

Utilization of Goat's milk in Making Functional Low- and Full- fat Yoghurt

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ABSTRACT

Functional set-type yoghurt manufactured from low-and full-fat goat's milk was studied. Optimal curd tension, whey syneresis, microbiological quality and sensory evaluation were achieved by supplementation of low- and full-fat goat's milk with buffalo's milk (1:1) and some type of stabilizers. Sodium caseinate (1 or 1.5%) came at the first; followed by particulate whey protein concentrated (0.25 or 0.5 %) and then Lacta (0.3 or 0.5 %) for full- and low-fat, respectively. Sodium caseinate increased curd tension and lactic acid bacterial count, reduced whey syneresis and coagulation time because it had a higher protein contents which can serve as a source of peptides and amino acids led to an increase in viable counts of lactic acid bacteria. Reduced fat of goat's milk, heat treatment of yoghurt milk and the addition of stabilizers masked the characteristic taste of goat's milk and improve the appearance, taste aroma, texture and overall acceptance of yoghurt.

Key words: goat's milk, stabilizers and Lacta.

INTRODUCTION

Yoghurt is always made from cow's and buffalo's milk although production of goat's milk is economically less expensive than either cow's or buffalo's milk (Abrahamsen and Holman, 1981). Comparing with cow's milk, buffalo's milk has a higher fat content, curd protein, lactose, total solid, vitamins, and minerals, which impart a rich flavour and taste, and make it a highly suitable ingredient for the manufacture of a wide variety of dairy products, such as yoghurt (Fundora *et al.*, 2001). Goat's milk has been described as having a higher digestibility and lower allergenic properties than cow's milk. In addition, goat's milk has been attributed with certain therapeutic values in human nutrition (Alferez *et al.*, 2001 and Barrionuevo *et al.*, 2002). However, the manufacture of fermented goat's milk products such as set-style yoghurt face a problem of over-acidification due to a low buffering capacity of goat's milk (Rysstad and Abrahamsen, 1983). Furthermore, goat's milk has slightly lower casein content than cow's milk, with a very low proportion or absence of α_{s1} casein, and higher degree of casein micelle dispersion and also, different structure and size of

fat globules (Remeuf & Lenoir, 1986; Vegarud *et al.*, 1999 and Tziboula-Clark, 2003). All the previous factors influence the rheological properties of the coagulum in goat's milk that is almost semi liquid. Moreover, goat's milk yoghurt shows a weaker gel, and a sharper flavour "goaty flavour", which is different from the typical flavour of cow's and buffalo's milk yoghurt (Haenlien, 2004) Several aroma compounds responsible for the specific "goaty flavour" have been identified: 3-methylbutanoic acid, octanoic acid, 4-methyloctanoic acid, 4-ethyloctanoic and nonanoic acid. These fatty acids are released by lipolysis (Ha and Lindsay, 1991). Heat treatment resulted in a general increase of volatile compounds of milk, leading to changes in flavour characteristics (Contarini and Povola, 2002).

To obtain a satisfactory curd tension and whey syneresis in goat's fermented milk, an increase in the content of non-fat solids is required. The addition of stabilizers to impart desirable texture characteristics in low-fat fermented milk and it masked the characteristics taste of goat's milk (Modler *et al.*, 1983 and Duboc and Mollet, 2001). Sodium caseinate was most effective in increasing gel strength and reducing syneresis of yoghurt (Molder *et al.*, 1983). Another possibility is the use of particulated whey protein concentrate (PWPC) that is cheaper and ready available additive that has been shown to increase viscosity and reduce syneresis (Martin-Diana *et al.*, 2003).

Therefore, the aim of the present study is to utilize low- and full-fat goat's milk for good quality functional yoghurt manufactured by mixed goat's milk with buffalo's milk and some types of stabilizers.

MATERIALS AND METHODS

Materials

Milk

Fresh mixed milk (Cow's and buffaloe's 1:1) milk was used in the manufacture of yoghurt obtained from the laboratory of Food Sci., Dept., Fac. of Agric., Benha Univ., and fresh whole goat's milk was obtained from the herds of Agric., Research Center, Ministry of Agric.,

Stabilizers

Spry dried sodium casienate (82% dry protein, 6% moisture, 6% fat) was obtained from DMV International Veghel, Weterlands parches from local market.

Particulated Whey Protein Concentrate (PWPC) (12.1% T.S, 6.72% protein, 0.79% ash and 4.59% carbohydrate) was prepared at Food Sci., Dept. (Dairy), Fac., of Agric., Moshtoher, and Benha. Univ., Egypt.

Lacta 555 consists of (**cow's gelatin**, pectin E440, starch E1422, free of alcohol and pig products) was obtained from Miser Food Additive Company, Giza, Egypt.

