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Color variation of Ultra High Temperature (UHT) sterilized milk during storage

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Abstract
The color variation of Ultra High Temperature (UHT) sterilized milk packed aseptically in glass bottles was studied using Hunter Lab Colorimeter during storage period at room temperature. Hunter color parameters (L, a, b) of stored milk samples were measured at 15 days intervals up to two months. The Chroma, Hue angle, Browning Index and Total color change were calculated from L, a, b values. The L value of raw milk was 81.35 while that of UHT sterilized milk was 78.80. The L value and Hue angle of UHT sterilized milk were found to decrease while a value, b value, chroma and Browning Index of UHT sterilized milk were found to increase with storage period due to formation of brown pigments resulting from Maillard reaction. These color attributes data could be helpful in monitoring the quality of UHT milk during storage and also useful in predicting the shelf life of UHT milk.

Keywords: UHT milk, storage period, color measurement, hunter lab, browning index

1. Introduction
Ultra High Temperature (UHT) milk sterilization is a novel technique of milk preservation. It is the most effective treatment for long shelf life at room temperature (Ansari, 2018) [3]. During UHT treatment of milk and subsequent storage of milk, color attributes of UHT milk varies due to browning reaction. Browning is a familiar phenomenon, which occurs in milk and milk products on sterilization and also during subsequent storage period (Burton, 1988; Patton, 1955) [4, 12]. The browning of the UHT sterilized milk is mainly dominated by a non-enzymatic reaction, known as Maillard reaction. The Maillard reaction is a complex network of chemical reactions between the lysine of milk proteins and the lactose. Such reactions usually produce a set of colorless intermediate compounds and are then converted into melanoidins; dark colored compounds which give rise to the brown colour (Carpenter & Booth, 1973; Finot *et al*., 1981) [7, 8]. Hydroxymethyl furfural (HMF) is an intermediate product of Maillard browning reaction. Since Maillard reaction has negative consequences both for sensory characteristics and nutritive value of sterilized milk, it is absolutely undesirable during milk sterilization (Carabasa-Giribet & Ibarz-Ribus, 2000) [6].
Color is an important quality attribute of food. Being the indicator of the brown pigments formed during non-enzymatic browning and caramelization process, it is important for the consumer acceptance. The abnormal colors especially those associated with deteriorative in eating quality or with spoilage, cause the product to be rejected by the consumer.
Anantha-Narayanan *et al*. (1993) [2] studied the browning of Ultra-High-Temperature (UHT) processed soy beverage stored at different temperatures. Colour changes during storage are important quality defect of UHT milk. The shelf-life of shelf-stable fruit-based products, such as strawberry juice, is primarily determined by colour changes during storage (Buv *et al*., 2018) [5]. Colour measurement is a simple and fast method that can be used to control storage conditions. The measurement of color is useful in evaluation of quality of UHT milk. Knowledge of variation of UHT milk color attributes during storage may be useful in optimizing the storage conditions. The present study was conducted to investigate the variation of colour-related attributes of UHT sterilized milk during storage period.

2. Materials & Methods
2.1 Theory: Hunter colour parameters (L, a, b) are useful in describing the colour changes in food. L, a, b can be located in three dimensional Hunter Lab colour space. The 'L' axis runs through the centre of the colour space with 100 at the top representing white and '0' at the bottom representing black.

The 'a' axis, running left to right, shows red when positive (+ve) and green when negative (-ve). Similarly the 'b' axis shows yellow when positive (+ve) and blue when negative (-ve). Neutral or grey is indicated by 'a' and 'b' values being close or equal to 0.0 (Laboratory Manual, 1994) [10]. Other parameters like total color difference (ΔE), Browning index (BI), Chroma (C) and Hue angle (H) are calculated from Hunter color parameter. The Chroma value indicates the degree of saturation of colour and is proportional to the strength of colour. The Hue angle is another parameter frequently used to characterize the colour in food products. An angle of 0^0 or 360^0 represents red Hue**,** while angles 90^0, 180^0 and 270^0 represents yellow, green and blue Hue respectively.

