

## PREPARATION OF FUNCTIONAL YOGHURT FROM SHEEP AND GOAT MILK BLENDS

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The main objective of this study was to develop functional yoghurt by using different concentrations of goat and sheep milk. The functional yoghurt was prepared by blending sheep and goat milk at different levels i.e., T<sub>1</sub> (100% goat milk) T<sub>2</sub> (75% goat milk and 25% sheep milk) T<sub>3</sub> (50% sheep milk and 50% sheep milk) T<sub>4</sub> (75 sheep milk and 25% goat milk) T<sub>5</sub> (100% sheep milk). All these treatments were compared with a control (T<sub>0</sub>) 100% buffalo milk. Yoghurt samples were stored at 4 °C. Physico-chemical analysis and sensory evaluation was conducted for 28 days at the interval of seven days. Addition of sheep milk in goat milk at all levels increased protein, fat, lactose, ash content and total solids of yoghurt. Acidity and pH of all the treatments were non significantly influenced from control and ranged from 0.78 to 0.85% and 4.46 to 4.51 respectively as compared to acidity and pH of control 0.82% and 4.50. Fat protein and lactose content non significantly decreased during storage while total solids non significantly increased in all the treatments. After 28 days of storage acidity of yoghurt increased from 0.76% to 0.92% and pH decreased from 4.56 to 4.39. Sheep milk up to T<sub>2</sub> level improved color, flavor and texture scores of yoghurt. The overall acceptability score of T<sub>2</sub> was (7.75) as compared to control (7.92). Sensory analysis revealed that functional yoghurt made from 75% goat milk and 25% (T<sub>2</sub>) sheep milk was better compared to other treatments.

**Keywords:** Yoghurt, sheep, goat milk, storage, overall acceptability

### INTRODUCTION

Goat milk has special nutritional properties that make it attractive to consumers Haenlein (2004). The composition of goat milk compares very well with that of the cow milk Gall (1981). Goat milk is known to have better qualities such as digestibility and longer shelf life when processed than cow milk. Despite these qualities, goats are kept mainly for meat in many countries Ohiokpehai (2003). The importance of feeding of infants with goat milk has been recognized since pre historic times. In developed countries like U.S and South Africa, the goat milk is specifically marketed for the infants. The milk allergy problem common in infants due to the consumption of cow milk is rarely encountered when replaced with goat milk. The symptoms like gastrointestinal disturbances, vomiting, colic, diarrhea, constipation and respiratory problems can be eliminated when goat milk is fed to infants. The reason cited for the relief in respiratory problems when fed with goat milk can be attributed to the structure of casein micelle of the goat milk (Haenlein, 2004). Pasteurized goat milk is well tolerated by the infants with gastro intestinal or respiratory problems. Fermented goat milk products are ideal for the persons allergic to cow milk. Regular intake of goat milk significantly improves the body weight, mineralization of skeleton, increased blood serum vitamin and hemoglobin levels. These points are considered advantageous when compared to consumption of cow milk. The other medicinal property of goat milk is higher concentration of medium chain fatty acids which play an

important role in imparting unique health benefits in mal-absorption syndrome, steatorrhoea, chyluria, hyperlipoproteinaemia and during conditions of cystic fibrosis, gall stones and childhood epilepsy. The medium chain fatty acids minimize cholesterol deposition in the arteries, aid in dissolving cholesterol and gallstones and significantly contribute to normal growth of infants (Ohiokpehai, 2003). The nutritional value of sheep milk is very high as compared to cow milk. It contains two times more solids than cow milk and has higher levels of vitamin E, water soluble vitamins and minerals. Up to seventy five percent of the world's population has some degree of lactose intolerance, making it difficult for them to drink milk without symptoms of gassiness and diarrhea. Many people who suffer from lactose intolerance are able to enjoy sheep milk without symptoms even though they are unable to drink goat milk or cow milk. Sheep milk as well as yogurt and cheese made from milk from the sheep may give the lactose intolerant individual the chance to enjoy milk again. Although it contains higher levels of butterfat, but actually lower in saturated fat than other types of milk and a good source of medium chain triglycerides which may play a role in reducing cholesterol levels. Sheep milk is higher in calcium than milk from the cow or goat and is a rich source of other important minerals such as zinc, magnesium, and phosphorus. Milk from sheep is also rich in vitamins A, D, and E. It is a particularly good source of the B vitamins including folic acid. It is also slightly higher in protein than other forms of milk Hardy (2000). Yoghurt is a dairy

