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Shelf Life Enhancement of *Paneer tikka* by Modified Atmospheric Packaging

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The present study was undertaken to increase the shelf-life of *paneer tikka*. It was done by using modified atmosphere packaging (MAP) technology. *Paneer tikka* has a short shelf-life of 1-2 days. MAP technology has increased its shelf-life for up to one month when stored at 5°C. The result showed that samples packed under 60% CO_2:40% N_2were more successful in preserving the moisture, sensory and microbial properties of *paneer tikka* at 5°C in comparison to samples stored at 10°C and 25°C.

Keywords: *Paneer tikka*, MAP packaging, shelf-life.

India is the world's largest producer of milk by volume. Milk is considered to be an appropriate source of valuable macronutrients (fat, protein and lactose) vitamins and micronutrients as minerals which can make it a wholesome food. It can serve as an excellent carrier product for extra nutrient and if enriched or fortified it can satisfy the nutritional needs of the people (Krupa *et al.,* 2011). The country accounts for more than 13% of world's total milk production and is also the world's largest consumer of dairy products. Dairying has been regarded as one of the activities that could contribute to alleviating the poverty and unemployment especially in the drought prone and rain fed areas. In India, about three fourth of the population live in rural areas and about 38% of them are poor. Therefore, among these people, as well as the large vegetarian segment of the country's population, dairy products provide a critical source of nutrition and animal protein to millions of people in India.

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Traditional milk products have greater commercial significance as they account for over 90% of the milk products consumed in the country (Aneja *et al.,* 2002). Out of total milk production 50-55% milk converted into different varieties of milk products through processes such as heat acid coagulation, heat desiccation and fermentation; out of which about 5.5% of total milk produced in the country used for khoa making (Bandyopadhyay *et al.*, 2006; Banerjee, 1997). Milk based products are integral part of the dietary system of Indian sub-continent. These products are consumed on various auspicious occasions such as weddings, festivals and day to day celebrations. Traditional milk products in India have great commercial importance as they account for over 90% of all milk products consumed in the country (Aneja *et al.,* 2002). Being the largest producer in the world, India produces about 121.8 million tons of milk annually (NDDB, 2012). About 50-55% of this milk production is converted into traditional dairy products like heat desiccated milk products viz., khoa, basundi, lalpeda, rabri, kalakand etc., coagulated milk products viz., *dahi*, *shrikhand*, *paneer*, chhana and chhana based products and clarified products viz. butter oil, ghee etc. which are inherent in ancient traditions and

have a strong social and cultural heritage in the Indian society. Indian traditional dairy products have a limited shelf life as many deteriorative changes take place during the storage. Milk based products during storage undergo several physical, biochemical and microbiological changes making them unfit for human consumption (Londhe *et al.*, 2012). Several previous studies have been reported to use hurdle technology, water activity changes and increase in sugar content to increase the shelf life of these traditional dairy foods (Kumar and Srinivasan, 1982; Biradar *et al.*, 1985; Thakur *et al.*, 1992; Kumar *et al.*, 1997; Sharma *et al.*, 2001), however, scientific literature on the use of MAP for extending the shelf life of traditional dairy foods is still limited. Scientific work on the application of MAP for preservation of peda (Birader *et al.*,1985), malaipeda (Sharma *et al.*, 2003), paneer (Rai *et al.*, 2008; Thippeswamy *et al.*, 2011), brown peda (Londhe *et al.*, 2012) and lalpeda (Jha *et al.*, 2013) have been reported which shows the promise this technology holds for enhancing the shelf life of traditional dairy foods.

In order to fulfil the consumers demand for foodstuffs with superior quality and nutritional value as well as minimally processed foods retaining the fresh products' features several non thermal techniques including modified atmospheric packaging (MAP) has been recently employed to increase the shelf life of these product, while still retaining the quality of the product (Singh *et al.*, 2010). *Paneer tikka*, a popular dish for vegetarians, is a tongue tingling favourite of Indian gourmets. It is a perishable commodity which requires more than five hours for its preparation (Ahuja *et al.*, 2012). The low shelf life of *paneer tikka* is mainly due to microbial and physicochemical changes (Ahuja *et al.*, 2011). MAP technique can be effectively used to reduce or eliminate the need of chemical preservatives while maintaining a desired shelf life for the packaged food product (Fernandez *et al.*, 2006). MAP technique is based on changing the gas combination of the environment in which the product is packed. The gases that are mostly used are carbon dioxide (CO_2) and nitrogen (N_2). CO_2 is both fungistatic and bacteriostatic and prevents insect growth in packaged and stored food products. Nitrogen is an inert, tasteless gas and is used as a filler gas. Generally O_2 concentration in MAP must be below atmospheric levels (i.e. <21% v/v) (Farber, 1991; O'Connor *et al*., 1992). MAP can alter the respiration rate, microbial growth, oxidation reactions and thus impacts the shelf life of food products (Mangarj and Goswami, 2009). The present work was undertaken to study the effect of modified atmosphere packaging (MAP) on the shelf life of *paneer tikka* at different storage temperatures.

