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ASSESSMENT OF THE QUALITY OF CONVENTIONAL YOGURT AS AFFECTED BY STORAGE

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The study was conducted to determine the changes in nutritive value and microbiological quality of fresh yogurt and that stored under household conditions. Samples of yogurt were collected from different shops and households at Faisalabad. The quality of conventional yogurt was assessed by chemical analysis and microbial count. The consumer's acceptability of fresh yogurt was assessed organoleptically. The nutritive value of yogurt was determined by acidity, pH, moisture, protein, ash and syneresis. The microbiological examination included viable count, fungal and *E.coli* contamination. The nutritional quality of freshly prepared yogurt whether drawn from shops or taken from households was similar except for moisture and syneresis which were higher in household yogurt than that of shops. During storage the percentage of acidity and protein increased in household yogurts but decreased in shop yogurt. However, the pH, moisture and syneresis of yogurt samples whether drawn from shops or from households increased, whereas ash percentage decreased during storage. The viable bacterial count in household yogurt increased during storage but decreased in shop yogurt and the number of *E.coli* also increased in conventional yogurt during storage. The fungi were detected only in fresh samples of the household yogurt but in shop yogurt they were also detected during storage. The organoleptic quality of freshly prepared yogurt was almost similar.

Keywords: Conventional yogurt, quality, storage

INTRODUCTION

Yogurt is a coagulated milk product that results from the fermentation of lactic acid in milk by *Lactobacillus bulgaricus* and *Streptococcus thermophilus* (Bourlioux and Pochart, 1988). However, other species of lactic acid bacteria (LAB) may also join the process (*Bifidobacterium* and *Lactobacillus acidophilus*). Yogurt is more nutritious as compared to milk. It has good amount of calcium, phosphorus, vitamin B_2 , B_6 , B_{12} , in addition to protein, zinc, potassium and molybdenum. One hundred grams of yogurt provide 72 calories, 3.6 g protein, 3.4 g fat, 4.9 g carbohydrates, 145 mg of calcium, 114 mg phosphorus, 47 mg sodium and 186 mg potassium (Deeth and Tamime, 1980). The most interesting health information about yogurt is, its potential inclusion of live bacteria. To meet the National Yogurt Association's criteria for "live and active culture yogurt", the finished product must contain live LAB in amount 10^8 organisms/g at the time of manufacture and the cultures must remain active at the end of the stated shelf life (Chandan and Shahani, 1993). During storage at 4°C, although, the specific flora decreased, but always remained within the range of recommended values. And it was also found that there was no significant variation in pH value of yogurt during storage, but the pH of the probiotic yogurt remained higher than of the traditional yogurt (Nogueira *et al*, 1998). Moreover, the concentration of free amino acids increases up to twofold during the first 24 hrs. and then doubles again during the next 21 days of storage at 7°C (Loones, 1989). Contamination of yogurt can occur due to poor handling but as far as pathogens are concerned, yogurt with an acidity of around 1% lactic acid is a fairly inhospitable medium and really troublesome pathogens like *salmonella spp.* are incapable of growth (Hobbs, 1972). Coliforms are also inactivated by low pH, and, in addition, some species may be susceptible to antibiotics released by the starter organisms. So, during the storage for 4 weeks, no coliforms were produced and the number of fungi also remained insignificant (Nogueira *et al.*, 1998).

There are various ways for yogurt preparation, but in Pakistan, it is mainly prepared in 2 ways; one is by traditional or conventional method and the other by commercial one. Dahi is prepared traditionally at home and by the shopkeepers, with the starter culture (Jag) under uncontrolled conditions. It has low viability of *Streptococcus thermophilus* and *Lactobacillus bulgaricus* as these are not present in equal ratio. Unbalanced ratio of these bacteria during fermentation causes low pH, higher acidity, sourness and the process of preparation takes much time to reach a desirable pH/acidity. While commercial yogurt is prepared using commercial starter culture in proper proportions under controlled conditions. Most of the work on storage has been done on commercial (factory made) yogurt. However, in Pakistan majority of the people use the conventional yogurt. But no proper guidelines are available for handling and storage of conventional yogurt at household level. This study was therefore, planned to determine the changes in

nutritive value as well as to assess the microbiological quality of fresh yogurt and that stored under household conditions. Also, organoleptic evaluation of fresh yogurt was carried out.

