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MICROBIOLOGICAL PROPERTIES OF LABNEH (CONCENTRATED YOGHURT) STORED WITHOUT VEGETABLE OIL AT ROOM OR REFRIGERATION TEMPERATURES

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Labnehs (concentrated yoghurts) were made from cow or goat milk (and produced directly from either yoghurt or strained yoghurt) and stored without submersion in vegetable oil at either room or refrigeration temperatures. The results showed that total aerobic mesophilic bacterial counts decreased during storage at both temperatures. Yeast and mould counts, however, increased especially in the samples stored at room temperature due to increased acidity during storage. The number of aerobic spore-forming bacteria decreased, although it was high at the beginning of storage. The number of psychrotrophic bacteria significantly decreased after 60 days in the samples stored at refrigeration temperature and to a smaller degree decreased in the samples stored at room temperature. The statistical analysis showed that the variety of milks and draining of the yoghurts and their interactions had no effect on the growth/survival of total aerobic mesophilic bacteria and psychrotrophic bacteria ($P>0.05$). However, storage time had a significant effect on the growth of aerobic mesophilic bacteria and aerobic spore-forming bacteria ($P<0.01$) and yeast, mould and psychrotrophic bacterial counts ($P<0.05$). No coliform bacteria and *Escherichia coli* were detected in any sample. The labnehs were consumable for a short period of time, if stored at room temperature and for 180 day, if stored at refrigeration temperature.

Keywords: labneh (concentrated yoghurt), storage temperature, microbiological properties

The production of labneh is one of the methods used to produce concentrated yoghurt in Turkey and Middle Eastern countries. Labneh produced in Turkey has the following characteristics: pH 3.6, 2.03% titratable acidity, 25.29% dry matter, 8.98% fat, 10.04% protein, 1.43% lactose and 4.11% salt and high mineral content (ŞAHAN & SAY, 1998).

Labneh is a local, fermented dairy product, which is produced by concentrating yoghurt by heating and addition of salt to extend the shelf-life of yoghurt. The finished product is cooled down, filled into jars and kept cool until consumption and is generally stored under vegetable oils or fats. The researches on labneh generally report on the chemical composition of the product (GÖNÇ & OKTAR, 1973; GÜLER & AVŞAR, 1999).

The chemical and microbiological properties of labneh sold in retail outlets have been determined by ŞAHAN & SAY (1998). The same authors have also investigated the effect of different cooking times and draining methods on the properties of labneh.

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They have determined the pH, acidity, dry matter, fat, non-fat dry matter, protein, lactose and salt content and penetrometer values of the finished product and calculated process yield (ŞAHAN & SAY, 2003).

The effect of storage under oil on the properties of labneh has also been examined (SAY, 2001). The aim of this research was to investigate the microbiological properties of labneh stored without vegetable oil at room and refrigeration temperatures for 6 months.

1. Materials and methods

Fresh cow and goat milks were obtained from Çukurova University, Faculty of Agriculture, Department of Animal Husbandry. Milks were heated in a stainless steel boiling pan at 100 °C for 1 min and cooled to 43 °C, inoculated with 2.5% starter culture (activated yoghurt 1 culture, Wisby) and then incubated at 42 °C until pH dropped to around 4.7. After fermentation had been completed, the yoghurt was kept at room temperature for 15 min and then at 4 °C for 24 h. It was then divided into two batches. The first batch was kept at 4 °C and the second one was held at room temperature for 3–4 h in a cloth bag to drain 50% of the whey.

The yoghurts and strained yoghurts were transferred into a boiling pan and cooked for 110 and 50 min by stirring with a wooden spoon. NaCl was added to both groups of yoghurt at a concentration of 1% near the end of cooking. The labnehs were allowed to cool down at room temperature and were placed into plastic bags. Then the labneh samples were stored without vegetable oil at either room (20 °C) or refrigeration temperature (4 °C) for 6 months.

Cow and goat milks (42 kg) were used to produce yoghurts for each trial. Half of the yoghurts (21 kg) were used directly and the other half was strained to make salted yoghurts. The labnehs were produced in triplicate at weekly intervals. Three packages of each sample were used for microbiological analysis during storage.

