Effect of different fat levels on physicochemical, sensory and microbiological attributes of fermented laban milk

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ABSTRACT
The present study analyses the effect of storage time and varying fat levels in fermented laban milk samples obtained from different sources through physicochemical, sensory and microbiological attributes. The milk samples were divided into three groups (T1 = Buffalo Milk, T2 = Cow Milk, T3 = Mixed Milk) with replication. Viscosity, acidity and syneresis of all three laban milk samples increased, whereas pH decreased significantly ($P \leq 0.05$) across storage days. The viscosity, protein and total solids (TS) were significantly ($P \leq 0.05$) decreased in all Laban milk samples with a 3.5% fat level compared to a 1.5% fat level at the 21st day of the storage period. The colour and appearance scores were unaffected for the T1 group but decreased with increased fat levels for T2 and T3 groups. The Total Plate Count tended to decrease with a 3.5% fat level in all three laban milk samples. However, days of storage had a non-significant effect. Buffalo laban milk seems best in terms of viscosity, protein, TS, taste and aroma. Furthermore, these attributes are affected by days of storage and fat level. The fermented laban prepared from mixed milk (T3) showed results at par with that from buffalo milk. Hence, considering the economical aspect, mixed milk laban at a fat level of 3.5% is highly recommended.

1. Introduction
Lactic fermentation has long been known to humans as the inexpensive food preservation technology. It is widely accepted that certain strains of lactic acid bacteria produce a wide range of antimicrobial compounds, which, in turn, prevent the growth of pathogenic bacteria and hence enhance the safety and quality of fermented food items (All and Dardir 2009). Using different fermented products as a major element of the human diet has been prevalent mostly in the Middle Eastern countries. However, this trend has gripped the Asian countries the specific and worldwide in general, and today many countries are using different fermented products.

Amongst fermented products, dairy products have gained special interest because of their enhanced taste, health benefits and ease of storage. Laban zeer, Laban khad, Laban buttermilk and yogurt are a few of the fermented dairy products which can be traced back to the Egyptian pharaoh's era of 4000BC (All and Dardir 2009; Saleh 2013). Mostly cow milk has been used for Laban preparation. However, buffalo milk has started gaining a strong footing as a source of fermented products in buffalo-rearing countries because the buffalo milk is richer in calcium, phosphorus, total solids, fat content and antioxidants (Blasi et al. 2008; Akgun et al. 2016).

At the moment, traditional Laban fermented milk is produced at an industrial and small household level mostly in Arab countries. It is obtained through the lactic fermentation of heat-treated milk by Streptococcus thermophilus and Lactobacillus delbrueckii subsp. bulgaricus at 40 °C to 45 °C. The nutritional and health-promoting properties of Laban fermented milk have been documented well (El-Samragy et al. 1988; Hagrass et al. 1991; All and Dardir 2009; Rahman et al. 2009). It has been reported that compared to milk, the Laban fermented milk contains lesser cholesterol, lesser lactic acid and protein, whereas the concentration of calcium, phosphorus, thiamine, vitamin B12, niacin, zinc, magnesium, riboflavin, folate, thiamine and niacin are higher (Arai et al. 2002; Chammas et al. 2006b).

Pakistan is a home track of some of the finest buffalo breeds globally, with a total population of 40.0 million heads, as per the Economic Survey of Pakistan (ESP 2019). Along with India, it provides 80% of the world's buffalo milk. Its milk is preferred over cow milk owing to its thickness, creaminess and enhanced taste. Lately, fermented products of buffalo milk are gaining attention for human consumption and hence the fermented products are being produced mostly at traditional household levels. Various physicochemical, sensory and microbiological parameters have been studied and reported for fermented Laban milk from Egypt (All and Dardir 2009; Saleh 2013), Lebanon (Chammas et al. 2006a, 2006b), Oman (Guizani et al. 2001), and many other countries to attain a precise quality for the products. However, there is a dearth...
of literature regarding similar studies from Pakistan for buffalo milk.