product of high nutritional value and healthful properties. The most important benefits of yoghurt consumption cover the reduction of blood cholesterol level, anti-cancer effects and the improvement of antimicrobial activity and immunity in the human body Desobry *et al.* (1999). Functional food is any fresh and processed food claimed to have a health-promoting or disease-preventing property beyond the basic function of supplying nutrients. Fermented foods with live cultures are considered as functional foods with probiotic benefits. Keeping in view the medicinal value of goat milk, nutritional value of sheep milk and health benefits of yoghurt, present study was designed to develop functional yoghurt from the blend of sheep and goat milk on the basis of certain physico-chemical and sensory characteristic of fresh product (functional yoghurt) and during storage of 28 days.

## MATERIALS AND METHODS

**Collection of Milk Samples:** Fresh goat and sheep milk was obtained from the flocks maintained at Small Ruminants Training & Research Centre, Pattoki, University of Veterinary and Animal Sciences, Lahore. Buffalo milk was obtained from Buffalo Research Institute Pattoki, and starter culture used for yoghurt preparation was obtained from Nestle Pakistan Limited, Lahore. Gelatin and Skim milk powder by Haleeb Foods (Queen Brand) was collected from Sakhawat Essence, Lahore.

**Preparation of Yoghurt:** Milk was divided into six batches of 3 liters. The experiments involved making of 6 types of yoghurt i.e. T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub>. All these treatments were compared with control T<sub>0</sub> (100% buffalo milk). Each treatment was replicated 2 times. Yoghurt was prepared by following the method of Robinson and Tamim (1995). Milk was heated to 45 °C skim milk powder (2%) and gelatin (0.25%) was added and dissolved and temperature was raised to 65°C and yoghurt milk was homogenized in a clean and sanitized double stage homogenizer (APV) at 200 kg/cm<sup>2</sup> and 50 kg/cm<sup>2</sup> pressure in the first and second stage respectively and pasteurized at 90 °C for five minutes. The pasteurized and homogenized milk was cooled immediately to 45°C and bulk starter culture CSK Y104 was added at the rate of 2.5% and incubation was carried out in polypropylene cups at 43 °C for 3 hours. After 3 hours yoghurt was cooled to 4 °C.

**Chemical Analysis:** The yoghurt was analyzed for fat content and titratable acidity as suggested by BIS (1989), the total solids of yoghurt was determined by the standard procedure Laboratory Manual (1959) pH of yoghurt was determined at 25°C using a systronic digital pH meter, model 335 (Systronic Ltd., India). The protein content of

yoghurt was determined by Kjeldhal method Menefee and Overman (1940). Ash and lactose content were determined by following the respective methods as given in A.O.A.C. (2000).

**Sensory Evaluation:** Functional yoghurt prepared with different levels of sheep and goat milk were subjected to sensory evaluation by a semi trained taste panel of 5 judges as described Larmond (1979). The panelists had previous experience in dairy products evaluation. The panel comprised of postgraduate students from faculty of Animal Production and technology, University of Veterinary & Animal Sciences, Lahore. Evaluations were done by the panelists using 9 point hedoni scale for the parameters of color, flavor, texture and overall acceptability on a sensory evaluation Performa. The first sensory evaluation was conducted within 24 hours of functional yoghurt prepared by using different proportions of sheep and goat milk. The testing was also carried out at 7, 14 21 and 28 days of storage intervals. All evaluations were carried out at room temperature on the same day in well illuminated laboratory in the Department of Animal Products Technology, University of Veterinary and Animal Sciences, Lahore, Pakistan. Panelists were provided with distilled water and unsalted crackers to clean their mouths between the samples. The samples were given in random order and the panelists were asked to rate their acceptance by marking a mark on the line for all the parameters. The data thus obtained was converted to numerical scores using metric scale.

