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The Quality of Yoghurt on Retail in Turkey

C. Karagozlu, S. Kilic, H. Uysal, N. Akbulut and H. Kesenkas
Department of Dairy Technology, Faculty of Agriculture, Ege University, 35040, Izmir, Turkey

Abstract: Some physico-chemical and microbiological properties of 47 commercial yoghurt samples collected from the local market were examined to determine their consistency to current codex. Results obtained showed that, considering non-fat solids contents, the majority (87.2%) of the samples were in line with the Turkish Food Codex Fermentative Milk Regulation. Nevertheless, 9 samples were found to be out of limits indicated in the relevant codex. The chemical composition of 80.9% of the samples did not match the values declared on their labels and not obey with the lower limits indicated in the codex. All samples had higher total acidity values than the upper limits given in the relevant codex. With regard to the counts of viable yoghurt bacteria, while almost half of the samples examined (49%) had numbers high enough for standard yoghurt, 23 samples (51%) had low counts of yoghurt bacteria.

Key words: Commercial yoghurt, food codex, yoghurt bacteria

INTRODUCTION

Fermented milk products have been known since the early civilisations. Among fermented dairy products, yoghurt has a distinguished place due to its extended shelf-life and organoleptic properties. The type of yoghurt produced depends upon regional tastes and marketing objectives. Generally, a smooth, light gel which is easily spooned out of its container is popular in Europe and North America, although in the Balkans and the Middle East, thick and more acidic yoghurt is preferred[1-3].

In Turkey, 10.500.000 ton milk is produced yearly and, 25.0% of this is used for yoghurt production. The annual consumption of yoghurt (28-30 kg/person) indicates that it is an important dairy food in Turkey since it is health-promoting property is well recognised by the Turkish people[3,4].

The health benefits of yoghurt have been known for hundreds of years, people in Turkey traditionally consume yoghurt at large quantities to maintain their overall well being. The presences of a large number of live and active bacterial cells and/or metabolites formed during yoghurt fermentation have beneficial effects on human health. Yoghurt containing health-promoting bacteria are an important segment of the functional food market. Potential benefits include; prevention of osteoporosis and hypertension, improvement of intestinal health, modulation of the immune response, reduced risk of cancer, reduced risk of heart diseases, control of serum cholesterol level and improved tolerance to milk sugar (lactose)[3,5].

The starter culture used in yoghurt production is a symbiotic blend of *Streptococcus salivarius* sp. *thermophilus (S. thermophilus)* and *Lactobacillus delbrueckii* sp. *bulgaricus (L. bulgaricus)* which are both thermophilic and homolactic. The ratio of 1:1 between *S. thermophilus* and *L. bulgaricus* is extensively quoted in the literatures as the optimum ratio for a good textural and organoleptic quality yoghurt[5-7]. The optimum number of active bacteria in a mix yoghurt starter culture should be $>10^8$ cfu g^{-1} and[5,6,8]. In France and Spain established the requirement of a minimum viable lactic acid bacteria number in yoghurt as 5×10^8 cfu mL^{-1}. In other countries, this value varies as follows: 10^6 cfu mL^{-1} in Switzerland and Italy, 10^7 cfu g^{-1} in Japan and 10^8 cfu g^{-1} in Portugal[9]. In addition, yoghurts produced in Turkey should contain $\geq10^7$ cfu g^{-1} specific yoghurt bacteria according to Turkish Food Codex[10]. However, during processing and storage, the number of viable cells tends to decline due to severe environmental conditions such as oxygen and high acidity[11]. There are few scientific studies reporting the viability of specific bacteria in commercial yoghurt products in Turkey.

The objective of this study was to investigate specific viable bacteria counts and some chemical properties of yoghurts in Turkish food market, according to Turkish food codex and to report of the 5th session of the codex committee on milk and milk products[12].

MATERIALS AND METHODS

Materials: Forty seven brands of commercial yoghurt samples were obtained randomly from the market. All

Corresponding Author: H. Kesenkas, Department of Dairy Technology, Faculty of Agriculture, Ege University, 35040, Izmir, Turkey Tel: +90232 388 40 00/1639

yoghurt samples were received in their own original packages and transported to the laboratory for analyses at 8±2°C.

