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# Modified atmosphere packaging and storage on sensory characteristics of ready-to-bake pizza

MAP and storage

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## Abstract

**Purpose** – Consumer's demand for fresh, naturally preserved, food products has grown dramatically in recent years. Modified atmosphere packaging (MAP) has proved to be most innovative growth area in food packaging. Studies have been conducted to increase the shelf life of ready-to-bake pizza by using MAP technique. The purpose of this paper is to study the influence of different modified atmospheres and refrigerated storage on the sensory characteristics of the ready-to-bake (unbaked) pizza.

**Design/methodology/approach** – The most up-to-date and pertinent studies within the literature have been included and summated in this paper.

**Findings** – To determine the shelf life of MAP ready-to-bake pizza, the samples were subjected to four types of atmospheres (air, 100 per cent CO<sub>2</sub>, 100 per cent N<sub>2</sub> and 50 per cent CO<sub>2</sub>/50 per cent N<sub>2</sub>) and stored for various time intervals at 7 ± 1 °C. The shelf life of ready-to-bake pizza significantly increased up to 15 days (a 300 per cent increase) for the samples packaged under 100 per cent CO<sub>2</sub> (atm 2), 50 per cent CO<sub>2</sub>/50 per cent N<sub>2</sub> (atm 4) and 100 per cent N<sub>2</sub> (atm 3), compared to conventional air pack (five days).

**Originality/value** – This paper gives a concise, up-to-date overview on how different gases affect the various sensory parameters of ready-to-bake-pizza.

**Keywords** Food technology, Food packaging, Packaging processes

**Paper type** Research paper

## Introduction

The technology of packaging products in modified atmosphere is the most advanced food preserving technique with many advantages. Modified atmosphere packaging (MAP) is a process by which the quality of food product is significantly improved compared to conventional packaging. MAP reduces physiological changes, respiration rates, oxidative deterioration and microbial growth by changing the levels of gas that surrounds the product. MAP is a process by which the shelf life of food product is significantly increased (Floros *et al.*, 2000). MAP is the enclosure of food products in barrier materials in which the atmosphere changes as a result of dynamic interaction between atmosphere product and environment (Brody, 1989). Generally three types of gas mixtures (N<sub>2</sub>, CO<sub>2</sub> and O<sub>2</sub>) are being used in MAP. MAP is extensively used to preserve a wide array of food products (Church and Parson, 1995; Phillips, 1996; Farber, 1991). MAP is applied to a wide range of food packaging technologies that rely on O<sub>2</sub>, CO<sub>2</sub> and N<sub>2</sub> to retard deterioration in foods and dairy products (Alam and Goyal, 2004; Singh and Goyal, 2008).

MAP is used to maintain the product's initial quality for much longer period and to extend its shelf life, besides retaining appeal to consumers. This method of packaging replaces the air headspace of package with a gas or mixture of gases like N<sub>2</sub>, CO<sub>2</sub>. So far there is no report on the MAP storage for pizza under Indian processing conditions. The low



shelf life of pizza is mainly due to microbial and physico-chemical changes, hence study was undertaken to observe the sensory quality and shelf life of the product and the interaction of the product and modified atmospheres after storage under refrigerated conditions.

### Materials and methods

In the present study, the method standardized by Alam (2004) was followed for preparation of mozzarella cheese from mixed milk (buffalo: cow: 60:40). The cheddar cheese and table butter were collected from the Experimental Dairy, National Dairy Research Institute, Karnal. Pizza bases each of 20 cm in diameter and weighing approx.  $120 \pm 10$  g were used for the preparation of pizza samples. The fresh vegetables namely tomatoes, capsicum and green chillies of superior quality were procured from the local market. The microwave oven having power output 900 W with internal dimensions of  $36 \times 37 \times 23$  cm<sup>3</sup> and 32 Lit capacity from Samsung, South Korea; Model Bio ceramic, CE118KF was used during the study.

#### *Dipping of vegetables in potassium metabisulphite*

The tomatoes, capsicum and green chillies used for the preparation of pizza samples were first thoroughly washed in clean tap water and then dipped in solution of potassium metabisulphite (KMS) (2 g/l) for 20 min and air dried. The onions and ginger were, however, peeled before dipping in KMS solution.

#### *Cutting of vegetables*

The air-dried tomatoes, capsicum and onions were sliced in round shape (approx. 0.5 cm thick) by using "Philips" make Food Processor (Essence HR7754). The green chillies were also cut in round shape (approx. 0.5 cm thick), while ginger was grated using clean stainless steel grater.

