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Effect of Modified Atmosphere Packaging on Colour Profile of Paneer Stored at 3±1 ° C

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ABSTRACT

Paneer, an acid coagulated dairy product, is very popular in Indian subcontinent, but its shelf life is quite low being approx. 6 days at refrigeration temperature. Hence, a study was planned to increase the shelf life of paneer by employing MAP technique. Two hundred fifty grams of paneer samples were packaged in high barrier bags (LLD/BA/Nylon-6/ BA/ LDPE) under five different atmospheres (air: atm 1; vacuum: atm 2; 100% CO_2: atm 3; 100% N_2: atm 4; 50% CO_2/ 50% N_2: atm 5), and stored at 3±1 °C. Periodically, the quality of paneer was evaluated for changes in colour profile, *viz.,* Hunter Lab colour profile, Hunter Lab Total colour difference, Relative yellowness and Hue angle.

Keywords: acid coagulated dairy product, Paneer, modified atmosphere packaging, colour profile.

1. INTRODUCTION

India is the largest milk producer in the world. The milk production in India is approximately 114 million tones (Goyal and Goyal, 2012). Approximately 5% of milk produced in India is converted into paneer, which is a well-known heat and acid coagulated milk product (ICMR, 2000; Chandan, 2007). Paneer is similar to soft cheese, and is not only very popular in Indian subcontinent, but has also made appearance in western and Middle East markets. It is marble white, somewhat spongy with mildly acidic flavour and is generally

prepared from buffalo milk (Patel, 1991). Paneer is of great value in diet because it is a rich source of high quality proteins, fat, minerals and vitamins (Shrivastava and Goyal, 2007). It forms base for a variety of culinary dishes, stuffing material for various vegetable dishes, snacks, and sweetmeats. Paneer, the great cottage cheese of Indian subcontinent is the only product that can be deep-fried and makes delicious snack (Aneja, 2007). However, the shelf life of paneer is quite low and it loses freshness after 2-3 days when stored at 10°C. Generally, surface spoilage of paneer limits its shelf life. Preservation of paneer is a major problem, which impedes the organized marketing commercially. Various preservation techniques including chemical additives, packaging, thermal processing, and low temperature storage have been tried by various workers to extend its shelf life.

Modified atmosphere packaging (MAP) is new area in food packaging. It reduces oxidative deterioration and microbial growth by changing the gas that surrounds the product. MAP is a process by which the shelf life of food product is significantly increased (Floros *et al.,* 1997). Hence, a study was undertaken to observe changes in the colour profile of the product and the interaction of the product and modified atmospheres after storage under refrigerated conditions

2. MATERIALS AND METHODS

The paneer samples were prepared by following the standard method of Bhattacharya *et al.*, (1071). The milk was collected from the receiving platform of the Experimental Dairy, National Dairy Research Institute, Karnal, India.

2.1 Packaging equipments

For packaging of paneer samples under modified atmospheres, the method recommended by Day (1992) and followed by Tanweer Alam (9) and Preeti Singh (8) was adopted, by using a vacuum chamber Quick 2000 machine (α Alfa Laval, Kramer Grebe, GmbH & Co. KG Maschinefabrik, 3560 Biedenkopf – Wallau,

Germany), with gas injection after establishing a vacuum of 25 inches Hg (ca. 85 Pa). The injection conditions of the gases were optimized in order to obtain gas headspace. The paneer samples were packaged under atmospheres (air) by using vertical heat-sealing machine model QS – 300 FE, obtained from M/s Sevana Traders Pvt. Ltd, Kizakkamabalam, Kerala, India.

2.2 Packaging material used

High barrier bags, namely LLD/BA*/Nylon-6/BA*/LDPE (110 micron) (*poly binding agent) were used for packaging and storage of paneer samples. The dimensions of packages used during the experiments were 32.5 x 35.0 cm (l x b). The high barrier packages were procured from a reputed packaging film producer and converter located at Himachal Pradesh, India.

2.3 Sterilization of packages

Immediately before packaging of paneer samples, the empty packages were sterilized under UV-light for 30 min.