Yoghurt starter culture:

Yoghurt starter consists of a mixed culture of *Lactobacillus delbrueckii* subsp. *bulgaricus* and *Streptococcus thermophilus* 1:1 obtained from Chr. Hansen's Lab., Horsholm, Denmark.

Methods

Functional yoghurt manufacture:

Yoghurt was manufactured as described by Tamime (1978). The treatments were as follows:

Low-fat yoghurt (1% fat) made from:

C₁: low-fat cow's and buffalo's milk (1:1) as a control

T₁: low-fat goat's milk (1:1)

T₂: low-fat goat's and buffalo's milk (1:1)

T₃: low-fat goat's and buffalo's milk (1:1) +1.5% Sodium casienate

T₄: low-fat goat's and buffalo's milk (1:1) + 0.5% PWPC

T₅: low-fat goat's and buffalo's milk (1:1) + 0.5% Lacta

Full-fat yoghurt (3% fat) made from:

C₂: Full -fat cow's and buffalo's milk (1:1) as a control

T₆: Full -fat goat's milk (1:1)

T₇: Full -fat goat's and buffalo's milk (1:1)

T₈: Full -fat goat's and buffalo's milk (1:1) +1.0% Sodium casienate

T₉: Full -fat goat's and buffalo's milk (1:1) + 0.25% PWPC

T₁₀: Full -fat goat's and buffalo's milk (1:1) + 0.30% Lacta

All treatments were heated at ~ 85°C for 20 minutes, immediately cooled to 42 °C and inoculated with 2% yoghurt starter cultures. All treatments were filled into leaded plastic cups (100ml) and incubated at 42°C until pH reached ~ 4.6. Then, the yoghurts refrigerated at ~ 5°C and analyzed for chemical, microbiological and rheological tests and they were sensory evaluated when fresh, 7 and 14 days, respectively.

Notes: The heat treatment (85°C for 20 minutes) was preferred to reduce "goaty flavour" from preliminary experiments (i.e. 80°C/ 20 min., 85°C /20 min. and 92°C / 5 min.).

Methods of analysis:

Rheological properties:

Curd-tension:

Curd-tension of yoghurt was measured using the penetrometer Model Koehler Instruments Co., (USA) controller as described by Kmmmerlehner and Kessler (1980). The depth of penetration (0.1mm = penetrometer unit) was measured after 5 sec at 5-7°C (using fiber cone weight 30 g ,cone angle 45°)

Curd syneresis:

Curd syneresis was determined according to the method of Mehanna and Mehanna (1989).

Chemical analysis:

Titrateable Acidity, total solids, fat, ash and total protein contents of the produced yoghurt were determined according to the methodology mentioned by A.O.A.C., (1990). Lactose, Total Volatile Fatty Acids (T.V.F.A) and Acetaldehyde contents were determined by the methods of Barnett and Abd El-Tawab (1957), Kosikowski, (1984) and Lees and Jago (1969), respectively. pH value of yoghurt samples was measured according to the methods of Godinho and Fox (1982) using a pH meter JENCO Model 1671, USA.

Microbiological examination:

Lactic acid bacteria (LAB), yeasts & moulds and coliform group counts were done according to Elliker *et al.* (1956), IDF, (1990) and APHA, respectively.

Sensory evaluation:

The yoghurt samples were evaluated organoleptically by 10 of the staff members of Food Sci., Dept., Faculty of Agriculture, Moshtoher; Benha Univ. scoring was carried out recommended by Mehanna *et al.* (2000).

Statistical analysis:

Statistical analysis for the obtained data was carried out according to the method described by Clark and Kempson (1997).

RESULTS AND DISCUSSION

Coagulation time:

Results presented in Table (1) show the coagulation time of low-fat yoghurt [made from cow's and buffalo's milk, 1:1 (C₁) as a control, goat's milk (T₁); goat's & buffalo's milk, 1:1 (T₂) and goats & buffalo's milk 1:1, mixed with 1.5% sodium caseinate (T₃), 0.5% particulated whey protein concentrate (T₄) and 0.5% Lacta (T₅)] and full-fat yoghurt [made from cow's and buffalo's milk, 1:1 (C₂) as a control, goat's milk (T₆); goat's & buffalo's milk, 1:1 (T₇) and goat's & buffalo's milk, 1:1 mixed with 1% sodium caseinate (T₈), 0.25% particulated whey protein concentrate (T₉) and 0.3% Lacta (T₁₀)]. These results indicated that, low-fat yoghurt made from goat's milk (T₁) recorded high coagulation time followed by (T₂) compared with the control low-fat yoghurt (C₁). This result agrees with Gabriel (1990). They found that, the coagulation time of yoghurt made from goat's milk was higher (180-270 min) than yoghurt made from cow's milk

(120-180 min). This may be due to goat's milk has slightly lower casein content than cow's and buffalo's milk, with a very low proportion or absence of α_{s-1} casein and a higher degree of casein micelle dispersion (Remeuf & Lenoir, 1986 and Vegarud et al. (1999).

