EFFECT OF PACKAGING MATERIALS, STORAGE PERIOD AND TEMPERATURE ON ACCEPTABILITY OF MILK CAKE

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ABSTRACT

The study was conducted to check the feasibility of enhancing the shelf life of milk cake using proper packaging material. Milk cake was prepared from buffalo milk (6% fat and 8.5% SNF) and packed in four packaging materials viz. aluminium foil-LDPE laminate (P1), craft paper-LDPE laminate (P2), wax coated paper (P3) and polypropylene (P4). The packed product was stored at 27°C and 5°C and the changes taking place in its sensory characteristics were recorded. The sensory quality of milk cake deteriorated during storage at both the temperatures, however, the product packed in P1 underwent slower changes because of the better barrier properties of the packaging material. The milk cake packed in P2, P3 and P4 developed off flavours within 2 weeks of storage at 27°C, whereas the product in P1 kept well for 21 days at 27°C and beyond 28 days at 5°C. Hence, it was recommended that milk cake be packaged in aluminium foil-LDPE laminate for enhancing the product’s shelf life without using any preservatives.

Key words: Packaging material, Storage period, Temperature, Milk cake.

INTRODUCTION

Milk cake is a very popular sweetened milk product popular throughout the country. It has a grainy texture and pleasant aroma with typical creamy to faint brown colour (Karwasra et al., 2001). The brown colour is darkest at the centre of the cake which spreads outwards and then fades towards peripheral regions. Numerous sweetmeat makers manufacture this product on a small scale and sell this product in fresh form. Normally, the cake is kept in open trays in shops and sold in quantities determined by customer’s requirements. In a survey conducted in Hyderabad city, Madhav Rao et al. (1999) found that the milk cake collected from the market had high SPC, yeast and mold and cloiform counts indicating unhygienic methods followed by halwais. The shelf life of the product is only a few days at ambient temperatures, which is because of improper manufacturing conditions without paying much attention to hygienic aspects. Madhav Rao et al. (1999), Arora et al. (1991) and Landge et al. (2005) have studied various aspects of milk cake. Madhav Rao et al. (1999) stated that the traders pay less attention towards hygienic production and packaging, and as a result milkcake of inferior quality is marketed. To achieve longer shelf life without the use of preservatives, Aneja et al. (2002) suggested that milk cake at the end of manufacture be packed in sealed moulds placed in insulated boxes to slow down cooling and to produce desirable flavour and colour. Since milk cake contains sugar, it is possible to enhance its shelf life by using appropriate packaging materials without the help of any preservative. Hence, the present work was undertaken to study the effect of packaging material on the shelf life of milk cake so that good quality product can be provided to consumers.

MATERIAL AND METHODS

Preparation of milk cake: Milk cake was prepared in a deep utensil (diameter – height ratio = 1:1.3) by adopting a special method as follows.
Thirty litres of buffalo milk was collected from the Institute's Farm and was standardised to 6% fat and 8.5% SNF. The milk was taken in a Khoa making pan and heated to boiling with vigorous stirring to avoid burning. After first boiling, sugar @16% on milk basis was added and desiccation continued. When dough like mass was formed, alum was added @0.01% on milk basis. The alum was dissolved in water @ 1g in 50 ml distilled water before addition. Then the contents of the pan were stirred for a few minutes for uniform mixing, desi ghee @ 0.5% (w/w) was added and vigorously stirred. The product was left undisturbed in the deep pan covered with a lid for about 12 h. Later, the product was transferred to a clean tray and cut to suitably sized cubes.

**Packaging and storage of milk cake:** The milk cake pieces were transferred under hygienic conditions to pouches made of aluminium foil-LDPE laminate (P1), craft paper – LDPE laminate (P2), wax coated paper (P3) and polypropylene (P4). The pouches were sealed by impulse sealer and transferred to incubators maintained at 27°C and 5°C. P1, P2, P3 and P4 were procured from Dorabjee and Co.Pvt. Ltd., Pune; Yogiraj packaging, Waluj; local market and Ashoka Plastics, Aurangabad, respectively.

**Sensory evaluation of milk cake:** The pouches were cut open and served to a panel of judges drawn from the Institute’s faculty, for evaluation of sensory quality. The samples stored at 5°C were tempered to about 27°C before serving to judges. The judges were asked to score for the sensory attributes viz. colour and appearance, flavour, body and texture and overall acceptance, on a 9-point Hedonic scale (Amerine et al., 1965). The judges were also requested to comment on any specific defects of sensory attributes of the milk cake.

**Statistical analysis:** The sensory evaluation data were subjected to factorial analysis to find out the significance of effect of packaging material, storage temperature, storage period and their interactions. The computations were done by SPSS (Statistical Package for Social Sciences, version 11.0) computer package and statistical significance at 5% level was obtained by Duncan’s multiple test (Duncan 1955).
Effect of storage period: The colour and appearance, flavour and body and texture scores of fresh milk cake were 8.6, 8.4 and 8.5, respectively which were almost in the range of ‘like extremely’, and the overall acceptance score was 8.8 out of 9.0. These scores gradually declined during storage indicating that the sensory characteristics of milk cake varied, the extent of decline was however depended on the type of packaging material and storage temperature. For example in product packed in P1 and stored at 27°C, the colour and appearance, flavour, body and texture and overall acceptance scores decreased to 6.0, 5.0, 6.1 and 6.0, respectively at the end of 28 days; at 5°C storage, these scores were 8.0, 6.0, 7.5 and 7.0. The decline in the scores during storage can be attributed to chemical and textural changes in the product. The colour and appearance of the product became dull and darker with dry appearance. These characteristics are because of browning reactions taking place in the product and possible moisture evaporation inside the package or through the packaging material. Since the product underwent intense heat treatment during manufacture, and lactose (a reducing sugar) and proteins were present in sufficient quantities, Maillard reactions were expected to occur in abundance imparting typical brown colour to the fresh product. The darkening of the colour during storage is attributed to the continued browning reactions taking place in the product. Navajeevan and Jayaraj Rao (2005) reported that browning reactions in products could take place even during storage which is because several active compounds continue to participate in reactions. Moreover, in the present study, evaporation of moisture during storage might have aggravated the appearance of the milk cake (presence of moisture enlivens the appearance of the product by reflecting incident light). These changes might have also caused decline in flavour scores. In fresh product, the compounds formed during browning reactions that took place during manufacture are responsible for the typical taste of the product, but in stored product progress of chemical reactions disturbed the delicate balance of the compounds.

