THE EFFECT OF FERMENTATION TEMPERATURE ON THE FUNCTIONAL DAIRY PRODUCT QUALITY

Katarina G. Kanurić\textsuperscript{a}, Dajana V. Hrnjež\textsuperscript{a}, Marjan I. Ranogajec\textsuperscript{a}, Spasenija D. Milanović\textsuperscript{a}, Mirela D. Iličić\textsuperscript{a}, Vladimir R. Vukić\textsuperscript{a} and Maja Lj. Milanović\textsuperscript{b}

\textsuperscript{a} University of Novi Sad, Faculty of Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia
\textsuperscript{b} University of Novi Sad, Faculty of Medicine, Hajduk Veljkova 3, 21000 Novi Sad, Serbia

The aim of this study was to examine the possibility of fermented dairy beverage production by the application of kombucha cultivated on thyme tea in combination with a probiotic starter and to evaluate the quality of the new functional product. Fermented dairy beverages are produced from milk with 1.6% milk fat at three fermentation temperatures: 37°C, 40°C and 43°C. Chemical quality, rheological properties and products of added starter cultures metabolism were determined in the fermented dairy beverages after production and after 10 days of storage. Produced fermented dairy beverages have reduced milk fat content and good textural characteristics. Besides the highly valuable milk components, they contain numerous compounds which have pronounced therapeutic properties. These products could be used as functional food in the diet of different populations for health improvement.

KEY WORDS: milk, kombucha, probiotics, fermented dairy product, functional food

INTRODUCTION

Nowadays, new food products have the potential to improve human health and also reduce the risk of disease. Functional food is positioned above the traditional food. A product is considered functional food if in addition to the nutritional value it contains components that have a positive effect on health, physical and mental condition of the human body. The most famous examples of functional foods are fermented milk products, especially those containing probiotic bacteria and prebiotics. Fermented dairy products contain a number of micronutritive components that, either individually or in combination with other such components, may influence the maintenance or even improvement of human health (1-3).

Fermented milk products, as well as milk, contain all the basic ingredients needed for growth, development, reproduction, maintenance and energy of a human body. These ingredients are lactose, lactic acid, protein, fat, minerals and vitamins. During the fer-
mentation, there is a change of some constituents of the milk and with creating of new constituents, fermented product get new features compared to milk (3, 4).

Metabolic activity of starter cultures causes numerous changes during the milk fermentation. Lactose content decreases up to 20-30%, transforming to lactic acid. The lactic acid content in mild acid yoghurt is around 0.85 - 0.95%, and 0.95 - 1.2% in more acidic yoghurt. Enzymes of lactic acid bacteria hydrolyse milk protein and induce better digestibility of casein. People with the problems such as lactose intolerance and milk protein allergy, can consume yoghurt to maintain the microflora balance in gastrointestinal tract. The fermentation process has a little effect on the content of minerals in yoghurt. Fermented milk products are rich in calcium and phosphorus, citric and other organic acids, but poor in the iron and iodine contents. During milk fermentation, there are no significant changes in vitamin A and D concentrations. Dramatic increase in folic acid and a decrease in vitamin B_{12} have been reported. Levels of thiamin, riboflavin, nicotinic acid, pantothenic acid and biotin are generally similar or higher compared to the average values of the starting milk (2, 5, 6).

New generation of the fermented dairy products, so called bio-yoghurts, shows a multifunctional effect on the human health comparing to traditional yoghurt because the probiotic microorganisms are natural inhabitants of the human intestine. Nowadays, health improvement is emphasized the implementation of functional ingredients and the fat reduction in nutrition.

Recent investigations are focused on the possibilities of the kombucha (unconventional starter) application for milk fermentation with the aim to enlarge assortment of the fermented dairy products as functional food (7, 8). Kombucha is a symbiotic association of yeast (Pichia, Zygosaccharomyces, Saccharomyces, Schizosaccharomyces, Saccharomyces, Brettanomyces, Torulaspora and Candida) and acetic acid bacteria (Acetobacter and Gluconobacter). Kombucha is traditionally cultivated on a sweetened black and green tea. It can be cultivated on a dark beer, red vine, white vine, coca-cola, whey, lactose or some other type of tea, too (9, 10).

Prophylactic and therapeutic properties of kombucha are the result of metabolic activity with the production of: acetic acid, ethanol, glycerol and others. Kombucha acts positively with tonsillitis, headaches, atherosclerosis, rheumatism, digestive difficulties, and so on. It shows beneficial effects in arthritis because of the presence of enzymes that break down and assimilate caffeine and other purine derivatives which cause arthritis. Antibiotic activity to Helicobacter pylori, Escherichia coli, Staphylococcus aureus and Agrobacterium tumefaciens has been proven by kombucha, and other activities mainly due to the production of acetic acid during fermentation. The role of kombucha in the detoxication is probably due to the ability of glucuronic acid to bind toxins and enhance their excretion from the body (11, 12). Cellulose pellicle kombucha is used for skin injuries and burns.