Chemical properties were determined according to ANON (2000). Total aerobic mesophilic bacteria (spoilage organisms) were enumerated in Plate Count Agar of pH 7.0±0.2, incubated aerobically at 30 °C for 48 h. Yeast and mould were determined in PDA of pH 3.5±0.2, incubated aerobically at 25 °C for 3–4 days. For aerobic spore-forming bacteria counts, samples were heated at 80 °C for10 min, plated on PCA of pH 7.0±0.2 and incubated aerobically at 30 °C for 48 h. Psychrotrophic bacteria were cultured in PCA of pH 7.0±0.2 and incubated aerobically at 7 °C for 10 days. Coliform bacteria and *Eschericia coli* were determined using Endo agar at pH 7.4±0.2 and were incubated aerobically at 37 °C for 24 h (HARRIGAN & MCCANCE, 1993).

The statistical analyses were done by using SPSS program, and analysis of variance was applied (RENNER, 1970).

2. Results and discussion

The composition of cow milk was as follows: pH 6.81±0.019, 0.13±0.003% titratable acidity, 10.66±0.229% dry matter, 2.72±0.164% fat, 3.10±0.176% protein, 4.09±0.182% lactose and 0.74±0.009% ash. The composition of goat milk was as follows: pH 6.37±0.186, 0.15±0.006% titratable acidity, 11.64±0.225% dry matter, 3.53±0.167% fat, 3.72±0.083% protein, 3.50±0.079% lactose and 0.83±0.017% ash.

The microbiological properties of labneh stored at room and refrigeration temperatures were presented in Tables 1 and 2.

2.1. Total aerobic mesophilic bacteria counts

As can be seen from Tables 1 and 2, the number of total aerobic mesophilic bacteria ranged from 0 to 5.9 log CFU g^{-1} and decreased during storage at both temperatures. The total aerobic mesophilic bacteria counts were found to be high on day 1. This could be due to fact that the products were cooled down to room temperature and packaging was done manually during processing. The statistical analysis showed that storage time had a significant effect on the number of total aerobic mesophilic bacteria ($P<0.01$). However, milk type and draining method had no effect on the bacterial counts ($P>0.05$).

The number of bacteria in labnehs, made from cow or goat milk and stored without vegetable oil, were found to be lower at both temperatures than those of commercially available labnehs in Turkey (ŞAHAN & SAY, 1998). The results of this study confirm the findings of RAO and co-workers (1987) and SAY and ŞAHAN (2002), who reported that the number of total bacteria in labnehs made from cow or goat milk decreased by 4 and 2 log cycles, respectively after 6 months of storage.

2.2. Yeast and mould counts

The yeast and mould counts of labneh varied, depending on the storage conditions. The yeast and mould counts in the labneh samples stored at room temperature increased very rapidly and the product became edible only after 1 day. The number of yeasts and moulds in the samples stored at room and refrigeration temperatures increased from 1.4 to 4.9 log CFU g^{-1} by the end of storage.

The statistical analysis showed that storage time had a significant effect ($P<0.01$) on the number of yeasts and moulds in the labneh samples, whereas milk type and draining process and their interaction had no effect ($P>0.05$). Similar findings for strained yoghurts were also found by UYSAL (1993). The yeast and mould counts of labneh obtained in this research were found to be higher than those obtained by ŞAHAN and SAY (1998). This could be due to the storage of yoghurt without vegetable oil. The number of yeast and mould in labneh samples increased from 2.00 to 4.00 log CFU g^{-1} during storage under vegetable oil for 6 months (SAY & ŞAHAN, 2002). KEÇELI and co-workers (1999) reported that the count of *Kluyveromyces marxianus* in concentrated yoghurts stored under olive oil at 25 °C declined over 45 days and remained constant during 90 days of storage.

