APTEFF, 43, 1-342 (2012)
DOI: 10.2298/APT1243051M
UDC: 637.146:663.88:582.282.23
BIBLID: 1450-7188 (2012) 43, 51-59
Original scientific paper

PHYSICAL AND TEXTURAL CHARACTERISTICS OF FERMENTED MILK PRODUCTS OBTAINED BY KOMBUCHA INOCULUMS WITH HERBAL TEAS

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In this investigation, kombucha fermented milk products were produced from milk with 1.6% milk fat using 10% (v/v) kombucha inoculums cultivated on the extracts of peppermint and stinging nettle.

The fermentation process was conducted at temperatures of 37, 40 and 43°C. Fermentation was stopped when the pH value of 4.5 was reached. The fermentation process was shortened with an increase of temperature. Physical characteristics of the fermented products were determined by using standard methods of analysis. Textural characteristics were determined by texture profile analysis. The obtained products showed good physical and textural characteristics, typical for the yoghurt-like products.

KEY WORDS: fermented milk products, kombucha, herbal tea, physical characteristics, texture

INTRODUCTION

Kombucha is a symbiosis of several yeast species (genera *Schizosaccharomyces*, *Saccharomycodes*, *Saccharomyces*, *Zygosaccharomyces*, *Candida*, *Pichia*, *Kloeckera*, *Brettanomyces* and *Torulopsis*) and acetic acid bacteria (*Gluconacetobacter xylinus* (formerly known as *Acetobacter xylinum*), *Acetobacter xylinoides*, *Bacterium gluconicum*, *Acetobacter aceti*, *Acetobacter pasteurianus*) (1, 2). Microbiological composition depends on the geographic origin of the culture. Kombucha metabolises on different substrates. Apart from traditional ones (sweetened black or green tea), it is capable for biotransformation of coca-cola, beer, coffee, Jerusalem artichoke, molasses, herbal tea, milk, and others. Kombucha is traditional refreshing beverage and food supplement (3, 4).

The products obtained after fermentation of kombucha on milk are, by their physicochemical and sensory characteristics, similar to fermented milk products such as yoghurt and kefir (5). These types of fermented milk products are widely consumed as functional food due to their good sensory and nutritional properties, and beneficial effects to human health (6, 7). Gel formation is the most important functional property of fermented milk products. The physical and textural characteristics of this composite gel are governed by

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milk composition, dry matter content, type and quantity of the starter culture that is used to inoculate the milk, fermentation temperature, and the storage conditions of the final product. In addition, the consistency and water-holding capacity of acidified milk gels are strongly related to the quality of fermented milk products (7).

Previous studies showed that it is possible to obtain kombucha beverage on herbal tea extract, and to use the obtained beverage in production of kombucha fermented milk products (8). Peppermint and stinging nettle are well known medicinal herbs, with a variety of positive effects to human health (9, 10).

The objective of this study was to investigate the physical and textural characteristics of fermented milk products obtained by kombucha inoculums with peppermint and stinging nettle.

EXPERIMENTAL

Production of kombucha inoculums

The inoculum for the fermentation of milk was obtained by cultivating kombucha on cooled tea, which was prepared as follows: to 1 L of boiling tap water was added 70 g sucrose and 2.25 g of appropriate tea: peppermint (label P) and stinging nettle (label SN), using herbal teas from a health food store. The tea extract was cooled to room temperature, filtered and then 100 mL of kombucha inoculum from a previous fermentation (10%, v/v) were added. The glass container was covered with cheesecloth for air. Kombucha incubation was performed at room temperature for 7 days. The obtained kombucha inoculums (marked as PI and SNI) were used for the fermentation of milk.

Production of fermented milk products

Fermented milk products were produced from pasteurized, homogenized milk with 1.6% milk fat (AD IMLEK Beograd, branch Novosadska mlekara, Novi Sad, Serbia), as follows: to the 500 mL of milk, 10% (v/v) of the appropriate kombucha inoculum (PI or SNI) was added. The fermentation was performed at 37, 40 and 43^{o}C and it lasted until the pH value of 4.5 was reached. Milk gel was then cooled to the temperature of 8°C, homogenized by mixer, and the samples were stored in refrigerator. The obtained products were marked as P37, P40, P43, SN37, SN40 and SN43 in dependence of the used herbal tea and the applied temperature.

Methods of analysis

The pH values were measured with a pH-meter (PT-70, Boeco, Germany).

The examined physical characteristics were whey syneresis (11) and water holding capacity (WHC) (12).

Textural characteristics were analyzed using Texture analyzer TA.HDplus, Micro Stable System, England (13).

