drinks [5].

Honey is a natural sweetener that is very popular for its aroma and positive health effects. It is the most valued natural product known to mankind since ancient times. Meadow honey, which was used as a natural sweetener in this research, is a polyfloral honey, which is made from nectar collected by bees from meadow plants - dandelion, grass, motherwort, kadun, cypress and others. The color varies from light to dark yellow, it also has a very pleasant taste and smell, is nutritious and medicinal [8].

Fermented food is defined as food or drink produced by the controlled growth of microorganisms and the conversion of food components by enzymatic action. In recent years, fermented foods have experienced a surge in popularity, largely due to the proposed health benefits [9]. The use of kombucha as an unconventional starter culture in the technology of fermented dairy products has been investigated from the aspect of the influence of the type of tea for kombucha cultivation, fermentation temperature, concentration and type of inoculum, and the influence of milk fat content [10, 11, 12, 13].

With kombucha inoculum, milk fermentation lasts significantly longer than in the production of classic fermented milk drink. This is primarily due to the specific microbiological composition of the inoculum and the complex composition of milk [14, 15].

The possibility of using the kombucha tea fungus and its inoculum for milk fermentation has been investigated by many authors [15, 16, 17, 18, 19, 20, 21, 22].

The aim of the study was to examine the sensory properties and acceptability of a fermented milk drinkusing kombucha as a non-traditional starter culture and compare it with a fermented milk drinkproduced with a conventional fermented milk drink starter culture.

Table 1. Sample of fermented milk drink

Sample	% of non-traditional starter inoculum	Starter culture	Sweetener	% of kombucha fermented milk drink as inoculum	
				kb1	kb2
kb1	10	-	sucrose	-	-
kb2	10	-	honey	-	-
kb3	-	-	-	10	-
kb4	-	-	-	-	10
ko	-	Lyofast Y 452	-	-	-

kb-kombucha

EXPERIMENTAL

Materials

A kombucha culture grown on black tea was used for the fermentation process. After seven days, the kombucha culture was transferred to fresh black tea with a specific sweetener. Mushroom cultivation on freshly prepared black tea was carried out with the addition of 70 g/L sucrose (kb1), or 61.25 g/L of meadow honey from our own production (kb2). After cooling the tea to 25°C, 10% of the kombucha inoculum was added to the total amount of tea (100 mL per 1L of tea) and mushrooms, left in a dark place for seven days at a temperature of 25°C until the kombucha culture biofilm was re-formed, which was later separated. After a sufficient number of kombucha mushrooms were formed, the milk fermentation process was started. For the production of fermented milk drink, UHT milk with 2.8% m.m. was used. manufacturer “Meggle” which was inoculated with 10% inoculum of non-traditional starter culture (fermented tea samples kb1 and kb2) in relation to the total amount of milk. Fermentation of inoculated milk samples with 10% inoculum (kb3 and kb4) was carried out in a water bath at 34ºC, with monitoring of pH value up to 4.6. (Table 1). Then the samples were cooled in ice water, packed in sterile glass packaging and stored at a temperature of +4ºC.

For the production of control fermented milk drink(ko) a lyophilized (FD-DVS, Frozen dried Direct Vat Set) culture (manufacturer Sacco Clerici, Italy) Lyofast Y 452 E (composed of: *Lactobacillus delbrueckii* ssp. *bulgaricus* and *Streptococcus thermophilus*) was used, respecting all parameters of the culture manufacturer.

Methods

Sensory analysis

The sensory properties of samples of a fermented milk drink were evaluated by a group of 15 evaluators using the scoring method, after 1, 7 and 14 days of storage. Table 2 shows the sensory test results of fermented milk drink.

The acceptability of fermented milk drinksamples was tested using the Periam hedonic scale, according to which consumers expressed their general impression of the tested products on a scale of 1-9 (Table 3). The desirability of the samples (%) was determined based on the statistical analysis of the results obtained from the evaluations of the tested consumers, as well as the mean value of all tests.