MATERIALS AND METHODS

The study was conducted in the Nutrition Research Laboratory, Department of Rural Home Economics and Microbiology Laboratory of the Department of Veterinary Microbiology, University of Agriculture, Faisalabad.

Yogurt preparation

For the preparation of yogurt at household level, already boiled milk was used which was then slightly heated to get it lukewarm. Then a one half full table spoon of starter per ½ kg milk was added and mixed thoroughly. The container was then covered with lid and placed over night at room temperature in summer season. The yogurt was ready in the morning. A similar recepie was reported to be used by the shopkeepers.

Sample collection

A total of 24 samples of yogurt were collected from different shops and households. Eighteen samples drawn from shops and households were analyzed for proximate composition and six samples were examined for microbiological quality. Triplicate samples were drawn at random for analysis and kept under ordinary refrigeration. The storage time was 4 days and each sample was analyzed thrice within this duration.

Chemical and microbiological analyses

All the samples of yogurt were analyzed for pH, acidity, protein, ash and moisture contents by the standard AOAC (2001) methods and syneresis was measured by the procedure described by Peri *et al* (1985). All the samples were examined for viable count on Nutrient Agar. Detection of fungi was done on Sabouraud Agar and that of *E.coli* on MacConkey's Agar following the procedures described by Refai (1979).

Sensory evaluation

The yogurt samples taken from households and shops were evaluated organoleptically on 9 point hedonic scale by a panel of 6 judges for colour, body texture, flavour and overall acceptability as described by Land and Shepherd (1988).

RESULTS AND DISCUSSION

Nutritional quality of fresh yogurt

The chemical composition of fresh yogurt prepared at household level and by shopkeepers is given in Table 1. The quality of fresh yogurt whether from households or shops did not vary significantly with respect to acidity, pH, protein and ash contents. These were 0.87%, 4.6, 2.77% and 0.74%, respectively, in household yogurt and 0.84%, 4.5, 3.09% and 0.86%, respectively in shop yogurt. This might be due to the similar recepies followed by the housewives and the shopkeepers. Many a time the starter "Jag" is exchanged and the milk is also purchased by the housewives from the shops. However, the syneresis and moisture contents of household yogurts were higher than that of shops. The syneresis was 20.63 ml in household yogurts and 7.07 ml in shop yogurts while moisture content was 89.09% in household yogurts and 85.11% in shop yogurts. The difference might be due to the removal of cream "Balai" from milk by the housewives or the addition of additives during the preparation of yogurt by the shopkeepers. The number of total solids increased by the addition of additives while these were reduced by the removal of cream.

Table 1. Chemical composition of fresh yogurt

	Households	Shops	Means ± S.D
Acidity (%)	0.87	0.84	0.86 ± 00.10
pH	4.6	4.5	4.60 ± 00.24
Moisture (%)	89.09[a]	85.11[b]	87.10 ± 03.84
Syneresis (ml/2hr)	20.63[a]	7.07[b]	13.85 ± 10.27
Protein (%)	2.77	3.09	2.93 ± 00.56
Ash (%)	0.74	0.86	0.80 ± 00.15

Different letters on means in a row show significant differences

The acidity and pH values determined in the present study fell within the ranges reported by Roberts and Maust (1995), Jay (1992) and Sarkar *et al* (1996). The protein percentage of fresh yogurt prepared in the present study was somewhat lower than the findings of Deeth and Tamime (1980) who reported 3.6% protein in yogurt. This might be due to the difference in the quality of milk used. They worked on the commercial yogurt which is prepared by the good quality milk.

