ORIGINAL SCIENTIFIC PAPER

Influence of yoghurt cultures on some chemical parameters of sheep's milk yoghurt during storage

Šimun ZAMBERLIN, Boro MIOČ, Dubravka SAMARŽIJA

University of Zagreb, Faculty of Agriculture, Svetošimunska cesta 25, 10000 Zagreb, Croatia, (e-mail: szamberlin@agr.hr)

Abstract

The aim of this study was to determine the influence of two different commercial yoghurt cultures (L811 and X11) on the changes of some chemical parameters of sheep's milk yoghurt during storage over a period of 21 days. Chemical parameters were determined in yoghurts on the 1st, 7th, 14th and the 21st day of storage at the temperature of 4 ± 1°C. The results showed that the pH, titratable acidity and protein content had changed significantly (P<0.05) during the whole storage period in the yoghurts produced with both used yoghurt cultures. On the other hand, the content of fat, lactose and total solids remained statistically unchanged (P<0.05). It can be concluded that both used yoghurt cultures are capable of producing yoghurt which maintains characteristic content of chemical parameters during whole storage period.

Key words: sheep's milk yoghurt, chemical parameters, yoghurt culture, yoghurt storage

Utjecaj mljekarskih kultura na određene kemijske parametre ovčjeg jogurta tijekom čuvanja

Sažetak

Cilj ovog rada bio je odrediti određene kemijske parametre čvrstog ovčjeg joguta (n=8) proizvedenog pomoću dvije različite komercijalne mljekarske kulture (L811 i X11) tijekom vremena čuvanja od 21 dan. Kemijski parametri su određeni 1., 7., 14. i 21. dana čuvanja na temperaturi od 4 ± 1°C. Rezultati su pokazali da su se pH, titracijska kiselost i sadržaj bjelančevina značajno promijenili (P<0,05) tijekom čuvanja u jogurtu proizvedenom korištenjem obje mljekarske kulture. Nasuprot tome, u oba jogurta nije utvrđena statistički značajna promjena (P<0,05) sadržaja mliječne masti, laktoze i ukupne suhe tvari. Na temelju rezultata analiza može se zaključiti da se obje mljekarske kulture mogu upotrijebiti za proizvodnju čvrstog ovčjeg jogurta koji, tijekom vremena čuvanja, posjeduje karakteristične vrijednosti istraživanih kemijskih parametara.

Ključne riječi: ovčji jogurt, kemijska svojstva, jogurtna kultura, čuvanje jogurta

Introduction

Sheep's milk is widely used in different regions of the world for the production of yoghurt. In comparison with cow's milk sheep's milk contains significantly higher content of total proteins, casein, calcium, magnesium, phosphorus and significantly higher content of metabolically valuable short and medium chain fatty acids (Park et al., 2007; Raynal-Ljutovac et al., 2008). Consequently, sheep's milk yoghurt possesses better versatile nutritional and functional properties than cow's milk yoghurt. During refrigerated storage

Proceedings. 46th Croatian and 6th International Symposium on Agriculture. Opatija. Croatia (908-911)

sheep's milk yoghurt undergoes microbiological, enzymatic and abiotic changes that can negatively affect its overall quality and shelf life. The cause of microbiological changes are microorganisms which are capable to survive low storage temperatures, low pH and create colonies and/or films on the yoghurt surface and therefore diminish yoghurt quality (Rašić and Kurmann, 1978; Tamime and Robinson, 1999). Moreover, bacterial enzymes cause negative changes of yoghurts consistency and texture during storage. Those enzymes mostly originate from yoghurt culture bacteria but also from microorganisms that contaminates milk and/or yoghurt. Abiotic processes includes chemical reactions which causes changes of fat, proteins, carbohydrates, vitamins and salts in yoghurt during storage. The outcome of those processes can be formation of unwanted changes on the yoghurt surface and degradation of overall quality. Depending on the quality of sheep's milk used for the yoghurt production, ratio between the number of viable yoghurt culture bacteria, final pH and storage conditions, above mentioned negative changes can be more or less expressed (Rašić i Kurmann, 1978.; Tratnik, 1998.).