**Statistical analysis:** The data was obtained by applying completely randomized design (CRD) and the outcome of the analyses was analyzed through analysis of variance technique Steel *et al.* (1997). Using Cohort version 6.1 (Co-stat 2003) to determine the level of significance. The separation of means or significant difference comparisons was made using Turkey's HSD test.

## RESULTS AND DISCUSSION

The results of acidity and pH are given in Table 1 which showed that addition of sheep milk into goat milk at all levels did not have significant effect ( $P > 0.05$ ) on acidity and pH of yoghurt. All the treatments were at par with control. The insignificant variation in the pH and acidity of different types of yoghurt was probably due to the non variations in the composition of the raw materials. Minimum mean value for acidity (0.76%) was observed at 0 day where as increasing tendency was observed with progressive increase of storage period (Table 2). At 7 days, it was 0.78% that increased to 0.82% at 14 days 0.86 at 21 days and 0.92% at 28 days. pH of all the treatments including control decreased

**Table 1. Effect of treatments on physico-chemical characteristics of functional yoghurt**

Treatments	Protein (%)	Fat (%)	Lactose (%)	Ash (%)	Total Solids (%)	Acidity (%)	pH
T <sub>0</sub>	4.25 <sup>c</sup> ±0.03	6.45 <sup>c</sup> ±0.03	4.86 <sup>c</sup> ±0.02	0.81 <sup>c</sup> ±0.02	17.38 <sup>c</sup> ±0.07	0.82 <sup>c</sup> ±0.04	4.50 <sup>a</sup> ±0.06
T <sub>1</sub>	3.96 <sup>f</sup> ±0.02	4.10 <sup>f</sup> ±0.04	4.38 <sup>f</sup> ±0.05	0.71 <sup>e</sup> ±0.01	14.01 <sup>f</sup> ±0.07	0.80 <sup>d</sup> ±0.03	4.51 <sup>a</sup> ±0.05
T <sub>2</sub>	4.02 <sup>e</sup> ±0.01	5.03 <sup>e</sup> ±0.02	4.57 <sup>e</sup> ±0.03	0.76 <sup>d</sup> ±0.02	15.19 <sup>e</sup> ±0.07	0.78 <sup>d</sup> ±0.05	4.51 <sup>a</sup> ±0.07
T <sub>3</sub>	4.23 <sup>d</sup> ±0.03	5.95 <sup>d</sup> ±0.03	4.82 <sup>d</sup> ±0.05	0.82 <sup>c</sup> ±0.02	16.67 <sup>d</sup> ±0.07	0.83 <sup>d</sup> ±0.05	4.46 <sup>b</sup> ±0.08
T <sub>4</sub>	4.40 <sup>b</sup> ±0.03	6.87 <sup>b</sup> ±0.05	4.96 <sup>b</sup> ±0.04	0.88 <sup>b</sup> ±0.01	17.95 <sup>b</sup> ±0.04	0.85 <sup>a</sup> ±0.06	4.48 <sup>ab</sup> ±0.10
T <sub>5</sub>	4.55 <sup>a</sup> ±0.01	7.80 <sup>a</sup> ±0.03	5.08 <sup>a</sup> ±0.04	0.94 <sup>a</sup> ±0.02	19.20 <sup>a</sup> ±0.05	0.84 <sup>b</sup> ±0.06	4.46 <sup>b</sup> ±0.08

Means with same expressions in columns are statistically non significant at 0.05% level of confidence