Effect of storage on the quality of yogurt

Acidity

The mean acidity percentages of yogurt samples drawn from households and shops were almost similar. However, the variations in acidity values during storage were apparent. The results revealed that the quality of yogurt samples whether drawn from households or taken from shops did not vary significantly even during short storage. In case of yogurt drawn from households the acidity remained constant up to 2nd day but after that it decreased while the acidity of yogurt samples taken from shops first increased up to 2nd day and then there was a decline. However, the acidity percentage was still greater than that of fresh yogurt. The results indicated that the acidity percentage of the yogurt drawn from shops increased during storage. Similar findings were reported by Masood (1997) and Kamruzzaman *et al.* (2002).

Table 2. Effect of storage on various nutritional components of yogurt

Storage period (Days)	Households	Shops
	Acidity (%)	
0	0.88	0.84
2	0.88	0.87
4	0.82	0.85
Means ± S.D:	0.86 ± 0.13	0.86 ± 0.10
	pH	
0	4.6	4.5
2	4.7	4.5
4	4.7	4.6
Means ± S.D:	4.7 ± 0.21	4.5 ± 0.23
	Moisture (%)	
0	89.09	85.11
2	90.56	84.78
4	90.77	86.54
Means ± S.D:	90.13 ± 2.84	85.47 ± 3.46
	Syneresis (ml/ 2 hrs.)	
0	20.6	7.1
2	24.3	12.3
4	26.3	12.1
Means ± S.D:	23.8 ± 7.91	10.52 ± 8.01
	Protein (%)	
0	2.77	3.09
2	2.72	3.06
4	2.45	3.21
Means ± S.D:	2.65 ± 0.77	3.12 ± 0.50
	Ash (%)	
0	0.74	0.86
2	0.65	0.84
4	0.70	0.75
Means ± S.D:	0.70 ± 0.15	0.82 ± 0.12

pH

The mean pH value of yogurt samples taken from household samples was 4.7 and that of shops was 4.5. The variations in the pH values during storage were apparent. The results revealed that the pH of yogurt drawn from shops was lower than that of household even during the storage period. The pH value of yogurt drawn from households increased up to 2nd day but after that it remained constant while the trend was reverse in case of yogurt drawn from shops. The differences in acidity and pH of yogurt taken from shops and households might be due to the use of different starter "Jag" by the housewives and the shopkeepers, having different number and types of bacteria. Moreover, the quality of milk and the temperature conditions during the preparation of yogurt might also have caused the difference.

Moisture

The mean moisture percentage of yogurt samples drawn from households was 9.13 and that of shops was 85.47. The results revealed that the moisture content of household yogurt was higher than that of shops. There was an increase in moisture content of yogurt taken from household during storage while in case of shop yogurt although there was a slight decrease in moisture up to 2nd day but after that it rapidly increased. The results indicated that the moisture content of yogurt samples whether drawn from shops or taken from the households increased during storage.

Syneresis

The mean syneresis value of household yogurt samples was 23.8 ml/2 hrs. and that of shops was 10.52 ml/2 hrs. The variations in the syneresis values during storage were marked. The results revealed that the syneresis of household yogurt was 55.7 percent more than that of shops. The effect of storage on the syneresis of yogurt samples taken from households and shops is shown in Fig IV. It shows that the syneresis of yogurt whether drawn from shops or taken from households increased during storage. Similar findings were reported by Masood (1997).

Protein

The mean protein content of yogurt samples drawn from households and shops were 2.65 and 3.12%, respectively. However, there were apparent variations in the protein values during storage. The results showed that the protein in yogurt drawn from shops was significantly higher than that of households. The difference in protein percentage of the two type of yogurt might be due to the difference in the quality of milk used. Moreover, the removal of cream "Balai" from milk by the housewives might also have created the difference.

Ash

The mean ash percentages of yogurt samples drawn from households and shops were 0.70 and 0.82, respectively. However, the variations in the ash values during storage were apparent. The results revealed that the ash content of yogurt drawn from shops was higher than that of households. There was a decline in ash content in shop yogurt during storage while the ash percentage of yogurt taken from households first decreased up to 2nd day but after that it increased. The results indicated that the ash content of the yogurt whether from shops or households decreased during storage.