The mathematical expressions for Browning Index (BI), Chroma (C), Hue angle (H) and total colour change (ΔE) in terms of L, a, b values are as follows (Maskan, 2001) [11].

$$BI = \frac{\left[100(x-0.31)\right]}{0.17} \quad (1)$$

where, $x = \frac{(a+1.75L)}{5.645L+a-3.012b}$

$$C = \sqrt{a^2+b^2} \quad (2)$$

$$H = \tan^{-1}\left(\frac{b}{a}\right) \quad (3)$$

$$\Delta E = \sqrt{(L_0-L)^2+(a_0-a)^2+(b_0-b)^2} \quad (4)$$

Where, L_0, a_0 and b_0 refer to the Hunter color parameters of fresh milk. L, a, b refer to the Hunter color parameters of UHT processed milk at any time t during ambient storage period.

2.2 Color Measurement

The raw, clarified whole cow milk was collected from the local market. The colour of raw milk samples (i.e. standard samples) was measured with the help of Hunter Lab Colorimeter. Before measuring the colour, the container was properly cleaned with tissue paper and then calibrated with black and white plates provided with colorimeter. A milk sample of 150 ml was taken every time in the container for measurement of colour values. For each sample three replications were taken. The milk was processed in a helical triple tube UHT milk sterilizer developed by Sahoo (2002) [13]. The UHT sterilized milk was filled into sterile bottles of capacity 250 ml and sealed aseptically. The color values (i.e. L, a, b) of UHT processed milk were measured during ambient storage period at 15 days interval upto two months.

3. Results and Discussion

The colour parameters (L, a, b) of raw and UHT sterilized milk obtained from Hunter Lab Colorimeter are shown in Table1. The 'L' value indicates the whiteness of milk samples. The negative value of 'a' and positive value of 'b' tends towards the green and yellow end respectively. As the values of 'a' and 'b' are very small in Hunter Lab colour space, the colour of raw milk can be specified as whitish with slightly greenish- yellow tint.

Table 1: Color attributes of raw and UHT sterilized milk

Product	L	a	b
Raw	81.35	-4.33	9.30
UHT sterilized milk	78.80	2.90	9.57

From Table1, it is clear that the 'L' value of the UHT processed milk is slightly lower than that of raw milk due to severity of heating, which decreases the whiteness of the sterilized milk slightly. The positive 'a' value of the sterilized milk tends to the red end. The higher positive 'b' value of the sterilized milk than that of raw milk imparts more yellowish tint to milk. The decrease in whiteness of sterilized milk and the change of greenish-yellow tint of raw milk into reddish-yellow tint of sterilized milk is due to the non-enzymatic Maillard browning reaction (Adrian, 1974; Patton, 1955) [1].

The decreasing trend of 'L' value and increasing trend of 'a' and 'b' values of UHT sterilized milk during ambient storage period are shown in Fig. 1, Fig. 2 and Fig. 3 respectively. The increase in b value indicates an increase in the yellowness of the colour. Both a and b values can serve as indicators of the browning reactions (Kwok *et al*., 1999) [9]. Since the chroma increases with storage period (Fig. 4), the intensity of colour increases. The Hue angle decreases from 73.14^0 to 70.47^0 during ambient storage period of UHT processed milk as shown in Fig. 5. Since 0^0 indicates red end and 90^0 indicates yellow end, the estimated Hue angle falls in reddish-yellow zone. With progress of storage period, the Hue angle proceeds towards the red end which is due to browning reaction. Similar findings were reported by Anantha-Narayanan *et al*. (1993) [2], Sahoo *et al*. (2003) [14] and Buv *et al*., (2018) [5].