All analyses were performed in triplicate. Statistical analyses were done using Microsoft Office Excel 2003.

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RESULTS AND DISCUSSION

The average pH value of milk used for the production of kombucha fermented milk products was 6.68, and therefore the milk was very slightly acidic. The determined pH value of the milk was in accordance to the current Regulation (14).

The average pH value of kombucha inoculum obtained from peppermint extract and stinging nettle extract was 3.27 and 2.84. It is evident that the measured pH values of the inoculums were significantly lower compared to the pH value of the milk.

The fermentation of milk with inoculums PI and SNI at 37, 40 and 43°C is presented in Figs. 1 and 2.

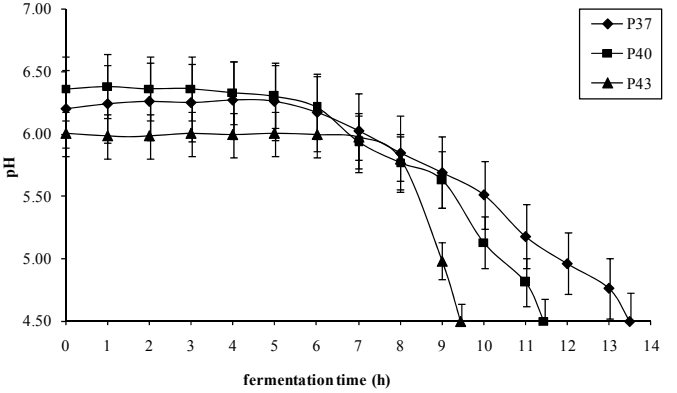

Figure 1. Fermentation process of milk at 37, 40 and 43°C with PI

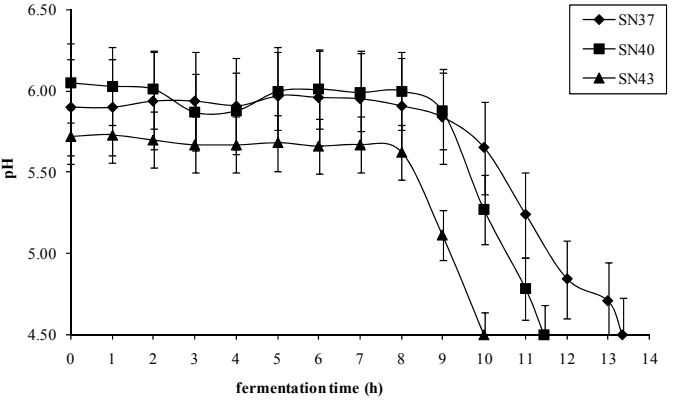

Figure 2. Fermentation process of milk at 37, 40 and 43°C with SNI

From the results presented in Figs. 1. and 2. it can be concluded that the fermentation temperature of 43°C shortened the time needed to reach the pH 4.5, with both applied

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inoculums. The fermentation process was the longest for the obtaining of P37 (13.50 hours) and the shortest for P43 (9.45 hours). The shape of all fermentation curves given in Figs. 1 and 2 is characteristic for the production of kombucha fermented milk products (5, 8, 13).

The results of whey syneresis and water holding capacity (WHC) are given in Figs. 3. and 4.

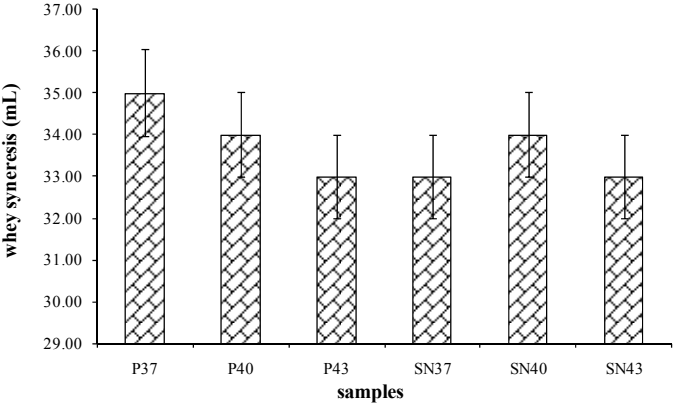

Figure 3. Whey syneresis of the kombucha fermented milk products

Whey separation, i.e. the appearance of whey on the surface of a gel, is a common defect during storage of fermented milk products like yogurts and cream cheese. Manufacturers try to prevent whey separation by increasing the total solid content of milk by heating it prior to the fermentation and/or by adding stabilizers. Spontaneous syneresis is the contraction of a gel without the application of any external force (e.g., centrifugation), and is related to the instability of the gel network (i.e., large-scale rearrangements) resulting in the loss of the ability to entrap all the serum phase (15). During the syneresis, whey passes through the protein matrix, which can be explained by the law of Darcy (16).