Table 1. Microbiological properties of labneh stored without vegetable oil at room temperature (20 °C)

Micro-organisms	Sample	Cell count (log CFU g^{-1} ± SD) Storage time						
		Day 1	Day 21	Day 28	Day 35	Day 42	Day 49	Day 56
Total aerobic mesophilic bacteria	Cow milk + Strained	5.52±0.66^{a}	1.00±1.00^{b}	0.90±0.17^{b}	0.00±0.00^{c}	0.00±0.00^{c}	0.00±0.00^{c}	0.00±0.00^{c}
	Cow milk	4.77±0.84^{a}	1.33±1.19^{b}	0.33±0.58^{c}	0.00±0.00^{c}	0.00±0.00^{c}	0.00±0.00^{c}	0.00±0.00^{c}
	Goat milk + Strained	5.09±2.14^{a}	1.53±0.50^{b}	0.83±0.75^{c}	0.00±0.00^{c}	0.00±0.00^{c}	0.00±0.00^{c}	0.00±0.00^{c}
	Goat milk	5.89±1.92^{a}	1.75±0.44^{b}	0.43±0.75^{c}	0.00±0.00^{c}	0.00±0.00^{c}	0.00±0.00^{c}	0.00±0.00^{c}
Yeast and mould	Cow milk + Strained	1.60±1.46^{ab}	3.04±0.07^{ab}	5.14±0.54^{b}	4.97±0.66^{b}	3.43±1.85^{b}	3.77±2.14^{b}	4.25±1.87^{b}
	Cow milk	1.64±1.49^{ab}	3.49±1.00^{ab}	4.74±0.37^{b}	4.67±0.78^{b}	4.81±1.14^{b}	5.47±1.71^{b}	4.88±0.66^{b}
	Goat milk + Strained	1.35±1.38^{ab}	2.26±0.65^{ab}	4.83±0.73^{b}	4.49±0.50^{b}	3.43±1.91^{b}	4.75±0.99^{b}	4.08±1.24^{b}
	Goat milk	1.69±1.64^{a}	3.08±0.14^{ab}	4.30±0.28^{b}	5.03±0.25^{b}	5.05±0.70^{b}	4.69±0.82^{b}	4.18±1.97^{b}
Aerobic spore-forming bacteria	Cow milk + Strained	2.58±0.10^{a}	1.36±0.39^{bc}	0.93±0.89^{bc}	0.33±0.58^{c}	1.10±0.17^{bc}	1.10±0.95^{bc}	0.90±0.17^{bc}
	Cow milk	3.05±0.66^{a}	0.57±0.51^{b}	1.30±0.30^{bc}	0.49±0.85^{b}	0.57±0.51^{b}	1.17±1.02^{bc}	0.83±0.75^{bc}
	Goat milk + Strained	2.49±0.34	1.37±0.35^{a}	0.83±0.75^{bc}	0.67±0.58^{bc}	1.20±0.17^{b}	1.39±0.36^{b}	0.33±0.58^{c}
	Goat milk	2.61±0.22^{a}	1.13±0.23^{b}	0.77±0.68^{c}	0.95±0.92^{c}	1.20±0.46^{b}	1.28±0.49^{b}	0.33±0.58^{c}
Psychrotrophic bacteria	Cow milk + Strained	1.17±2.03^{ab}	1.10±0.17^{ab}	0.67±0.58^{b}	1.62±0.58^{ab}	0.33±0.58^{b}	0.67±0.58^{b}	1.20±0.35^{ab}
	Cow milk	1.28±2.22^{ab}	1.46±0.41^{ab}	1.12±1.19^{ab}	1.58±0.53^{ab}	1.70±0.63^{ab}	1.09±1.14^{ab}	0.67±0.58^{b}
	Goat milk + Strained	1.11±1.93^{ab}	0.90±0.17^{ab}	1.16±0.28^{ab}	1.39±0.36^{ab}	1.69±0.60^{ab}	1.20±0.35^{ab}	0.67±0.58^{ab}
	Goat milk	2.20±1.94^{a}	1.03±0.35^{b}	1.23±0.40^{ab}	1.53±0.61^{ab}	1.37±0.64^{ab}	1.36±0.62^{ab}	0.67±0.58^{b}
Coliform bacteria	Cow milk + Strained	0.00±0.00^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Cow milk	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Goat milk + Strained	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Goat milk	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
Escherichia coli	Cow milk + Strained	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Cow milk	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Goat milk + Strained	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Goat milk	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}

Values are means based on nine observations (three samples, three replicates).
[a,b,c] Means in the same row followed by different letters were significantly different ($P<0.05$).