2.4 Packaging of paneer samples

The prepared paneer samples were individually packed in sterilized packages under different atmospheres (atm), i.e. air (atm 1), vacuum (atm2), 100 % CO2 (atm 3), 100% N2 (atm 4) and 50% CO2/ 50% N2 (atm 5) by using packaging machines as referred to under section 4.2.1.0. Initially the gas headspace to paneer weight ratio was approx. 2 lit of gas per kg of the product. The packaged samples were then stored at 3±1 ºC. The gases used were of industrial grade procured from the local reputed supplier.

2.5 Technique of Sampling:

The sampling of paneer was done as per the procedure detailed in I.C.A.R Bulletin No. 70 (1951) for chhana. About 20 gm paneer from different portions of the entire mass was taken with a cheese trier and pooled together. It was then

passed through a 20-mesh size grater and transferred to screw cap sample bottles for analysis.

2.6 Colour measurement

2.6.1 Hunter Lab Colour Values (L*, a*, b*)

The colour of the paneer samples was determined by taking multiple readings and then calculating the average value, using a Colourflex Model 45º/0º (Hunter Lab, Reston, Virginia, USA) along with the universal software (version 4.10). Before the test, instrument was calibrated with standard black glass and white tile as per the instructions of the manufacturer. The light source was dual beam xenon flash lamp. Data was received through the software in terms of L* [lightness, which ranges from zero (black) to 100 (white)], a* [redness, range: +60 (red) to -60 (green)] and b* [yellowness, ranging from +60 (yellow) to -60 (blue)] in values of the international colour system, when placing the samples in the instrument in a standard, repeatable manner.

2.6.2 Hunter Lab Total Colour Difference (ΔE)

The Hunter Lab total colour difference (ΔE) of paneer samples was calculated by the following formula proposed by Liu *et al.* (7):

$$\Delta E = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2}$$

where,

$$\Delta L = L_{sample} - L_{standard}$$

(if +ΔL, sample is lighter than standard;
if -ΔL, sample is darker than standard)

$$\Delta a = a_{sample} - a_{standard}$$

(if +Δa, sample is redder than standard;
if -Δa, sample is greener than standard)

$$\Delta b = b_{sample} - b_{standard}$$

(if $+\Delta b$, sample is yellower than standard;

if $-\Delta b$, sample is bluer than standard)

2.6.3 Relative Yellowness (E*)

The comprehensive contributions from the variations of three colour indices are represented by Hunter lab total colour difference. To enhance the fraction of yellowness relative to those of lightness and redness, relative yellowness (E*) of paneer samples was calculated by the formula suggested by Liu *et al.* (7):

$$E^* = b^* / L^* + b^* / a^*$$

2.6.4 Hue angle

Hue angle represents the arctan (b*/a*), where lower values indicate more redness. The Hue angle for paneer samples was calculated as per the following formula given by Jayasingh *et al.* (6):

$$\text{Hue angle} = \tan^{-1} (b^*/a^*).$$

3. RESULTS AND DISCUSSION

Changes in colour profile (L*, a*, b*)

The values in Table 1 reveal that the initial value 87.55 of L* (lightness) decreased to 87.37, 87.36, 87.49, 87.33, and 87.44 in paneer samples packaged under atm 1, atm 2, atm 3, atm 4, and atm 5 respectively, after 10 days of storage at 3±1 °C, suggesting that L* decreased in all cases but the minimum decrease was noted for the samples packaged under 100% CO_2 followed by 50% CO_2/50% N_2, 100% N_2, vacuum, and air respectively, in ascending order. The trend continued during further storage up to 40 days for gas packed samples (atm 3, atm 4, atm 5). The results agree with the observations of Preeti Singh (8), who also found that the lightness (L*) decreased during storage (7±1 °C) in ready-to-serve and ready-to-bake pizza samples packaged under 100% CO_2, 100% N_2, and 50% CO_2/50% N_2 and the minimum decrease had been in case of samples packaged under 100% CO_2. Contrary to the values of lightness (L*), the values of a* (redness), and b*

(yellowness) increased in all the paneer samples during storage at 3±1 ° (Table 1) the maximum increase was recorded for the samples packaged under 100% CO_2 (atm 3) followed by 50% CO_2/50% N_2 (atm 5), 100% N_2 (atm 4), vacuum (atm 2), and air (atm 1) in descending order. In respect of the values for redness (a*), our results are at variance with the findings of Preeti Singh (8), who found increasing trend for a* during storage of MAP pizza.

