QUALITY OF QUARG PRODUCED BY PROBIOTICS APPLICATION

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Quarg is a soft fresh cheese which is characterised by nutritive and energy value. Presence of essential milk components and usage of various starter cultures, most important of which are probiotics, contribute to the increase of the consumers interest because of great health effects. In addition to their nutritive and economic importance, probiotics are important from technological point of view, as well. Therefore, the possibilities of probiotic Quarg manufacture, the effect of probiotics, traditional starter culture and their combination, on Quarg quality have been investigated in this study. Quarg was produced of milk with 2.5% and 4.2% fat content.

The obtained results showed significant differences in chemical composition, physical and sensory properties and shelf-life of the produced cheese samples. From 10 samples produced, 2 samples were of excellent sensory properties and have been evaluated with maximum score. All samples were shelf-stable 5 weeks, while decrease of pH value was insignificant during 30 days of storage at below 4°C.

Different kinds of Quarg, produced by use of probiotics, could be used by all consumers categories having beneficial effect on intestinal function and promoting good health because of probiotic bacteria presence.

KEYWORDS: Quarg; probiotics; quality

INTRODUCTION

Quarg is an unripened fresh cheese which is normally made from pasteurized skim milk, cultured with lactic acid starter (Lactococcus lactis spp. lactis and Lactococcus lactis spp. cremoris) and a small amount of rennet.

Quarg differs from rennet-curd cheese varieties (e.g. Camembert, Cheddar, Emmental), where coagulation is induced by the action of rennet at pH values of 6.4-6.6, in that coagulation occurs close to the isoelectric point of casein (pH=4.6), or at higher values when
elevated temperatures are used, e.g. in Ricotta (pH 6.0 na 80°C). A very small amount of rennet may be used in the production of Quarg, to give firmer coagula and minimize casein losses on subsequent whey separation and reduce the susceptibility to over-acid products (1,3).

Various methods have been employed to reduce the loss of whey proteins and increase yield:

1. Westfalia Thermoprocess, where, a) the milk is pasteurized at 95-98°C for 2-3 min, b) the gelled milk (pH 4.6) is heated to 60°C for 3 min, and then cooled (25°C). This process gives recovery of 50-60% of whey proteins in cheese;
2. Centry whey process, where the whey is heated (95°C) to precipitate the whey proteins. The denatured whey proteins are recovered by centrifugation as a concentrate (12-14% solids), which is added to the milk for the next batch of Quarg;
3. Lactal process, where the whey is heated (95°C) to precipitate the whey proteins which are allowed to settle; by partial decantation of the serum, a concentrated whey of 7-8% solids is obtained, using a nozzle centrifuge, into a whey Quarg (17-18% solids), which is blended at a rate of 10 with regular Quarg;
4. Ultrafiltration (of the gelled milk) is now being used at a large scale for the commercial production of Quarg and other fresh cheese varieties. This method gives complete recovery of whey proteins in the cheese (3).

Many processing factors (milk pre-heat treatment, rate and temperature of acidification, level of gel-forming protein, pH) influence the coagulum structure and hence the rheological and physico-chemical stability of the product (1,3).

The composition, as well as processing steps, provide the specific cheese texture, while bacteria used to provide the acid usually generate the characteristic flavour of cheese. Probiotics application in Quarg manufacture is becoming more and more interesting because of their therapeutic and prophylactic characteristics (1-4).

Probiotic bacteria, specifically *Bifidobacteria* and *Lactobacilli*, are normal inhabitants of human colon. These bacteria beneficially affect human health by improving the balance of intestinal microflora and improving mucosal defenses against pathogens. To perform this functions, the *Bifidobacteria* must be viable at the time of consumption and maintain their viability through the gastrointestinal tract. Also, to successfully develop cheeses and other dairy products containing probiotics, it is important to understand the growth characteristics of probiotics, so that processing conditions can be manipulated to optimize their survival. For example, one of the major limitations of the incorporation of *Bifidobacteria* into dairy products is the pH of product and the aerobic conditions of production (5,6).