#### *Topping of pizza*

The pizza samples were prepared by adapting the procedure of Alam (2004) with slight modification. Firstly the lower side of each pizza base was grilled (heated) for a minute in a microwave oven on a rotating table, then the upper side of the pizza base was smeared with approx. 5 g table butter followed by spreading of tomato sauce (approximately 40 g) over the butter smeared pizza surface. Approximately 4 g chopped green chillies (*Capsicum annum var. acuminatum*) and approximately 10 g grated ginger (*Zingiber officinale*) was then evenly spread all over the pizza base. Thereafter, grated mozzarella and cheddar cheese in the ratio of 80:20 (approx 120 g per pizza) were topped on pizza base followed by vegetable toppings which included approx. 50 g sliced onion (*Allium cepa*), approx. 70 g sliced tomatoes (*Lycopersicon esculatum*), and approx. 50 g sliced capsicum (*Capsicum annum var. grossum*).

#### *Packaging materials used*

For packaging and storage of ready-to-bake pizza, high barrier bags namely LLD/BA\*/Nylon-6/BA\*/LDPE (110 μ) (\*poly binding agent) were used. The water vapour transmission rate and oxygen transmission rate of the packaging material used were 3.96 g/sqm/24 h and 36 ml/sqm/24 h, respectively. The dimensions of the packages used in the study were  $32.5 \times 35.0$  cm ( $L \times B$ ).

#### *Packaging equipment*

Packaging under modified atmospheres was accomplished following the method of Day (1992) by using a vacuum chamber Quick 2000 machine (Alfa-Laval, Kramer, Grebe GmbH & Co. KG Maschinenfabrik, 3560 Biedenkopf-Wallau, Germany), with

gas injection after establishing a vacuum of 25" Hg (ca. 85 Pa). Packaging under atmosphere (air) was done by using vertical heat-sealing machine, model QS-300 FE.

#### MAP of ready-to-bake pizza

The prepared pizza samples were individually packed in pre-sterilized (under UV-light for 30 min) packages under different atmospheres (atm), i.e. air (atm 1), 100 per cent CO<sub>2</sub> (atm 2), 100 per cent N<sub>2</sub> (atm 3) and 50 per cent CO<sub>2</sub>/50 per cent N<sub>2</sub> (atm 4). Initially the gas headspace to pizza weight ratio was approx. 1-2 lit of gas per kg of the product. The packaged samples were stored at 7 ± 1 °C. The gases used were of industrial grade.

#### Sensory evaluation

The packed pizza samples were evaluated organoleptically for sensory attributes by a trained panel for Appearance, Flavour, Body and texture, and Overall acceptability. Before presenting the pizza samples to judges, the stored test samples were baked in microwave oven in combination mode (convection at 200 °C + microwave at 100 per cent power level) for 7 min. To minimize variability during baking, single samples were placed in the central position on the turntable. The baking time was based on the amount of time necessary for the product to yield an adequately baked appearance. The pizza samples were evaluated using 5-point Hedonic Scale. A score of 5 represented excellent; 4, very good; 3, good; 2, fair; and 1, poor.

## Results and discussion

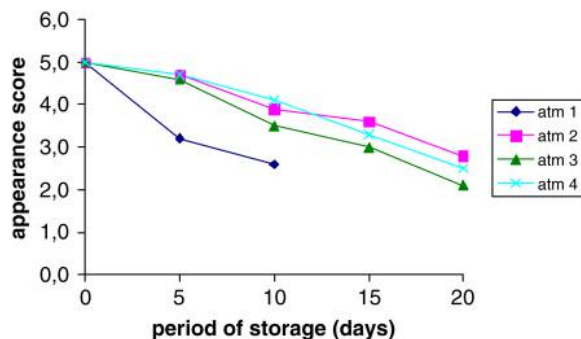
### Appearance

The initial mean Appearance value of 5 of fresh unbaked pizza samples decreased to 2.6 in case of atm 1 (air), 3.5 (atm 3), 3.9 (atm 2) and 4.1 (atm 4), indicating that the lowest value had been for the samples packaged under air (Figure 1). On further storage, the value decreased to 2.1 (atm 3), 2.5 (atm 4) and 2.8 (atm 2) revealing highest Appearance score for pizza samples packed under 100 per cent CO<sub>2</sub> followed by 50 per cent CO<sub>2</sub>/50 per cent N<sub>2</sub> and 100 per cent N<sub>2</sub>, respectively. The results confirm the observations of Floros *et al.* (2000) that MAP is effective in retaining appeal of the product to consumers.