Yoghurt treatments T₃ followed by T₅ and then T₄ presented highly decrease in coagulation time compared with T₁ and T₂. The coagulation time of yoghurt was not only affected by the type of milk used but also, with the type of stabilizers. This may be attributed to the addition of

Table (1): Coagulation time of low-and full-fat functional goat's yoghurt.

Treatments	Coagulation time	
	hr: min.	Increase %
Low-fat		
C ₁	3:00	0.00
T ₁	4:00	33.33
T ₂	3:50	27.78
T ₃	3:10	5.56
T ₄	3:30	16.67
T ₅	3:20	11.11
Full-fat		
C ₂	3:40	0.00
T ₆	4:25	20.45
T ₇	4:15	15.91
T ₈	3:45	2.27
T ₉	4:00	9.09
T ₁₀	3:50	4.55

Yoghurt made from:

C₁= low-fat cow's and buffalo's milk (1:1)

T₁= ~ ~ goat's milk

T₂= ~ ~ goat's and buffalo's milk (1:1)

T₃= ~ ~ goat's and buffalo's milk (1:1) mixed with sodium caseinate

T₄= ~ ~ goat's and buffalo's milk (1:1) mixed with PWPC

T₅= ~ ~ goat's and buffalo's milk (1:1) mixed with Lacta

C₂= full-fat cow's and buffalo's milk (1:1)

T₆= ~ ~ goat's milk

T₇= ~ ~ goat's and buffalo's milk (1:1)

T₈= ~ ~ goat's and buffalo's milk (1:1) mixed with sodium caseinate

T₉= ~ ~ goat's and buffalo's milk (1:1) mixed with PWPC

T₁₀= ~ ~ goat's and buffalo's milk (1:1) mixed with Lacta

stabilizers had a higher protein contents which can server as a source of peptides and amino acids (Molder *et al.*, 1983; Dave and Shah, 1998 and Sandoval-Castilla et al., 2004). Duistschaever (1978) and Omer (1990) found that, the protein particles of milk to disintegrate upon heating into smaller sized particles with an increasing of denaturated whey proteins,

which resulted in prolonged coagulation time when PWPC was added o goat's milk. On the other hand, the coagulation time of full-fat yoghurts take the same trend of low-fat yoghurts but with a slight increase. These results agree with El-Nagar and Brennan (2001).

Rheological properties:

Fig. (1 a and b) shows the curd tension of low- and full-fat goat's milk mixed with buffalo's milk and some type of stabilizers. (The higher record by the penetrometer reading, the less curd tension of yoghurt). It could be observed that the lowest curd tension ($p < 0.05$) was recorded for T1 followed by T2, while the highest curd tension ($p < 0.05$) was recorded for C1, followed by T3, T4 and then T5 when fresh and during storage.

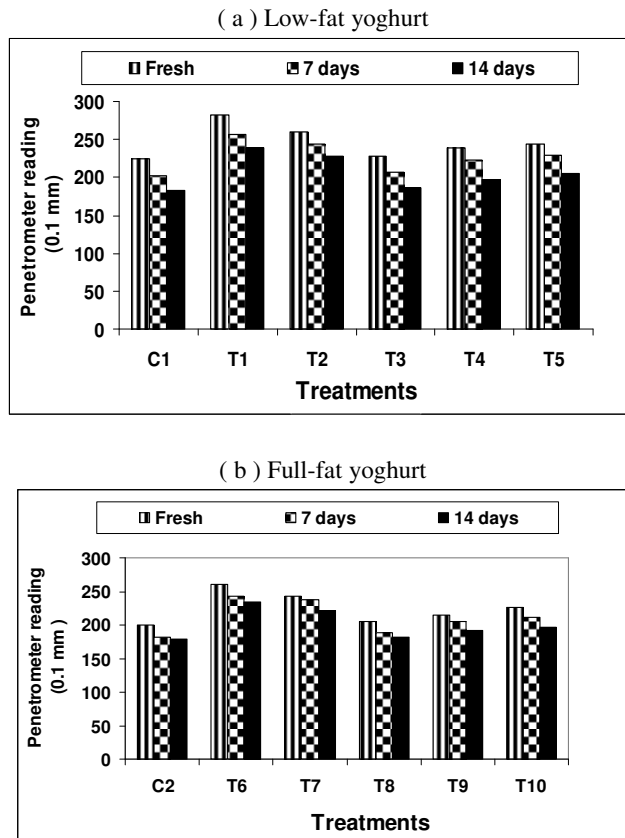


Fig. (1 a and b): Penetrometer reading of low- and full-fat functional goat's yoghurt when fresh and during storage.