Aside from the probiotic microorganisms of human and animal origins, several probiotics are isolated from functional foods (Nasim et al. 2020). Functional foods are groups of food and their nutritional properties, also provide health benefits when an adequate amount of them is consumed (Yousefi et al. 2017; Khanniri et al. 2018). There has been extensive production and consumption of fermented milk in recent years. The consumers’ awareness regarding the importance of consuming healthy food products and their direct effects on the human body has directed the manufacturers in the food industry to develop functional food (Nasim et al. 2020). The live yeast cultures as probiotics in fermented food are considered as fermented functional foods. Upon consumption of probiotics, health benefits are rendered to the host directly or indirectly by virtue of metabolite production (Shalini and Mishra 2012). Fermented milk products induce various beneficial effects on human health such as anti-diabetic, antihypertensive, anticancer and anti-obesity effects. Fermented dairy products are reliable for probiotic proliferation as supplying a rich source of essential amino acids and carbons resulting from the proteolytic system involved in using and hydrolyzing the lactose. Additionally, the buffering capacity of milk and milk-fat contents develops a suitable environment for probiotics to tolerate the unfavourable conditions in the gastro-intestinal tract (Nasim et al. 2020).

Foreseeing the research gap, the present study analyzes the effect of variable fat levels and storage time in different fermented laban milk samples (cow milk, buffalo milk, and mixed milk) through physicochemical, sensory and microbiological attributes.

2. Materials and methods

2.1. Experimental site and animals

The study was conducted at the Department of Dairy Technology, the University of Veterinary and Animal Sciences (UVAS), Lahore, Pakistan (latitude 33.738, longitude 73.084/33° 44′ 16.962″ N and 73° 5′ 4.156″ E).

The animals utilized were Nili-Ravi buffaloes (Bubalus bubalis) and Sahiwal breed of cows that were at mid-lactation, reared at the dairy farm of UVAS, Lahore.

2.2. Milk samples, chemical analyses and standardization

The milk samples attained from the buffaloes and cows were divided into three groups (T1 = Buffalo Milk, T2 = Cow Milk, T3 = Mixed Milk). The T3 group had mixed milk from buffalo and cows at a 50/50 ratio. The protein, fat, lactose and total solid content of milk samples were deduced using a multifunctional analyzer of dairy products (MilkoScan FT-120, FOSS Electric A/S, Hillerod, Denmark) and stored at 4 °C until further used.

Standardization of milk samples was attained through the removal of excess fat using a cream separator (Milk Cream Separator, 80L/H-100L/H, Wenzhou Yuanyu Mechanical Co. Ltd, China) (Ahmed et al. 2014; Akgun et al. 2016), and the final fat content was 1.5 and 3.5 g/100 g.

Six types of fermented laban were prepared from buffalo milk (T1), cow milk (T2) and their blend (T3) using 3.5 and 1.5% fat levels. Each treatment was replicated and analyzed thrice.

2.3. Laban preparation

Standardized milk samples obtained from different bovine animals (cow, buffalo and blend of cow/buffalo) were stored at 4 °C till their compositional analysis. Later, these milk samples were heated at 60 °C for the addition of a stabilizer (Gelatin 0.5%), pasteurized at 85 °C with a holding time of five minutes in a water bath followed by cooling to 44 °C for DVS starter culture inoculation. It was then incubated for fermentation by the bacterial activity of typical laban starter culture (SACCO Lyofast Y082, Italy) until the final pH of 4.6 (Irvine et al. 2011). Yogurt curd was shifted for blast cooling in freezers till it attained 4 °C temperature. Homogenization/blending of yogurt was carried out to convert yogurt into Laban, then packaging in Polyethylene bottles of 250 mL. It was then stored in a refrigerator at 4 °C for 21 days.

2.4. Physicochemical analyses

The viscosity, protein, total solids (TS), pH, acidity and syneresis were assessed as physicochemical attributes of prepared laban samples using established protocols. An average of three recordings was taken for each attribute. The pH was measured with a pH meter (Eutech Cyberscan pH 100, Indonesia). The protein, TS and acidity were measured, per prescribed methods (Helrich 1990; Bradley et al. 1992). The viscosity was measured using a Brookfield Viscometer (Model D-II, 5550 HPHT, Ametek Chandler Engineering, USA) and represented as Pascal-Second (Pa-s). The operation of the viscometer was carried out at 10 rpm using spindle no. 3 recorded after 20 seconds of rotation. Results were recorded in centipoise (cp), as described earlier (Akgun et al. 2016).

