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The effects of certain factors on the properties of yoghurt made from ewe's milk

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Abstract

Standardized fat content (skimmed, 4.5 and 6.5%) ewe's milk was used for production of yoghurt and probiotic-fermented milk. The yoghurt was made using a starter culture that consisted of *Streptococcus* ssp.*thermophilus* and *Lactobacillus delbrueckii* ssp. *bulgaricus* whilst, for the production of probiotic-fermented milk an ABT (*S. thermophilus*, *Lactobacillus acidophilus* and *Bifidobacterium* ssp.) starter culture was used to inoculate the processed milk. All the products were analyzed when fresh and after 7 and 14 days of storage, for the determination of diacetyl, acetaldehyde and free fatty acid contents, as well as pH and titratable acidity. Sensory assessment and firmness of these products were also obtained. The type of starter culture used and the storage time influenced the overall properties of the yoghurt and probiotic-fermented milk products. The fat level in the ewe's milk significantly influenced the free fatty acid content in the products.

Keywords: Ewe's milk, Yoghurt, Probiotic-fermented milk, Chemical composition, Firmness, Organoleptic evaluation

1. Introduction

Ewe's milk is widely used in different regions of the world for the production of yoghurt. Traditionally, natural/plain flavour yoghurt is made on the farms in farm in Bulgaria and Greece, relying on the indigenous microflora to ferment the milk. In many European and Asiatic countries, yoghurt-related products, such as frozen (i.e. similar to ice cream), dried or condensed with consistency similar to soft cheese, have been developed during the last century; moreover, milk from different species of mammals, including sheep, have been used successfully for the manufacture of yoghurt. Irrespective of what type of milk is used, the technology of yoghurt-making is standard and includes the following processing stages: (1) standardization of the fat content and fortification of the solids-not-fat level (SNF); the latter process is achieved by the addition of dairy powders and/or concentration of the milk using vacuum-evaporation or membrane concentration, such as ultrafiltration (UF) or reverse osmosis (RO), (2) homogenization, followed by heat-treatment, partial cooling and fermentation of the milk base by a thermophilic starter culture, and (3) at the desired pH value, the fermentate is cooled, blended with, for example, fruits, honey and/or cereals, and finally stored at <5 °C. (Alichanidis & Polychroniadou, 1995; Kurmann, 1986; Tamime & Robinson, 1999).

In general, the overall properties of yoghurt, such as acidity level, free fatty acid content, the production of aroma compounds (diacetyl, acetaldehyde, acetoin) as well as the sensory profile, and nutritional value, are important traits of the product. These aspects are influenced by the chemical composition of the milk base, processing conditions, the added flavours, and the activity of starter culture during the incubation period (Beshkova, Simova, Frengova, & Simov, 1988; Georgala, Tsakalidou, Kandarakis, & Kalantzopoulos, 1995; Kneifel, Ulberth, Erhard, & Jaros, 1992; Tamime & Robinson, 1999; Ulberth & Kneifel, 1992). Mixed strains of starter culture (e.g. *Streptococcus thermophilus* and *Lactobacillus delbrueckii* ssp.*bulgaricus*) are normally used for the manufacture of yoghurt; however, mixed strains of *Lactobacillus* species, *Lactobacillus acidophilus*, *Bifidobacterium* ssp. or one or both of these

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yoghurt organisms, are used for the production of the so-called probiotic-fermented milks (Tamime & Robinson, 1999). The beneficial health properties of the latter products and their use in the treatment of body ailments are currently well accepted (Kosikowska & Jakubczyk, 2000; Oberman & Libudzisz, 1996, Shah, 1997; Tamime, Marshall, & Robinson, 1995).

It is evident that the associative growth that exists between *S. thermophilus* and *L. delbreuckii* ssp. *bulgaricus* can greatly influence the physicochemical properties and the level of aroma compounds in the yoghurt when compared with products made using single strains of these micro-organisms (Beshkova et al., 1988; Georgala et al., 1995; Tamime & Robinson, 1999).

The consistency of cow's milk yoghurt is dependent on the level of SNF in the milk base, and it is normally increased to obtain ~4.5 g/100 g protein in the final product; however, the fat content is standardized to a level ranging between 0.5 and 3.5 g/100 g. Nevertheless, the SNF content of ewe's milk is rather high (~10.9 g/100 g) compared with cow's milk, which is ~8.7 g/100 g (Tamime & Robinson, 1999) and, as a consequence, the fortification of the SNF level in ewe's milk is not required (Bonczar & Wszołek, 1997). The fat content in ewe's milk yoghurt is not normally standardized in order to retain the typical characteristic of such a product but, due to the high fat content in ewe's milk, it is sometimes standardized to different levels to meet consumers demand.