On the other side, the results of whey syneresis (Table 2) take the opposite trend with curd tension values. These results generally clarify that any type of stabilizers used had higher in curd tension and lower syneresis of the manufactured yoghurt compared to low- and full-fat goat's milk yoghurt made without stabilizers. This demonstrates the high influence on texture caused by the differences in casein content and micelle structure between different types of milk, in addition to the type of stabilizer, which used in manufacture (Vegarud *et al.*, 1999 and Vargas *et al.*, 2008). Yoghurts mixed with stabilizers may lead to the increased bound water and larger protein aggregates. These, consequently increased the curd tension and decreased syneresis of the resulting gel (Martin-Diana *et al.*, 2003 and Sandoval-Castilla *et al.*, 2004). Modler *et al.* (1983) reported that yoghurts mixed with casein preparation exhibited fusion of casein micelles. Sodium caseinate had the greatest micelle fusion effect, contributing to higher firmness and less whey expulsion. Shukla and Jain (1991) found that, the addition of 0.3-0.6% gelatin improved consistency and reduced the whey separation in yoghurts.

Fat content significantly affected the curd tension and whey syneresis of yoghurt. In general, yoghurts made from low-fat milk had significantly lower curd tension and higher whey syneresis than the yoghurts made from full-fat milk. This may be due to the decrease of total solids which exhibit weak body, poor texture and whey separation. While, the greater total solids and positive interactions of fat globules with the gel network in full-fat yoghurt are reasons the great curd tension and lower syneresis of this treatment (Sandoval-Castille *et al.*, 2004; Pereira *et al.*, 2006 and Aziznia *et al.*, 2008).

The curd tension progressively increased and whey syneresis decreased in all treatments with advanced storage, which may be attributed to a slight increase of total solids content and acidity development as well as the complete setting of curd during storage. These results are confirmed with El-Sayed (2003) and El-Nagar *et al.* (2007).

Chemical composition of yoghurt:

The changes in the chemical composition of low- and full-fat yoghurt made from goat's milk or mixed goat's and buffalo's milk (1:1) with or without stabilizers are presented in Table (3). These results indicated that T₃ treatment had a slightly higher percentage of T.S, protein and ash contents followed by C₁, T₄, T₅, T₂ and then T₁ when fresh and during storage of yoghurt. These results could be attributed to the different types of milk and different types and amounts of stabilizer. Sodium caseinate, microparticulated whey protein and gelatin had a higher protein contents (Molder *et al.*, 1983 and Sandoval-Castilla *et al.*, 2004). On the other hand,

Table (2): Whey syneresis (g/100 g) of low and full-fat functional goat's yoghurt when fresh and during storage.

Treatments	Time					
	15 min	30 min	45 min	60 min	90 min	120 min
Low-fat						
Fresh						
C ₁	16.23	21.38	23.32	28.16	30.84	32.00
T ₁	32.16	39.38	42.36	45.60	47.30	51.50
T ₂	27.50	32.07	35.41	39.54	42.04	45.00
T ₃	17.85	22.26	24.46	28.44	31.26	34.00
T ₄	20.14	24.68	27.76	32.72	35.26	37.00
T ₅	23.27	26.68	30.78	34.65	36.00	38.54
7 days						
C ₁	15.90	19.90	21.79	24.66	28.22	30.80
T ₁	30.00	35.71	40.11	44.08	45.00	50.30
T ₂	26.15	30.88	32.45	37.82	41.13	43.80
T ₃	16.77	19.31	21.66	25.07	29.98	32.44
T ₄	18.23	22.25	25.85	29.90	33.10	35.70
T ₅	21.80	24.50	28.17	32.81	34.90	37.32
14 days						
C ₁	11.11	15.00	19.84	23.01	26.60	29.23
T ₁	26.08	23.21	37.20	40.51	43.16	48.40
T ₂	23.18	26.14	29.88	34.90	38.19	41.62
T ₃	13.94	16.26	18.91	23.19	27.30	30.27
T ₄	15.46	18.09	21.12	27.13	31.10	33.90
T ₅	19.12	21.75	25.00	29.80	33.05	35.71
Full-fat						
Fresh						
C ₂	12.60	13.25	15.50	19.18	22.41	24.21
T ₆	25.08	29.11	32.36	34.33	38.90	39.46
T ₇	19.15	24.61	24.58	29.65	36.31	33.50
T ₈	14.15	17.74	19.65	21.42	23.21	25.62
T ₉	15.30	19.92	21.57	23.95	25.28	27.53
T ₁₀	18.76	21.25	23.66	24.97	26.81	28.89
7 days						
C ₂	11.00	12.81	14.50	17.95	20.50	22.70
T ₆	24.50	26.81	29.00	32.11	36.60	38.00
T ₇	18.21	20.69	22.01	26.32	29.45	32.10
T ₈	12.32	16.11	17.15	19.16	21.46	24.42
T ₉	14.60	17.25	19.61	22.20	20.24	26.73
T ₁₀	16.01	20.07	21.30	23.00	25.10	27.05
14 days						
C ₂	10.05	11.00	13.20	15.10	19.21	50.21
T ₆	23.00	24.11	27.98	30.96	34.90	36.82
T ₇	17.97	19.20	20.90	25.50	28.26	30.53
T ₈	12.98	15.02	16.25	18.23	20.29	23.37
T ₉	14.03	16.00	18.00	21.08	23.30	25.00
T ₁₀	15.11	18.91	19.99	21.46	24.09	26.11