T<sub>0</sub>= Control yoghurt (100% Buffalo Milk);

T<sub>1</sub>= yoghurt with (100% Goat Milk)

T<sub>2</sub>= yoghurt with (75% Goat Milk: 25% Sheep Milk);

T<sub>3</sub>= yoghurt with (50% Goat Milk: 50% Sheep Milk)

T<sub>4</sub>= yoghurt with (25% Goat Milk: 75% Sheep Milk);

T<sub>5</sub>=yoghurt with (100% Sheep Milk)

**Table 2. Effect of storage on physico-chemical characteristics of functional yoghurt**

Storage Interval	Protein (%)	Fat (%)	Lactose (%)	Ash (%)	Total Solids (%)	Acidity (%)	pH
0 Day	4.24 <sup>a</sup> ±0.21	6.05 <sup>a</sup> ±1.14	4.83 <sup>a</sup> ±0.23	0.83 <sup>a</sup> ±0.07	16.75 <sup>a</sup> ±1.17	0.76 <sup>d</sup> ±0.01	4.56 <sup>a</sup> ±0.02
07 Days	4.24 <sup>a</sup> ±0.21	6.04 <sup>a</sup> ±1.10	4.81 <sup>a</sup> ±0.24	0.83 <sup>a</sup> ±0.07	16.77 <sup>a</sup> ±1.29	0.78 <sup>c</sup> ±0.02	4.53 <sup>a</sup> ±0.03
14 Days	4.23 <sup>a</sup> ±0.21	6.03 <sup>a</sup> ±1.24	4.78 <sup>a</sup> ±0.24	0.82 <sup>a</sup> ±0.08	16.77 <sup>a</sup> ±1.12	0.82 <sup>b</sup> ±0.02	4.50 <sup>ab</sup> ±0.03
21 Days	4.23 <sup>a</sup> ±0.21	6.03 <sup>a</sup> ±1.21	4.75 <sup>a</sup> ±0.24	0.81 <sup>a</sup> ±0.08	16.72 <sup>a</sup> ±1.78	0.86 <sup>a</sup> ±0.02	4.46 <sup>c</sup> ±0.05
28 Days	4.23 <sup>a</sup> ±0.21	6.02 <sup>a</sup> ±1.18	4.72 <sup>a</sup> ±0.24	0.82 <sup>a</sup> ±0.07	16.80 <sup>a</sup> ±1.49	0.92 <sup>a</sup> ±0.03	4.39 <sup>d</sup> ±0.05

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T<sub>0</sub>= Control yoghurt (100% Buffalo Milk);

T<sub>1</sub>= yoghurt with (100% Goat Milk)

T<sub>2</sub>= yoghurt with (75% Goat Milk: 25% Sheep Milk);

T<sub>3</sub>= yoghurt with (50% Goat Milk: 50% Sheep Milk)

T<sub>4</sub>= yoghurt with (25% Goat Milk: 75% Sheep Milk);

T<sub>5</sub>=yoghurt with (100% Sheep Milk)

through out the storage period. This may be due to the growth of bacteria which convert lactose into lactic acid. Salwa *et al.* (2004) reported an increase in the acidity of plain yogurt during storage of three weeks. Akin and Akin (2007) studied the effect of cysteine on micro flora and physico-chemical characteristics of bio yoghurt from goat milk for 8 weeks and reported that acidity of all the experimental samples increased while pH decreased during storage of 4 weeks. Addition of sheep milk resulted in progressive increase in fat, protein and lactose content of T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> and T<sub>5</sub>. All the five treatments showed significant differences for the fat, protein and lactose content of the product (sheep and goat milk yoghurt). The highest level of fat, protein and lactose was observed in T<sub>5</sub> (100% sheep milk) and lowest values for compositional attributes were observed in T<sub>1</sub> (100% goat milk). This may be attributed to the higher levels of fat, protein and lactose in sheep milk which may have been contributed to this phenomena. Fat, protein and lactose content non significantly ( $P>0.05$ ) decreased during storage of 28 days. Decline in fat and protein content may be attributed to lipolytic and proteolytic changes. Hussain (2004) while studying the effects of different protein sources on keeping quality of yogurt reported a decreasing trend in the fat content during storage of 21 days. Mistry and Hassan (1992) used a high milk protein powder in the preparation of yogurt and observed increase in protein content of the end product (5.2 to 11.3%).