The objectives of this paper were to produce yoghurt and probiotic-fermented milk products (natural/plain, unsweetened and set-type) from ewe's milk using commercial blends of starter cultures, to determine the effect of the starter cultures and the fat level on the overall quality, to evaluate the rheological properties, and to organoleptically evaluate the products. The yoghurt and fermented milks were evaluated when fresh and after storage at 5 °C for 7 and 14 days.

2. Materials and methods

2.1. Materials

Ewe's milk (morning milking) used in yoghurt and probiotic-fermented milk preparation was collected three times during the summer period of 2000 in June from Polish Long Fleece ewes that were bred at the Agricultural University farm in Krakow. The ewes were fed ad libitum at a pasture and, additionally, they were given straw. The treated milks were inoculated with direct-to-vat system (DVS) yoghurt culture (YC-380; *S. thermophilus* and *L. delbreuckii* ssp. *bulgaricus*) and probiotic culture (ABT-5) that consisted of *S. thermophilus*, *L. acidophilus* and *Bifidobacterium* species, which were obtained from Chr. Hansen, Poland.

2.2. Production of yoghurt and probiotic-fermented milk

Three different trials were performed for the manufacture of yoghurt and probiotic-fermented milk. On each occasion, the raw ewe's milk (i.e. processed within 2 h of reception) was strained using a cloth filter, warmed to 45 °C, and the fat was separated (model LWG 24E, centrifugal separator). The skimmed ewe's milk was divided into three equal portions (5 kg), and only two batches where the fat content was standardized with the separated cream. The first batch of ewe's milk was retained as skimmed, whilst the other two batches were mixed with cream to yield milks containing 4.5 and 6.0 g/100 g fat, respectively.

Each batch of ewe's milk was heated to 93 °C for 10 min, cooled to 45 °C, inoculated at a rate of 0.5 μ/2.5 kg of milk (95 mg of yoghurt culture and 120 mg of probiotic culture per 2.5 kg of milk, respectively), dispensed into plastic cups (250 cm^3), incubated at 45 °C for 4–5 h (YC-380) and at 40 °C for ABT-5, or to pH 4.6 and transferred to a cold store.

2.3. Analytical methods

2.3.1. Determination of acidity

The pH of the milk, yoghurt and probiotic-fermented milk was measured using a digital pH meter and the titratable acidity was determined according to the Soxhlet-Henkel method (Budslawski, 1973).

2.3.2. Determination of protein and moisture contents

The protein and moisture contents of the ewe's milk, yoghurt and probiotic-fermented milk were estimated from the crude nitrogen content of the samples determined by the Kjeldahl and oven drying methods (AOAC, 1990).

2.3.3. Fat and lactose determinations

The total fat and lactose contents of the milk and samples were determined by the Gerber and Bertrand methods as described by Budslawski (1973).

2.3.4. Density determination

The milk density was measured using a densitometer (Budslawski, 1973).

2.3.5. Free fatty acid determination

The free fatty acid contents in ewe's milk, yoghurt, and probiotic-fermented milk were determined by the Doyle method, as described by Deeth and Fitz-Gerald (1976).

2.3.6. Aroma determination

The diacetyl and acetaldehyde contents of the samples were determined by the methods described by Pien (1974) and Lees and Jago (1969), respectively.

2.4. Rheological analysis

The hardness, adhesiveness, cohesiveness, springiness and gumminess of yoghurt and probiotic-fermented milk were measured using The Universal TA-XT2 Texture Analyser (Stable Micro Systems, UK). The operating conditions were an artificial plastic cylinder (20 mm in diameter) was inserted into each product to a depth of 20 mm and speed of 1 mm/s (PN, 1999; Surmacka-Szcześniak, 1963).

The instrument was connected to a computer (fitted with a Texture Expert v. 1.05, programmed using the algorithm Fracture TPA) to measure the texture profiles of each product. The measurements recorded were: (1) hardness, determined as the final power required to reach a stable deformation (i.e. the maximum point of inflection on the curve was during the first cycle of pressing), (2) adhesiveness, calculated as the field surface of a negative peak, (3) cohesiveness, calculated as quotient field surfaces indicated by the curves of the second and the first press, (4) springiness, as a ratio of the time measured from the start of the second and the first cycles of pressing to reach maximum deformation during each cycle, and (5) gumminess, determined as a multiple of hardness and cohesiveness.