Methods

Chemical analysis: Total Solids (TS) and fat content were determined by gravimetric method[13] and by Gerber method[14], respectively. Non fat solids were calculated by subtracting fat from TS and pH was measured by using a combined glass electrode pH-meter (Hanna 210, Hanna Instruments Deutschland GmbH). Titratable acidity was determined according to Kurt *et al.*[15] and expressed as percentage lactic acid.

Microbiological analysis: *S. thermophilus* and *L. bulgaricus* counts were determined in each yoghurt samples. Each sample (10 g) was serially diluted to 10^{-8} by means of 1/4 strength Ringers' solution. Appropriate dilutions were plated using the following media: (I) M_{17} Agar (Oxoid Ltd, Basingstoke, Hampshire, England, CM 785) for the enumeration of *Str. thermophilus*; incubated aerobically at 35±1°C for 48 h (ii) MRS Agar (Oxoid Ltd, Basingstoke, Hampshire, England, CM 361) for the enumeration of *L. bulgaricus*; incubated anaerobically for 48 h. at 42±1°C[16]. Statistical evaluations were carried out using SPSS for Windows 9.05 package program.

RESULTS AND DISCUSSION

The average total solids content as 15.89% and varied between 12.45-20.76% in the yoghurt samples. Total solids contents of only three samples were found to be higher than 18% which is too high for natural set yoghurt (Table 1). However, there is no limitations for total solids level of yoghurt in Turkish Food Codex[10].

According to, the Turkish Food Codex Fermentative Milk Regulation, the non-fat solids content of yoghurt must be at least 12.0% in all types of yoghurt. The average Non Fat Solids (NFS) value was 12.78% in the samples analysed as 12.78 % and varied between 9.83 -15.96%. Statistical evaluation of NFS % is given in Fig. 1. The NFS of 6 samples was not in agreement with the minimum level given in the codex[10].

In Turkish Food Codex Fermentative Milk Regulation, yoghurts are classified according to their fat contents. The full fat, fatty, half fat and skimmed yoghurts must contain minimum 3.8, 3.0, 1.5 and 0.15% milk fat, respectively. According to the label information of the yoghurt samples, 15 of them were declared as full fat; however, only 6 of these yoghurts were analytically determined as full fat yoghurt. The fat contents of 38 samples out of 47 were found to be higher than the

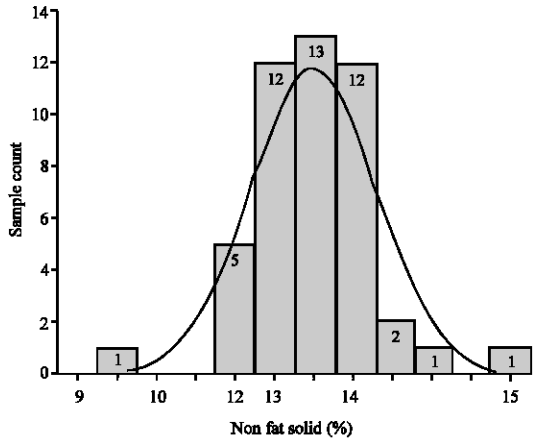

Fig. 1: NFS (%) histogram of commercial yoghurt samples (n=47)

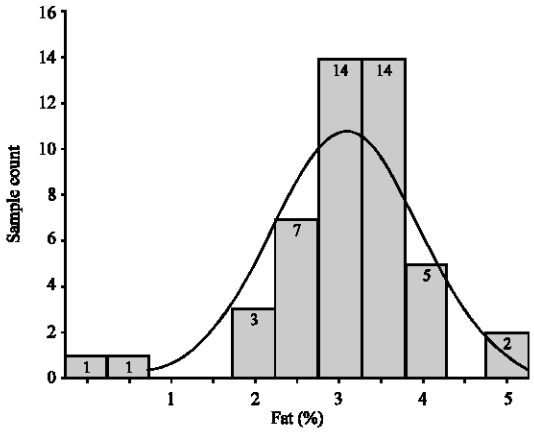

Fig. 2: Fat (%) histogram of commercial yoghurt samples (n=47)

