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PHYSICO-CHEMICAL CHANGES IN UHT TREATED AND WHOLE MILK POWDER DURING STORAGE AT AMBIENT TEMPERATURE

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Abstract: We studied the changes in pH, acidity and viscosity of ultra high temperature (UHT) treated and reconstituted whole milk powder (WMP) during storage of 90 days at room temperature. The samples were analyzed at 0, 30, 60 and 90 days intervals for these physico - chemical properties of the milk types. Values indicated an increase in acidity and viscosity with a decrease in pH with the storage time increased both in UHT treated and reconstituted whole milk powder. Apart from many enzymatic changes to deteriorate the milk, these apparent changes in milk characteristics may be one of the reasons that UHT milk cannot be kept unspoiled above 90 days and the quality of WMP is influenced within this time period.

Keywords: Physico-chemical changes, storage stability, UHT milk, whole milk powder.

INTRODUCTION

Ultra high temperature and spray drying of milk is being attempted in our country for marketing fluid milk and powder milk. Therefore, it was of interest to carry out research on changes in physico-chemical behavior of UHT and whole milk powder stored at room temperature. In the present study acidity, pH and viscosity of the samples of UHT milk and reconstituted whole milk powder stored at room temperature have been discussed with a view point to minimize the changes resulting in the deterioration of the milk types and ultimately increasing the shelf life of UHT milk and whole milk powder. Kim [1982] reported the changes during storage at 25 ºC for up to 10 days. All samples gave positive alcohol and clot on boiling tests. In all samples acidity increased from day one. Kocak and Zadow [1985] observed the rate of increase in apparent viscosity in samples stored at 10 ºC, 15 ºC and 25 ºC. Below 25 ºC rate of increase in apparent viscosity with storage time decreased with decreasing storage temperature. The apparent viscosity of the samples stored at 30 ºC decreased during early storage stages. They also observed the effect of storage time and storage temperature on the pH of UHT milk samples stored above 20 ºC and indicated a general decrease in pH. In samples stored above or at 30 ºC decrease in pH was more pronounced after about 100 days of storage.

MATERIAL AND METHODS

The milk from collection centers was brought to the laboratory of the main dairy processing plant i.e. Milk Pak Ltd. (Nestle) Lahore under chilled conditions and organoleptic tests, acidity test, clot on boiling test, alcohol

precipitate test, methylene blue test, pH, fat percent test and solid not fat (SNF) percent test were performed to check the quality of milk for processing. Air was removed from the milk, measured, chilled at 4 ºC and standardized at 3.5% fat and 8.9% SNF. Then the milk was pasteurized by a plate heat exchanger in which heat was transferred by an indirect method i.e. heat medium (steam) did not directly come in contact with milk. Pasteurized milk was then treated at ultra high temperature (UHT). To produce whole milk powder, the liquid milk after heating, separation of cream, evaporation and homogenization was dried with hot air at temperature 163 ºC (325 ºF) with a pressure of 1500-4000 lbs. in a spray drier. The samples of UHT treated and whole milk powder were kept at room temperature for subsequent analysis at a time interval of 30 days for a total period of 90 days. Whole milk powder was reconstituted @10 gm powder in 90 ml of distilled water mixed at 45 ºC. Titratable acidity of UHT and WMP milk was determined by the method of A.O.A.C [1984].

The pH was directly measured by a pH meter (Met Rohm 632) in accordance with A.O.A.C [1984]. The apparent viscosity of milk samples was determined by using Brookfield Syncro lactic Viscometer U.S.A.

Table 1: Physico-chemical changes in UHT treated milk stored at room temperature.

Storage period in days	Acidity	pH	Viscosity
0	0.09 b	6.74 a	1.98 b
30	0.10 b	6.63 b	2.28 a
60	0.12 a	6.62 b	2.22 b
90	0.14 a	6.54 c	2.29 a

Table 2: Physico-chemical changes in reconstituted whole milk powder stored at room temperature.

Storage period in days	Acidity	pH	Viscosity
0	0.09 b	6.73 a	2.02 a
30	0.09 b	6.65 b	2.24 b
60	0.10 a	6.62 b	2.22 b
90	0.11 a	6.54 c	2.34 a

The mean values followed by the same letter in the columns are non-significantly different (LSD: P=0.05).

RESULTS AND DISCUSSION

The mean values for acidity in UHT treated milk during storage of 90 days manifested a non-significant difference at 0-30 days storage and 60-90 days storage but the mean values at 0 and 30 days were significantly different from 60 to 90 days storage. This means the acidity of UHT treated milk increased from day 30 to day 60 during the entire storage period (Table 1). In case of whole milk the mean values for acidity displayed the similar trend as in case of UHT treated milk i.e. no significant change from 0 to 30 days took place and acidity increased from day 30 to 60 during 90 days storage (Table 2). The mean values at 30 and 60 days storage for pH in case of UHT treated milk were significantly different from the values at 0 and 90 days but the values at 30 and 60 were non-significantly different. So the pH of UHT treated milk samples decreased from day 0 to 30 and no change took place till 60

