EFFECT OF MODIFIED ATMOSPHERE PACKAGING (MAP) AND STORAGE ON THE CHEMICAL QUALITY OF PANEER

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ABSTRACT

Traditional food packaging protects food from external contamination, oxygen, water vapour and light. However, newer packaging technologies such as Modified Atmosphere Packaging (MAP) do more than just provide protection from outside influences. The study was conducted to increase the shelf life of paneer by using MAP technique. The paneer samples were packaged in high barrier bags (LLD/BA/Nylon-6/BA/LDPE) under different atmospheres: atmospheric air (atm1), vacuum (atm2), 100% CO2 (atm3) and 100% N2 (atm4). A headspace to product ratio of 1-2 litres gas / kg product was initially set in the MAP system and stored the samples at 7±1ºC. Periodically, paneer samples were evaluated for changes in chemical characteristics. The analysis of variance of the data revealed that the MAP had significant influence on moisture, titratable acidity, pH, free fatty acids, and tyrosine content of the paneer samples during storage.

INTRODUCTION

Paneer is a coagulated indigenous milk product, which is very widely used for various dishes including curry in Indian sub-continent and even in foreign countries. Goyal and Rajorhia (1991) have emphasized the importance of chemical quality of dairy products with special reference to packaging materials, and that these attributes of indigenous dairy products require attention. Goyal and Swati Shrivastava (2006) were of the opinion that the common types of chemical spoilage in paneer can be significantly delayed or altogether prevented by using suitable packaging technique.

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 (Florous et al. 1997). MAP maintains the product’s initial quality for much longer period and extends its shelf life, besides retaining appeal to consumers. The low shelf life of paneer is mainly due to deteriorative changes in chemical characteristics. Hence, a study was undertaken to observe changes in the chemical quality of the product and the interaction of the product and modified atmospheres after storage under refrigerated conditions.

MATERIAL AND METHODS

Preparation of paneer: The method employed for the preparation of paneer from buffalo milk was the one suggested by Bhattacharya et al. (1971) with slight modification.

Packages: High barrier packaging bags consisting of LLD/BA*/Nylon - 6/BA*/LDPE (*poly binding agent) of the following specifications were used in the experiments, and were procured from a reputed packaging film producer and converter of India:

- Thickness: 110 micron
- Water vapour transmission rate (WVTR): 3.96 g/sq mt/24hrs
- Oxygen transmission rate (OTR): 36 ml/per sq mt/24hrs
- Dimensions of the packages: 22.5 cm x 19 cm

Packaging and Storage:

Packaging Equipments: Packaging under modified atmospheres was done (Day, 1992) by using a vacuum chamber Quick 2000 machine (Alfa- Laval,Kramer Greber, GmbH & Co. KG Maschinenfabrik, 3560 Biedelkopf- Wallan, Germany), with gas injection after establishing...
a vacuum of 25 inches Hg (ca. 85 Pa). Polyethylene poly bag vertical heat sealing machine, model QS-300 FE, procured from Sevana Traders Pvt. Ltd., Kizhakkambalam, Kerala was used for conventional packaging of paneer.

**Sterilization of Packages:** The empty packages were sterilized under UV-light for 30 min immediately before packaging of the samples.

**Modified Atmosphere Packaging of Paneer:** The freshly prepared paneer samples (250 gm) were individually packaged in sterilized packages under different atmospheres (atm), i.e. atmospheric air (atm1), vacuum (atm2), 100% CO₂ (atm3) and 100% N₂ (atm4). The gases used were of industrial grade procured from the reputed supplier. The packaged samples were then stored at 7 ± 1°C.

**Chemical Evaluation:** The paneer samples were analysed to determine moisture (Arora, 1979), titratable acidity (A.O.A.C, 1975), tyrosine content (Hull, 1947) and FFA (% oleic acid) (Thomas. et al, 1954). The pH of paneer sample was measured using a pH meter, Model No. 420 A, Thermo Electron Corporation, U.S.A.

**Statistical analysis:** The methods of Snedecor (1956) were followed for the statistical analysis of the data.

### RESULTS AND DISCUSSION

**Moisture content:** The changes in moisture content of paneer samples packaged under 4 different atmospheres in high barrier bags and stored at 7 ± 1°C for specified period are shown in Fig 1. The analysis of variance of data is given in Table 1.

On storage, the maximum loss in moisture content after 15 days of paneer was observed in atm1 followed by atm2, atm4 and atm3, respectively. On storage for 45 days, the initial moisture content of 51.60% decreased to 51.16% (atm2), 51.21% (atm4) and 51.25% (atm3).

![Fig. 1. Effect of MAP on the moisture content of paneer stored at 7± 1°C](image1)

![Fig. 2. Effect of MAP on titratable acidity (% LA) of paneer stored at 7± 1°C](image2)

### TABLE 1. Analysis of Variance for Chemical Quality of MAP Paneer Stored at 7± 1°C

<table>
<thead>
<tr>
<th>Source of variance</th>
<th>d.f.</th>
<th>Moisture</th>
<th>Titratable acidity</th>
<th>pH</th>
<th>FFA</th>
<th>Tyrosine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Among intervals of storage</td>
<td>3</td>
<td>679.233*</td>
<td>0.085**</td>
<td>11.694**</td>
<td>0.004*</td>
<td>284.123*</td>
</tr>
<tr>
<td>Among atmospheres</td>
<td>3</td>
<td>1975.312**</td>
<td>0.238**</td>
<td>22.569**</td>
<td>0.040**</td>
<td>599.508**</td>
</tr>
<tr>
<td>Interaction intervals × atmospheres</td>
<td>9</td>
<td>657.929*</td>
<td>0.128**</td>
<td>7.376*</td>
<td>0.017*</td>
<td>0.018*</td>
</tr>
<tr>
<td>Error</td>
<td>41</td>
<td>144.423</td>
<td>0.028</td>
<td>1.619</td>
<td>0.004</td>
<td>57.748</td>
</tr>
</tbody>
</table>

*Significant at 5% level of probability  
** Significant at 1% level of probability
indicating that the minimum moisture loss had been with the samples packaged under 100% CO₂.