For syneresis, fermented laban samples were centrifuged at 2200 G for 20 minutes at 4 °C. Whey thus separated was measured and the rate was expressed as the volume of separated whey per 100 g of fermented laban milk sample using a prescribed protocol (Wacher-Rodarte et al. 1993).

2.5. Sensory analyses

Sensory profiling (colour, taste, appearance, aroma, texture and overall acceptability) of fermented laban samples was done using a 10-member volunteer panel, as described earlier (Katxiari et al. 2002). Three 2-hour sittings were directed to train panelists in the virtuous practice of the features and the intensity scale and to associate their observation. A combination of pre-established lists of sensory features found in the literature was cast off to define the samples (Harper et al. 1991). All the study samples were categorized for every descriptor, allowing for a 9-point scale (1 = dislike extremely/absence of the considered perception, 5 = neither like nor dislike, and 9 = liked
extremely/a very intense perception; 24). Within a session, four varying products were assessed, containing one in duplicate to test the performance of the panelists. Samples (stored at 4 °C for 21 days) were shown concurrently. Extrinsic factors, like temperature, quantity presented, and container, were homogeneous for all products. The temperature of samples at the time of serving was 6 °C, as frequently consumed. Between samples, crumb and spring water were provided for rinsing the mouth.

2.6. Microbiological analyses

For total plate count (TPC) and coliform count (CC) analysis, fermented laban samples at 0, 7, 14 and 21 days of storage period were examined following the prescribed procedures (Marshall 1992; Uzeh et al. 2006). Briefly, the samples were diluted with sterile distilled water and 1 mL was used through the pour-plate method. Nutrient agar, MacConkey agar and potato dextrose agar were utilized for growth. Developed colonies were counted after appropriate incubation and represented as TPC. Coliform bacteria were counted through a Violet Red Bile Agar at 37 °C (Al-Kadamany et al. 2002).

2.7. Statistical analyses

The data have been presented as mean (±SE). All the data were analyzed statistically using Statistical Package for Social Sciences (SPSS for Windows, V12, SPSS Inc., Chicago, IL., USA). Statistical analysis of data for effects of varying fat levels (1.5 & 3.5%) as well as storage time (day 1, 7, 14 and 21) on physicochemical, sensory and microbiological attributes was performed through a two-way ANOVA and Tukey’s posthoc test at 5% significance level.

3. Results and discussion

The present work from Pakistan aims to determine the effect of different fat levels and storage times on three different fermented milk samples (buffalo milk, cow milk, and mixed milk) by various physicochemical, sensory and microbiological attributes. As there is a paucity of literature on such aspects for buffalo laban milk, comparisons have been made with cow laban milk, where needed.

3.1 Physicochemical attributes

The physicochemical analyses for three types of laban milk samples in the present study revealed that viscosity, protein and TS were significantly (P ≤ .05) higher in the T1 group (buffalo laban milk samples) than T1 group (cow laban milk) and T2 group (mixed laban milk samples) (Table 1). The pH, acidity and syneresis were non-significantly (P ≥ .05) different for the three types of study laban milk samples. The results are in line with previously published reports which have clearly depicted a higher viscosity, proteins and TS in buffalo laban milk (Kapadiya et al. 2016). Casein molecules in the buffalo milk are found in a micellar form, which causes phosphorylation of casein and hence leads to a higher casein level. This micellar mineralization has been dubbed as a major factor for higher proteins and TS in buffalo laban milk (Ahmad et al. 2008). The TS of buffalo laban milk samples in the present study ranged from 11.4 to 14.9%, which is in line with that reported for commercial laban but higher than that for home-made laban (Guizani et al. 2001; All and Dardir 2009; Kapadiya et al. 2016). The difference could be attributed to different milk sources (cow) and the geography of the study. However, the range of protein (2.8% to 3.6%) present in buffalo laban milk samples of the present study is within the limits reported earlier (All and Dardir 2009; Mahmood and Usman 2010). The pH of all the three laban milk samples ranged from 4.0–4.6, which is in the range presented earlier by various researchers for commercial laban milk (Guizani et al. 2001; Arai et al. 2002). This range is higher than that reported for home-made laban milk reported elsewhere (Guizani et al. 2001; All and Dardir 2009). It is generally accepted that the commercial laban has higher pH than home-made laban milk because water is added in home-made laban to include coalescence of butter granules. The milk composition is altered as per genetics of the animal, lactation stage, season, husbandry and feeding regimen, which alters the composition of milk and ultimately the characteristics of its products.