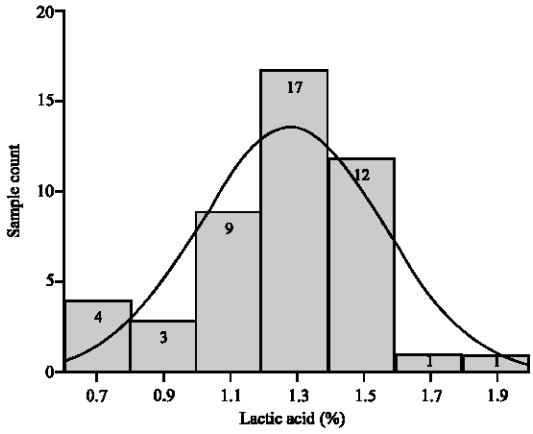

Fig. 3: Lactic acid (%) histogram of commercial yoghurt samples (n=47)

Table 1: Some properties of commercial yoghurt samples

Sample No.	Label Information	TS (%)	NSF (%)	Fat (%)	pH	LA (%)	*L. bulgaricus*(cfu/g)	*S. thermophilus* (cfu/g)	S:L
1	FF[1]	15.71	12.110	3.600	4.400	1.360	$2.9x10^7$	$2.4x10^7$	0.828
2	HF[3]	14.35	12.500	2.000	4.500	1.590	$1.0x10^5$	$2.1x10^4$	0.210
3	L[4]	12.45	12.150	0.300	4.450	1.400	$4.8x10^6$	$1.1x10^7$	2.292
4	FF	15.70	12.150	3.550	4.450	1.300	$5.3x10^7$	$9.1x10^6$	0.172
5	FF	15.95	12.350	3.600	4.450	1.300	$4.9x10^6$	$2.5x10^6$	0.510
6	F[2]	15.68	12.480	3.200	4.400	1.330	$3.1x10^3$	$4.1x10^4$	13.226
7	F	15.90	12.500	3.400	4.850	0.730	$9.2x10^7$	$2.0x10^6$	0.022
8	F	16.15	12.800	3.300	4.550	0.780	$8.0x10^6$	$1.7x10^7$	2.125
9	F	16.79	13.590	3.200	4.100	1.320	$4.0x10^7$	$1.0x10^7$	0.250
10	F	15.80	12.500	3.300	4.600	0.780	$5.3x10^5$	$9.0x10^5$	1.698
11	HF	15.09	13.340	1.750	4.150	1.370	$4.9x10^6$	$2.5x10^6$	0.510
12	F	15.40	12.300	3.100	4.300	1.010	$3.7x10^7$	$7.1x10^7$	1.919
13	HF	16.21	13.610	2.600	4.300	1.170	$6.1x10^7$	$5.5x10^6$	0.090
14	HF	15.45	13.300	2.100	4.450	0.810	$3.0 x10^7$	$3.6x10^7$	1.200
15	F	16.59	13.440	3.150	4.250	0.780	$1.5x10^7$	$1.1x10^7$	0.733
16	HF	15.33	13.030	2.300	4.150	1.230	$5.5x10^6$	$4.6x10^4$	0.008
17	F	15.88	12.780	3.100	4.250	1.390	$3.8x10^7$	$2.1x10^6$	0.055
18	HF	16.10	13.500	2.600	4.500	1.080	$3.8x10^5$	$8.9x10^4$	0.234
19	HF	16.38	13.980	2.400	4.450	1.010	$3.2x10^6$	$8.9x10^5$	0.278
20	FF	16.28	12.680	3.600	4.350	1.190	$6.2x10^6$	$1.0x10^6$	0.161
21	FF	18.10	14.400	3.700	4.100	1.320	$2.7x10^7$	$8.1x10^6$	0.300
22	F	16.80	13.600	3.200	4.250	1.100	$1.5x10^7$	$1.1x10^5$	0.007
23	FF	15.93	12.330	3.600	4.550	0.870	$4.6x10^6$	$5.5x10^6$	1.196
24	L	12.50	12.300	0.200	4.500	0.920	$4.0x10^6$	$1.3x10^7$	3.250
25	FF	16.76	12.460	3.300	4.400	1.080	$3.1x10^6$	$2.5x10^7$	8.065
26	FF	15.82	12.620	3.200	4.500	1.100	$3.2x10^7$	$3.5x10^7$	1.094
27	HF	15.05	12.550	2.500	4.050	1.590	$71.1x10^7$	$1.5x10^7$	0.211
28	HF	16.11	13.310	2.800	4.200	1.390	$1.1x10^7$	$2.1x10^6$	0.191
29	HF	16.48	14.180	2.300	4.150	1.530	$3.8x10^7$	$1.2x10^5$	0.003