Table 2. Microbiological properties of labneh stored without vegetable oil at refrigeration temperature (4 °C)

Micro-organisms	Sample	Cell count (log CFU g^{-1} ± SD) Storage time						
		Day 1	Day 30	Day 60	Day 90	Day 120	Day 150	Day 180
Total aerobic mesophilic bacteria	Cow milk + Strained	5.52±0.66^{a}	2.00±0.30^{b}	1.27±0.47^{bc}	0.33±0.58^{c}	0.70±0.70^{bc}	0.90±0.35^{bc}	0.23±0.40^{c}
	Cow milk	4.77±0.84^{a}	1.43±1.25^{b}	1.45±1.26^{b}	0.00±0.00^{c}	0.33±0.58^{c}	0.47±0.81^{c}	0.00±0.00^{c}
	Goat milk + Strained	5.09±2.14^{a}	3.10±0.50^{b}	1.50±0.70^{c}	1.10±0.10^{c}	0.30±0.60^{d}	0.80±0.70^{cd}	0.00±0.00^{e}
	Goat milk	5.89±1.92^{a}	2.20±0.17^{b}	0.77±1.33^{c}	1.30±0.52^{d}	0.47±0.40^{e}	0.33±0.58^{e}	0.23±0.40^{e}
Yeast and mould	Cow milk + Strained	1.60±1.46^{ab}	2.39±0.67^{ab}	4.42±2.24^{b}	3.65±3.18^{b}	2.16±1.75^{ab}	2.86±1.27^{ab}	1.33±1.15^{a}
	Cow milk	1.64±1.49^{ab}	3.18±1.37^{b}	4.22±1.79^{b}	4.65±3.19^{b}	4.95±1.99^{b}	3.63±2.43^{b}	2.65±1.49
	Goat milk + Strained	1.35±1.38^{ab}	2.07±0.36^{ab}	2.75±1.35^{ab}	1.84±0.40^{ab}	1.40±1.22^{ab}	1.39±1.27^{ab}	1.33±1.15
	Goat milk	1.69±1.64^{ab}	1.37±1.59^{ab}	2.53±1.29^{ab}	1.92±0.25^{ab}	1.58±0.63	3.99±2.59^{b}	2.33±1.53
Aerobic spore-forming bacteria	Cow milk + Strained	2.58±0.10^{a}	1.13±0.23^{b}	0.98±0.90^{bc}	0.83±0.75^{bc}	1.81±0.22^{b}	1.73±0.27^{b}	0.33±0.58^{c}
	Cow milk	3.39±1.13^{a}	1.24±0.28^{b}	1.00±0.30^{bc}	0.68±0.59^{bc}	1.49±0.43^{b}	1.80±0.26^{b}	0.00±0.00^{c}
	Goat milk + Strained	2.49±0.34^{a}	1.13±0.38^{b}	0.57±0.51^{c}	1.20±0.35^{b}	0.87±0.75^{bc}	1.50±0.25^{b}	0.77±0.68^{c}
	Goat milk	2.61±0.22^{a}	0.90±0.17^{b}	1.75±0.48^{c}	1.16±1.09^{bc}	0.77±0.68^{b}	1.62±0.22^{c}	0.57±0.51^{b}
Psychrotrophic bacteria	Cow milk + Strained	1.17±2.03^{ab}	1.33±0.58^{b}	1.00±0.00^{c}	0.77±0.68^{bc}	1.36±0.58^{ab}	1.16±1.09^{a}	0.43±0.75^{bc}
	Cow milk	1.28±2.22^{ab}	1.43±0.75^{b}	0.67±0.58^{c}	0.73±0.63^{c}	1.23±0.40^{ab}	2.26±0.07^{a}	0.93±0.89^{c}
	Goat milk + Strained	1.11±1.93^{ab}	1.53±0.50^{b}	1.00±0.00^{c}	0.87±0.81^{bc}	1.75±0.30^{a}	1.61±0.39^{a}	0.53±0.92^{c}
	Goat milk	2.20±1.94^{a}	1.72±0.66^{b}	1.00±0.00^{bc}	0.77±0.68^{c}	1.00±0.89^{bc}	1.48±0.44^{bc}	0.62±1.07^{c}
Coliform bacteria	Cow milk + Strained	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Cow milk	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Goat milk + Strained	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Goat milk	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
Escherichia coli	Cow milk + Strained	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Cow milk	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Goat milk + Strained	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}
	Goat milk	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}	0.00±0.00 ^{a}