Statistically, the influence of intervals of storage, the four types of atmospheres and the interaction intervals × atmospheres (atm 2, atm 3, atm 4), each individually, were highly significant ( $p < 0.01$ ) for changes in appearance of pizza samples (Table I).

### Flavour

The mean hedonic sensory scores for Flavour of pizza prepared from unbaked samples packed under four atmospheres and stored at 7 ± 1 °C reveal that the initial value



**Figure 1.**  
Effect of MAP on the Appearance of unbaked pizza stored at 7 ± 1 °C

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4.8 decreased to 1.3 (atm 1), 2.3 (atm 3), 2.8 (atm 4) and 3.1 (atm 2), respectively, after ten days of storage (Figure 2). Based on the Flavour scores, the product was acceptable up to five days when packed under air (score 2.7) and up to 15 days for atm 2 (score 2.6), atm 3 (score 2.3) and atm 4 (score 2.8), indicating that the maximum Flavour score was for the samples packaged under 100 per cent CO<sub>2</sub> followed by 50 per cent CO<sub>2</sub>/50 per cent N<sub>2</sub> and 100 per cent N<sub>2</sub>, in descending order.

The analysis of variance for Flavour scores of pizza samples packaged under four different atmospheres and stored at  $7 \pm 1^\circ\text{C}$  (shown as a part of Table I) indicate that the intervals of storage, the four types of atmospheres used during packaging and the interaction intervals  $\times$  atmospheres (atm 2, atm 3, atm 4), each individually, were highly significant ( $p < 0.01$ ).

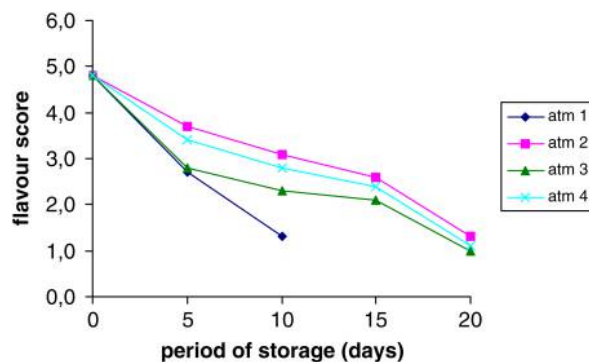
### Body and texture

The data for the changes in Body and texture in pizza prepared from unbaked samples packaged under four atmospheres and stored at  $7 \pm 1^\circ\text{C}$  are illustrated in Figure 3. The results revealed decreasing trend in the values for Body and texture of pizza samples during storage. The initial value of 4.6 for Body and texture of pizza decreased to 1.3 in case of atm 1, 3.5 (atm 2), 2.9 (atm 3) and 3.1 (atm 4), respectively, after ten days of storage, indicating least changes in Body and texture for samples packed under 100 per cent CO<sub>2</sub>, and maximum changes in case of pizza samples packaged under air, while the values had been intermediary for the samples packed under atm 3 and atm 4,

Source of variation	df	Appearance	Mean sum of squares Flavour	Body and texture	Overall acceptability
Among intervals of storage	4	11.1042*	20.2670*	18.8333*	18.8100*
Among atmospheres	3	2.1798*	1.6669*	2.0877*	2.5150*
Error	46	0.0805	0.0719	0.1109	0.1086
Interaction intervals $\times$ atmospheres (atm 2, atm 3, atm 4)	8	0.0985*	0.1074*	0.1194*	0.0674*
Error	30	0.0033	0.0033	0.0032	0.0039

**Table I.**  
Analysis of variance for sensory characteristics of MAP ready-to-bake pizza stored at  $7 \pm 1^\circ\text{C}$

**Notes:** \*Significant at 1 per cent level of probability; atm 2: 100 per cent CO<sub>2</sub>; atm 3: 100 per cent N<sub>2</sub>; atm 4: 50 per cent CO<sub>2</sub>: 50 per cent N<sub>2</sub>