Legend : see under Table 1

Table (3): Chemical composition of low and full- functional goat's yoghurt when fresh and during storage (for legend see under Table 1).

Treatments	Storage Period (days)	T.S %	Fat %	Protein %	Lactose %	Ash %	Acidity %	pH value	Acetaldehyde ($\mu\text{g}/100\text{g}$)	TVFA (ml NaoH 0.1N/100g)
Low-fat										
C ₁	Fresh	11.27	1.06	4.51	4.90	0.959	0.890	4.42	26.99	4.814
T ₁		09.95	1.00	3.73	4.47	0.881	0.98	4.31	29.72	6.730
T ₂		10.64	1.02	4.22	4.72	0.920	0.88	4.43	25.76	5.176
T ₃		11.66	1.04	4.94	4.53	0.967	0.92	4.41	25.40	5.101
T ₄		11.13	1.00	4.42	4.61	0.945	0.90	4.44	25.13	5.076
T ₅		11.07	1.02	4.39	4.59	0.935	0.89	4.30	25.54	5.120
C ₁	7	11.39	1.125	4.45	4.66	0.970	0.94	4.32	25.83	7.086
T ₁		10.08	1.140	3.67	4.23	0.890	1.04	4.10	28.35	9.810
T ₂		10.73	1.133	4.20	4.43	0.928	0.92	4.31	24.93	8.775
T ₃		11.78	1.126	4.89	4.26	0.972	0.96	4.28	24.87	8.387
T ₄		11.26	1.122	4.37	4.38	0.960	0.95	4.28	24.57	8.196
T ₅		11.17	1.118	4.31	4.33	0.941	0.93	4.31	24.98	8.573
C ₁	14	11.45	1.142	4.41	4.39	0.979	0.98	4.26	23.94	9.543
T ₁		10.27	1.163	3.61	4.02	0.903	1.12	4.05	25.11	11.185
T ₂		10.87	1.139	4.17	4.31	0.930	0.96	4.28	22.81	10.965
T ₃		11.90	1.134	4.83	4.15	0.990	0.99	4.10	22.40	10.502
T ₄		11.36	1.128	4.32	4.21	0.983	0.98	4.10	22.14	10.230
T ₅		11.24	1.123	4.28	4.18	0.950	0.97	4.27	22.68	10.754
Full-fat										
C ₂	Fresh	13.50	3.12	4.44	4.82	0.930	0.84	4.48	98.50	22.94
T ₆		12.40	2.96	3.63	4.41	0.875	0.91	4.40	136.90	35.42
T ₇		13.00	3.08	4.10	4.63	0.916	0.86	4.45	112.34	27.54
T ₈		13.70	2.94	4.72	4.42	0.960	0.88	4.42	108.67	26.80
T ₉		13.15	3.01	4.33	4.56	0.930	0.86	4.43	104.42	25.80
T ₁₀		13.11	3.04	4.21	4.51	0.940	0.85	4.45	107.50	26.10
C ₂	7	13.68	3.15	4.32	4.62	0.942	0.87	4.42	93.66	26.86
T ₆		12.71	3.17	3.49	4.14	0.884	1.02	4.12	129.30	38.52
T ₇		13.22	3.12	4.08	4.51	0.928	0.89	4.42	108.21	31.08
T ₈		13.81	3.08	4.81	4.30	0.972	0.93	4.31	105.16	29.73
T ₉		13.30	3.10	4.30	4.43	0.953	0.90	4.38	102.31	29.41
T ₁₀		13.27	3.10	4.16	4.40	0.951	0.89	4.43	104.80	29.94
C ₂	14	13.79	3.18	4.28	4.26	0.949	0.91	4.35	79.20	28.28
T ₆		12.82	3.19	3.41	4.01	0.886	1.06	4.10	107.23	39.74
T ₇		13.30	3.15	4.05	4.20	0.935	0.94	4.29	86.51	33.02
T ₈		13.89	3.12	4.72	4.12	0.980	0.97	4.28	83.74	32.24
T ₉		13.39	3.14	4.25	4.16	0.964	0.94	4.34	83.18	32.08
T ₁₀		13.34	3.13	4.17	4.14	0.960	0.92	4.39	82.85	32.16