2.5. Sensory characterization

The fresh and stored products were assessed by six judges using a sensory rating scale of 1–5 (unacceptable/excellent) as described by Kurpisz (1984). The panel of assessors was an internal panel of female non-smokers who were checked on the basis of sensory acuity and consistency, and are highly familiar with fermented dairy products.

The sensory vocabulary comprised attributes describing consistency, appearance, taste and flavour; the significance coefficients were 0.2 and 0.6 for consistency and appearance, and for taste and flavour, respectively.

The data were computed with statistical software using Statgrafic version 5.2 used analysis of variance and analysis of regression.

3. Results and discussion

The gross chemical composition (g/100 g) of ewe's milk used for the production of yoghurt and probiotic-fermented milk (data not shown) fell within the following averages: total solids (TS) 18.79 (±1.98), fat 6.75 (±0.97), lactose 4.63 (±0.65), protein 6.75 (±0.85), free fatty acid 2.45 μg Eq/g (±0.15), density 1.036 g/ml (±0.0002), titratable acidity 11.2 SH (±1.56), and pH 6.66 (±0.08). Such compositional and density data were similar to those reported by Alichanidis and Polychroniadou (1995), Bonczar and Wszołek (1997) and Haenlein (1995). It is evident that the SNF content of ewe's milk averaged 12.04 g/100 g, which corresponded to a fortified cow's milk base and, as a result, the milk in the present study did not require any fortification (PN, 1983). Thus, the ewe's milk did not need to be condensed.

The fat content in the experimental samples is shown in Table 1, and the amount present in each product significantly affected the level of free fatty acids (FFA) in the yoghurt and probiotic-fermented milk. The highest amounts of FFA were in the products made from milk containing 6 g/100 g fat. The microbial activity of the starter cultures (e.g. lipase that hydrolyses the fat) could be the main source of FFA in the samples (Beshkova et al., 1988; Staniewski, 1998; Tamime & Robinson, 1999). According to Beshkova et al. (1988), another possible source of FFA in yoghurt and related products could be from the amino acid fraction; this could explain why the skimmed products and the milk used also contain appreciable amounts of FFA (7.02 and 2.45 μg Eq/ml, respectively). However, during the storage period, the level of FFA in these products had increased significantly.

With an aim to study the effect of kind of starter cultures on beverage production, the level of fat in yoghurts and the time of storage were used in a three factorial analysis of variance (ANOVA). Type of starter culture significantly influenced pH, titration acidity, content of diacetyl and acetaldehyde, hardness, adhesiveness, cohesiveness and yoghurt gumminess. Yoghurts, in comparison to probiotic-fermented milks, contained a little less diacetyl and acetaldehyde, had lower pH, and higher titration acidity. Also, they were characterized by increasing hardness, adhesiveness and gumminess and received a slightly inferior average score on organoleptic evaluation.

The mean concentration of acidity (i.e. pH value and titratable acidity) of the yoghurt was lower or higher, respectively, when compared to probiotic-fermented milk products (see Table 1); this could be attributed to the presence *L. delbrueckii* ssp.*bulgaricus* in the yoghurt starter culture, but absent in the ABT culture that was used. However, the milk fermentate with single strain of *L. delbreuckii* ssp. *bulgaricus* was lower in pH than the parallel fermentate by *S. thermophilus* (Beshkova et al., 1988), but even lower in the milk fermentate when using a mixed culture of these micro-organisms (Georgala et al., 1995; Ulberth & Kneifel, 1992). As expected, the storage time significantly affected the acidity level in the products; titratable acidity increased, whilst the pH was decreased.