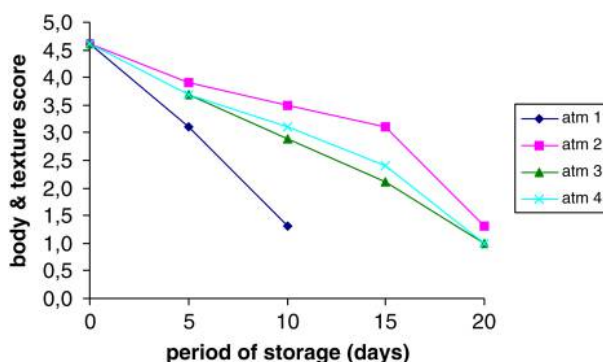
**Figure 2.**  
Effect of MAP on the Flavour of unbaked pizza stored at  $7 \pm 1^\circ\text{C}$

and the trend persisted till the product was stored for 20 days (Figure 3). The results, in general, are in harmony with the findings of Alam (2004) who also observed that the values for Body and texture decreased in the similar fashion when mozzarella cheese was packaged under different modified atmospheres.

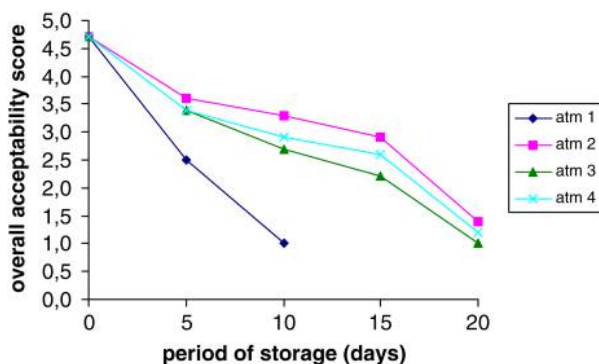
Analysis of variance (ANOVA) of the data on Body and texture of stored pizza samples revealed (Table I) that intervals of storage, types of atmospheres, and the interaction intervals  $\times$  atmospheres (atm 2, atm 3, atm 4) were highly significant ( $p < 0.01$ ) with regard to Body and texture characteristics.

#### Overall acceptability

The Overall acceptability of pizza samples exhibited a decreasing trend throughout the storage period under all studied atmospheres. The initial Overall acceptability score 4.7 (atm 1) decreased to 2.5 and 1.0, respectively, after five and ten days of storage, indicating that the air packed unbaked (ready-to-bake) pizza samples were acceptable only up to 5 days. At the end of 20 days of storage, none of the sample was acceptable under all the three modified atmospheres (atm 2, atm 3, atm 4), but were acceptable only up to 15 days. The samples packed under 100 per cent CO<sub>2</sub> (atm 2) were liked most followed by 50 per cent CO<sub>2</sub>/50 per cent N<sub>2</sub> and 100 per cent N<sub>2</sub>, respectively, in descending order (Figure 4). In general, the results are in agreement with the findings of Maniar *et al.* (1994), Alves *et al.* (1996) and Alam (2004) who also observed that 100 per cent CO<sub>2</sub> atmosphere best maintained the sensorial characteristics of the product.



**Figure 3.**  
Effect of MAP on the  
Body and texture of  
unbaked pizza stored  
at  $7 \pm 1^\circ\text{C}$



**Figure 4.**  
Effect of MAP on the  
Overall acceptability  
score of unbaked pizza  
stored at  $7 \pm 1^\circ\text{C}$

ANOVA for the data on Overall acceptability (Table I) revealed that different intervals of storage, the four types of atmospheres, and the interaction intervals  $\times$  atmospheres (atm 2, atm 3, atm 4), each individually, contributed very significantly ( $p < 0.01$ ) towards the changes in overall acceptability of unbaked pizza samples.

### Conclusion

In order to determine the shelf life of MAP ready-to-bake pizza, the samples were subjected to four types of atmospheres (air, 100 per cent CO<sub>2</sub>, 100 per cent N<sub>2</sub>, and 50 per cent CO<sub>2</sub>/50 per cent N<sub>2</sub>) and stored for various time intervals at  $7 \pm 1$  °C. The data obtained for the overall acceptability were used to establish the product's shelf life. The shelf life of ready-to-bake pizza significantly increased up to 15 days (a 300 per cent increase) for the samples packaged under 100 per cent CO<sub>2</sub> (atm 2), 50 per cent CO<sub>2</sub>/50 per cent N<sub>2</sub> (atm 4) and 100 per cent N<sub>2</sub> (atm 3), compared to conventional air pack (five days).

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