The results of the hedonic scale were statistically processed to determine the average value of the ratings and the percentage of desirability.

$$UD = \frac{I}{Y} \cdot 100(\%);$$
$$D = 100 - UD(\%)$$

UD - undesirability
I - number of raters who gave the product a rating lower than 5
Y - total number of raters
D - desirability

Statistical analysis

Statistical analysis (ANOVA) was performed using SPSS software (version 25), and Dunnett's test was used to assess statistical significance (p<0.05).

Table 2. Table for evaluating the sensory properties of fermented milk drink

Sensory properties	Descriptive parameters	Points
General appearance	Homogeneous, uniform appearance over the entire surface	1
	Noticeable impurity on the surface, it is not homogeneous	0
Color	Uniform white color	1
	Uneven color or presence of foreign color	0
Taste	Pleasantly sour, refreshing, no lumps, fine consistency in the mouth	10-12
	A little too sour or sweetish, tastes like sour cream	5-9
	The product is significantly sour, has a foreign taste, is not homogeneous in the mouth, leaves an unpleasant aftertaste	0-4
Smell	Clean, characteristic of fermented milk drink, slightly sour and free of foreign impurities	2
	Clean, characteristic of fermented milk drink, more sour and slightly foreign impurities	1
	Odor faults more pronounced	0
Consistency	Uniform consistency, thick-viscous, no whey separation	4
	A few lumps present in the curd, thick-viscous, no whey separation	3
	Fermented milk drink consistency too thick/liquid, with whey separation (on the surface)	1-2
	Consistency errors very pronounced	0

Table 3. Periam Acceptability Test

Description	Evaluation
Extremely highly desirable	9
Highly desirable	8
Moderately desirable	7
Slightly desirable	6
Neutral	5
Slightly undesirable	4
Moderately undesirable	3
Highly undesirable	2
Extremely highly undesirable	1

RESULTS AND DISCUSSION

Sensory analysis is an important and best method for assessing the organoleptic properties of products. Sensory properties such as taste, appearance, smell, texture and consistency are important parameters in assessing the quality of products that change during storage. The primary criteria for ensuring the quality of dairy products are structural and textural properties. In addition to the type of milk, composition, and production conditions, the sensory, rheological and nutritional properties of fermented drinks are also affected by the type of starter and sweetener used for fermentation. Honey also has a positive effect on the antimicrobial, antioxidant and preservative properties of the product [23]. It is widely used to reduce the acidity of fermented milk drink and improve its sensory properties.

The mean values (±st. deviation) of sensory properties and acceptability depending on the applied starter and sweetener are shown in Tables 4 and 5. Analysis of variance showed that there was no statistically significant difference for the 1st day of storage in the sensory properties of samples fermented with kombucha (kb1, kb2, kb3 and kb4) compared to the control sample (ko). The color of all samples was stable and rated with the maximum score. The fermented milk drinkhad a homogeneous consistency without lumps with a more pronounced fullness of taste compared to the kombucha fermented milk drink. The fermented milk drink produced using a non-traditional starter (tea mushroom) had a characteristic, slightly sour, refreshing taste and a distinct aroma, which is consistent with observations on kombucha fermentation, where the production of organic acids and microbial metabolites contributes to unique sensory properties [22] In addition, microbial fermentation has been shown to improve sensory, nutritional, and functional attributes in various food matrices, supporting the potential of non-traditional starters to enhance taste, texture, and health-promoting compounds in fermented milk products [23].

The fermented milk drink produced using the starter culture Lyofast Y 452E had a characteristic smell and taste typical of this type of fermented milk drink.

In all samples, the color was almost unchanged during the 7-day storage period, while the taste, aroma and consistency received lower ratings, primarily due to the increase in acidity and intensity of syneresis in the samples during storage, in accordance with the published research [24, 25]. During storage, changes in consistency occurred (day 7 and 14) as a result of an increase in the intensity of syneresis in the samples [24], which was statistically significant ($p<0.05$). Proteins lose their ability to bind water, there is a decrease in pH and an increase in titratable acidity, which can affect the occurrence of syneresis. The changes observed in texture and consistency during storage can be explained by the activity of lactic acid bacteria, which influence protein structure, water-holding capacity, and acidity in fermented milk products. This aligns with recent studies highlighting the role of both traditional and novel microbial strains in modulating sensory and functional properties of fermented dairy products [26].