The aim of this study was to determine the influence of two different commercial yoghurt cultures on the changes of some chemical parameters of sheep's milk yoghurt during storage.

Material and methods

The whole sheep's milk (milk) from East Friesian breed was collected from a farm located in Varazdin, Croatia. Milk quality has been established according to European legislation which sets out the microbiological quality parameters for the production and placing on the market of raw milk, heat-treated milk and milk-based products (European Commission 1992). Two commercial FD-DVS yoghurt cultures L811 and X11 (starters) (Christian Hansen, Denmark), were used for the inoculation of milk. Both starters are available on the Croatian market and mostly used on Croatian dairy plants for the production of cow's milk set yoghurt. It is assumed that use of those starters will also be appropriate for the production of sheep's milk set yoghurt (yoghurt). Starters were mixed cultures consisting of *Streptococcus thermophilus* and *Lactobacillus delbrueckii* subsp. *bulgaricus*.

The milk for yoghurt production was neither standardised nor homogenised. The experiment was designed in a way that the collected milk (4 l) was divided into two equal portions for the production of two yoghurt sets using two different starters. After thermal treatment (90°C/5 minutes) the milk was cooled to 42°C and inoculated with starter in the concentration of 0,02%. The inoculated milk (2 l per set) was then poured into 100 ml glass flasks (flasks), corked and left for fermentation at a temperature of 42°C until pH 4.60 was attained. The flasks were then transferred to cold storage (4 ± 1°C). All steps of yoghurt production were carried out in the sterile environment.

Twenty flasks of yoghurt made by starter L811 (Set L811) and twenty flasks made by starter X11 (Set X11) were produced. Yoghurt analysis was conducted in a way that five flasks of each yoghurt set were taken out on the 1st, 7th, 14th and 21st day of cold storage and used for chemical analysis. The number of samples (n) used in this study was 8 (n = two portions for the production of L811 and X11 yoghurt set x four different days of storage).

The pH of milk was measured using a pH meter (SevenMulti, Mettler Toledo, Switzerland). Titratable acidity (TA) was determined by the titration method (Sabadoš 1996a). The content of milk fat, protein,lactose, total solids (TS) and solids non fat (SNF) were determined by the infrared method (ISO 1999).

The pH of yoghurts was measured using a pH meter (SevenMulti, Mettler Toledo, Switzerland). TA was determined by the titration method (Sabadoš 1996b). The content of milk fat (fat), protein, carbohydrates and total solids (TS) were determined by the infrared method on the instrument Milkoscan FT 120 (FossElectric, Denmark). All measurements were taken in five parallel determinations.

One-way analysis of variance (ANOVA) was used to analyse the data, Bartlett's test for equal variances testing and Tukey's test for multiple comparisons at 95% confidence interval. The data was analysed using Prism software (GraphPad Software, San Diego CA).

Results and discussion

The average composition of milk used for yoghurt production was as follows: TA 9.50 °SH, pH 6.67, fat 5.54 g/100g, protein 4.48 g/100g, lactose 4.70 g/100g, TS 15.50 g/100g and SNF 10.21 g/100g. The content of fat, protein, lactose, TS and SNF of milk were lower than reported by Anifantakis (1986) for East Friesian breed

and roughly equal to the results reported by Niznikovski (1992). It must be emphasised that the reported results from these two authors were averages for a whole lactation period and not only for a segment of lactation period as is the case in this study.

The results for pH and TA (Table 1) were significantly (P<0.05) affected by storage in both yoghurt sets and decreased continuously. This can be attributed to acid production during cold storage as a result of the conversion of lactose to lactic acid by the bacterial cultures (Katsiari et al., 2002). Similar results for a total storage period of 14 days were reported by Dave and Shah (1997), Birollo et al., (2000), Bonczar et al., (2002) and Gűler-Akin (2005). Different starters significantly influenced (P<0.05) TA of yoghurts on the 14th and the 21st day of storage. On the other hand, different starters did not significantly influence the pH in yoghurts during whole storage period.