In practical application the most strains of *Bifidobacteria* are sensitive to pH values below 4.6. Because of that the pH value in the final product must be maintained above 4.6. So, fermented milks are not optimal for the maintenance of high concentrations of some strains, while cheese has a markedly higher pH than fermented milks and provides more stable medium to support long-term survival of the acid-sensitive *Bifidobacteria*. Furthermore, the cheese composition and its relatively high fat content offer protection to probiotic bacteria during the passage through the gastrointestinal tract (6).

The lactic acid bacteria used to produce the characteristic attributes of different types of cheese, also enhance the growth and viability of *Bifidobacteria* altering the pH, content of growth promoters and inhibitors, and oxygen content of the cheese. Selected strains of *S. thermophilus*, with high oxygen consumption ability, have been shown to enhance
the viability of *Bifidobacteria*. Incorporation of probiotic bacteria with traditional starter culture into cheeses positively affects the composition, flavour, texture and other sensory characteristics of the cheese, so their application in cheese manufacture could contribute to the development of probiotic cheeses attractive for commercial production (6,7).

The aim of this study was to investigate the quality of Quarg produced by probiotics application.

**EXPERIMENTAL**

**Materials**

**Quarg manufacture.** Quarg samples were produced in A.D. *Novosadska mlekarina* and *Mlekarška škola*, Pirot, of milk with 2.5% fat and milk with 4.2% fat. Milk was pasteurized at 71°C, during 15 s, and cooled to 28°C.

At 28°C, 0.01% probiotic starter culture ABT-1 (LA-5, BB-12, *S. thermophilus*) /ABT-2 (LA-5, BB-12, *S. thermophilus*) or traditional culture CH-N22-Flora Danica, (Chr.Hansen, Denmark), and 0.005% enzyme for coagulation were added into milk.

Coagulation lasted 18-19 hours (pH=4.6). After that the coagulum was cut, pasteurized by gently stirring at 60°C (5 min) and quickly cooled and drained. Cheese samples were homogenized by mixing and packaged in cups of 1.8 dl volume.

The produced Quarg was stored in the refrigerator at 4°C.

Technology of Quarg manufacture is shown in Fig. 1.

Two series of Quarg samples with different fat content were produced under semi-industrial condition.

**I series:** Quarg samples produced of milk with 2.5% fat

1. Quarg produced with traditional culture Flora Danica - CH-N22
2. Quarg produced with probiotic and traditional culture - ABT-1: CH-N22=1:1
3. Quarg produced with probiotic and traditional culture - ABT-1: CH-N22=1:3
4. Quarg produced with probiotic and traditional culture - ABT-2: CH-N22=1:1
5. Quarg produced with probiotic and traditional culture - ABT-2: CH-N22=1:3

**II series:** Quarg samples produced of milk with 4.2% fat

6. Quarg produced with traditional culture Flora Danica - CH-N22
7. Quarg produced with probiotic and traditional culture - ABT-1: CH-N22=1:1
8. Quarg produced with probiotic and traditional culture - ABT-1: CH-N22=1:3
9. Quarg produced with probiotic and traditional culture - ABT-2: CH-N22=1:1
10. Quarg produced with probiotic and traditional culture - ABT-2: CH-N22=1:3

**Methods**

Quarg quality was analysed by standard methods (total solids content, fat content, proteins content and ash content) (8). pH value was measured by pH-meter MA 5724, Iskra, Slovenia (8).
RESULTS AND DISCUSSION

Quarg was produced of partially skimmed milk (2.5% fat) and full-fat milk (4.2% fat). The milk quality was in accordance with the actual Regulations of milk and dairy products (9).

The yield of produced Quarg samples is presented in Table 1.

It is evident that the amount of produced Quarg and volume of separated whey vary depending on: chemical composition of milk, kind and amount of added starter.