The results regarding the effect of days of storage on physicochemical attributes in three different fermented laban milk samples (Table 1) revealed that viscosity, acidity and syneresis of all three laban milk samples increased, whereas pH decreased significantly (P ≤ .05) across the storage days. However, protein and TS were non-significantly (P ≥ .05) affected by the days of storage. The results are in line with those conducted for sheep laban (Katsiari et al. 2002) and cow laban milk (Arai et al. 2002; Chammas et al. 2006b) which reported that storage time had no effect on protein content and TS and that the laban maintained its ‘physical stability’. Previous studies have also revealed that titrable acidity values increase for laban samples at the end of the storage time and the rates are higher for higher fat samples. This increased acidity has been attributed to an elevated lactic acid-producing bacteria in the samples and ultimate increased lactic acid.

Regarding the effect of different fat levels on the three laban milk samples under study, the viscosity, protein and TS significantly (P ≤ .05) decreased in laban milk samples with 3.5% fat compared to the 1.5% fat (Table 1). The remaining physicochemical attributes, such as pH, acidity and syneresis, remained fairly constant for both fat levels under study. Laban milk prepared from buffalo milk with low fat had non-significantly (P ≥ .05) developed acidity compared to the other samples of laban milk prepared from other milk resources. Our results are in line with those reported earlier with buffalo milk (Cunha Neto et al. 2005; Akgun et al. 2016) who stated that the main cause of changes in the acidity of fermented laban milk made with low fat was the higher moisture contents. The titratable acidity values of laban milk produced from buffalo milk increased at the end of the storage days. However, the rate of increase was not the same for all types of test samples. The rate of increase in acidity% of high-fat laban milk samples was higher than that of low-fat laban milk samples. These changes were due to their higher free fatty
The overall mean (±SE) values for three laban milk samples revealed that the group T3 (buffalo milk laban) had significantly ($P \leq 0.05$) higher scores for taste and aroma than other two samples, which is in consistent with reports for buffalo and cow milk (Chammas et al. 2009). The remaining attributes (colour, appearance, texture and overall acceptability) were non-significantly ($P \geq 0.05$) different for the three study laban milk samples. The overall mean (±SE) values for all sensory attributes were within the range provided earlier for cattle (Chammas et al. 2006a) and buffalo milk laban samples (Cunha Neto et al. 2005; Raju and Pal 2009; Akgun et al. 2016). Throughout the buffalo-rearing countries, it is generally accepted that the sensory attributes for buffalo milk are usually higher than that for cow milk. The findings of our study are close in line with Dimitrellou et al. (Dimitrellou et al. 2019). They reported that dairy products from cow milk have less intense flavour than those from goat milk as it affects sensory characteristics of fermented milk products (Dimitrellou et al. 2019). Another study reported that compared to those of cow milk, the sensory and physicochemical characteristics changed by adding goat milk contents and the overall sensory score of fermented milk were decreased by the addition of goat milk into the cow milk that might be due to the different nature of caprine and bovine caseins in aggregation behaviour (Maria et al. 2008). However, some reported no effect in sensory attributes by adding goat milk up to 50% (Roberto et al. 2016).

An extensive variability was noticed for the results regarding the effect of days of storage on sensory attributes in three different fermented laban milk samples (Table 2). Mean (±SE) values for colour and taste decreased significantly ($P \leq 0.05$) for T2 (cow laban milk) and T3 (mixed laban milk), whereas they remained unaffected for T1 (buffalo laban milk). Aroma and texture scores significantly ($P \leq 0.05$) increased by the 14th day of storage but decreased on the 21st day.