The results given in Fig. 3. show that the values of whey syneresis of the obtained products did not differ significantly. The highest value of syneresis had the sample P37 (35.00 mL) and this indicated its lower quality comparing to the other products.

The increase of fermentation temperature does not create the same trend for the WHC of products with peppermint and stinging nettle. While WHC was increased with an increase of temperature for the kombucha fermented milk products containing peppermint, the opposite behaviour for the products with stinging nettle was noticed (Fig. 4). The results show that the average values of WHC were higher for products obtained with SNI (43.44%), which suggested its better quality in comparison to products obtained with PI (36.82%).

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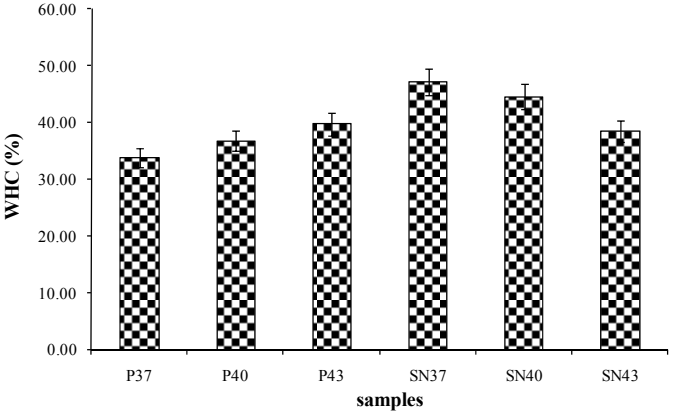

Figure 4. Water holding capacity of the kombucha fermented milk products

The results of texture analyses (firmness, consistency, cohesiveness and index of viscosity) are presented in Figs. 5-8.

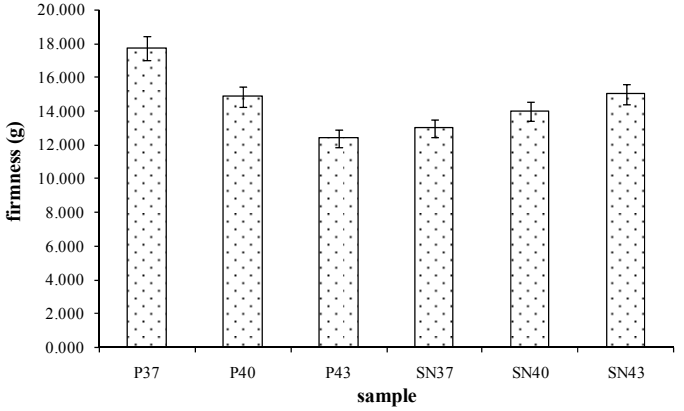

Figure 5. Firmness of the kombucha fermented milk products

Sweetening agents, such as sucrose, high-fructose corn syrup or honey, are usually added to stirred yoghurts to mask the acidity for acid-conscious consumers and, perhaps, produce a firmer texture (17). It is important fact because kombucha inoculums contain sucrose and fructose.

For yoghurt products, lower incubation temperatures (e.g. 40°C instead of 45°C) lead to slightly longer gelation times but firmer more viscous gels are formed that are less prone to whey separation (18).

The firmness of the products obtained with SNI increased with the increase of temperature, while for the products obtained with PI, this trend was reversing (Fig. 5).

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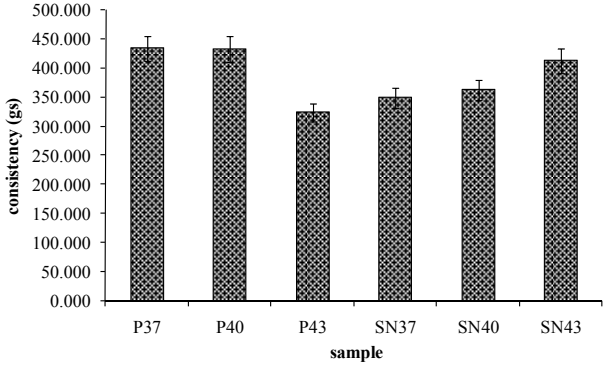

Figure 6. Consistency of the kombucha fermented milk products

The consistency of the yoghurt base is enhanced by homogenisation, in that a portion of the casein and whey proteins become attached to the fat globule surfaces, so effectively increasing the number of structure-building components in the system; native fat globule membranes do not interact with proteins in the same way (17).