Microbial quality

The mean values for viable count and *E.coli* count estimated during short storage of yogurt prepared at household level and that obtained from shopkeepers are shown in Table 3. The presence of fungi in yogurt samples drawn from households and shops was also detected during storage.

Table 3. Effect of storage on microbiological quality of yogurt

Storage period (Days)	Households	Shops
	Viable Count (10^{10} c.f.u/ml)	
0	1.67	2.73
2	2.73	2.27
4	4.36	1.8
Means:	2.92	2.26
	E.coli (10^8 c.f.u/ml)	
0	3.35	1.05
2	1.69	3.55
4	4.8	3.6
Means:	3.28	2.59

Viable count

The mean viable bacterial count in the freshly prepared yogurt samples drawn from household was 1.67 x 10^{10} c.f.u/ml and that of shops was 2.73 x 10^{10} c.f.u/ml. During storage the number of viable bacteria increased from 1.67 x 10^{10} to 4.36 x 10^{10} c.f.u/ml in household yogurts while in case of shop yogurts decreased from 2.73 x 10^{10} to 1.8 x 10^{10} c.f.u/ml. The results revealed that during short storage the number of viable bacteria increased in yogurt drawn from households which is similar to the finding of El-Kenery *et al.* (1999). However, it decreased in case of yogurt taken from shops which has also been reported by Nogueira *et al.* (1998). The difference might be due to the use of different starter "Jag" by the housewives and the shopkeepers, having different number and types of bacteria.

Escherichia Coli

The mean count of *E.coli* in the freshly prepared yogurt samples drawn from households was 3.35 x 10^8 c.f.u/ml and that of shops was 1.05 x 10^8 c.f.u/ml. It indicated that the contamination in yogurt taken from households was more than that of shops with respect to *E.coli* even under fresh condition. This might be due to more unhygienic conditions during the preparation of yogurt at household level. During storage the number of *E.coli* increased from 3.35 x 10^8 to 4.8 x 10^8 c.f.u/ml in household yogurts and from 1.05 x 10^8 to 3.6 x 10^8 c.f.u/ml in shop yogurts. However, Massa *et al.* (1997) and Ogwaro *et al.* (2002) reported the decrease in the number of *E.coli* during storage. The difference might be due to poor sanitary condition of utensils and unhygienic environment during the preparation of yogurt.

Fungi

The presence of Fungi in the yogurt samples prepared at household level and by shopkeepers was detected in the fresh condition as well as during storage. The fungi were observed in almost all the samples and they were white cottony fungi with black spores. The detection of fungi in yogurt have also been detected by McKay (1992), Sharma *at al* (1993), Sarkar *et al* (1996) and Viljoen *et al* (2003).

Sensory evaluation of yogurt

The scores given to the quality characteristics of fresh yogurt samples taken from shops and households are shown in Table 4. This table showed that the

Table 4. Scores of sensory evaluation of freshly prepared yogurt at household and shop level

Characteristics	Households			Shops		
	H_1	H_2	H_3	S_1	S_2	S_3
Colour	6.2^b	5.9^b	5.2^{bc}	5.0^c	6.0^b	7.3^a
Body Texture	4.7^b	6.1^{ab}	5.3^b	4.3^b	5.8^b	7.1^a
Flavour	5.8^{ab}	6.5^a	4.8^b	5.0^b	4.9^b	6.3^a
Overall Acceptability	5.5^b	6.9^{ab}	5.3^b	4.7^b	5.1^b	7.0^a

Different letters show significant differences

organoleptic quality of all the yogurt samples had almost similar scores. The sensory evaluation was graded as within fair to good quality. This might be due to the use of similar recepies and the same source of milk by the housewives and the shopkeepers.

REFERENCES

AOAC, 2001. Official Methods of Analysis. The Association of Official Analytical Chemists, 15th Ed. Arlington, Virginia–22201.

Bourlioux, P. and P. Pochart. 1988. Nutritional and health properties of yogurt. World Rev. Nutr. Diet. 56: 217-58.

Chandan, R.C. and K.M. Shahani. 1993. Yogurt. In: Hui Y.H., Ed. Dairy Science and Technology Handbook. VCH Publishers, Inc., New York. pp.1-57.