The increase in acidity of the samples [24] influenced the changes in the smell of the samples (day 7 of storage) fermented with kombucha, which was statistically significant ($p<0.05$). After 14 days of storage, all products had lower sensory ratings, which is a consequence of the increase in product acidity. During storage, the samples had a relatively good external appearance.

Consistency ratings of the fermented milk drinksamples also varied during storage. Dunnett's t-test showed that there was a statistically significant difference between kb1i ko in consistency (7th and 14th day), and all samples fermented with kombucha compared to the control sample in terms of smell (7th day of storage).

When examining samples with sweeteners, honey had a positive effect on the sensory properties of the samples compared to sucrose as a sweetener. This positive effect was also observed when assessing the acceptability of the samples.

According Anwar et al. [21], honey improves antioxidant activity, probiotic viability and sensory properties, especially taste and viscosity of fermented milk drink.

Acceptability of new products was determined by one of the most useful sensory methods of consumer testing using the hedonic scale, a verbal scale with 9 possible answers according to Peryam [27, 28]. All investigated samples showed a high percentage of acceptability by the examined group of consumers after the first day of storage. Observing the results of acceptability during storage (table 5), the highest scores were obtained by the control samples of the fermented drink. Analysis of variance did not show a statistically significant difference in comparing the samples fermented with kombucha with the control sample.

Table 4. Average values and standard deviation of sensory properties fermented milk drink during 14 days storage

Day storage	Samples	Sensory properties				
		External apperance	Consistency	Smell	Taste	Colour
1.	ko	1.00(±0.00)	4.00(±0.00)	2.00(±0.00)	12.00(±0.00)	1.00(±0.00)
	kb1	0.91(±0.10)	3.42 (±0.60)	1.71(±0.38)	10.28(±2.67)	1.00(±0.00)
	kb2	1.00 (±0.00)	3.65(±0.42)	1.71(±0.38)	10.28(±2.67)	1.00(±0.00)
	kb3	0.92(±0.97)	3.77(±0.39)	1.82(±0.31)	9.94(±2.56)	1.00(±0.00)
	kb4	0.97(±0.07)	3.54(±0.42)	1.71(±0.38)	9.94(±2.56)	1.00(±0.00)
7.	ko	0.91(±0,10)	3.65(±0.42)	1.82(±0.21)	10.62(±1.28)	0.94(±0.09)
	kb1	0.88(±0.10)	2.97(±0.39)*	1.37(±0.31)*	9.60(±2.40)	1.00(±0.00)
	kb2	0.91(±0,10)	3.54(±0.42)	1.37(±0.31)*	9.60(±2.77)	1.00(±0.00)
	kb3	0.88(±0.10)	4.00(±0.00)	1.37(±0.31)*	8.91(±1.81)	1.00(±0.00)
	kb4	0.94(±0.09)	3.77(±0.39)	1.71(±0.44)	9.60(±2.40)	1.00(±0.00)
14.	ko	0.88(±0.10)	3.54(±0.42)	1.77(±0.21)	10.28(±1.71)	0.94(±0.09)
	kb1	0.88(±0.10)	2.85(±0.42)*	1.42(±0.50)	8.91(±2.28)	1.00(±0.00)
	kb2	0.91(±0.10)	3.20(±0.65)	1.31(±0.30)	9.25(±2.56)	0.94(±0.09)
	kb3	0.85(±0.15)	3.54(±0.78)	1.31(±0.44)	8.91(±1.81)	0.94(±0.09)
	kb4	0.94(±0.09)	3.77(±0.39)	1.60(±0.40)	9.60(±2.40)	1.00(±0.00)

ko – control; kb-kombucha

**- the mean difference is significant at the 0,05 level*

Table 5. Average values and standard deviation of acceptability fermented milk drink during 14 days storage

Samples	Acceptability fermented milk drink during storage		
	1.	7.	14.
ko	9.00(±0.00)	8.42(±0.53)	8.42(±0.53)
kb1	8.42(±0.78)	7.85(±0.37)	7.85(±0.37)
kb2	8.71(±0.48)	8.14(±0.37)	8.00(±0.57)
kb3	8.71(±0.48)	8.14(±0.37)	8.00(±0.57)
kb4	8.71(±0.48)	8.57(±0.53)	8.42(±0.53)

CONCLUSION

The research included testing the sensory properties and acceptability of the samples during storage, and a comparison with a fermented milk drinkobtained using a conventional starter culture, fermented milk drink culture. The influence of sweeteners and starters on the sensory properties of the fermented samples was monitored.

