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Effect of Storage on Hydroxyme Thylfurfural (HMF) Contents of UHT Treated and Whole Milk Powder at Ambient Temperature

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Abstract: Formation of hydroxymethylfurfural (HMF) during heat treatment and subsequent storage for 90 days of UHT treated and whole milk powder at ambient temperature increases significantly. Values of HMF were significantly higher at 60 and 90 days as compared to the values at 0 and 30 days storage in case of UHT treated milk with fresh milk as standard. The difference between 0 and 30 and 60 and 90 days storage were non significant. The values for the same type of milk but with distilled water as control were significantly different and increased at each time interval i.e. 0, 30, 60 and 90 days. Analysis of reconstituted whole milk powder during the entire storage period with fresh milk as control showed HMF values significantly different at each time interval. The values were significantly different from 0 to 60 days but were non significantly different from 60 to 90 days with distilled water as standard.

Key words: UHT treated milk, whole milk powder, heat treatment, storage, browning reaction, hydroxy-meth1lfurfural

Introduction

The Maillard reaction is a complex series of reactions in which, in milk a condensation reaction first occurs between carbonyl group of lactose and the amino group of lysine. Various pathways then ultimately lead to the production of brown pigments. These are responsible for the brown colour of the heated milk. Hydroxymethylfurfural is one of the compounds of these pigments, which appears in the early stages of the Maillard reaction. The most important negative consequence of the early Maillard reaction is blockage of lysine in milk based products (Infant Formulate). Lysine is essential for growth and Maillard reaction products have negative nutritional effects as these are responsible for reducing protein digestibility (Macrae *et al*.,1993). Ipsen and Hansen (1988) studied that storage stability increased with severity of heat treatment. This effect being most pronounced in dried milk stored at 30°C. Compounds affecting both colour and flavour of milk are produced by heat treatment. Many of these compounds have unsaturated heterocyclic rings. Brown and some of the other products are covalently bound to the protein. Small molecular weight compounds contributing to the aroma of heated milk products include Maltol, 5-hydroxymethylfurfural and 0-aminoaceptonone (Badings and Neeter, 1980). Storage of UHT processed milk at 4°C maintained flavour quality more than storage at 40°C (Hansen, 1987). The present study was designed to observe the extent of formation of HMF in UHT treated and whole milk powder during heat treatment and subsequent storage at ambient temperature. The objective of the research project was to enhance the shelf life of both types of milk with reference to the formation of HMF which greatly lowers the organoleptic and nutritional quality of the milk.

Materials and Methods

The milk from collection center was brought to the main dairy processing plant under chilled conditions and initial tests like organoleptic test, acidity, clot on boiling test, alcohol precipitate test, methylene blue test, pH, fat %age and solid not fat %age tests were performed to check the quality of milk for processing in the laboratory of Milk Pak Limited (Nestle) Lahore. Milk was then Berated, measured, chilled at 4°C, standardized at 3.5 percent fat and 8.9 percent solid not fat, pasteurized, heated at ultra high temperature i.e. 140-145°C for 3-5 seconds and then aseptically packed on fully automatic machines. To produce whole milk powder, the liquid milk after heating, separation of cream, pasteurization, evaporation and homogenization was dried with hot air at a temperature 325°F with pressure 1500-4000 lbs. in a spray drier. Whole milk powder was analyzed for the determination of HMF by spectrophotometer at wavelength 250 n after reconstitution with water at 14 gm powder in 86 gm distilled water mixed at 45°C keeping water and fresh milk as standard at 0, 30, 60 and 90 days interval. The experiment was conducted in a completely randomized design and data were analyzed by using analysis of variance and mean separation was done by using LSD.

Results and Discussion

Samples of UHT treated and whole milk powder stored at room temperature for a period of 90 days and analyzed at an interval of 30 days manifested pronounced changes in the production of Hydroxymethylfurfural (HMF) contents. The mean values at 0 day and 90 days keeping fresh UHT treated milk and distilled water as standards, given in Table 1 and 2 displayed that the values of HMF contents were significantly higher at 60 and 90 days interval as compared to the values at 0 and 30 days and were non significantly different from 0-30 days of storage period as well as 60-90 days storage period in case of UHT treated milk when fresh milk was kept as standard. When the mean values in case of UHT treated milk with distilled water as standard were analyzed gave significant differences and increased at each time interval i.e. 0, 30, 60 and 90 days storage as given in Table 1. Statistical analysis of data in Table 2 for reconstituted whole milk powder manifested profound changes in the contents of HMF during a storage period of 90 days. The values of HMF with fresh milk as standard were significantly different and increased at each time interval i.e. 0, 30, 60 and 90 days storage. The HMF values for reconstituted whole milk powder when analyzed keeping distilled water as standard showed non significant differences from 60 to 90 days storage but significantly different from day 0 to 60 days storage period. Interaction of storage with both types of milk was highly significant as the contents of HMF increased in different time intervals with fresh milk as well as distilled water as standards.

Lactose and casein are two principal reactants in the browning of dairy products but whey proteins are involved in some

circumstances. A number of components have been shown to influence the reaction in model systems if not in milk, including phosphates, oxygen metals and such components as acetaldehyde, 5-hydroxymethylfurfural and methyl glyoxal

Table 1: Effect of storage on the hydroxymethylfurfural (HMF) contents in UHT treated milk

Storage period in days	Fresh milk as standard	Distilled water as standard
0	0.84b	0.87d
30	0.88b	0.92c
60	1.20a	1.22b
90	1.26a	1.30a

Means in columns followed by the same letter are non significantly different (LSD = 0.05)

Table 2: Effect of storage on the hydroxymethylfurfural (HMF) contents in whole milk powder

Storage period in days	Fresh milk as standard	Distilled water as standard
0	1.24d	0.73c
30	1.06c	1.60b
60	1.43b	1.72a
90	1.51a	1.72a

Means in columns followed by the same letter are non significantly different (LSD = 0.05)

(Webb *et al*., 1974). According to Zadow (1970) HMF values in UHT treated milk dropped sharply when stored at 2°C. In the present study the values of HMF increased because of the reason that the temperature was high i.e. 30°C and storage conditions were different. Temperature during storage affects the formation of HMF. Mottar *et al*. (1979) did not notice increase in HMF values of UHT treated milk stored at 20°C for four month. The reason for no formation of HMF in UHT treated milk during four months storage at 20°C might be the relatively lower temperature and the method of determination of HMF. Kieseker and Clark (1984) studied the storage of milk powders and reported that milk powders deteriorate during storage, the rate of change dewds on a number of factors including powder characteristics and storage temperature. Singh and Patil (1989) performed the same experiments and the rate of increase was almost same as the results obtained in the present study. High storage temperature badly affects the quality of all types of milk and one of the factor of deterioration of milk is the formation of HMF contents. Heat treatment of milk causes interaction between lactose and protein giving Maillard browning and loss of available lysine, The reaction goes in three stages and one is the formation of furfural, these finally convert into melanoiden pigments (Macrae *et al*., 1993). Browning reaction in UHT treated milk and whole milk powder contribute discolouration which is equivalent to a lowering of quality.

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