Regarding the effect of varying fat levels on sensory attributes of three laban milk samples studied, it was noticed that colour and appearance scores were unaffected for the T1 group (buffalo laban milk), but decreased significantly ($P \leq 0.05$) with increased fat level for the T2 (cow laban milk) and T3 groups (mixed laban milk) (Table 2). Similarly, taste

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**3.2 Sensory attributes**

The overall mean (±SE) values for three laban milk samples revealed that the group T3 (buffalo milk laban) had significantly ($P \leq 0.05$) higher scores for taste and aroma than the other two samples, which is in consistent with reports for buffalo laban milk (Raju and Pal 2009). The remaining attributes (colour, appearance, texture and overall acceptability) were non-significantly ($P \geq 0.05$) different for the three study laban milk samples. The overall mean (±SE) values for all sensory attributes were within the range provided earlier for cattle (Chammas et al. 2006a) and buffalo milk laban samples (Cunha Neto et al. 2005; Raju and Pal 2009; Akgun et al. 2016). Throughout the buffalo-rearing countries, it is generally accepted that the sensory attributes for buffalo milk are usually higher than that for cow milk. The findings of our study are close in line with Dimitrellou et al. (Dimitrellou et al. 2019). They reported that dairy products from cow milk have less intense flavour than those from goat milk as it affects sensory characteristics of fermented milk products (Dimitrellou et al. 2019). Another study reported that compared to those of cow milk, the sensory and physicochemical characteristics changed by adding goat milk contents and the overall sensory score of fermented milk were decreased by the addition of goat milk into the cow milk that might be due to the different nature of caprine and bovine caseins in aggregation behaviour (Maria et al. 2008). However, some reported no effect in sensory attributes by adding goat milk up to 50% (Roberto et al. 2016).

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### Table 1. Mean (±SE) values for various physicochemical attributes of Laban milk as affected by different fat levels during storage.

| Physicochemical Attributes | Laban Type | Fat % | 1st Storage Time (Days) | 7th Storage Time (Days) | 14th Storage Time (Days) | 21st Storage Time (Days) |
|----------------------------|------------|------|-------------------------|------------------------|-------------------------|-------------------------|
| Viscosity (cP)             | T1         | 1.5  | 4.265.3 ± 1.3^A          | 5.297.3 ± 0.6^B        | 6.196.6 ± 1.3^C        | 7.266.6 ± 5.3^D         |
|                            | T2         | 3.5  | 434.40 ± 2.0^A           | 6032.3 ± 2.3^B         | 6522.6 ± 2.6^C         | 6966.3 ± 1.6^D         |
|                            | T3         | 3.5  | 3882.3 ± 2.3^A           | 4884.00 ± 2.0^B        | 5197.33 ± 0.6^C        | 5266.67 ± 33.3^C       |
|                            |            | 3.5  | 3743.6 ± 1.6^A           | 4032.67 ± 2.6^B        | 4721.67 ± 1.6^E        | 5067.00 ± 1.0^D        |
| Total Solids (%)           | T1         | 1.5  | 16.7 ± 0.02^A            | 16.7 ± 0.01^A          | 16.7 ± 0.01^A          | 16.7 ± 0.01^A          |
|                            | T2         | 3.5  | 14.9 ± 0.02^A            | 14.9 ± 0.01^A          | 14.9 ± 0.01^A          | 14.9 ± 0.01^A          |
|                            | T3         | 3.5  | 15.0 ± 0.01^A            | 14.9 ± 0.00^A          | 14.9 ± 0.00^A          | 14.9 ± 0.00^A          |
| pH                         | T1         | 1.5  | 4.5 ± 0.03^A             | 4.3 ± 0.04^A           | 4.3 ± 0.01^A           | 4.3 ± 0.01^A           |
|                            | T2         | 3.5  | 4.6 ± 0.01^A             | 4.4 ± 0.03^A           | 4.1 ± 0.01^C           | 4.0 ± 0.02^C           |
|                            | T3         | 3.5  | 4.6 ± 0.01^A             | 4.4 ± 0.01^A           | 4.2 ± 0.01^C           | 4.1 ± 0.01^C           |
| Protein (%)                | T1         | 1.5  | 3.2 ± 0.01^A             | 3.2 ± 0.01^A           | 3.2 ± 0.01^A           | 3.2 ± 0.01^A           |
|                            | T2         | 3.5  | 2.9 ± 0.01^A             | 2.9 ± 0.02^A           | 2.8 ± 0.02^A           | 2.8 ± 0.03^A           |
|                            | T3         | 3.5  | 3.1 ± 0.02^A             | 3.1 ± 0.01^A           | 3.1 ± 0.01^A           | 3.1 ± 0.01^A           |
| Fat (%)                    | T1         | 1.5  | 3.6 ± 0.02^A             | 3.6 ± 0.01^A           | 3.6 ± 0.01^A           | 3.6 ± 0.01^A           |
|                            | T2         | 3.5  | 3.6 ± 0.01^A             | 3.6 ± 0.01^A           | 3.6 ± 0.01^A           | 3.6 ± 0.01^A           |
|                            | T3         | 3.5  | 3.6 ± 0.01^A             | 3.6 ± 0.01^A           | 3.6 ± 0.01^A           | 3.6 ± 0.01^A           |
| Syneresis (mL/100 g)       | T1         | 1.5  | 426.5 ± 0.6^A            | 43.6 ± 0.6^A           | 45.5 ± 0.02^B          | 45.6 ± 0.3^C           |
|                            | T2         | 3.5  | 426.5 ± 0.3^A            | 44.1 ± 0.1^A           | 44.6 ± 0.1^A           | 45.3 ± 0.3^C           |
|                            | T3         | 3.5  | 425.5 ± 0.0^A            | 436.6 ± 0.1^A          | 447.0 ± 0.02^B         | 463.6 ± 0.1^C           |
scores significantly \( P \leq 0.05 \) increased with a higher fat level (3.5\%) for the T1 group (buffalo laban milk) than T2 and T3 groups. Aroma scores were significantly \( P \leq 0.05 \) higher for the T3 group (buffalo laban milk) than T2 and T1 groups at a fat level of 3.5\%. Comparing our results with previous reports, it was noticed that variable results had been reported elsewhere. A study conducted on assessing the effect of varying fat levels on buffalo laban milk reported a significant \( P \leq 0.05 \) decrease in colour, texture and appearance, and an increase in overall acceptability with a higher fat level (Yadav et al. 2005). Our results are in line with those conducted for cattle in overall acceptability with a higher fat level (Yadav et al. 2005). Another study reported similar findings and stated that the results of the viability of LAB (lactic acid bacteria) used in fermented products from buffalo milk are not significant at \( P \leq 0.05 \).