Table 1. Titratable acidity and pH values of yoghurt during storage[1]

Yoghurt set	Day of storage	Titratable acidity (^{0}SH)	pH
L-818	1	39,77±0,08^a	4,62±0,02^a
	7	42,58±0,21^b	4,54±0,03^b
	14	47,02±0,10^c	4,24±0,05^c
	21	48,23±0,08^d	4,12±0,04^d
X-11	1	39,72±0,09^a	4,62±0,03^a
	7	42,71±0,11^b	4,54±0,04^b
	14	47,40±0,18^e	4,27±0,04^c
	21	47,90±0,08^f	4,09±0,04^d

[1] presented values are the means ± standard deviations of five parallel results.
$^{a, b, c, d, e, f}$, values in the same in the same column for the same property having different superscripts differ significantly (P<0.05).

There was no observed significant (P<0.05) change in the fat content within both yoghurt sets (L-818 and X-11) (Table 2). This indicates that there was no significant lipolysis during storage period. Normally, lipolysis tends to cause negative changes in yoghurt due to the combination of factors such as low pH, low storage temperature and relatively short shelf life (Deeth, 2002) which was not the case in this study. Moreover, there was no significant difference (P<0.05) in the concentration of fat between yoghurt sets L-818 and X-11 which indicates that used starters do not have influence on the degradation of fat.

The content of protein (Table 2) was statistically the same (P<0.05) in both used yoghurt sets during the 1st and 7th day of storage. On the14th and the 21st day of storage the proteolysis was more expressed in yoghurt set L818 than in the X-11 (P<0.5) probably due to the higher proteolytic activity of starter microorganisms. Furthermore, Serra et al., (2009) determined hydrolisation of casein and increase in soluble nitrogen at the end of storage of yoghurt which consequently means decrease of total protein content which was not the case in this study.

Table 2. Some chemical parameters of sheep's milk yoghurt during storage[1]

Yoghurt set	Day of storage	Fat (g/100g)	Protein (g/100g)	Lactose (g/100g)	Total solids (g/100g)
L-818	1	5,50±0,02^a	4,72±0,04^a	4,64±0,04^a	15,23±0,05^a
	7	5,49±0,02^a	4,62±0,02^b	4,64±0,02^a	15,23±0,06^a
	14	5,49±0,03^a	4,58±0,01^c	4,63±0,02^a	15,23±0,06^a
	21	5,49±0,02^a	4,49±0,04^d	4,62±0,02^a	15,22±0,07^a
X-11	1	5,50±0,03^a	4,70±0,02^a	4,65±0,02^a	15,23±004^a
	7	5,50±0,02^a	4,62±0,03^b	4,63±0,03^a	15,22±0,05^a
	14	5,50±0,02^a	4,62±0,02^b	4,63±0,03^a	15,23±0,05^a
	21	5,50±0,02^a	4,62±0,03^b	4,63±0,03^a	15,22±0,06^a

[1] presented values are the means ± standard deviations of five parallel results.
$^{a, b}$ values in the same in the same column for the same property having different superscripts differ significantly (P<0.05).

Unexpectedly, there was no statistically significant (P<0.05) change in the content of lactose between and within sets during whole storage period (Table 2). It was assumed that the concentration of lactose would decrease due to its fermentation by starter bacteria. Katsiary et al., (2002) reported the 6% decrease of lactose concentration on 14th day of storage of ovine yoghurt which is not in compliance with the results of this

study. It must be emphasised that the measurement uncertainty of the IR method used in this study for the detection of lactose was 1.08% of the total lactose content.

There was no statistically significant change ($P<0.05$) in the total solids content between and within sets of yoghurt (L-818 and X-11) during whole storage period. The total solids content was unaffected by the decrease of protein content because of the permanent presence of hydrolysed protein and other nitrogen compounds in yoghurt.