Milk cake also underwent textural changes during storage. The integrity of the grains remained intact, but the grains became harder and more chewy becoming conspicuous in the product. This naturally reduced body and textural scores. Like chemical reactions, textural changes also continued during storage. This is because of dynamic structural and conformational changes, which may or may not be dependent on changes in moisture content (Navajeevan and Jayaraj Rao 2008) and can be attributed to decline in hydrophilic groups. Because of changes in colour and appearance, flavour and body and texture aspects, overall acceptance scores (which is a combination of all organic parameters) awarded by judges also varied. From the results, it was observed that the product was acceptable up to 14–21 days depending on packaging material and storage temperature. Estimated means of sensory scores as computed by statistical analysis (factorial analysis) of the data clearly indicated that storage period (SP1–SP5) had significant effect on all sensory attributes (Table 1). These figures indicated that the sensory scores significantly decreased week after week (P<0.05). Ahamed and Ranganathan (1967) reported that sensory scores Khoa packed in various packaging materials also decreased during storage accompanied by sour smell, bitterness and rancidity.

Effect of storage temperature: As expected, the changes in all sensory scores were faster at higher temperature (27°C) than at 5°C. This is reflected by the higher estimated sensory score means of 5°C presented in Table - 1, which also revealed significant difference between the two temperatures (P<0.05). At higher temperature, since more energy is available for reactions to take place, more browning reactions and textural changes occurred. It is well established that the Q-value of the chemical reactions enhances with temperature, and the reaction rate constants as determined by Arrhenius relationships increase with temperature (Walstra et al., 2006). The sensory scores of stored milk cake were in acceptable range (6.0) up to 2 – 4 weeks depending on the type of packaging material. The interaction effect of storage period and temperature of storage was significant for changes in colour and appearance, flavour and body and texture, but not for overall acceptance. It means that for individual attributes, temperature had additive effect during storage which however was not taken into consideration by the judges for overall evaluation.
Fig. 1. Changes in sensory acceptance scores of milk cake packed in various packaging materials and stored at 27°C and 5°C.
Effect of packaging material: The changes in the sensory scores were highly dependent on the type of packaging material. This was clearly illustrated in Fig 1 a-d. The trend represented by the graphical portrayals indicated that the decline in the scores was slowest in P1 packaging material (aluminium foil and LDPE laminate). The estimated sensory score means presented in Table - 1 also showed highest values for P1 reflecting slower changes in the product packed in P1. The estimated overall acceptance scores were 7.9, 6.6, 7.2 and 6.2, respectively for P1, P2, P3 and P4. Their Duncan significance test revealed no significant difference between P2 and P4, while P1 and P2 differed significantly between themselves and others. These differences among the packaging materials may be attributed to their varying barrier properties. P1 has aluminium component in its configuration, hence possessed highest barrier property to moisture and gases. Therefore it may be understood that there was minimum moisture loss in the product packed in P1, hence minimal changes occurred in the product packed in P1. The WVTR of metallised PET/LDPE was reported as 0.5 g / m²/24h at 38°C, 90%RH (Kumar 1991). The WVTR of HDPE, polypropylene, LDPE were reported as 4.7 – 7.8, 9.3 – 11 and 16-23g/m²/24 h at 37°C, 90%RH (www.polyprint.com). The OTR values of Poster paper-Al foil-LDPE and Poster paper-Al foil-LDPE were reported as 0.16 and 0.43 ml/24 h/m2/atm, respectively (Goyal, 1992), who also stated that the barrier properties of laminates might alter even during storage. In the present study, the packaging materials were ranked P1>P3>P2>P4 with respect to quality retention of milk cake at the two storage temperatures. At 27°C, the product remained acceptable up to 21 days in P1, 14 days in P2 and P4, whereas at 5°C, the product remained acceptable up to 28 days in P1, 14 days in P2 and P4, and 21 days in P3. The results obtained in the present study could also be supported by the observations of Suresh and Jha (1994) and Ravi Varma (2005). Kumar et al. (1975) reported that four-ply aluminium coated laminates proved to be the best for packaging Khoa followed by 2-ply packs, HDPE and parchment paper. The interaction effect between packaging material and storage period was significant for colour and appearance and flavour; packaging material and storage temperature effect was significant for colour and appearance, and not for body and texture and overall acceptance. Goyal (1992) also reported significant interaction effects of packages and storage period during the storage studies of khoa. The interaction results in the present study indicate that the changes in sensory characteristics were accelerated by storage temperature as the storage period progressed.

CONCLUSION
The sensory attributes of milk cake packed in four packaging materials declined during storage at 27°C and 5°C, the changes being slower at the refrigerated temperature. It was concluded that among the packaging materials used in the study for packaging of milk cake, aluminium foil with LDPE laminate was found to be most suitable followed by wax coated paper, craft paper with LDPE laminate and polypropylene materials. Thus it was observed that shelf life of milk cake could be enhanced by using a packaging material with good barrier properties.

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