The fermented milk drink(ko) had a homogeneous consistency without lumps with a more pronounced fullness of flavor compared to the drinkfermented with kombucha. In all samples, the color was almost unchanged during the 7-day storage period, while the taste, smell and consistency received lower ratings, primarily due to pronounced acidic characteristics. After 14 days of storage, all products had lower sensory ratings, which is a consequence of the increase in product acidity. Honey as a sweetener showed a positive effect on some sensory characteristics compared to sucrose, but it was not statistically significant. The highest acceptability after the first day of storage was the ko sample, and at the end of storage, the kbo and kb4 samples.

REFERENCES

[1] C. Dufresne, E. Farnworth, E. ″Tea, Kombucha, and health: a review″. *Food Research International,* vol. 33, pp. 409-421, 2008

[2] A. May, S. Narayanan, J. Alcock, A. Varsani, C. Maley, A. Aktipis. *″Kombucha: a novel model system for cooperation and conflict in a complex multi-species microbial ecosystem″*, PeerJ, pp. 1-22, 2019

[3] T. De Filippis, E. Vitaglione. *″Different temperatures select distinctive acetic acid bacteria species and promotes organic acids production during Kombucha tea fermentation″*, Food Microbiology, vol.73, pp 11-16, 2018

[4] P. Sarkaya, E. Akan, O. Kinik. ″Use of kombucha culture in the production of fermented dairy drinks″, *Lebensmittel-Wissenschaft & Technologie*, vol. 137(1), 110326, 2021

[5] https://doi. org/10.1016/j.lwt.2020.110326

[6] H. Dutta, S.K. Paul. ″Kombucha drink: Production, quality, and safety aspects. In Production and Management of Drinks″, Grumezescu, A.M., Holban, A.M., Eds.; Woodhead Publishing: Sawston, UK, pp. 259–288, 2019

[7] T. Brčina, R. Cvrk, Lj. Bojanović. Kontrola kvaliteta meda i pčelinjih proizvoda, OFF-SET, Tuzla, pp. 23, 2022

[8] C. Dimidi, W. Rossi. *″Fermented Foods: Definitions and Characteristics, Impact on the Gut Microbiota and Effects on Gastrointestinal Health and Disease″*, Nutrients, vol. 11(8), pp. 1806, 2019

[9] M. Iličić. Optimizacija tehnološkog procesa proizvodnje funkcionalnog mlečnog napitka. Novi Sad, Tehnološki fakultet Univerziteta u Novom Sadu. Doktorska disertacija(2010).

[10] K. Kanurić, D. Hrnjez, M. Ranogajec, S. Milanović, M. Iličić, V. Vukić, M. Milanović. *″The effect of fermentation temperature on the functional dairy product quality″*, Acta Periodica Technologica vol 42, pp. 63-70, 2011

[11] J. Vitas, R. Malbaša, J. Grahovac, E. Lončar. *″The antioxidant activity of kombucha fermented milk products with stinging nettle and winter savory″*. Chemical Industry & Chemical Engineering Quarterly, vol.19 (1), pp. 129-139, 2013

[12] M. Kruk, M. Trząskowska, I. Ścibisz, P. Pokorski. *″Application of the "SCOBY" and Kombucha Tea for the Production of Fermented Milk Drinks″*, Microorganisms, vol 9(1), pp. 123, 2021 doi: 10.3390/microorganisms9010123.