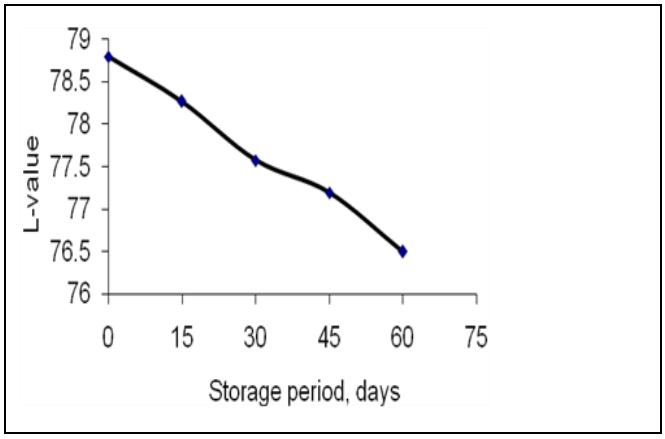

Fig 1: Variation of L-value of UHT sterilized milk with storage period

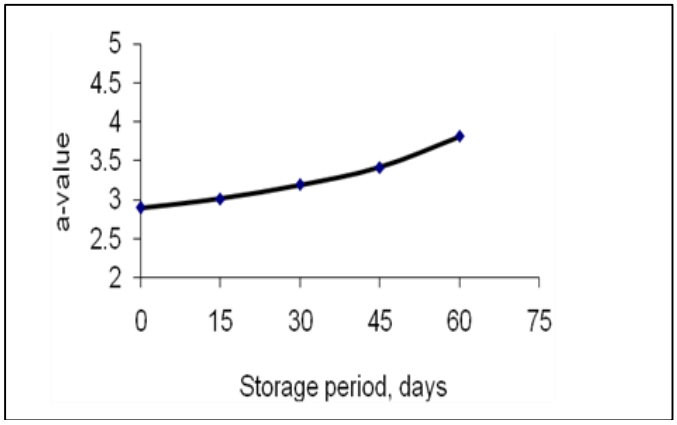

Fig 2: Variation of a-value of UHT sterilized milk with storage period

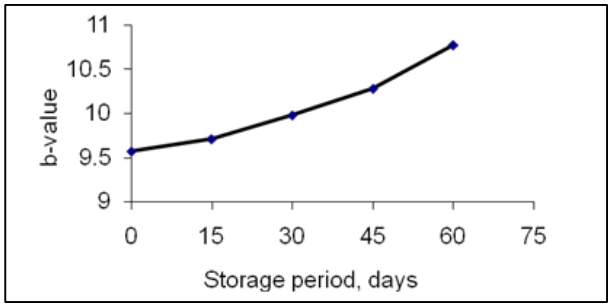

Fig 3: Variation of b-value of UHT sterilized milk with storage period

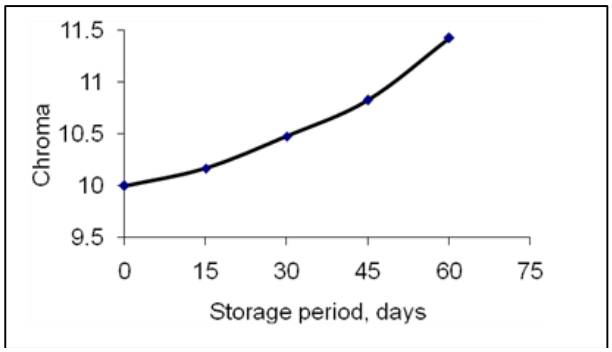

Fig 4: Variation of Chroma of UHT sterilized milk with storage period

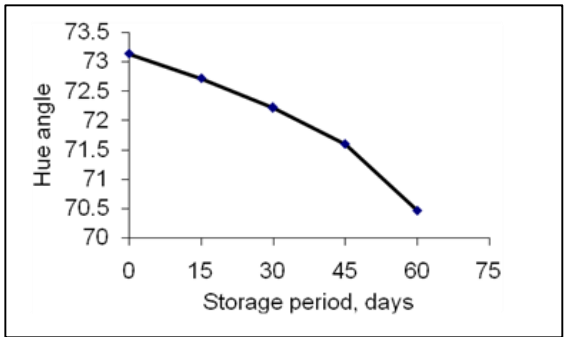

Fig 5: Variation of Hue angle of UHT sterilized milk with storage period

From Fig. 6, it is clear that Browning Index (BI) of UHT milk varied progressively due to Maillard browning reaction during storage period. Total colour change of stored milk depends on the change in L, a, b values with that of fresh milk. Since L, a, b values changes during storage period, the total colour change (ΔE) is presented in Fig. 7. It is also observed that total colour change increased with storage period due to browning reaction. Similar findings were reported by Sahoo *et al*. (2003) [14] and Buv *et al*., (2018) [5].