MATERIALS AND METHODS

The present work was carried out in the laboratory of Centre of Food Science and Technology, Banaras Hindu University, Varanasi, India. Paneer Tikka was manufactured using milk standardized to 5% fat and 9% SNF. The Milk was procured from the Dairy Farm, Banaras Hindu University, Varanasi, India. Other required material used for the manufacture of paneer tikkawas procured from the local market of Varanasi, India.

Manufacturing of *Paneer tikka*

In the present study, paneer is the base material for preparation of *paneer tikka* which was prepared by method as described by Shrivastava and Goyal, (2009) with slight modification. Curd was prepared from standardized cow milk (5 % fat). Butter and cream were collected from the Amul Dairy Shop, Banaras Hindu University, Vranasi. The fresh vegetables namely tomatoes, onion, garlic and ginger of superior quality, spices such as red chilli powder, chicken masala (ingredients: coriander, chillies, cumin, turmeric, fenugreek leaves, salt, black pepper, dry ginger, mustard, bay leaf, pulse, cloves, nutmeg, caraway, cinnamon, cardamom seeds, mace, asafoetida), garam masala (ingredients: cumin, black pepper, coriander, cardamom seeds, cloves, nutmeg, cinnamon, dry ginger, bay leaf, caraway, mace) of a famous Indian brand, common salt, black salt and amchur powder (from unripened mango) were procured from the local market. Microwave oven having power output of 900W with internal dimensions of 36×37×23 cm^3 and 32 L capacity from Samsung, South Korea; Model Bio ceramic CE118KF was used for baking *paneer tikka*.

Preparation of marinade

For preparing marinade for making *paneer tikka* from 1 kg of paneer, onion (50 g), ginger (15 g) and garlic (8 g) were peeled off, washed with water and cut into small pieces. Tomatoes (50 g)

after washing with water were cut into two halves and pedicels were removed. Powdered spices (chicken masala 13 g, garam masala 7 g, red chilli powder 10 g and amchur powder 10 g) and salt (table salt 15 g and black salt 5 g) were blended thoroughly. Onion, ginger, garlic and tomatoes along with powdered spices were grounded in a mixer. Forty grams out of 1 kg curd was added prior to grinding in order to prevent jamming of mixer. Well mixed and ground spice blend was added to rest of the curd (960 g) along with cream (50 ml) and mixed thoroughly with a ladle. The prepared marinade was kept under refrigeration at 3±1°C.

Baking of *paneer tikka*

The marinated pieces of paneer chunks were skewed on stainless steel skewers (3.5 mm diameter), previously brushed with butter (to avoid stickiness). Skewers were inserted through the centre of paneer chunks from the 2.5×2.5 cm^2 side. The baking of marinated paneer chunks was achieved in a preheated (10 min at 200°C) microwave oven at 200°C for 22–24 min in convection/oven mode. The skewers containing marinated paneer chunks were placed horizontally over a stand in oven keeping a tray beneath the stand for collecting the drips of marinade during baking. After baking, the *paneer tikka* pieces were removed from skewers on a previously cleaned tray with the help of a flat spatula.

Packaging and storage of *paneer tikka* under MAP

The *paneer tikka* samples were packed in polyethylene pouches (5 layers) using MAP equipment Reepack® and MAP mix 9000 Gas mixer, manufactured by PBI DANSENSOR A/S, Ringstead, Denmark. The combination of gases i.e. 60% CO_2:40% N_2were used to pack the *Paneer Tikka* samples. The samples were stored in a BOD incubator (Remi Elektrotechnik Ltd., New Delhi, India) at 5, 10 and 25°C and were analyzed for physico-chemical, microbial, sensory and textural changes at an interval of 7 days.

Proximate analysis

The moisture content was determined by the method of AOAC (1995). The protein estimation was done by Kjeldhal method (IDF, 2001). The fat estimation was done by AOAC (2000) and total ash content was analyzed by AOAC (1995) method. The carbohydrate content was calculated by difference method.

Microbial analysis

All the samples were subjected to microbiological analysis for total plate count (TPC), yeast and mould count (YMC) and coliform count. The TPC was determined by surface spreading, the homogenate with appropriate dilutions (10^{-2}) on plate count agar (PCA) and incubated at 37°C for 24-48 h. For yeast and mould detection, appropriate dilutions (10^{-2}) of sample was spread on potato dextrose agar (PDA) and incubated at 25°C for 24-481 h. Coliforms in the samples were estimated by plating appropriate dilutions (10^{-2}) on Violet Red Bile Agar (VRBA) before being incubated at 37°C for 24-48 h.