The diacetyl and acetaldehyde contents of yoghurt samples were less than those made with probiotic starter culture (Table 1). These results could be attributed to variations in the metabolic activities that existed in microbial species or differences within strains of the same species. It is well established that *L. delbrueckii* ssp.*bulgaricus* produces higher amounts of aroma

Table 1
Yoghurt properties, type of starter culture, fat level and day of storage

Yogurt properties	Type of starter culture[a]			Fat level in yogurt				Day of storage			
	Y (n=27) $x \pm s$**	ABT5 (n=27) $x \pm s$	Statistically significant	Skimmed (n=18) $x \pm s$	4.5% (n=18) $x \pm s$	6.0% (n=18) $x \pm$s	Statistically significant	Fresh (n=18) $x \pm s$	7 (n=18) $x \pm s$	14 (n=18) $x \pm s$	Statistically significant
	1	2		3	4	5		6	7	8	
Sensory											
Organoleptic evaluation (scores)	4.46±0.03	4.53±0.03	1–2*	4.51±0.03	4.49±0.03	4.49±0.03		4.92±0.03	4.63±0.03	3.94±0.03	6.7.8**
Physical and chemical data											
pH	4.86±0.03	5.02±0.03	1–2**	4.89±0.04	4.98±0.04	4.94±0.04		5.05±0.04	4.93±0.04	4.81±0.04	6–7.8**;7–8*
Titration acidity (°SH)	41.2±0.70	38.7±0.70	1–2*	40.1±0.85	40.0±0.85	39.6±0.85		38.01±0.85	40.32±0.85	41.4±0.85	6–8**
Free fatty acid content (μg Eq/g)	7.93±0.14	7.53±0.14		7.02±0.18	8.09±0.18	8.08±0.18	3–4.5**	7.01±0.18	7.78±0.18	8.40±0.18	6–7.8**;7–8*
Diacetyl content (mg/dm^3)	0.58±0.04	0.86±0.04	1–2**	0.73±0.04	0.75±0.04	0.68±0.04	5–3.4*	0.54±0.05	0.95±0.05	0.67±0.05	7–6.8**
Acetaldehyde content (mg/dm^3)	6.70±0.30	7.82±0.30	1–2*	6.82±0.37	7.39±0.37	7.58±0.38		6.64±0.37	9.47±0.37	5.68±0.37	7–6.8**
Rheological											
Hardness TPA (G)	92.1±6.6	57.1±6.8	1–2**	78.5±9.8	75.9±9.4	70.5±9.4		75.9±10.6	72.4±8.3	76.6±1.01	
Adhesiveness TPA (Gs)	−809±104	−207±107	1–2**	−546±159	−519±152	−489±152		−349±171	−627±133	−579±163	
Springiness TPA	0.90±0.02	0.94±0.02		0.92±0.03	0.92±0.02	0.93±0.02		0.96±0.03	0.88±0.02	0.92±0.03	6–7*
Cohesiveness TPA	0.45±0.02	0.53±0.02	1–2**	0.49±0.02	0.49±0.02	0.49±0.02		0.53±0.03	0.48±0.02	0.46±0.03	6–8*
Gumminess TPA (G)	41.2±31.2	32.6±32.3	1–2*	40.3±4.3	37.0±4.1	34.4±4.1		40.4±4.6	33.6±3.6	37.8±2.9	

*Statistically significant difference between averages at $P \leqslant 0.05$. **Statistically significant difference between averages at $P \leqslant 0.01$.

[a] Y, yogurt starter culture: *S. thermophilus* and *L. delbrueckii* ssp. *bulgaricus*. ABT5, probiotic starter culture: *S. thermophilus*, *L. acidophilus* and *Bifidobacterium* ssp.

metabolites in milk than does *S. thermophilus* (Beshkova et al., 1988; Georgala et al., 1995). The activity of alcohol dehydrogenase in a microbial species is important and should not be overlooked. According to Fuller (1989), *L. acidophilus* strains possess lower alcohol dehydrogenase activity than *L. delbreuckii* ssp. *bulgaricus*, which results in lower hydrolysis activity of acetaldehyde to ethanol. Hence, the presence of either lactobacilli species in the starter culture can influence the cumulative content of acetaldehyde in these products. Also, Kneifel et al. (1992) reported that yoghurt made with *Bifidobacterium* ssp. and *L. acidophilus* starter cultures had more acetaldehyde than fermented milk product made without these micro-organisms. In general, the level of these carbonyl compounds increased during storage up to 7 day, and later decreased; this could be associated with further metabolic activity of the starter cultures during the storage period. The decrease in diacetyl and acetaldeyde contents in yoghurt and probiotic-fermented milk by the end of the storage period could be due to evaporation from the samples and/or hydrolysis by microbial enzymes to form other substances (Beshkova et al., 1988; Georgala et al., 1995; Libudzisz, 1990; Tamime & Robinson, 1999).