Hunter Lab Total Colour Difference (ΔE)

Since the acceptability of paneer samples is also influenced by its Appearance, which in turn is also affected by the colour of the product, the effect of MAP on the hunter lab total colour difference (ΔE) of paneer samples for various time intervals was studied, and graphically presented in Figure 1. The hunter lab values decreased from 44.36 to 44.17 (0.43% decrease), 44.27 (0.20% decrease) respectively in atm 1 (air) and atm 2(vacuum), while increasing trend was observed for the samples packaged under atm 3, atm 4, and atm 5 after 10 days of storage at 3±1 °C. Interestingly, on further storage for 20, 30 and 40 days, the values for ΔE decreased in case of all paneer samples packed under 100% CO_2 (atm 3), 100% N_2 (atm 4) and 50% CO_2/50% N2 (atm 5).

The statistical analysis of the data concerning the total colour difference (ΔE) reveals that the 5 types of atmospheres, and the interaction intervals x atmospheres (atm 3, atm 4, atm 5), both individually had highly significant ($P<0.01$) influence on the changes in hunter lab total colour difference values (ΔE) for stored paneer samples (Table 2).

Relative yellowness (E*)

The values obtained during study depicted in Figure 2, indicate that the relative yellowness (E*) decreased in all the samples during storage irrespective of the type of atmosphere employed for the packaging of paneer samples, under both the storage conditions. The decrease had been, minimum in case of atm 3 (100% CO_2), followed by atm 5 (50% CO_2/50% N_2), atm 4 (100% N_2), atm 2 (vacuum), and atm 1 (air), in descending order.

Statistically, highly significant ($P<0.01$) differences in the values of relative yellowness (E*) were observed due to the intervals of storage, the 5 types of atmosphere, and the interaction intervals x atmospheres (atm 3, atm 4, atm 5), each individually.

Hue Angle

A perusal of the data for hue angle indicates that there was a consistent decrease in the values of hue angle in all the samples throughout the storage for all the studied atmospheres. However, maximum decrease in hue angle was observed in case of samples packed under atm 3 (100% CO_2), followed by atm 5 (50% CO_2/50% N_2), atm 4 (100% N_2), vacuum (atm 2), and air (atm 1) respectively. The intervals of storage, the types of atmospheres, and the interaction intervals x atmospheres (atm 3, atm 4, atm 5), each individually had highly significant ($P<0.01$) effect on the hue angle of paneer samples (Table 2).

4. CONCLUSIONS

In order to determine the shelf-life of MAP Paneer, the samples were packaged in high barrier bags (LLD/BA/Nylon-6/ BA/ LDPE) under five different atmospheres (air: atm 1; vacuum: atm 2; 100% CO_2: atm 3; 100% N_2: atm 4; 50% CO_2/ 50% N_2: atm 5), and stored at 3±1 °C for various time intervals. The quality of stored paneer was periodically evaluated for changes in colour profile, *viz.,* Hunter Lab colour profile, Hunter Lab Total colour difference, Relative yellowness and Hue angle. The data obtained by the Hunter lab were used to determine the colour profile of product.

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Table 1: Effect of MAP on the Colour Profile (L*, a*, b*) of Paneer stored at 3 1 °C (mean of 3 trials)

Period of storage (days)	Treatment given to package														
	atm 1 air			atm 2 vacuum			atm 3 100% CO_2			atm 4 100% N_2			atm 5 50% CO_2 : 50% N_2		
	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*	L*	a*	b*
0	87.55	-1.35	8.36	87.55	-1.35	8.36	87.55	-1.35	8.36	87.55	-1.35	8.36	87.55	-1.35	8.36
10	87.37	-1.22	12.95	87.36	-1.16	8.95	87.49	-0.56	8.56	87.33	-0.81	8.80	87.44	-0.76	8.68
20	■	■	■	87.16	-1.12	9.16	87.32	-0.51	8.85	87.11	-0.74	9.05	87.24	-0.68	8.98
30	■	■	■	■	■	■	87.30	-0.47	9.13	87.05	-0.66	9.42	87.18	-0.61	9.27
40	■	■	■	■	■	■	87.18	-0.41	9.21	86.94	-0.58	9.57	87.07	-0.52	9.39

atm: atmosphere
Package used: LLD /BA*/ Nylon-6/ BA*/ LDPE (110 μ)