30	HF	15.95	13.500	2.450	4.300	1.350	$1.8x10^7$	$1.0x10^7$	0.556
31	FF	16.10	12.200	3.900	3.700	1.980	$1.1x10^5$	$1.1x10^4$	0.100
32	F	16.70	13.600	3.100	4.000	1.530	$8.3x10^3$	$7.1x10^3$	0.855
33	F	15.50	11.800	3.700	4.550	1.230	$9.1x10^6$	$2.3x10^6$	0.253
34	FF	16.50	12.700	3.800	4.400	1.280	$7.2x10^7$	$8.1x10^7$	1.125
35	FF	20.76	15.960	4.800	4.150	1.190	$99.4x10^5$	$6.2x10^5$	0.624
36	FF	13.03	9.830	3.200	3.920	1.540	$22.9x10^5$	$3.3x10^4$	0.144
37	F	15.00	11.700	3.300	4.200	1.300	$1.7x10^5$	$8.1x10^4$	0.476
38	F	18.08	13.080	5.000	3.940	1.530	$8.1x10^5$	$6.1x10^5$	0.753
39	F	16.81	13.410	3.400	3.900	1.570	$3.8x10^6$	$2.7x10^3$	0.001
40	F	15.27	12.270	3.000	3.950	1.580	$8.1x10^4$	$3.4x10^4$	0.420
41	F	15.50	12.300	3.200	3.800	1.630	$7.3x10^4$	$5.4x10^4$	0.740
42	F	15.81	12.610	3.200	4.150	1.350	$2.1x10^5$	$6.3x10^4$	0.300
43	F	16.60	13.400	3.200	4.010	1.500	$9.2x10^6$	$7.6x10^5$	0.083
44	FF	15.53	11.730	3.800	3.950	1.510	$1.8x10^3$	$1.3x10^3$	0.722
45	FF	15.58	11.780	3.800	3.910	1.550	$3.4x10^4$	$2.5x10^3$	0.074
46	F	15.00	11.700	3.300	4.030	1.420	$6.2x10^6$	$7.3x10^5$	0.118
47	FF	16.40	12.600	3.800	4.100	1.370	$9.3x10^6$	$7.3x10^6$	0.785
Max.		20.76	15.960	5.000	4.850	1.980	$9.2x10^7$	$8.1x10^7$	13.226
Min.		12.45	9.830	0.200	3.700	0.730	$1.8x10^3$	$1.3x10^3$	0.001
Mean		15.89	12.780	3.080	4.240	1.280	$16.3x10^7$	$8.8x10^6$	1.042
±SD		1.307	0.929	0.871	0.245	0.272	$22.5x10^7$	$16.8x10^7$	2.225

[1]FF: Full fat, [2]F: Fatty, [3]HF: Half fat, [4]L: Light

minimum fat level for fatty yoghurt stated in the codex. According to the label declaration, 11 samples were declared as half fat yoghurt, but our analytical studies showed that these samples had higher level of fat than the minimum values designated for half fat yoghurt in the codex. This can also be seen from the histogram (Fig. 2). The fat contents of two low fat yoghurt samples were higher than the limit values stated in the food codex (Table 1).

The pH values of yoghurt samples varied between 3.70-4.85, averaging 4.24. According to literature data, these results are in good agreement with other studies[17-20] carried out on market yoghurts.