The results given in Fig. 6 present that consistency of the products obtained with SNI increased with the increase of temperature, while for the products obtained with PI, this trend was opposite, but similar with firmness (Fig. 5).

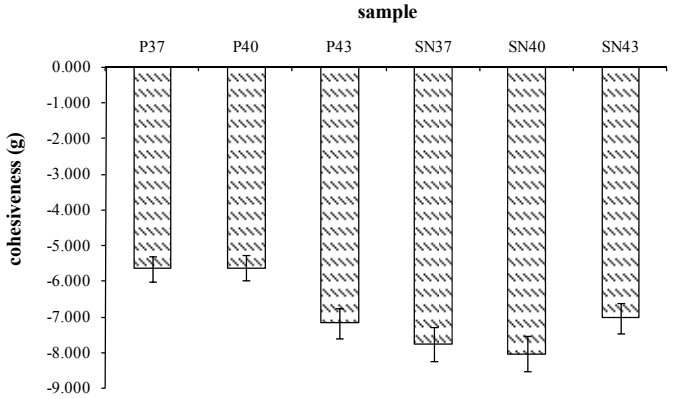

Figure 7. Cohesiveness of the kombucha fermented milk products

The cohesiveness indicates the maximum capacity of possible deformation of the sample before the break and could be very important for the consumers. The best cohesiveness of the products obtained with PI had the sample produced at 43°C, while for products obtained with SNI, the best cohesiveness had the sample SN40 (Fig. 7).

The viscosity and the structure of the gel are influenced by several factors, including the incubation temperature, casein concentration, heat treatment of the milk, acidity and type of starter culture; as well as the temperature at which the measurements are made (17).

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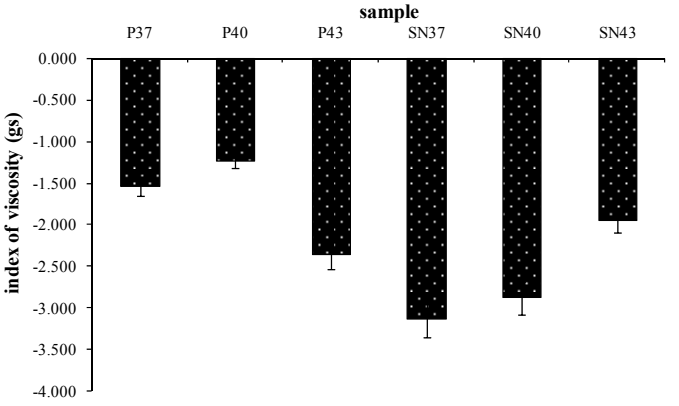

Figure 8. Index of viscosity of the kombucha fermented milk products

Index of viscosity for products obtained with SNI increased with the decrease of temperature. The best index of viscosity of the products obtained with PI had sample P43 (Fig. 8).

CONCLUSION

This study examined the physical and textural characteristics of fermented milk products obtained at the fermentation temperatures of 37, 40 and 43°C, using milk with 1.6% milk fat and kombucha inoculums cultivated on peppermint and stinging nettle. The fermentation was stopped after reaching pH 4.5.

The values obtained for the physical properties were in the range characteristic for that type of products. The values of whey syneresis and water holding capacity suggest that the best quality has the sample produced with kombucha inoculum cultivated on stinging nettle at the fermentation temperature of 37°C.

The highest joint value of firmness and consistency had the sample P37, the highest value of cohesiveness had the sample SN40 and the best index of viscosity showed the sample SN37.

Acknowledgement

Authors want to thank to the Ministry of Education, Science and Technological Development of the Republic of Serbia for financing the investigations presented in this article, Grant III-46009.

REFERENCES

1. Teoh, A.L., Heard, G. and Cox, J.: Yeast ecology of Kombucha fermentation. Int. J. Food Microbiol. **95,** 2 (2004) 119-126.
2. Nguyen, V.T., Flanagan, B., Mikkelsen, D., Ramirez, S., Rivas, L., Gidley, M.J. and Dykes, G.A.: Spontaneous mutation results in lower cellulose production by a *Gluco-*