The variations in the rheological measurements of yoghurt and probiotic-fermented milk are shown in Table 1; hardness, adhesiveness and gumminess values were highly significant. According to Tamime and Robinson (1999), one of the factors that could influence the firmness and texture of the fermented milk products is the ability of the starter micro-organism to produce exopolysaccharide (EPS) from the lactose present in the milk. However, such differences (see Table 1) could be attributed to the microbial strains blended in the starter cultures. It is well established that *L. delbrueckii* ssp.*bulgaricus* produces more EPS in milk fermentate than does *S. thermophilus*, *L. acidophilus* and/or bifidobacteria species. It is most likely that the presence of *L. delbrueckii* ssp. *bulgaricus* in the yoghurt culture had influenced the higher measurements of hardness, adhesiveness and gumminess in these samples. Both, the type of starter culture used and the storage period significantly affected the rheological measurements of the yoghurt and probiotic-fermented milk products.

The results of organoleptic evaluation indicate that 1 day yoghurts received higher scores than probiotic-fermented milk (Tables 2 and 3). However, after 14 days the scores in probiotic-fermented milk were higher than the yoghurts (Tables 2 and 3). At the beginning, yoghurts were superior to probiotic-fermented milk, mainly because of more intensive flavour and better consistency. However, after 14 days yoghurts appeared to be more acid than the (more gentle) probiotic-fermented milk. The pH and titration acidities of yoghurts and probiotic-fermented milk supported this attribute (Tables 2 and 3). Taking into account the acetaldehyde and diacetyl contents of these products through the total storage period, the probiotic-fermented milk surpassed yoghurts (Tables 2 and 3). Irrespective of starter culture used, the acetaldehyde content was highest on day 7, but lowest on day 14 of storage. Similarly, diacetyl concentration was highest on day 7, whilst 1 day stored probiotic-fermented milks and 14 day stored yoghurts had the lowest diacetyl values (Tables 2 and 3).

Free fatty acid contents were enhanced in yoghurts and probiotic-fermented milk during storage and the amount was a little higher in yoghurts. Some authors (Beshkova et al., 1988) consider that single strains of

Table 2
The variations in yoghurt properties during time of storage

Yoghurt properties	Day of storage[a]		
	1 $x \pm s$	7 $x \pm s$	14 $x \pm s$
Sensory			
Organoleptic evaluation (scores)	4.96±0.03 A	4.66±0.06 B	3.78±0.05 C
Physical and chemical data			
Titration acidity (SH)	39.5±0.85	41.7±1.03	42.3±1.31
PH	4.99±0.07 a	4.86±0.06	4.72±0.09 b
Acetaldehyde content (mg/dm^3)	6.00±0.61 A	8.72±0.42 B	5.38±0.55 C
Diacetyl content (mg/dm^3)	0.48±0.08 a	0.79±0.10 b	0.47±0.08 a
Free fatty acids content (μg Eq/cm^3)	7.16±0.33 A	8.05±0.32	8.58±0.28 B
Rheological			
Hardness TPA (G)	86.2±9.4 a	95.8±13.2 b	91.7±1.7
Adhesivness TPA (Gs)	−422±48.7 A	−1024±189 B	−934±320 B
Springiness TPA	0.96±0.02	0.86±0.04	0.88 ±0.04
Cohesiveness TPA	0.52±0.02	0.42±0.03	0.42±0.01
Gumminess TPA (G)	45.2±5.6	41.9±7.2	36.8±5.9

[a] Data with different letters in a row (A–C or a, b) are statistically different at $P \leqslant 0.05$).

L. delbrueckii ssp. *bulgaricus* produce more free fatty acids than *S. thermophilus*, but both strains together produce more of these compounds than each of them separately. Other authors report that, among thermophilic bacteria, lipolitic capabilities are shown by only *S. thermophilus* cultures (Staniewski, 1998).

The variations of texture measurements in yoghurts and probiotic-fermented milk were different during storage. The hardness and adhesivness of yoghurt were highest on day 7, whilst after 14 days of storage these values were slightly lowered. On the other hand, on day 7 probiotic-fermented milk, hardness was a little lower than in the rest of the trials. The adhesivness changed in the same way as springiness, cohesiveness and gumminess.

The correlation between yoghurts and probiotic-fermented milk properties appeared to be significant ($P \leqslant 0.01$ or 0.05) only in some cases. Table 4 shows the significant correlation coefficients of studied beverages.