The acidity and level of proteolysis in yoghurt play important roles in the formation of yoghurt flavour. Therefore, the acidity is another quality criteria for yoghurt. The consumers in Turkey do not prefer too sour and plain taste in yoghurt. In the Turkish food codex and

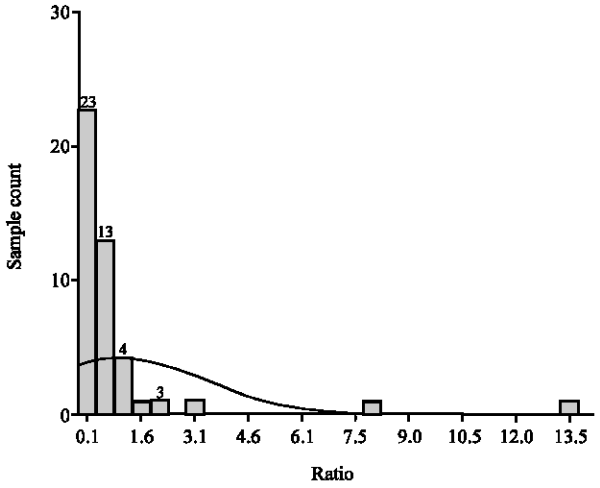

Fig. 4: Histogram of ratio between viable numbers of *S.thermophilus* and *L. bulgaricus*

Report of the fifth session of the codex committee on milk and milk products, the minimum titratable acidity value in yoghurt is given as 0.6% lactic acid. The titration acidity of the 47 samples examined in our study varied between 0.73-1.98% with an average of 1.28% lactic acid (Table 1). All of the samples had higher level of acidity than the minimum level stated in the codex and report. In the previous studies, it was found that Turkish consumers prefer yoghurts having 0.9% lactic acid level on average[17-21]. Figure 3 shows the distribution of yoghurts according to their lactic acid levels.

The quality and shelf life of the Turkish yoghurt is closely related with the quality of the milk, technological processes applied and starter culture used. Yoghurt should contain viable starter bacteria high enough for ith attributed therapeutic properties. The level and type of starter culture are also important for the development of texture and aroma/flavour desirable to the consumers. Besides, the ratio between *L. bulgaricus* and *S. thermophilus* should be approximately 1:1[22]. When the number of *L. bulgaricus* is accepted as 1 in Table 1, the value of *S. thermophilus* varied between 0.001-13.226 and average ratio was 1:1.042. This ratio was determined approximately 1:1 in only 7 out of 47 yoghurt samples. Whilst the number of *S. thermophilus* was higher than *L. bulgaricus* in 11 samples, the *L. bulgaricus* cells were dominant in 36 samples (Fig. 4). It is well-established that 1 to 1 ratio is obtained at the end of the incubation as long as standard production conditions are followed. Therefore, the yoghurts produced by standardized production methods will be in good quality and will have longer shelf life. The defects determined in the yoghurts examined in this study could be attributed to the property of the culture selected, the ratio between *S. thermophilus* and *L. bulgaricus* uncontrolled incubation period and lack of cooling after incubation[7,8,11]. Previous studies showed that the majority of yoghurt factories in Turkey achieve incubation at temperatures varying between 35-55°C for up to 7 h. The viable counts of *Lb. bulgaricus* were between 1.8×10^2-9.2×10^7 cfu g^{-1} with an average of 1.63×10^7 cfu g^{-1}. The average viable counts of *S. thermophilus* was found to be 8.8×10^6 cfu g^{-1} ranging between 1.3×10^2 and 8.1×10^7 cfu g^{-1} (Table 1). According to Turkish food codex fermentative milk regulation[10] and report on the 5th session of the codex committee on milk and milk products[12], the number of specific microorganisms in yoghurt must be minimum 10^7 cfu g^{-1}. In the present study, we found that half of the yoghurt samples examined were in good agreement with the codexes.

More than half of the 47 yoghurt samples examined in the study were not in agreement with the Turkish food codex which has been in effect for nearly two years. With regard to the number of viable yoghurt bacteria which should be present in the end product, the samples examined did not show consistency with the current codex and regulations in Turkey.

To conclude, the incompatibility of yoghurts to the codex determined in this study reflects, to some extent, the general problems of Turkish dairy industry as well. To overcome basic quality problems in dairy sector, the companies producing dairy products in Turkey should apply HACCP in accordance with the food codex and they should start to put total quality management into effect as soon as possible.

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