1. Introduction

The primary milk is the mixture of more than 200 ingredients many with special functional and nutritional properties (Chatterjee & Acharya, 1992). It contains high-quality protein, fat and minerals. For unprotected groups such as infants and school age children, milk and milk products are the main constituents of daily diet (Davies, Freed, & Whittemore, 1986).

Milk handling and maintenance of its quality before supply to the market is a main difficulty. In various regions of the country, adequate cold series and refrigeration services are not accessible for rural people because these systems are very costly. To solve these problems, new technical and well-organized process is necessary. It will be a blessing for rural people if a little cost methods for conservation of milk become practicable in rural regions (Sahoo, 2003).

The UHT milk is recognized as extended shelf life milk. The exceptional quality of UHT milk is that it is germ-free and has extended shelf life at room temperature. It offers germ-free product of supreme class which can be bought from anywhere, at any time and in any quantity (Beha, 1992). The special effects of heat analysis on the milk components (proteins, lipids, carbohydrates and minerals) are very significant for the ending item for consumption quality, since they undergo alteration that change the sensory and nutritional value of milk (Burton, 1984). Shelf life of UHT milk is affected at the stage after processing due to physico-chemical and biochemical alterations. The major difficulties happening in the product during storage stage are the proteolytic, lipolytic, oxidative and Millard reactions (Singh et al., 1998).

Two major difficulties resulted due to heating of milk are age gelation and off flavor occurrence that lowers the shelf life of milk. In contrast to raw or pasteurized milk, UHT treatment of milk showed much bigger development of tiny casein micelles (Singh, 1993). With the increase in storage time there is a raise in acidity and viscosity with a decline in pH. Clare et al. (2005) concluded that sugary aromatic flavor and sweet taste of UHT milk reduces during storage.
By keeping in view the importance of UHT milk, this study was conducted to know about the effect of storage period and storage temperature of UHT milk on the milk composition and to check at which temperature minimum quality losses occur and which temperature is suitable for UHT milk storage.

2. Material and methods

The planned research was approved in the Department of Food Technology PMAS-Arid Agriculture University, Rawalpindi. Evaluation of UHT milk samples was done and stored at different temperatures.

2.1. Milk Sample Collection

Milk samples were taken from the controlled batch of commercial dairy industry. Samples were stored at different temperatures (10 °C, 25 °C and 37 °C) and analysis made fortnightly in the food technology laboratory.

2.2. Physico-chemical analyses of UHT milk

Different physicochemical analyses of UHT milk stored at different temperatures for 90 days were done by the method described in AOAC (1990).

2.3. Determination of Lactose (%)

Lactose content of UHT milk was measured according to AOAC method No. 930.28 (1990) by applying the following expression:

\[
Lactose \% = \frac{a \times 500 \times 100}{b \times 25 \times 1000} = 2 \times \frac{a}{b}
\]

Where

\(a\) = amount of lactose in mg equivalent to the weight of precipitated Cu2O as found in Hammond Table.

\(b\) = amount of sample used in ml.

2.4. pH

pH was determined by electronic digital type Hanna pH meter No.981.12 of AOAC (1990). pH meter was standardized before pH measurement using pH 4.0 and 9.0 buffers.

2.5. Titrable acidity (%)

It was calculated by AOAC method No.947.05 (1990). 9 ml UHT milk trials were pipetted out into 250 ml beaker. Samples were titrated against 0.1 N NaOH until light pink color was attained by using the phenolphthalein indicator. Acidity was calculated according to following formula:

\[
0.1 \text{ N NaOH (ml)} \times 0.09 = \frac{\text{Titrable acidity (\%)} \times 100}{10}
\]

2.6. Moisture (%)

Moisture was measured according to AOAC method No. 920.116 (1990) and calculated according to following formula:

\[
\text{Moisture (\%)} = \frac{\text{Wt.of fresh sample} - \text{Wt. after drying}}{\text{Wt. of sample}} \times 100
\]

2.7. Total solids (%)

Total solids were measured by AOAC method No. 925.23(1990). UHT milk samples (2-3ml) were transferred in clean dried and tarred china dish. Samples were held in reserve in hot air oven for 2-3 hrs at 100 °C. Samples were chilled in desiccators. After cooling the samples, these were weighed directly. Total solids were calculated by applying the following expression.

\[
\text{Total Solids (\%)} = \frac{(\text{weight of dish + dry sample}) - \text{wt.of dish}}{\text{(wt of dish + sample) - wt of dish}}
\]

2.8. Statistical Analyses

Analysis of variance of the data was applied according to complete randomized design. Treatment means were compared by the method recommended by Steel, Torrie & Dickey (1997).

3. Results and discussions

Significantly lowest lactose content (3.69%) was found at 37 °C while highest lactose content (3.87 %) was observed at 10 °C UHT storage temperature as shown in figure 1. It was also noted that lactose substances of UHT milk decreased with the passage of time. Significantly highest value of lactose (4.08%) was observed at 0 day storage of UHT milk whereas lowest lactose content (3.61%) was observed at the end of 90 d as shown in figure 2. The interactive affect of UHT
Figure 1. Effect of UHT Storage temperature on lactose content of UHT processed milk

Figure 2. Effect of UHT Storage period on lactose content of UHT processed milk

Figure 3. Effect of UHT temperature and UHT storage period on lactose content of UHT processed milk

Figure 4. Effect of UHT Storage temperature on pH of UHT processed milk

Figure 5. Effect of UHT Storage period on pH of UHT processed milk

Figure 6. Effect of UHT Storage temperature and storage period on pH of UHT processed milk

Figure 7. Effect of UHT Storage period on total solids of UHT processed milk

The present findings are in complete agreement with other researchers (Cattaneo, Masotti, & Pellegrino, 2008; Gaucher et al., 2008; Rehman et al., 2002; Walstra et al., 1999; Fox & McSweeney, 1996; Van Boekel & Folkers, 1991).