[13] S. Milanović, M. Carić, E. Lončar, M. Panić, R. Malbaša, D. Dobrić. *″Primena koncentrata čajne gljive u proizvodnji fermentisanih mlečnih napitaka″*, Prehrambena industrija - Mleko i mlečni proizvodi, vol. 13(2), pp. 8-13, 2002

[14] R.V. Malbaša, S.D. Milanović, E.S. Lončar, M.S. Djurić, M.Đ. Carić, M.D. Iličić, L. Kolarov. *″Milk-based drinks obtained by Kombucha application″*, Food Chemistry, vol. 112, pp. 178–184, 2009

[15] S. Milanović, K. Kanurić, V. Vukić, D. Hrnjez, M. Iličić, M. Ranogajec, M. Milanović ″Physicochemical and textural properties of kombucha fermented dairy products″, *African Journal of Biotechnology*, vol. 11, pp. 2320-2327, 2012

[16] R. Malbaša, J. Vitas, E. Lončar, J. Grahovac, S. Milanović ″Optimization of the Antioxidant Activity of Kombucha Fermented Milk Products″, *Czech Journal of Food*, vol 32 (5), pp. 477- 484, 2014

[17] V.R. Vukic, D.V. Hrnjez, K.G. Kanuric, S.D. Milanovic, M.D. Iličić, A.M. Torbica, J.M. Tomic ″The Effect of Kombucha Starter Culture on the Gelation Process, Microstructure and Rheological Properties during Milk Fermentation″ *Journal of Texture Studies*, vol. 45, pp. 261–273, 2014,

[18] K.G. Kanurić, S.D. Milanović, B.B. Ikonić, E.S. Lončar, M.D. Iličić, V.R.; Vukić, D.V. Vukić ″Kinetics of lactose fermentation in milk with kombucha starter″ *Journal of Food and Drug Analysis*, vol. 26 pp. 1229–1234, 2018

[19] M. Kruk, T. Wójcik, M. Trząskowska ″Application of Kombucha tea brew and SCOBY symbiotic culture to produce fermented milk drink″, *ŻYWNOŚĆ. Nauka. Technologia. Jakość,* vol.26,3 (120), pp. 97–108, 2019

[20] M. Kruk, M. Trząskowska, I. Ścibisz, P. Pokorski ″Application of the "SCOBY" and Kombucha Tea for the Production of Fermented Milk Drinks″ *Microorganisms,* vol. 9(1), pp. 123, 2021.

[21] M. Czarnowska-Kujawska, M. Starowicz, B. Paszczyk, J. Klepacka, M. Popielarczyk, E. Tońska ″The chemical, antioxidant and sensorial properties of milk and plant based kombucha analogues″ *LWT*, vol. (206), pp. 116610, 2024

[22] A. Anwar, M.A. Faiz, J. Hou ″Effect of Honey Concentration on the Quality and Antioxidant Properties of Probiotic Fermented milk drink Drinks from Different Milk Sources″, *Appl. Sci.* 2025, vol. 15, pp. 2210, 2025

[23] D. Dutta, A. Singh, V. Kumar, P. Sharma, et al. ″Kombucha Healthy—Recent Advances in Production, Chemical Composition and Health Benefits″. *Fermentation*, vol. 9(1), pp. 48, 2023

[24] L. Zhou, Y. Wang, H. Li, J. Chen, Q. Zhang, et al. ″Microbial Fermentation for Improving the Sensory, Nutritional and Functional Attributes of Legumes″. *Fermentation*, vol. 9(6), pp. 635, 2023.

[25] T.Brčina, M.Vilušić, M.Zahirović. ″Influence of starter and sweetaner on the syneresis intensity of fermented milk drink″. *Technologica Acta* vol 15(2), pp.15-18, 2022

[26] T.Brčina, M.Vilušić, M.Zahirović, D. Miličević. ″Antioksidativna aktivnost kombucha fermentiranog mliječnog napitka″. *Radovi Poljoprivredno-prehrambenog fakulteta Univerziteta u Sarajevu,* vol. 72(2), pp.145-156, 2022

[27] M. Żmudziński, K. Sionek, A. Kowalska, R. Nowak, et al. ″Traditional and New Microorganisms in Lactic Acid Fermentation of Food″. Fermentation, vol. 9, (12), pp. 1019, 2023.

[28] H. Stone, J.L. Sidel Sensory Evaluation Practices, Academic Press, Orlando, Florida, 1985

[29] R. Radovanović, J. Popov-Raljić, Senzorna analiza prehrambenih proizvoda., Poljoprivredni fakultet, Beograd i Tehnološki fakultet, Novi Sad, 2001