### 3.3 Microbiological attributes

The overall mean (±SE) values for TPC were significantly \( P \leq 0.05 \) higher for the T1 group (buffalo laban milk) than those of the other two laban milk groups. Our findings are close in line with the results of other researchers, who reported that viable count was highest i.e. 7.33–8.83 log cfu/mL detected in fermented products from buffalo milk than the cow milk products which don’t show better bacterial viability (Thamires et al. 2020). Another study reported similar findings and stated that the results of the viability of LAB (lactic acid bacteria) used for the preparation of fermented dairy products were shown better in fermented buffalo milk for up to 21 d of refrigerated storage. However, researchers reported that challenges are associated with incorporating probiotics in dairy products based on buffalo milk, especially the viability can be reduced due to environmental stress and processing during storage (Abesinghe et al. 2020).

A higher level of protein and TS in buffalo milk, as depicted in our results, may be a plausible justification. The range of TPC from 7.7 ± 0.03 for cow laban milk to 9.0 ± 0.0 log cfu/g for buffalo milk in the present study is within the range given earlier (Saleh 2013; Akgun et al. 2016). No coliform colonies were observed for any of the tested laban milk samples in our study. A lower pH level in fermented milk is considered for the absence of these bacteria (Raju and Pal 2009).
Regarding the effect of storage days, the TPC tended to decrease significantly ($P \leq .05$) with a higher fat level of $3.5\%$ in all three laban milk samples under study. However, days of storage had a non-significant ($P \leq .05$) effect. The results are entirely in line with earlier reports (Chammas et al. 2006a; Akgun et al. 2016).

4. Conclusion

The results of the present study reveal that the physico-chemical, sensory and microbiological attributes differ significantly for three laban milk samples prepared from buffalo milk, cow milk and mixed milk. Buffalo laban milk seems best in terms of viscosity, protein, TS, taste and aroma. Furthermore, these attributes are affected by the days of storage and fat level. The fermented laban prepared from mixed milk (50/50 ratio of cow and buffalo milk) showed results at par with that for buffalo milk. Hence, considering the economical aspect, mixed milk laban at a fat level of $3.5\%$ is highly recommended.