The decreasing trend of fat, protein and lactose has been reported by Multag and Hassan (2008) fat, protein and lactose content in Labneh (concentrated yoghurt) decreased during storage of 21 days. Goodnaught and Kleyn (1976) reported that the decrease in lactose content of yoghurt during storage was due to the production of lactic acid. Total solids and ash content increased significantly at all levels of sheep milk addition in the yoghurt milk. All the treatments differed significantly ( $P<0.05$ ) for total solids and ash content. The highest total solids were noted in T<sub>5</sub> (19.23%) followed by T<sub>4</sub> (17.98%) and T<sub>3</sub> (16.69%), whereas the lowest total solids were found in T<sub>1</sub> (14.03%) (Table 1). Total solids of all the treatments non significantly ( $P>0.05$ ) increased during storage of 28 days. The increase in total solids may be attributed to the evaporation of moisture from yoghurt. Ismail (2006) studied the effect of butter milk and butter milk powder on quality of yoghurt and reported that total solids increased during storage of 21 days. Ash content almost remained same through the storage of 28 days. The ash content in the food stuff represents inorganic residue remaining after the organic matter has been burnt away. The results of ash contents is in line with the findings of Siddique (1999). Robinson and Tamim (1995) reported that total solids of yoghurt ranged from 14-16%.

**Effect on Sensory Attributes of Yoghurt:** The results depicted in Table 3 and 4 represents the sensory attributes of yoghurt as adjudged by a panel of five judges in terms of

**Table 3. Effect of treatments on sensory evaluation functional yoghurt**

Treatments	Color	Flavor	Texture	Overall acceptability
T <sub>0</sub>	7.33 <sup>a</sup> ±0.79	6.96 <sup>b</sup> ±0.89	8.26 <sup>a</sup> ±0.75	7.92 <sup>a</sup> ±0.81
T <sub>1</sub>	6.16 <sup>b</sup> ±0.74	6.36 <sup>c</sup> ±0.59	5.86 <sup>b</sup> ±0.65	6.05 <sup>b</sup> ±0.69
T <sub>2</sub>	7.73 <sup>a</sup> ±0.95	7.66 <sup>a</sup> ±1.15	8.11 <sup>a</sup> ±1.48	7.75 <sup>a</sup> ±0.51
T <sub>3</sub>	3.50 <sup>c</sup> ±0.25	5.56 <sup>d</sup> ±0.43	4.93 <sup>c</sup> ±0.55	4.26 <sup>c</sup> ±0.38
T <sub>4</sub>	5.43 <sup>c</sup> ±0.62	4.60 <sup>e</sup> ±0.29	4.46 <sup>c</sup> ±0.42	4.99 <sup>c</sup> ±0.29
T <sub>5</sub>	5.06 <sup>c</sup> ±0.84	4.73 <sup>e</sup> ±0.33	4.60 <sup>c</sup> ±0.45	4.59 <sup>c</sup> ±0.37

Means with same expressions in columns are statistically non significant at 0.05% level of confidence

T<sub>0</sub>= Control yoghurt (100% Buffalo Milk);

T<sub>1</sub>= yoghurt with (100% Goat Milk)

T<sub>2</sub>= yoghurt with (75% Goat Milk: 25% Sheep Milk);

T<sub>3</sub>= yoghurt with (50% Goat Milk: 50% Sheep Milk)

T<sub>4</sub>= yoghurt with (25% Goat Milk: 75% Sheep Milk);

T<sub>5</sub>=yoghurt with (100% Sheep Milk)