Conclusion

The results of this study indicate that the pH, titratable acidity and protein content significantly ($P<0.05$) changed during storage ($4 \pm 1^{o}C$) over a period of 21 days in sheep's milk yoghurts produced with both used yoghurt cultures (L-818 and X-11). On the other hand, the content of fat, lactose and total solids remained statistically unchanged ($P<0.05$) meaning that both used yoghurt cultures are capable of producing set type sheep's milk yoghurt which maintains acceptable chemical parameters during whole storage period.

References

Anifantakis E.M. (1986). Comparison of the physico-chemical properties of ewe's and cow's milk. Bulletin of the International Dairy Federation No. 202/11986 42-53.

Birrollo G.A., Reinheimer J.A., Vinderola C.G. (2000). Viability of lactic acid microflora in different types of yogurt. Food Research International 33: 799-805.

Bonczar,G., Wszolek,M., Siuta, A. (2002). The effects of certain factors on the properties of yogurt made from ovine milk. Food Chemistry 79: 85-91.

Dave R.I., Shah N.P. (1997). Viability of yogurt and probiotic bacteria in yogurts made from commercial starter cultures. International Dairy Journal 7: 31-41.

Deeth H.G. (2002). Lipolysis in: Encyclopedia of Dairy Science. London:Elsevier Publisher Ltd. pp. 1595-1600.

European Commission (1992) Council Directive 92/46 /EEC. Available at a:< http://ec.europa.eu/food/fs/sfp/mr/mr03_en.pdf> Accessed 15 Sep 2010.

Gűler-Akin M.B. (2005). The effects of different incubation temperatures on the acetaldehyde content and viable bacteria counts of bio-yogurt made from ovine milk. International Journal of Dairy Technology 58: 174-179.

ISO (1999). Whole milk-Determination of milk fat, protein and lactose content -- Guidance on the operation of mid-infrared instruments. International Organisation for Standardisation No. 9622, Geneva: ISO copyright office.

Katsiari M.C., Voutsinas L.P., Kondyli E. (2002). Manufacture of yoghurt from stored frozen sheep's milk. Food Chemistry 77: 413-420.

Niznikovski R. (1992). The effect of crossbreeding of sheep of the Polish Corriedall breed with the East Friesian milk sheep on chosen commercial characteristics of their progeny. II Milk production Annals of Warsaw Agricultural University, SGGW, AR, Animal Science 27: 43-46.

Park Y.W., Juárez M., Ramos M., Haenlein G.F.W. (2007). Physico-chemical characteristics of goat and sheep milk. Small Ruminant Research 68: 88-113.

Rašić J., Kurmann J.A. (1978). Storage, Keeping Quality, Transport and Consumption of Yoghurt, in: Yoghurt, Copenhagen:Tehnical Dairy Publishing House, 273-282.

Raynal-Ljutovac K., Lagriffoul G., Paccard P., Guillet I., Chilliard Y. (2008). Composition of goat and sheep milk products: An update. Small Ruminant Research 79: 57-72.

Sabadoš D. (1996a). Kontrola i ocjenjivanje kakvoće mlijeka i mliječnih proizvoda, Zagreb: Hrvatsko mljekarsko društvo, 70-71.

Sabadoš D. (1996b). Kontrola i ocjenjivanje kakvoće mlijeka i mliječnih proizvoda, Zagreb: Hrvatsko mljekarsko društvo, 168-169.

Serra M., Trujillo A.J., Guamis B., Ferragut V. (2009). Proteolysis of yoghurts made from ultra-high pressure homogenized milk during cold storage. Journal of Dairy Science 92: 71-78.

Tamime A.Y., Robinson R.K. (1999). Background to Manufacturing Practice, in: Yoghurt Science and Technology, Cambridge:Woodhead Publishing, 11-129.

Tratnik LJ. (1998). Fermentirani mliječni napici, in: Mlijeko-tehnologija, biokemija i mikrobiologija, Zagreb: Hrvatska mljekarska udruga, 129-187.

sa2011_0720