Significantly highest pH (6.69) was observed in UHT milk samples stored at 10 °C while, lowest value (6.58) was found in UHT milk samples stored at 37 °C as shown in figure 4. Similarly UHT milk samples at 0 day of storage gave significantly higher (6.90) pH value while the lowest value (6.47) for pH was observed in
UHT milk samples at the end of the storage period. The pH of UHT milk samples also vary considerably as a meaning of temperature treatments and storage interval. Significantly higher pH (6.79) was found in UHT milk samples at 0 d of storage at 10 °C while significantly low pH (6.42) was found in UHT milk samples at the 90 d stored at 37 °C . UHT milk was significantly affected during storage. These results could be related to the early scientist Samel et al. (1971) who reported that during storage of UHT milk, decline in pH occurred. A decreasing trend in pH with raise in storage may be recognized to increase in acidity of milk which increases the fatty acid and lactic acid.

Figure 8. Effect of UHT Storage period on titrable acidity of UHT processed milk

Figure 9. Effect of UHT Storage temperature and UHT period on total solids content of UHT processed milk

Figure 10. Effect of UHT Storage temperature on titrable acidity of UHT processed milk

Figure 11. Effect of UHT Storage period on titrable acidity of UHT processed milk

Figure 12. Effect of UHT Storage temperature and UHT storage period on titrable acidity of UHT processed milk

Figure 13. Effect of UHT Storage period on moisture content of UHT processed milk

concentration. These results could be related with the work of Rehman et al. (2002) who studied that storage period cause a decline in pH and increase in acidity of milk that increase lactic acid concentration due to degradation of lactose. The present study was also supported by Clare et al. (2005). Faster reduction in pH of milk at high temperature as compared to lower storage temperature was also observed by Narvhus et al. (1998).

The data regarding the influence of different storage temperature and storage time on the total solids of the UHT milk showed in the Figure 7 and 8. Significantly the highest (12.32%) total solids were recorded in the UHT milk samples preserved at 37 °C temperature and lowest total solids (12.19%) were observed at 10 °C storage temperature. Similarly UHT milk samples at 0 day storage possessed significantly lower value (12.08%) of total solids while significantly the highest
value (12.32%) for total solids was observed in UHT milk samples at 90 d of storage interval. Highest total solids (12.34%) were found on 90 d of storage period stored at 37 °C while significantly lower (12.08) total solids were found in UHT milk samples at 0 day stored at 10 °C temperature as shown in figure 9. The total solids of UHT milk were observed to be significantly diverse in UHT milk sample stored at different temperatures for 90 d of storage. The existence of significant difference in all UHT milk samples might be due to sedimentation and fat separation. The outcome of current study can be related to the finding of Datta et al. (2002) who relates the increase in total solids content to sedimentation and fat separation. The increase in total solids also supported by researcher who reported that total solids increase at all temperature with the passage of time.

The titrable acidity of UHT milk showed in Figure 10 exposes that the highest titrable acidity (0.18%) was found in UHT treated milk stored at 37 °C temperature while the lowest titrable acidity (0.14%) was possessed by UHT milk samples stored at 10 °C. Highest titrable acidity (0.18%) was found during storage of UHT milk samples at 90 d of storage and significantly the lowest acidity (0.11%) was obtained at 0 day storage of UHT milk as shown in figure 11. The results further revealed that outcome of different temperatures and storage period on Ultra High Temperature (UHT) milk as shown in Figure 12 showed the interactive affect of two exhibited significant (p<0.05) effect on titrable acidity of the UHT milk samples. Significantly the highest titrable acidity (0.21%) was observed in UHT milk samples stored at 37 °C at 90 day of storage while significantly the lowest titrable acidity (0.11%) was observed in UHT milk samples stored at 10 °C at 0 day of storage interval.

The titrable acidity of UHT milk sample increase during storage period of 90 d at different temperatures. The results of present findings can be related with the work of Clare et al. (2005) who reported there is a raise in acidity with a decrease in pH with the passage of time increased in UHT milk samples. Lesser pH and higher acidity of milk at high storage temperature could be the result of Millard reaction that can take place at faster rate at high temperature. These trends are also reported by Manji & Kakuda (1988).

Highest moisture content (87.92%) was found in UHT milk samples at 0 day of storage interval as shown in figure 13 and 14. While lowest moisture content (86.70%) was observed in UHT processed milk samples at 10 °C while significantly the lowest moisture content (86.66) was observed in UHT processed milk samples stored at 37 °C temperature. Highest moisture percentage (87.92%) was found in UHT processed milk samples which were stored at 10 °C at 0 d of storage while significantly the lowest moisture content (86.66%) was found in UHT processed milk samples stored for 90 day at 37 °C temperature as shown in figure XV.

In the current study the reduction in moisture content of UHT milk sample was found stored at different temperatures with the passage of time might be due to increase in total solids of UHT milk during storage. The present study can be supported by Datta et al. (2002) who described that when total solids increased ultimately moisture will be decreased and this happened more significantly in storage at higher temperature. Sedimentation also occurred during
storage at higher temperature as reported by Datta et al. (2002).

4. Conclusions

Results of this study showed that there was a raise in titrable acidity, total solids content during storage at high temperature while decrease in pH, moisture and lactose content. These all factors deteriorate the quality of UHT milk. Less extensive changes were observed in that milk stores at 10 °C so if we store this UHT milk at refrigeration temperature we can avoid these changes while more extensive changes were observed at 37 °C temperature.

5. References