Table 4 shows that the sensory results were significant ($P \leqslant 0.01$) and positively correlated with pH both in yoghurts and probiotic-fermented milk, whilst a negative correlation was found with titration acidity and free fatty acids content. This means that pH, titration acidity and free fatty acids play an important role in the sensory evaluation of these beverages. Significant corre-

Table 3
The variations in bio-yoghurt properties during storage

Bio-yoghurt properties	Day of storage[a]		
	1 $x \pm s$	7 $x \pm s$	14 $x \pm s$
Sensory			
Organoleptic evaluation (scores)	4.88±0.02 A	4.60±0.06 B	4.10±0.06 C
Physical and chemical data			
Titration acidity (°SH)	36.5±1.49 a	39.0±1.23	40.5±1.20 b
PH	5.18±0.03 A	5.00±0.03 aB	4.89±0.03 bB
Acetaldehyde content (mg/dm^3)	7.28±0.50 A	10.21±0.67 B	5.98±0.36 C
Diacetyl content (mg/dm^3)	0.59±0.07 A	1.10±0.03 B	0.87±0.04 C
Free fatty acids content (μeq/g)	6.87±0.26 A	7.50±0.24	8.21±0.38 B
Rheological			
Hardness TPA (G)	62.8±4.6	49.1±6.4	61.5±10.3
Adhesivness TPA (Gs)	−255±49.2	−229±133	−224±47
Springiness TPA	0.96±0.01	0.90±0.03	0.96 ±0.01
Cohesiveness TPA	0.54±0.03	0.54±0.04	0.50±0.02
Gumminess TPA (G)	34.0±2.3	25.3±3.1 a	38.7±3.3 b

[a] Data with different letters in a row (A–C or a, b) are statistically different at $P \leqslant 0.05$).

Table 4
The values of some correlation coefficient between yoghurts and bio-yoghurt parameters

Correlation	Correlation coefficient (r)	
	Yogurt	Bio-yoghurt
Organoleptic evaluation × pH	+0.50**	+0.72**
Organoleptic evaluation × titration acidity	−0.31	−0.41**
Organoleptic evaluation × free fatty acids	−0.50**	−0.50**
pH × titration acidity	−0.62*	−0.22
pH × free fatty acids	−0.01	−0.52**
pH × diacetyl	+0.24	−0..46*
pH × hardness	−0.57**	−0.20
pH × gumminess	−0.40*	−0.22
Titration acidity × free fatty acids	+0.27	+0.48**
Acetaldehyde × diacetyl	+0.24	+0.50**
Hardness × gumminess	+0.88**	+0.42*
Springiness × cohesiveness	+0.79**	+0.51**
Adhesivness × springiness	+0.62**	+0.65**
Adhesivness × cohesiveness	+0.72**	+0.69**
Cohesiveness × gumminess	−0.10	+0.43*

*$P \leqslant 0.05$. **$P \leqslant 0.01$.

lations were found between some texture measurements in both yoghurts and probiotic-fermented milk, especially with to reagrd to, adhesivness, springiness and cohesivness of yoghurts and probiotic-fermented milk. The remaining correlation coefficients differed in the trials, possibly due to various activities (fermentative and aroma-creative) of starter cultures used for production of these beverages. Yoghurt pH was highly correlated with hardness and gumminess, whilst probiotic-fermented milk pH was negatively, but highly correlated with free fatty acids. Dependence on diacetyl and acetaldehyde contents was positive and highly significant only in the case of probiotic-fermented milk. Ulberth and Kneifel (1992) also found a relationship between aroma compounds in yoghurts and probiotic-fermented milk beverages.

4. Conclusion

1. It was found that yoghurts and probiotic-fermented milk made of ewe's milk, differed in their properties, depending on type of starter culture used and the time of storage.
   a. Yoghurts were characterized by lower pH, higher titration acidity and lower diacetyl and acetaldehyde contents than probiotic-fermented milk. Also, they had higher hardness, adhesiveness and gumminess.
   b. During storage, yoghurt pH decreased, but the titration acidity and free fatty acid content increased. At the beginning of storage, acetaldehyde and diacetyl contents increased, then after 7 days decreased. The texture measurements did not change much.
2. The free fatty acid content in yoghurts and probiotic-fermented milk depended on the fat level. The highest free fatty acids were in yogurts with highest fat contents.

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