In view of the multiple positive effects of kombucha on the human health, the aim of this study was to examine the possibility of fermented dairy beverage production by the application of kombucha cultivated on thymeta in combination with probiotic starter, and to evaluate the quality of the new functional product.
EXPERIMENTAL

Homogenized and pasteurized cow milk with 1.6% fat was taken from AD Imlek, Division Novi Sad Dairy, for the production of kombucha fermented milk beverage. For milk fermentation, the following starters were used: kombuchacultivated on thyme tea in theconcentration of 1.25g/L sweetened with sucrose concentration of 70g/L as a source of carbon (9) and probiotic culture (ABT-7 Probio-Tek®contains BB-12®, CHR Hansen, Denmark).

Production of fermented milk beverages included these operations: pasteurized milk with 1.6% milkfat was inoculated with a combination of starters (10% kombucha inoculum and 0.01% probiotic starter) at three fermentation temperatures: 37°C, 40ºC and 43ºC. Fermentation was continued until pH=4.5 were reached. Then gel was cooled to the temperature of 4ºC, homogenized, packed in an appropriate packaging material and stored in the refrigerator at 4ºC.

The following samples were produced:
1. FMN37: fermented milk beverage obtained by inoculating 10% of kombucha inoculum and 0.01% probiotic cultures at 37°C.
2. FMN40: fermented milk beverage obtained by inoculating 10% kombucha inoculum and 0.01% probiotic cultures at 40ºC.
3. FMN43: fermented milk beverage obtained by inoculating 10% of kombucha inoculum and 0.01% probiotic cultures at 43ºC.

Samples were produced in duplicate, and the results are presented as mean values. Program Microsoft Excel 2003 was used for statistical analysis of the data.

Chemical quality of fermented dairy beverages was determined after production and after 10 days of storage by using the following methods (13): dry matter (DM) (IDF/ISO 21A:1982); milk fat (MF) according to Gerber (IDF 105:1985); total proteins (TP) (IDF 20:1962); ash (A)(IDF 90:1979). Products of metabolisms of added starter cultures were analysed by enzymatic tests (Megazyme, Ireland): D-lactic i L-lactic acid (K-DLATE 11/05); lactose and D-galactose (K-LACGAR 12/05).

Water holding capacity-WHC(14), whey syneresis (15) and textural characteristics (Texture analyser TA.HDplus, Micro Stable System, England) were also analysed in all samples.

RESULTS AND DISCUSSION

Fermentation is a very important operation for forming optimal physico-chemical, rheological and sensory properties of the fermented dairy products (2, 16).

Fermentation of milk (Figure 1a) with kombucha and probiotic starter was performed to reach pH=4.5 and lasted from 3.75 to 4.5 hours. The obtained results showed that the increasing temperature caused the decreasing fermentation time. The most significant change of pH value during 10 days of storage (Figure 1b) was measured in sample FMN43 (pH=4.2) obtained at the highest fermentation temperature (43ºC).
Different temperatures of milk fermentation had no significant effect on the chemical characteristics of fermented dairy products. The obtained samples contained in average 10.23% dry matter, 1.6% milk fat, 3.0% total proteins, 3.27% lactose and 0.69% ash content.

The changes in the contents of lactose, D-galactose and L-lactic acid content during 10 days of storage are presented in Figure 2.

The lactose content in milk was 4.88%. After the fermentation at different temperatures (37°C, 40°C and 43°C), lactose as a main source of carbohydrates for microorganisms nutrition is hydrolysed into glucose and D-galactose. Therefore, its content was 3.37%; 3.17% and 3.37% in the samples FMN37, FMN40 and FMN43, respectively.

After 10 days of storage, the lactose content decreased in all analysed samples in average by 0.34%, which is in agreement with previous studies (7, 8, 17).
The decrease of the lactose content in milk is followed by an increase of the galactose content. The content of D-galactose was similar in samples FMN37 and FMN43. After 10 days of storage, the content of D-galactose increased in average by 18% in the samples FMN37 and FMN43, and 24% in the sample FMN40.

Kombucha's metabolism during fermentation of lactose is directed towards the production of L-lactic acid. Higher content of L-lactic acid is very important for the quality and therapeutic effects of dairy beverages. L-lactic acid promotes blood circulation, prevents putrefaction in the intestines and constipation, stimulating bowel movements. It also has influence the acid-base balance and increases the effect of vitamin C in the body, there by improving the natural resistance to infection (7). The content of L-lactic acid in fermented dairy beverages after production was highest in the sample FMN43 with a value of 0.48%, which indicates that the temperature of 43ºC has the best influence on the metabolism of used starters.