* Poly binding agent

■ Samples spoiled, hence analysis discontinued

Table 2. Analysis of variance for Colour profile of MAP Paneer stored at 3±1 °C

Source of variation	d. f.	Mean sum of square: Total colour difference (ΔE)	Relative yellowness (E*)	Hue angle
Among Intervals of storage	4	0.014	68.648**	20.755**
Among atmospheres	4	0.075**	19.454**	2.595**
Error	11	0.012	2.571	0.428
Interaction [Intervals x atmospheres (atm 3, atm 4, atm 5)]	8	0.009**	3.128**	0.261**
Error	15	0.001	0.005	0.017

**** Significant at 1% level of probability**
atm 3: 100% CO_2
atm 4: 100% N_2
atm 5: 50% CO_2 : 50% N_2

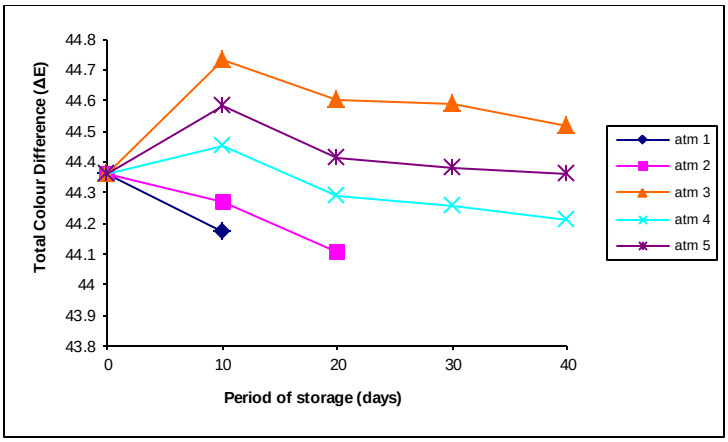

Fig 1: Effect of MAP on the Total Colour Difference (ΔE) of Paneer stored at 3 ± 1 ºC

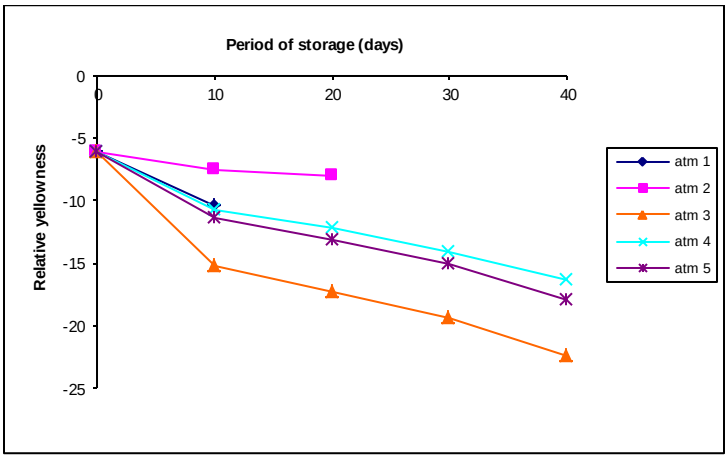

Fig 3: Effect of MAP on the Relative Yellowness (E*) of paneer stored at 3 ± 1 ºC

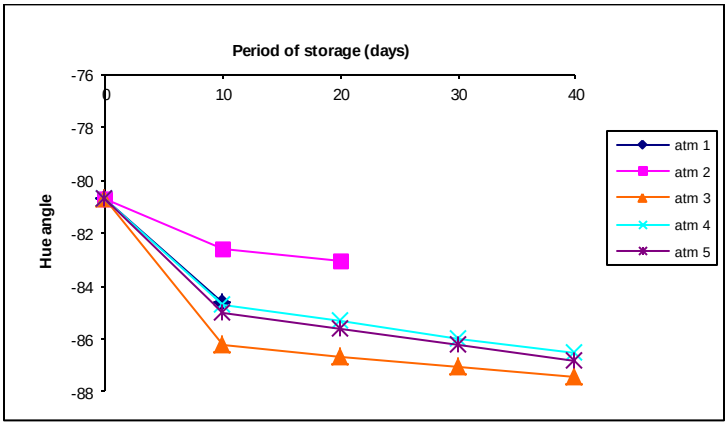

Fig 4: Effect of MAP on the Hue angle of paneer stored at 3 ± 1 ºC