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References

Abesinghe AMNL, Priyashantha H, Prasanna PHP, Kurukulasuriya MS, Ranadheera CS, Vidanarachchi JK. 2020. Inclusion of probiotics into fermented buffalo (Bubalus bubalis) milk: An overview of challenges and opportunities. Fermentation. 6(4):121. doi:10.3390/fermentation6040121.

Ahmad S, Gaucher I, Rousseau F, Beaucher E, Piot M, Gronnet JF, et al. 2008. Effects of acidification on physico-chemical characteristics of buffalo milk: A comparison with cow’s milk. Food Chem. 106(1):11–17.

Ahmed L, Morgan S, Hafez R, Abdel-All A. 2014. Influence of yoghurt starter culture on viability of some pathogenic microorganisms in yoghurt. Int J Dairy Sci. 9(3):82–88.

Akgun A, Yazici F, Gulec HA. 2016. Effect of reduced fat content on the physicochemical and microbiological properties of buffalo milk yoghurt. LWT. 74:521–527.

Al-Kadamany E, Toufeili I, Khattar M, Abou-Jawdeh Y, Harakeh S, Hadad T. 2002. Determination of shelf life of concentrated yogurt (Labneh) produced by in-bag straining of set yogurt using hazard analysis. J Dairy Sci. 85(5):1023–1030.

All AA, Dardir H. 2009. Hygienic quality of local traditional fermented skimmed milk (Laban Rayb) sold in Egypt. World J Dairy Food Sci. 4 (2):205–209.

Arai I, Nakajima K, Maruyama C, Nakamura T, Toba T, Urashima T. 2002. Microflora of microorganisms and several characteristics of laban, a traditional natural fermented milk in Yemen. Milk Sci (Japan). 51(2):63–72.

Blasi F, Montesano D, De Angelis M, Maurizi A, Ventura F, Cossignani L, et al. 2008. Results of stereospecific analysis of triacylglycerol fraction from donkey, cow, ewe, goat and buffalo milk. J Food Compos Anal. 21 (1):1–7.

Bradley R, Arnold E, Barbano D, Semerad R, Smith D, Vines B. 1992. Chemical and physical methods. Stand Methods Exam Dairy Prod. 16:433–531.

Chammas GI, Saliba R, Corrieu G, Beal C. 2006a. Characterisation of lactic acid bacteria isolated from fermented milk “laban”. Int J Food Microbiol. 110(1):52–61. Epub 2006/05/01.

Chammas IG, Saliba R, Béal C. 2006b. Characterization of the fermented milk “laban” with sensory analysis and instrumental measurements. J Food Sci. 71(2):S156–S156.

Cunha Neto OC, Oliveira CAF, Hotta RM, Sobral PJA. 2005. Physico-chemical and sensory evaluation of plain yogurt manufactured from buffalo milk with different fat content. Food Sci Technol. 25(3):448–453.

Dimitrellou D, Salamouna C, Kontogianni A, Katsiopi D, Kandylis P, Zakynthinos G, Varzakas T. 2019. Effect of milk type on the microbiological, physicochemical and sensory characteristics of probiotic fermented milk. Microorganisms. 7(9):274. doi:10.3390/microorganisms7090274.

El-Samragy YA, Fayad EO, Aly AA, Hagrass AEA. 1988. Properties of labneh-like product manufactured using enterococcus starter cultures as novel dairy fermentation bacteria. J Food Prot. 51(5):386–390. Epub 1988/05/01.

ESP. 2019. Pakistan Economic Survey 2018-19. Islamabad, Pakistan: Ministry of Finance, Government of Pakistan; 2019 [cited 2019 08/04/2020]; Available from: http://www.fin.gov.pk/survey/chapters_19/2-Agriculture.pdf.

Guizani N, Kasapis S, Al Ruzeiki M. 2001. Microbial, chemical and rheological properties of laban (cultured milk). Int J Food Sci Technol. 36(2):199–205.

Hagrass AE, Fayad EO, Aly AA, el-Samragy YA. 1991. Growth characteristics of enterococci isolated from Laban Rayeb. Nahrung. 35(2):209–213. Epub 1991/01/01.

Harper SJ, Barnes DL, Bodyfelt FW, McDaniel MR. 1991. Sensory ratings of commercial plain yogurts by consumer and descriptive panels. J Dairy Sci. 74(9):2927–2935.

Helrich K. 1990. Official methods of analysis of Association of official Analytical Chemists. Association of Official Analytical Chemist. Washington DC.