**Table 4. Effect of storage on sensory evaluation scores of functional yoghurt**

Storage Interval	Color	Flavor	Texture	Overall acceptability
0 Day	7.50 <sup>a</sup> ±0.72	7.08 <sup>a</sup> ±0.99	6.94 <sup>a</sup> ±0.61	7.17 <sup>a</sup> ±0.99
7 Days	6.88 <sup>ab</sup> ±0.65	6.52 <sup>b</sup> ±0.74	6.44 <sup>b</sup> ±0.47	6.62 <sup>b</sup> ±0.72
14 Days	6.13 <sup>c</sup> ±0.51	6.22 <sup>c</sup> ±0.43	5.31 <sup>c</sup> ±0.41	5.89 <sup>c</sup> ±0.64
21 Days	5.55 <sup>d</sup> ±0.44	5.27 <sup>d</sup> ±0.32	5.14 <sup>c</sup> ±0.36	5.55 <sup>d</sup> ±0.69
28 Days	4.88 <sup>e</sup> ±0.24	4.80 <sup>e</sup> ±0.38	4.84 <sup>d</sup> ±0.54	4.65 <sup>e</sup> ±0.57

Means with same expressions in columns are statistically non significant at 0.05% level of confidence

color, flavor, texture and overall acceptability. Addition of sheep milk up to 25% level improved the flavor of yoghurt beyond this level it affected the flavor and products were too much creamy. The flavor score of T<sub>2</sub> was at par with control (P>0.05). The decrease in flavor score of T<sub>3</sub>, T<sub>4</sub> and T<sub>5</sub> was because it was criticized for buttery flavor by some panelists. The decrease in flavor score as the level of incorporation (sheep milk) increase could be attributed to formation of free fatty acids. Flavor score for all the treatments decreased during storage of 28 days. This may be due to the presence of higher levels of lactose and production of lactic acid during storage. Addition of sheep milk up to T<sub>2</sub> level improved the color of yoghurt as the level of augmentation increased score for color decreased. The color score of T<sub>2</sub> was even more than control. Color score for all the treatments were significantly (P<0.05) different from each other and significantly affected by storage period. Texture score of T<sub>2</sub> (75% goat milk and 25% sheep milk) was not significantly influenced from control and decreased as the concentration of sheep milk was more than 25%. The increase in texture score of T<sub>2</sub> may probably be due to the formation of firm gel. This may be attributed to the presence of higher levels of protein in sheep milk which may have contributed in the formation of firm curd. Score for sensory evaluation including control decreased during storage of 28 days. Masood (1997) and app *et al.* (1983) reported that the storage had a negative effect on color and appearance of yogurt; resulting in reduced acceptability with respect to color. Mistry and Hassan (1992) while studying the effect of high protein powder on quality of non fat yoghurt reported that score for sensory evaluation decreased during storage of

14 days. Rehman (1987) reported a decrease in flavor acceptability of yogurt during storage. Average overall acceptability scores ranged from 4.26 to 7.92 among various treatments. Overall acceptability score of T<sub>2</sub> is at par with control (P>0.05) while decreasing trend was observed during storage of 28 days. This may be due to the break down of various ingredients like protein, fat and lactose etc in the product and also affected its texture and thus resulted in low acceptance. Fadela (2009) during evaluation of yoghurt prepared from skim milk and sheep milk reported that yoghurt prepared from sheep milk was much better from, texture and overall acceptability view points.

## CONCLUSION

The results of this study have demonstrated that addition of sheep milk up to 25% level improved color, flavor, texture and overall acceptability scores of functional yoghurt. pH and acidity of T<sub>2</sub> (75% goat milk and 25% sheep milk) was not significantly different from control. T<sub>2</sub> obtained overall acceptability score of 7.75 out of 9 which is more than 83%. Hence 25% sheep milk and 75% goat milk can be used for the preparation of functional yoghurt with acceptable sensory characteristics.

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