nacetobacter xylinus strain from Kombucha. Carbohydr. Polym. **80**, 2 (2010) 337-343.
3. Dufresne, C. and Farnworth, E.: Tea, Kombucha and health: A review. Food Res. Int. **33**, 6 (2000) 409-421.
4. Malbaša R.: Chemical characterization of kombucha products, Faculty of Technology, University of Novi Sad, Novi Sad, Serbia (2009) (in Serbian).
5. Malbaša R., Milanović, S., Lončar, E., Djurić, M., Carić, M., Iličić, M. and Kolarov, Lj.: Milk-based beverages obtained by Kombucha application. Food Chem. **112**, 1 (2009) 178-184.
6. Amirdivani, S. and Baba, A.S.: Changes in yogurt fermentation characteristics, and antioxidant potential and *in vitro* inhibition of angiotensin-1converting enzyme upon the inclusion of peppermint, dill and basil. LWT-Food Sci. Technol. **44**, 6 (2011) 1458-1464.
7. Bensmira, M., and Jiang, B.: Effect of some operating variables on the microstructure and physical properties of a novel Kefir formulation. J. Food Eng. **108**, 4 (2012) 579-584.
8. Malbaša, R.V., Vitas, J.S., Lončar, E.S. and Kravić, S.Ž.: Influence of fermentation temperature on the content of fatty acids in low energy milk-based kombucha products. Acta Period. Technol. **42** (2011) 81-90.
9. Akdogan, M., Ozguner, M., Kocak, A., Oncu, M. and Cicek, E.: Effects of peppermint teas on plasma testosterone, follicle-stimulating hormone, and luteinizing hormone levels and testicular tissue in rats. Urology, **64**, 2 (2004) 394-398.
10. Hojnik M., Škerget M. and Knez Ž.: Isolation of chlorophylls from stinging nettle (*Urtica dioica* L.). Sep. Purif. Technol. **57**, 1 (2007) 37-46.
11. Atamer, M., Carić, M., Milanović, S. and Gavarić, D.: The quality of yoghurt produced from UF milk. Zbornik Matice srpske za prirodne nauke, Matica srpska Novi Sad, **91** (1996) 19-26.
12. Guzman-Gonzalez, M., Morais, F., Ramons, M., and Amigo, L.: Influence of skimmed milk concentrate replacement by dry dairy products in a low fat set-type yoghurt model system. I: Use of whey protein concentrates, milk protein concentrates and skimmed milk powder. J. Sci. Food Agric. **79**, 8 (1999) 1117-1122.
13. Milanović, S.D., Iličić, M.D., Duraković, K.G. and Vukić, V.R.: Textural characteristics of fermented milk beverages produced by kombucha. APTEFF **40** (2009) 63-69.
14. Regulation on quality of milk products and starter cultures. Offic.Gaz. RS. number 33 and 69 (2010) (in Serbian).
15. Lucey, J.A., Tamehana, M., Singh, H. and Munro, P.A.: Effect of heat treatment on the physical properties of milk gels made with both rennet and acid. Int. Dairy J. **11**, 4-7 (2001) 559-565.
16. Jovanović, S., Maćej, O. and Barać, M.: Influence of various coagulation factors on chemical composition of sera gained by centrifugation from casein gel. J. Agric. Sci. **49**, 2 (2004) 219-232.
17. Tamime, A.Y.: Fermented milks. Blackwell Science Ltd, a Blackwell Publishing company, Oxford, UK (2006) pp. 60, 82.
18. Lucey, J.A.: Cultured dairy products: an overview of their gelation and texture properties. Int. J. Dairy Technol. **57**, 2-3 (2004) 77-84.

APTEFF, 43, 1-342 (2012) UDC: 637.146:663.88:582.282.23
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ФИЗИЧКЕ И ТЕКСТУРАЛНЕ КАРАКТЕРИСТИКЕ ФЕРМЕНТИСАНИХ МЛЕЧНИХ ПРОИЗВОДА ДОБИЈЕНИХ ПОМОЋУ КОМБУХЕ ГАЈЕНЕ НА БИЉНИМ ЧАЈЕВИМА

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Циљ овог рада је било истраживање физичких и текстуралних карактеристика ферментисаних млечних производа добијених помоћу комбухе култивисане на биљним чајевима.

У овом раду, ферментисани млечни производи добијени помоћу комбухе су произведени коришћењем млека са 1,6% млечне масти додатком 10% (v/v) инокулума комбухе гајене на екстрактима нане и коприве.

Процес ферментације је изведен на температурама од 37, 40 и 43°C. Ферментација је заустављена након што је достигнута вредност pH од 4,5. Са порастом температуре процес ферментације је био краћи.

Физичке карактеристике су одређене применом стандардних метода анализе. Текстуралне карактеристике су одређене анализом текстуралног профила. Добијени производи су показали добре физичке и текстуралне карактеристике, типичне за јогурту сличне производе.

Кључне речи: ферментисани млечни производи, комбуха, биљни чај, физичке карактеристике, текстура

Received: 03 September 2012
Accepted: 12 October 2012