fat, acidity, lactose, TVFA, acetaldehyde content and pH values of yoghurt were noticeably affected by the addition of stabilizers as apparent from the close acidity of the different treatments except low-fat yoghurt made from goat's milk (T₁) had a slightly higher acidity, acetaldehyde and TVFA content than the other treatments when fresh and during storage. These results agree with Manjunath *et al.* (1983). The manufacture of fermented goat's products such as set-style yoghurt faces a problem of over-acidification due to a low buffering capacity of goat's milk (Rysstad and Abrahamsen, 1983). On the other side, low-fat yoghurt was shown to have slightly higher acidity and lower pH than full-fat yoghurt ($p < 0.05$). It is probably due to the impact of fat content on the growth and activity of lactic acid bacteria in yoghurt (Shaker *et al.*, 2000).

A gradual increase in the T.S, ash, fat, acidity and TVFA of yoghurt treatments was recorded over the storage period. The opposite trend of

results was noticed with respect to protein, lactose, acetaldehyde content and pH values. The increase in T.S, ash, and fat content may be due to loss of moisture content during storage. These results agreement with Mahanna *et al.* (2000) and El-Nagar and Brennan (2001). Titratable acidity increased, while pH values and lactose content decreased during the storage period in all treatments which may be due to the ability of lactic acid bacteria to convert lactose to i.e. lactic acid, acetaldehyde and acetone (Rasic and Kurmmann,1978 and Laye *et al.*, 1993). Slight decreases were found in protein content during storage in all treatments which may be due to the proteolytic effect by *lactobacillus delbrueckii* subsp. *bulgaricus* (Rasic and Kurmmann, 1978). Acetaldehyde content slightly decreased during the first week of storage, and then it decreased ($p < 0.01$) as prolonging the storage period in all treatments. This decrease may be due to the demonstrated ability of numerous lactic acid bacteria to convert the acetaldehyde to ethanol (Tamime and Robinson, 1999). During storage, TVFA gradually increased ($p < 0.05$) in all treatments until the end of storage. The increase in TVFA may be due to several lipases and esterases activity of yoghurt bacteria (Gupta and Prasad 1989). On the other side, the changes of the chemical composition of full-fat yoghurts take the same trend of low-fat yoghurts when fresh and during storage.

Microbiological quality of yoghurt:

The influence of different types of milk and stabilizers on the microbiological quality of low-and full-fat yoghurt during storage for 14 days are shown in Fig (2 a and b). It could be noticed that the lactic acid bacterial counts were no obvious effects due to types of milk but there were obvious slight effects due to the different type of stabilizers. This may be due to, sodium casinate, PWPC and gelatin had a higher protein contents which can serve as a source of peptides and amino acids led to an increase in viable counts of LAB (Molder *et al.*, 1983; Dave and Shah, 1998 and Sandoval-Castilla *et al.*, 2004). The increase in available nutrients from caseinate or whey proteins may partially influence the growth of yoghurt bacteria (Amatayakul *et al.*, 2006). The effect of storage on the lactic acid bacterial counts was more pronounced than the effect of stabilizers. Growth pattern indicated a slight increase in the count of lactic acid bacteria after 7 days of storage, but thereafter the count decrease, this may be due to the increase of acidity which effect on *Streptococcus thermophilus* activity. These results, with respect to the growth pattern of lactic acid bacteria during storage of yoghurt, are in agreement with Khalafalla and Roushdy (1996).