Changes of physico-chemical characteristics of fermented dairy beverages during storage are shown in Table 1. An important parameter of fermented dairy beverage's quality is the ability of milk proteins to bind water and form compact gel without whey syneresis during the storage. The highest value of syneresis had the sample FMN43 (33.00 mL) after production (Table 1). Whey syneresis increased from the lowest to the highest fermentation temperature during the storage. Generally, the sample FMN43 showed better quality and sustainability compared to the other two samples according to the obtained values for syneresis and water holding capacity.

**Table 1. Whey syneresis and water holding capacity of the functional dairy products after production and 10 days of storage**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Sample</th>
<th>0. day</th>
<th>10. day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syneresis (mL)</td>
<td>FMN37</td>
<td>Sv</td>
<td>31.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sd</td>
<td>0.71</td>
</tr>
<tr>
<td></td>
<td>FMN40</td>
<td>Sv</td>
<td>31.75</td>
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<tr>
<td></td>
<td></td>
<td>Sd</td>
<td>1.06</td>
</tr>
<tr>
<td></td>
<td>FMN43</td>
<td>Sv</td>
<td>33.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sd</td>
<td>0.00</td>
</tr>
<tr>
<td>WHC (%)</td>
<td>FMN37</td>
<td>Sv</td>
<td>30.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sd</td>
<td>7.70</td>
</tr>
<tr>
<td></td>
<td>FMN40</td>
<td>Sv</td>
<td>32.75</td>
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<tr>
<td></td>
<td></td>
<td>Sd</td>
<td>0.35</td>
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<tr>
<td></td>
<td>FMN43</td>
<td>Sv</td>
<td>32.00</td>
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<td></td>
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</table>

Textural properties of the fermented dairy products are an indicator of the stability and durability of the products. The highest firmness in samples (Figure 3) was recorded before the homogenization, with a value of 79.48g in the sample FMN40. After the homogenization, the firmness of all samples decreased significantly. It is evident that the firmness decreased in all homogenized samples after 10 days of storage.
**Figure 3.** Changes the firmness of fermented dairy products before homogenization, after homogenization and after 10 days of storage

The value of consistency (Figure 4) indicates the density of products. The highest consistency had the samples before the homogenization. After 10 days of storage, these values decreased slightly, by 2.24% in the sample FMN40, then by 0.78% in the sample FMN43, and by 1.91% in the sample FMN37.

**Figure 4.** Changes of the consistency of fermented dairy products before homogenization, after homogenization and after 10 days of storage

In comparison with the previous results (3, 7, 8, 17), in which kombucha was cultivated on black tea as starter culture, it could be concluded that there are no significant changes in the firmness and consistency during storage. These results indicate that the use of kombucha inoculum cultivated on thyme tea in combination with the probiotic starter could be used as a starter culture for the production of beverage with good rheological characteristics.
CONCLUSION

The produced fermented dairy beverages with reduced milk fat content have a high nutritional value and good textural characteristics. In addition to the high value of milk components, they contain metabolic products of added starter cultures (probiotic lactic acid bacteria, acetic acid bacteria and yeast in the kombucha cultured on thyme tea), which have pronounced therapeutic properties. These products belong to functional food and could be used in the diet of different populations for health improvement.

Acknowledgement

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REFERENCES


УТИЦАЈ ТЕМПЕРАТУРЕ ФЕРМЕНТАЦИЈЕ НА КВАЛИТЕТ ФУНКЦИОНАЛНОГ МЛЕЧНОГ ПРОИЗВОДА

Катарина Г. Канурића, Дајана В. Хрњеза, Марјан И. Раногајеца, Спасенија Д. Милановића, Мирела Д. Иличића, Владимир Р. Вукића и Маја Љ. Милановићб

а Универзитет у Новом Саду, Технологски факултет, Булевар цара Лазара 1, 21000 Нови Сад, Србија
б Универзитет у Новом Саду, Медицински факултет, Хајдук Вељкова 3, 21000 Нови Сад, Србија

Циљ рада је испитивање могућности производње ферментисаних млечних напитака применом комбухе култивисане на чају од мајчине душице у комбинацији са пробиотском стартер културом. Млечен напици произведени су из млека са 1,6% млечне масти на три температуре ферментације: 37ºC, 40ºC и 43ºC. Хемијски квалитет, реолошке особине и садржај продукта метаболизма додатних стартер култура анализиран је након производње и после 10 дана складиштења. Произведени ферментисани млечни напици су са смањеним садржајем млечне масти и добрих текстурализних особина. Садрже поред високо вредних компонената млека и бројна једињења која поседују терапеутска својства. Наведени производи припадају функционалној храни и могу да се користе у исхрани различитих популација за очување и унапређење здравља.

Кључне речи: млеко, комбуха, пробиотици, ферментисани млечни производ, функционална храна

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