Yield of Quarg produced of partially skimmed milk ranged from 10.3% (Quarg produced using combination of cultures: ABT-2:CH-N22 = 1:1) to 20% (Quarg samples produ-
ced with ABT-1 culture). Higher yield values were obtained for Quarg samples produced of full-fat milk, 15.7% (sample AT-2 - CH-N22 = 1:3) to 26.7% (ABT-1:CH-N22 = 1:3).

Table 1. Yield of Quarg samples

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>MEASURED PARAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td>I SERIES Milk with 2.5% fat</td>
<td>Milk Volume (L)</td>
</tr>
<tr>
<td>1</td>
<td>15</td>
</tr>
<tr>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>5</td>
<td>15</td>
</tr>
<tr>
<td>II SERIES Milk with 4.2% fat</td>
<td>Milk Volume (L)</td>
</tr>
<tr>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>7</td>
<td>15</td>
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<tr>
<td>8</td>
<td>15</td>
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<td>9</td>
<td>15</td>
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<td>10</td>
<td>15</td>
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</tbody>
</table>

Chemical composition and energy value of Quarg samples produced of partially skimmed and full-fat milk are presented in Table 2.

The chemical composition of Quarg depends on the milk quality, kind and concentration of inoculated starter (Table 2). The total solids content of Quarg samples produced of partially skimmed milk ranges from 23.13% (ABT-1:CH-N22 = 1:3) to 33.44% (ABT-2:CH-N22 = 1:3), and the fat content in dry matter varies from 38.92% (ABT-2 : CH-N22 = 1:3) to 46 (ABT-2:CH-N22 = 1:1). Regarding the results of chemical analyses, the produced Quarg samples belong to the group of semi-fat fresh cheeses, according to Regulations of milk and dairy products (9).

A significant difference in protein content was noticed between the samples produced by application of the probiotic culture ABT-2 (Table 2). Further, Quarg samples produced of partially skimmed milk contain different amounts of lactose. This can be explained by the fact that different concentrations and combinations of probiotic bacteria Bifido bacteria and Lactobacillus were used, which have different lactose metabolism.

Comparing the results presented in Table 2 it is evident that the total solids and protein content of Quarg samples produced of milk with 4.2% fat is lower than of Quarg samples produced of partially skimmed milk (I series). However, in the second series, the fat content in dry matter is significantly higher, 51.48% to 58.53%.

Comparing the results presented in Table 2 it is evident that the total solids and protein content of Quarg samples produced of milk with 4.2% fat is lower than of Quarg samples produced of partially skimmed milk (I series). However, in the second series, the fat content in dry matter is significantly higher, 51.48% to 58.53%.

Regarding the chemical composition of Quarg samples produced of full-fat milk are rather similar among themselves, so the differences in energy value of the samples are smaller compared to the samples produced from partially skimmed milk. This can be associated with the milk quality variation and batch production process of Quarg.
**Table 2.** Chemical composition and energy value of Quarg samples produced of milk with 2.5 % fat and 4.2 % fat

<table>
<thead>
<tr>
<th>Component (%)</th>
<th>I SERIES (Milk with 2.5% fat)</th>
<th>II SERIES (Milk with 4.2% fat)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SAMPLE</td>
<td>SAMPLE</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total solids (TS)</td>
<td>29.36</td>
<td>24.66</td>
</tr>
<tr>
<td>FAT (F)</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>F/TS</td>
<td>44.28</td>
<td>40.55</td>
</tr>
<tr>
<td>Non-protein nitrogen</td>
<td>0.09</td>
<td>0.05</td>
</tr>
<tr>
<td>Non-casein nitrogen</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Total nitrogen</td>
<td>2.19</td>
<td>1.70</td>
</tr>
<tr>
<td>Total proteins</td>
<td>13.95</td>
<td>10.86</td>
</tr>
<tr>
<td>Lactose</td>
<td>1.21</td>
<td>3.09</td>
</tr>
<tr>
<td>Ash (A)</td>
<td>0.7</td>
<td>0.71</td>
</tr>
<tr>
<td>A/TS</td>
<td>2.38</td>
<td>2.88</td>
</tr>
<tr>
<td>Energy value kJ/100 g</td>
<td>805.94</td>
<td>644.5</td>
</tr>
</tbody>
</table>
Change of pH values of Quarg samples made of full-fat and partially skimmed milk, during 30 days of storage is presented in Figure 2. The pH values of samples of the group I slightly decreased during storage, while in the second group of samples the values increased. The differences in two groups of samples are the result of different metabolic activity of the applied starter cultures, which depends on milk quality, process parameters and storage conditions.