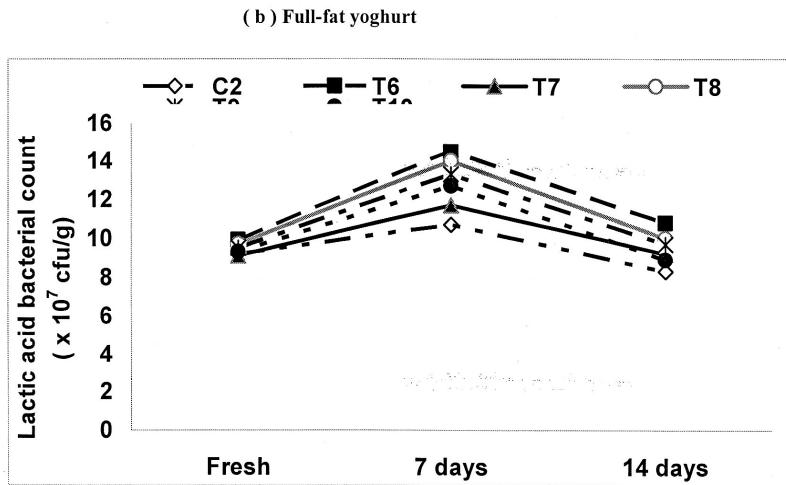
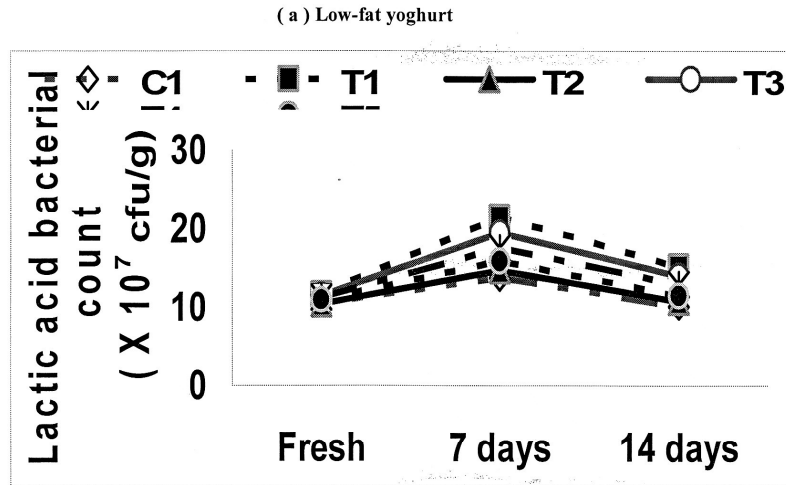


Fig. (2 a and b): Lactic acid bacterial counts of low- and full-fat functional goat's yoghurt when fresh and during storage

Concerning to the coliform group, they were not detected in all treatments either when fresh or during storage. This due to the combined effect of high heat treatment of milk and the suppressive effect of the used LAB culture during the manufacture of yoghurt, which associated with their ability to produce some of acidity and antimicrobial compounds (Abd El-Aty *et al.*, 1998).

With regard to the yeasts and moulds (Y&M) they were not detected in all fresh treatments and up to 7 days of storage, where they started to appear in some products at the end of storage but the count was less than 10 cfu/g and this may be due to the post contamination of these products during handling and storage of these products.

Organoleptic Properties of Yoghurt:

Organoleptic properties of yoghurt treatments including flavour, appearance, and body & texture are presented in Table (4). Results indicated that, no foreign or undesirable flavour and no pronounced differences were noticed in the flavour and appearance of all yoghurt samples with exception that an undesirable taste was detected in full- and low-fat yoghurt made from goat's milk only (T₆ and T₁ respectively). This may be due to peculiarities of goat's milk fatty acid composition which play an important role in the development of goat flavour, leading to changes in characteristics (Contarini and Povola, 2002 and Chilliard *et al.*, 2003). Martin- Diana *et al.* (2003) they found that, yoghurt made from goat's milk was the least flavour and appearance objecting to its liquid texture and non-typical yoghurt taste.

Mixed low-fat goat's milk with buffalo's milk (1:1) without stabilizers had slightly improved the flavour and texture of yoghurt compared with yoghurt made from goat's milk only. Whereas, mixed low-fat goat's milk with buffalo's milk (1:1) and stabilizers had highly improved the flavour and texture of yoghurt. The yoghurt sample made with 1.5% sodium casienate (T₃) came at first, followed by the 0.5% PWPC (T₄) and then 0.5% Lacta (T₅). However, yoghurt samples without stabilizers (C₁, T₂ and T₁, respectively) as it had the lowest score. This variation in flavour, appearance and texture between yoghurt treatments are due to goat's milk has slightly higher acidity, lower casein content, with a very low proportion or absence of α_{s-1} casein and higher degree of casein micelle dispersion than cow's and buffalo's milk. All these factors influence the rheological properties of the coagulum in goat's milk that is almost semi liquid (Remuf & Lenoir, 1986 and Vegarud *et al.*, 1999) and also, due to the addition of stabilizers masked the characteristic taste of goat's milk and its affected on the activity of yoghurt culture (Modler *et al.*, 1983; Dave & Shah, 1998 and Amatayakul *et al.*, 2006). Sinha (1984) recommended using edible stabilizer for improving texture and consistency of the fermented products. Modler *et al.* (1983) who found that, sodium casienate (1.5%) was most effective in increasing gel strength and reducing syneresis of yoghurt.