days storage. The pH values decreased again from 60 days storage to 90 days (Table 1). In case of whole milk powder the mean values for pH showed almost the similar trend of change during the entire storage period of 90 days as in case of UHT treated milk. The mean values for viscosity of UHT treated milk showed very prominent variation at different storage intervals, as the values at 0 and 60 days were non-significantly different from each other. Similarly the values at 30 and 90 days storage were also non-significantly different (Table 1), the trend of change in viscosity can be well expressed in bell shaped curve. The mean values for viscosity in case of whole milk powder at 30 and 60 days storage were significantly different from the values at 0 and 90 days. But the values at 30 and 60 days were non-significantly different. The viscosity in that case increased from 0 to 30 days and no significant change occurred till 60 days storage. Viscosity of WMP increased again from 60 to 90 days storage (Table 2). The increase in acidity of the samples of UHT treated milk and whole milk powder during storage period of 90 days might be due to the formation of lactic acid by lactic acid bacteria. Samples of commercially processed UHT milk (indirectly heated at 140 ºC for 3 sec) packed in polylaminated paper cartoons were stored at 22 ºC and 37 ºC. During storage at 22 ºC and 37 ºC respectively, log psychrotrophic spore count increased from 0.77 initially to 2.61 and 2.64 on 22nd day. Total spore count increased from 1.00 initially to 2.39 and 2.63 on 32nd day. Titratable acidity increased gradually from 0.135 to 0.177 and 0.192 after 33 days [Adhikari and Singhal 1992]. Ito [1985] confirmed the increase in acidity of UHT milk during storage. Gorner *et al.* [1977] observed a gradual increase in titratable acidity at an irregular rate and attributed this behavior to the changes in milk protein. These changes in milk protein may be the result of sterilization of milk at very high temperature as the weight of casein micelles increased with the severity of heat treatment, or the residual proteinases action on the protein fraction of milk resulting in gelatin. One of the most important factors involved in increasing the acidity of milk samples during storage is the storage condition; milk treated at ultra high temperature can be stored for a certain period of time. During storage milk undergoes various changes, therefore, storage conditions may have a pronounced effect on titratable acidity of the stored samples, e.g. storage temperature determines the microbial activity leading to the formation of lactic acids. Rerkrai *et al.* [1986] found that titratable acidity varies due to prevailing storage conditions. The decrease in pH of the milk samples during storage of 90 days may be due to a number of reasons. It is well known that pH involves the negative logarithm of hydrogen ion concentration, which means if acidity increases pH will decrease. Storage time and temperature have great effect on pH values of the stored samples as reported by Kocak and Zadow [1985]. Reddy *et al.* [1991] studied the effect of storage temperature on UHT whole milk stored at room temperature (20 - 22 ºC), 37 ºC and at

refrigeration temperature (4 - 6 ºC) for six months. During storage pH, heat stability, alcohol stability and reflectance of all samples decreased. The greatest rate of decrease was observed in samples stored at 37 ºC followed by those samples stored at room temperature. Rise in temperature favored the growth of bacteria resulting in the production of lactic acid and eventually lowering the pH value of milk samples. The pH of milk is more dependent on temperature than on inorganic buffer solutions such as phosphate, therefore, pH of the refrigerated milk will not be equal to that of the same milk at room temperature. This effect is probably due to changes in the solubility of calcium phosphate as reported by Sherbon [1981]. Renner and Schmidt [1981] stated the reason of this drop in pH as a result of interaction between lactose and milk protein. Celestino et al. [1997] studied the reconstituted UHT milk produced from dried whole milk and stored for 8 months at 25 $\pm$ 1 ºC for lipolytic and proteolytic activities, physico-chemical and flavor changes, and gelatin in UHT milk during storage. During this study, non-protein nitrogen content of UHT milk was found to increase while pH and color lightness decreased with storage. Comparisons have been made with the milk types with low and high fat contents after UHT treatment for the evaluation of pH. Changes in physico-chemical properties of UHT buffalo milk (processed in indirect type plant at 140 ºC for 2 sec and packed in wax paper/polyethylene laminated tetra pack) during storage at 30 ºC were studied. Acid degree value increased from 4.20 and 3.75 to 6.15 and 8.87, and pH decreased from 6.80 to 6.70 and 6.60 respectively, for the milk with 5% and 6% fat [Singh and Patil 1989]. The values for viscosity in this experiment showed an irregular trend at different time intervals of 30 days. Storage time, storage temperature and other conditions like enzymatic activity may be the reason for this type of fluctuation in viscosity of the samples of UHT treated and whole milk powder. Kocak and Zadow [1985] gave different values for viscosity at different storage periods as UHT milks were stored at room temperature (20-22ºC) and 37 ºC and at refrigeration temperature (4-6 ºC) for six months. During storage viscosity of all samples increased however, the rise in viscosity was slow at 37 ºC compared with other storage temperatures. Addition of sodium hexametaphosphate (SHMP) reduced the magnitude of rise in viscosity [Reddy *et al.* 1991]. The extent of proteolysis and age gelatin may have an impact on the viscosity of milk samples during storage on account of sedimentation.

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