Deeth, H.C. and A.Y. Tamime. 1980. Yogurt: Nutritive and therapeutic aspects. J. Food Prot. 44(1): 78-86 (FSTA 13(8): 1482, 1981).

El-Kenery, Y.M., J. Seamov and F.S. Ibrahim. 1999. Improving the shelf life of yogurt. Annals Agri. Sci. Moshtohor. 34(1): 335-343.

Harun-ur-Rashid, M., T. Kaname, U. Minoru and M. Taku. 2007. Identification and characterization of dominant lactic acid bacteria isolated from traditional fermented milk Dahi in Bangladesh. World J. Microbiol. Biotech. 23(1): 125-133.

Hobbs, B.C. 1972. Microbiological Analysis. In: Yogurt Science and Technology by Tamime A.Y. and R.K. Robinson (Ed.) Pergamon Press, New York. pp.393.

Jay, I.M. 1992. Modern Food Microbiology. 4th Ed. Chapman and Hall, Inc., New York. p.379.

Kamruzzaman, M., M.N. Islam and M.M. Rehman. 2002. Shelf life of different types of dahi at room and refrigeration temperature. Pak. J. Nutr. 1(6): 234-237.

Land, D.G. and R. Shepherd. 1988. Scaling and ranking methods. In: Sensory Analysis of Foods by J.R. Piggott (Ed.): Elsevier Appl. Sci., London.

Loones, A. 1989. Transformation of milk components during yogurt fermentation. In: Yogurt: Nutritional and Health Properties by R.C. Chandan (Ed.) McLean, VA: National Yogurt Association. pp.95-114.

Masood, H. 1997. The effect of different heat treatments and stabilizers on the quality of yogurt. M.Sc. (Hons.) thesis, Deptt. Food Tech. Univ. Agri., Faisalabad.

Massa, S., C. Altieri, V. Quaranta and R.De Pace. 1997. Survival of *Escherichia coli* O157:H7 in yogurt during preparation and storage at 4 degree C. Lett. Appl. Microbiol. 24(5): 2374-2385.

McKay, A.M. 1992. Growth of fermentive ad non-fermentive yeasts in natural yogurt, stored in polystyrene cartons. Int. J. Food Microbiol. 15(3-4): 383-388.

Nogueira, C., H. Abano, P. Gibbs and P. Teixeira. 1998. Microbiological quality of Portuguese yogurt. J. Indust. Microbiol. and Biotech. 21: 19-21.

Ogwaro, B.A., H. Gibson, M. Whitehead and D.J. Hill. 2002. Survival of *Escherchia coli* O157:H7 in traditional African yogurt fermentation. Int. J. Food Microbiol. 79(1-2):105-112.

Peri, C., M. Lucisano and E. Donati. 1985. Studies on coagulation of milk ultrafiltration retentates-II Kinetics of whey syneresis. Milchwissenschaft, 40(11): 650-652. (FSTA, 18(10): 99, 1986).

Refai, M.K. 1979. Manuals of Food Quality Control 14/4. Microbiological Analysis. Food and Agriculture Organization of the United Nations, Rome.

Roberts, R.F. and J.M Maust. 1995. Composition and number of viable *S. Salivarius* subsp. *thermophilus* and *L. delbrueckii* subsp. *bulgaricus* in refrigerated non-fat and low fat yogurts available at retail out lets. Cultured Dairy Products J. 30(4): 2-6.

Sarkar, S., R.K. Kuile and A.K. Misra. 1996. Organoleptical, microbiological and chemical quality of misti dahi sold in different districts of west Bengal. Indian J. Dairy Sci. 59(1): 54-61.

Sharma, N.K., J.P.S. Gill, D.V. Joshi and M.S. Kwatra. 1993. Mycoflora of Indian fermented milk product (Dahi). Indian J. Dairy Sci. 46(2): 85-87.

Viljoen, B.C., A.L. Hattingh, B. Ikalafeng and G. Peter. 2003. Temperature abuse initiating yeast growth in yogurt. Food Res. Int. 36: 193-197.