Table (4): Organoleptic properties of low and full-fat functional goat's yoghurt when fresh and during storage.

Treatments	Storage period (days)	Flavour (60)	Appearance (10)	Texture (30)	Total (100)
Low-fat					
C ₁	Fresh	55.51	8.25	26.60	90.36
	7	55.70	8.50	26.90	91.10
	14	55.82	8.60	27.20	91.62
T ₁	Fresh	52.10	7.13	21.10	80.33
	7	52.52	7.70	21.26	81.48
	14	52.86	7.92	21.58	82.36
T ₂	Fresh	54.00	8.15	25.90	88.05
	7	54.42	8.27	26.02	88.71
	14	54.78	8.32	26.80	89.90
T ₃	Fresh	58.29	9.16	28.56	96.01
	7	58.72	9.47	28.68	96.87
	14	58.93	9.63	28.94	97.50
T ₄	Fresh	57.29	8.93	28.12	94.34
	7	57.35	9.21	28.33	94.89
	14	58.11	9.39	28.50	96.00
T ₅	Fresh	56.1	8.7	27.65	92.45
	7	56.30	8.95	27.86	93.11
	14	56.56	9.14	28.04	93.71
Full-fat					
C ₂	Fresh	57.12	8.55	27.60	93.27
	7	57.76	8.78	27.84	94.38
	14	58.90	8.93	28.09	95.92
T ₆	Fresh	49.07	7.85	23.16	80.01
	7	49.34	7.94	23.66	80.94
	14	49.72	8.08	24.01	81.81
T ₇	Fresh	56.60	8.45	26.90	91.95
	7	56.83	8.63	27.02	92.48
	14	57.57	8.75	27.80	94.12
T ₈	Fresh	59.12	9.42	29.30	97.84
	7	59.20	9.73	29.50	98.43
	14	59.43	9.95	29.72	99.10
T ₉	Fresh	58.49	9.22	28.27	95.98
	7	58.78	9.55	28.52	96.85
	14	58.93	9.76	28.81	97.50
T ₁₀	Fresh	57.76	8.93	28.08	94.77
	7	58.01	9.48	28.25	95.74
	14	58.24	9.59	28.57	96.40

For legend see under Table 1

On the other hand, full – fat yoghurt treatments scored higher for flavour, appearance and texture than those with low–fat yoghurt treatments. This was expected as the fat is the main carrier of flavour for many compounds and also, the fat greatly affects rheological and sensory properties (Ohmes

et al., 1998) All treatments take the same trend for flavour, appearance and texture when fresh and during storage.

CONCLUSIONS

From the foregoing results, it can be recommended that, the optimal curd tension, whey syneresis and sensory evaluation of functional goat's milk yoghurt were achieved by supplementation of full- or low-fat goat's milk with buffalo's milk (1:1) and sodium casienate (1 and 1.5% for full- or low-fat, respectively).

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الاستفادة من لبن الماعز في صناعة زبادي وظيفي منخفض وكامل الدهن

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يهدف البحث الي دراسة صناعة زبادي وظيفي من لبن ماعز منخفض وكامل الدهن بتدعيمه باللبين الجاموسي وبعض أنواع المثبتات. وقد أشارت النتائج الي أن أفضل قوة شد للخثرة وانفصال الشرش وجودة بكتريولوجية وتقييم حسي تم الحصول عليها كانت بتدعيم لبن الماعز منخفض وكامل الدهن باللبين الجاموسي بنسبة (1:1) وبعض أنواع المثبتات. ووجد أن التدعيم بكازينات الصوديوم بنسبة (1 أو 1,5%) جاءت في المقدمة يليها التدعيم بمعدّات بروتينات الشرش المركزة (0,25 أو 0,5%) وأخيرا التدعيم باللاكتا (0,3 أو 0,5%) لكل من لبن الماعز كامل ومنخفض الدهن علي الترتيب. وقد أدى التدعيم بكازينات الصوديوم الي زيادة قوة الشد للخثرة و العد الكلي لبكتريا حمض اللاكتيك كما أدت الي انخفاض انفصال الشرش ووقت التجبن وهذا يرجع الي ارتفاع محتواها من البروتين والاحماض الامينية التي تنشط وتزيد أعداد بكتريا حمض اللاكتيك. كما لوحظ أيضا أن انخفاض نسبة الدهن بلبن الماعز وكذلك المعاملة الحرارية للبن الزبادي وازافة المثبتات أدت الي اخفاء خصائص طعم ورائحة لبن الماعز والي تحسين المظهر والنكهة والتركيب ونتاج زبادي مقبول حسيا.