**Fig. 2.** Change of pH value during 30 days of storage
a) Quarg samples produced of milk with 2.5% fat
b) Quarg samples produced of milk with 4.2% fat
Changes of viscosity of Quarg samples made of milk with 2.5% fat during storage are presented in Figure 3. The viscosity of Quarg samples determined at spindle speed 20 min⁻¹, decreased with time (Figure 3a). After 30 days of storage the viscosity decreased too, however, the recorded values were significantly higher in the same time intervals compared with the values obtained after the production.

![Figure 3a](image1.png)

**Fig. 3.** Viscosity of Quarg samples produced of milk with 2.5 % fat after production after 30 days of storage.
The viscosity of Quarg samples produced of full-fat milk also decreased in time (Figures 4a and 4b), whereas the decrease trend both after the production and after 30 days of storage was the same as in the first group of samples.

Fig. 4. Viscosity of Quarg samples produced from milk with 4.2 % fat after production after 30 days of storage.
The results of sensory analyses of Quarg samples are presented in Table 5. The produced Quarg samples have a typical, mild milky (smell and white colour). The consistency, aroma and flavour of Quarg samples made of full-fat milk, with the probiotic culture ABT-1 are excellent, while the sample ABT-2:CH-N22 = 1:3 is of significantly poorer sensory characteristics due to coarse consistency and very poor spreadability. The total score of series II of samples is in the range from 13 (ABT-2:CH-N22 = 1:3) to 19.5 (samples with ABT-1 culture) (Figure 5a).

Regarding the obtained results, it can be noticed that the sensory characteristics of Quarg samples produced of full-fat milk are significantly better than of the samples produced of partially skimmed milk. Therefore, the total score of II series samples is higher, ranging from 19.8 to 20 points.

Fig. 5. Sensory analyses of Quarg after production
a) produced of milk with 2.5% fat; b) produced of milk with 4.2% fat.
Comparing the results of analyses of Quarg samples made of full-fat and partially skimmed milk, the conclusion is that the fat content and the combination of starter cultures affect the physico-chemical characteristics of the final product in different way. Quarg samples made of full-fat milk are characterized by better spreadability and significantly better sensory characteristics compared to the samples made of partially skimmed milk.

CONCLUSION

Quarg samples were produced of partially skimmed milk (2.5% fat) and full-fat milk (4.2% fat) by chosen technological process under semi-industrial conditions, applying appropriate probiotic starter cultures in combination with the conventional culture.

The coagulation time needed for the achievement of a desired pH value of the cheese is approximately the same in all Quarg samples in a narrow range, from 18 to 19 hours. The yield and chemical quality of produced Quarg samples depend on milk composition, concentration and combination of starter cultures used.

The quality and physico-chemical and sensory characteristics of Quarg samples made of full-fat milk are rather uniform and significantly better when compared to the samples produced of partially skimmed milk.

The physico-chemical and sensory characteristics of Quarg samples produced using combination of probiotic culture ABT-1 and traditional culture (Flora Danica) are significantly better compared to the control sample (produced with traditional culture) and of Quarg samples produced with the combination of traditional starter culture and probiotic culture ABT-2.

Generally, it can be said that the development of Quarg technology by use of probiotics is of special importance (significance) to the widening of the assortment of nutritively high-valuable, energetically ballanced functional food, and in the nutrition of the population, since certain kinds of probiotics have a number of prophylactic and therapeutical characteristics.

REFERENCES


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