Highly significant (P ≤ 0.01) differences among the 4 types of atmospheres towards the moisture content of paneer were noticed. The influence of periods of storage, and the interaction intervals x atmospheres were also found to be significant (P ≤ 0.01).

**Titratable acidity (TA)**: The values for TA of paneer packaged under four atmospheres and stored at 7±1°C are given in Figure 2. Analysis of variance is shown as a part of Table 1.

The mean value for TA (% lactic) of paneer gradually increased from 0.31 to 0.59, 0.46, 0.42, and 0.45 in atm1, atm 2, atm 3, and atm 4, respectively after 15 days of storage. Chawla (1981), Shukla et al. (1984) and Sachdeva and Singh (1990) also observed increase in TA of paneer samples during storage. Further storage up to 45 days revealed that the TA increased to 0.69, 0.62 and 0.66, respectively in samples packaged under atm 2, atm3, and atm 4. The results showed minimum increase in atm 3, indicating that the minimum moisture loss had been with the samples packaged under 100% CO₂.

Highly significant (P ≤0.01) differences among the 4 types of atmospheres towards the moisture content of paneer were noticed. The influence of periods of storage, and the interaction intervals x atmospheres were also found to be significant (P ≤0.01).

**pH**: Figure 3 indicates the changes in pH of paneer samples packaged under 4 different atmospheres and stored at 7±1°C for specified periods.

On storage of paneer for 15 days, the pH decreased from 5.92 to 5.61, 5.66, 5.71 and 5.63, respectively in case of samples packaged under atm 1 (air), atm 2 (vacuum), atm 3 (100 % CO₂) and atm 4 (100 % N₂). The pH further decreased to 5.32, 5.36 and 5.30 in case of atm 2, atm 3 and atm 4, respectively after 45 days of storage, indicating that the maximum decrease had been with the product packaged under vacuum, and the minimum decrease was observed in samples packaged under 100% CO₂. Arora and Gupta (1980), and Sachdeva and Singh (1990) also reported decrease in pH of paneer samples during storage.

Analysis of variance (Table 1) revealed highly significant (P ≤0.01) differences among the 4 types of atmospheres, and duration of storage. In the case of atm 3 (100 % CO₂) followed by atm 4 (100 % N₂) and atm 2 (vacuum), respectively in the ascending order (Fig. 2), establishing a decisive role of CO₂ towards acidity development. The results are in agreement with the findings of Alves et al. (1996), Eliot et al. (1998) and Tanweer Alam (2004) that mozzarella cheese samples packed under 100% CO₂ resulted in least TA compared to samples packed in air, vacuum, or N₂. From the consideration of TA, the types of atmospheres, the duration of storage and interaction intervals x atmospheres were found to be highly significant (P ≤0.01).
storage. Interaction intervals x atmospheres was also found to be significant (P ≤ 0.05).

**Free fatty acids (FFA)**: The values for FFA of paneer samples packaged under 4 atmospheres in high barrier bags and stored at 7 ± 1 °C for various time intervals are given in Figure 4.

A perusal of Fig. 4 shows that the mean value for FFA (% oleic) of paneer stored for 15 days, increased from 0.18 to 0.24, 0.21, 0.20 and 0.21 respectively, in atm 1 (air), atm 2 (vacuum), atm 3 (100 % CO₂) and atm 4 (100 % N₂), indicating maximum lipolysis in case of air packed samples, and minimum in case of samples packaged under 100 % CO₂. Similar trend was observed when the product was stored for 45 days.

The 4 types of atmospheres (P ≤ 0.01), duration of storage (P ≤ 0.05), and the interaction intervals x atmospheres (P ≤ 0.05) were found to be significant from the consideration of FFA (Table 1).

**Tyrosine content**: The mean values for tyrosine content of paneer samples packaged under 4 different atmospheres in high barrier bags for specified periods are illustrated in Figure 5.

On storage for 45 days, the initial mean tyrosine content value increased from 12.61 (mg/100 g) to 34.80, 29.18 and 33.21 respectively, for the samples packaged under atm 2 (vacuum), atm 3 (100 % CO₂) and atm 4 (100 % N₂), suggesting that the minimum proteolysis had been in the samples packaged under 100 % CO₂, and maximum in samples packed under vacuum, establishing a very significant influence of MAP on the proteolysis of paneer during storage.

Analysis of variance for the data on tyrosine revealed highly significant (P ≤ 0.01) differences among the atmospheres. Differences in the values for tyrosine of paneer due to intervals of storage, and interaction intervals x atmospheres were also found to be significant (P ≤ 0.05).

**CONCLUSION**

Analysis of variance of the data pertaining to chemical quality of stored MAP paneer showed that the moisture content, titratable acidity, pH, FFA, and tyrosine content were significantly (P ≤ 0.01) affected by different package atmospheres used for MAP of paneer. The influence of intervals of storage on titratable acidity and pH were also observed to be highly significant (P ≤ 0.01). For titratable acidity, the interaction intervals x atmospheres was found to be highly significant (P ≤ 0.01), while for other studied parameters, it was less significant (P ≤ 0.05). The various durations of storage affected the moisture content, FFA and tyrosine content of MAP paneer significantly (P ≤ 0.05) (Table 1).

**REFERENCES**