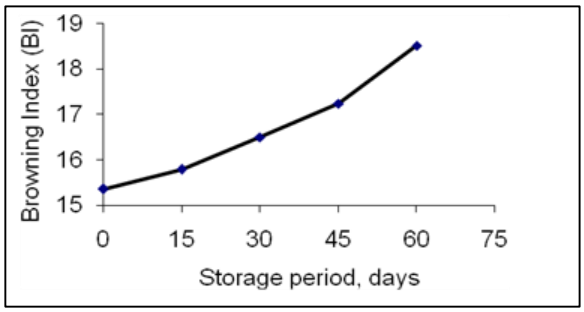

Fig 6: Variation of Browning Index of UHT sterilized milk with storage period

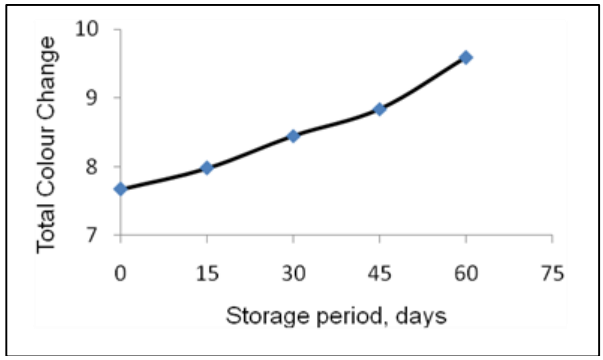

Fig 7: Variation of Total Color Change of UHT processed milk with storage period

4. Conclusion

The UHT sterilized milk was aseptically packed in sterilized glass bottle and stored for two months to study the colour variation in milk. Colour measurement is a simple and fast method to control different storage conditions. The milk samples were analyzed for different color attributes such as L, a, b, Hue, Chroma, Browning index and total color change for two months of storage at 15 days interval. The L value was decreased while BI value and Total color change value were increased with storage period due to browning reaction. The UHT milk was organoleptically safe up to two months of storage period since there was no drastic variation in color. The information on color variation could be useful in monitoring the quality of the UHT milk and estimation of shelf life.

5. References

1. Adrian J. World Review of nutrition and dietetics, Bard: Karger., 1974; 19:71.
2. Anantha-Narayana KR, Kumar A, Patil GR. Kinetics of various deteriorative changes during storage of UHT soy beverage and development of a shelf life prediction model. Lebensm. Wiss. Technol. 1993; 26:191-197.
3. Ansari Md. IA. Performance evaluation of helical triple tube ultra-high-temperature milk sterilizer, International Journal of Chemical Studies, 2018; 6(1):338-340.
4. Burton H. Ultra-High-Temperature processing of milk and milk products, Elsevier Applied Science, London., 1988.
5. Buv Carolien, Kebede Biniam T, Batselier C De, Carrillo Celia, Pham Huong TT, Hendrickx Marc. *et al.* Kinetics of colour changes in pasteurized strawberry juice during storage, Journal of Food Engineering, 2018; 216:42-51.
6. Carabasa-Giribet M, Ibarz-Ribus A. Kinetics of color development in aqueous glucose systems at high temperatures. J. Food Engineering, 2000; 44:181-189.
7. Carpenter KJ, Booth VH. Damage to lysine in food processing: its measurement and its significance. Nutrition Abstracts Review, 1973; 43:423-451.
8. Finot PA, Deutsch R, Bujard E. The extent of Maillard reaction during the processing of milk. Progress in Food and Nutrition Science, 1981; 5:345-355.
9. Kwok KC, MacDougall DB, Niranjan K. Reaction kinetics of heat-induced colour changes in soymilk, Journal of Food Engineering. 1999; 40:15-20.
10. Laboratory Manual for Hunter Lab Colorimeter. Hunter associates Laboratory, Inc., Virginia, USA, 1994.
11. Maskan M. Kinetics of color change of kiwifruits during hot air and microwave drying. J Food Engineering. 2001; 48:169-175.

12. Patton S. Browning and associated changes in milk and its products: A review. J Dairy Science. 1955; 38:457-478.
13. Sahoo PK, Ansari Md IA, Datta AK. Computer aided design and performance evaluation of an indirect type helical tube Ultra High Temperature (UHT) Milk Sterilizer. Journal of Food Engineering. 2002; 51(1):13-19.
14. Sahoo PK, Ansari Md IA, Datta AK. Colour variation of Ultra High Temperature (UHT) processed milk using CIE L, a, b color scale. Indian Journal of Dairy Science. 2003; 56(3):158-162.