Values are means based on nine observations (three samples, three replicates).
[a,b,c] Means in the same row followed by different letters were significantly different ($P<0.05$).

2.3. Aerobic spore-forming bacteria counts

The number of aerobic spore-forming bacteria of labneh during storage at both room and refrigeration temperatures were presented in Tables 1 and 2. Their counts changed between 0.3 to 3.1 and 0.0 to 3.4 log CFU g^{-1} in the samples stored at both temperatures, and in some samples the bacteria were either not detected or decreased during storage. This could be due to cooking of labneh. Aerobic spore-forming bacteria counts declined rapidly during storage at both temperatures. The possible reason for this could be transformation of spores to vegetative forms during storage. The results indicated that storage time had a significant effect ($P<0.01$), whereas milk type and draining process had no effect on the number of spore-forming bacteria ($P>0.05$).

SAY and ŞAHAN (2002) reported that the number of spore-forming bacteria decreased from an initial 3.00 to 2.00 log CFU g^{-1} after 6 months of storage.

2.4. Psychrotrophic bacteria counts

The psychrotrophic bacteria counts of labneh in the samples stored at room and refrigeration temperatures changed between 0.7 to 2.2 log CFU g^{-1} and 0.4 to 2.3 log CFU g^{-1}, respectively (Tables 1 and 2). Psychrotrophic bacteria counts were higher than expected at day 1, indicating that hygienic conditions were not good enough during processing and packaging. The psychrotrophic bacterial counts decreased significantly during the second month of the storage at refrigeration temperature. The number of bacteria fluctuated and then decreased by the end of storage time. Psychrotrophic bacteria can cause sour and bitter taste in yoghurt. As the number of bacteria declined in the samples stored at refrigeration temperature, the yoghurts were edible throughout the storage period. Our findings indicated that the number of psychrotrophic bacteria had been significantly affected by storage time ($P<0.01$), however, milk type and draining had no effect on the number of bacteria ($P>0.05$).

The number of psychrotrophic bacteria in strained yoghurt samples was found to be 0.54 log CFU g^{-1} (OCAK, 1998). SAY and ŞAHAN (2002) reported that the number of psychrotrophic bacteria decreased from an initial value of 3.00 to 1.00 log CFU g^{-1} after 6 months of storage.

2.5. Coliform and E. coli *counts*

Neither *E. coli* nor coliform organisms were detected in any labneh sample (Tables 1 and 2). This may be due to low pH, salt content and the long cooking time of yoghurts.

The coliform counts were reported to be as high as 6.3 log CFU g^{-1}, whereas *E. coli* was not detected in labnehs sold in Turkey (ŞAHAN & SAY, 1998). SALJI and co-workers (1983, 1987a, b) reported the coliform counts of labneh to be lower than 10 log CFU g^{-1}. Coliform bacteria were also detected only in low amounts in salted yoghurts (SAY and ŞAHAN, 2002).

3. Conclusions

Labneh is a selective environment for the growth of contaminating microorganisms, especially of yeast species due to its a_w and pH. The growth of spoilage organisms during storage is a serious problem and may render the product inedible.

Microbiological quality of labneh is not affected by the variety of the milk used or the draining method applied. However, storage time was found to be an important factor. The yeast and mould counts of labneh stored without vegetable oil and kept at room temperature may increase rapidly, so the product should be consumed in a short time or should be kept in refrigerator at 4 °C.

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