Irvine SL, Hummelen R, Hekmat S. 2011. Probiotic yogurt consumption may improve gastrointestinal symptoms, productivity, and nutritional intake of people living with human immunodeficiency virus in mwanza, Tanzania. Nutr Res. 31(12):875–881.

Kapadiya DB, Prajapati DB, Jain AK, Mehta BM, Darji VB, Aparnathi KD. 2016. Comparison of surti goat milk with cow and buffalo milk for gross composition, nitrogen distribution, and selected minerals content. Vet World. 9(7):710–716.

Katsiri MC, Voutsinas LP, Kondyli E. 2002. Manufacture of yoghurt from stored frozen sheep’s milk. Food Chem. 77(4):413–420.

Khanmiri E, Sobravandi S, Mortazavian AM, Khoshridian N, Malgani S. 2018. Effect of fermentation, cold storage and carbonation on the antioxidant activity of probiotic grape beverage. Curr Nutr Food Sci. 14 (4):335–340. doi:10.2174/15737401313666170614100418.

Mahmood A, Usman S. 2010. A comparative study on the physicochemical parameters of milk samples collected from buffalo, cow, goat and sheep of Gujrat, Pakistan. Pak J Nutr. 9(12):1192–1197.

Maria V, Maite C, Ana A, Amparo C, Chelo GM. 2008. Physicochemical and sensory characteristics of yoghurt produced from mixtures of cows’ and goats’ milk. Int Dairy J. 18(12):1146–1152. doi:10.1016/j.idairyj.2008.06.007.

Marshall RT. 1992. Standard methods for the examination of dairy products. American Public Health Association Washington DC.

Nasim K, Yousefia M, Amir MM. 2020. Fermented milk: The most popular probiotic food carrier. Adv Food Nutr Res. 94:91–114. ISSN 1043-4526. doi:10.1016/bs.afnr.2020.06.007.

Rahman IEA, Dirar HA, Osman MA. 2009. Microbiological and biochemical changes and sensory evaluation of camel milk fermented by selected bacterial starter cultures. Afr J Food Sci. 3(12):398–405.

Raju PN, Pal D. 2009. The physico-chemical, sensory, and textural properties of Misti Dahi prepared from reduced fat buffalo milk. Food Bioprocess Technol. 2(1):101–108.
Roberto GC, Edvaldo MBF, Solange S, George RBC, Rita CREQ, Eliel NC. 2016. Physicochemical and sensory characteristics of yoghurts made from goat and cow milk. Anim Sci J. 87(5):703–709. doi:10.1111/asj.12435.
Saleh F. 2013. Isolation and identification of microorganisms and antibacterial activity of Laban Zeer, an Egyptian traditional fermented milk product. Saudi Arabia: Food and Nutrition Sciences Dep College of Agriculture and Food Science, King Faisal University. No. 2, pp. 31–42.
Shalini M, Mishra HN. 2012. Technological aspects of probiotic functional food development a review. Nutrafoods. 11:117–130. doi:10.1007/s13749-012-0055-6.
Thamires MSS, Anna CMP, Carlos MNM, Attilio C, Cristina SBB, Diego M, Ricardo PSO. 2020. Buffalo milk increases viability and resistance of probiotic bacteria in dairy beverages under in vitro simulated gastrointestinal conditions. J Dairy Sci. 103(9):7890–7897. doi:10.3168/jds.2019-18078.
Uzeh RE, Ohenhen RE, Rojubokan AK. 2006. Microbiological and nutritional qualities of dairy products: Nono and Wara. Nat Sci. 4(3):37–40.
Wacher-Rodarte C, Galvan MV, Farres A, Gallardo F, Marshall VM, Garcia-Garibay M. 1993. Yogurt production from reconstituted skim milk powders using different polymer and non-polymer forming starter cultures. J Dairy Res. 60(2):247–254.
Yadav H, Jain S, Sinha P. 2005. Preparation of low fat probiotic dahi. J Dairy Foods Home Sci. 24(3-4):172–177.
Yousefi AM, Khorshidian N, Mohammad MA, Hosseini H. 2017. A review on the impact of herbal extracts and essential oils on viability of probiotics in fermented milks. Curr Nutr Food Sci. 13(1):6–15.