Sensory evaluation

The sensory analysis of *paneer tikka* was carried out at 5, 10 and 25°C by a semi-trained panel of 9 judges drawn from staff and students of the Department of Animal Husbandry and Dairying and the Centre of Food Science and Technology at Banaras Hindu University, Varanasi (India). The judges were asked to score for the sensory attributes *viz*. color and appearance, flavor, body and texture, sweetness and overall acceptability, on a 100-point score card (flavor-50, body & texture-30 and color & appearance- 20).

Statistical analysis

Observation related to mean and standard deviation at different temperature and days of the microbial changes (Total Plate Count, Coliform Count and Yeast & Mould Count) and sensory profile (Flavour, Body & Texture, Color & Appearance and Overall Acceptability) are calculated.Analysis of variance technique (ANOVA) and Factorial Complete randomized design was applied for detecting the effect of temperature and days simultaneously on moisture content.

RESULTS AND DISCUSSION

Changes in the moisture content

Moisture content of any product is a critical parameter in determining the textural and organoleptic parameters of the product. It is evident from Table1 that the average moisture content of the *paneer tikka* samples decreased with increase in the storage period. The moisture content was also affected by the temperature of the storage. It

can be seen from Table1 that the reduction in moisture content was the least in samples stored at 5°C while it was highest in the samples stored at 25°C. Work done on lal peda has also showed that the loss of moisture content was more at 37C than at 4C. (Jha *et al*.,2012).

Proximate composition of *paneer tikka*

The average protein, fat, carbohydrate and ash contents of *paneer tikka* were20.4%, 25.5%, 36.3% and 2.0%, respectively.

Changes in sensory properties

The sensory characteristics of *paneer tikka* samples were evaluated on the basis of flavor, body and texture, color and appearance and overall acceptability. Table 2 depicts the data for sensory evaluation of *paneer tikka* packed under MAP and stored at 5, 10 and 25°C. The maximum score was obtained at day 0 (34.76±0.30) which decreased with progression in the storage period. It could also be seen from Table 2 that the samples stored at 5°C scored the maximum among all the samples at all the temperatures. The sensory scores for flavor, body and texture, color and appearance and overall acceptability varying significantly among MAP samples after 28 days of storage at all temperatures. Increase in the temperature had a detrimental effect on the sensory score of the product. The sensory properties viz. color and appearance, flavor and body and texture was affected the most by an increase in the storage temperature with progression of storage period. Nonetheless, the samples stored at 5°C packed under 60%CO_2:40%N_2 showed the best preservation of sensory characteristics of the *paneer tikka* samples.

Microbial analysis

Paneer tikka samples were analyzed at

Table 1. Moisture changes in *Paneer Tikka* packed under MAP and stored at 5, 10 and 25°C

Temp/Days	5°C	10°C	25°C
0 Days	15.00±0.43	14.53±0.49	14.30±0.20
7 Days	14.83±0.41	14.30±0.40	13.60±0.43
14 Days	14.66±0.20	14.26±0.05	12.53±0.05
21 Days	14.26±0.20	11.56±1.05	10.23±0.40
28 Days	13.43±0.20	08.56±0.25	06.46±0.15

Value represents Mean± Standard deviation
Level of significance at P<0.01 & P<0.05 both
MAP = Modified Atmospheric Packaging

Table 2. Sensory Profile of *Paneer Tikka* packed under MAP and stored at 5, 10 and 25°C

StudyPeriod	Flavour			Body & Texture			Color & Appearance			Overall Acceptability		
Days	5°C	10°C	25°C	5°C	10°C	25°C	5°C	10°C	25°C	5°C	10°C	25°C
0	34.76±0.30	34.53±0.51	34.26±0.20	29.73±0.73	29.66±0.75	28.70±0.10	12.30±0.10	12.20±0.10	11.76±0.23	78.16±2.60	78.06±2.90	77.90±0.79
7	34.66±0.37	32.33±0.25	27.76±0.35	29.66±0.77	29.36±0.49	27.40±0.17	12.10±0.85	11.86±0.25	10.43±0.92	78.13±2.51	75.23±2.90	77.50±1.04
14	29.73±0.32	27.03±0.20	17.66±0.56	26.86±0.55	24.26±0.05	20.70±0.43	11.96±0.35	11.56±0.40	5.93±0.73	78.06±2.62	73.00±0.86	70.16±0.15
21	25.10±0.10	19.60±0.45	10.20±0.10	19.46±0.15	14.20±0.30	7.96±0.49	10.16±0.30	7.63±0.15	4.13±0.15	69.20±0.90	63.16±0.96	62.50±4.94
28	19.26±0.20	14.66±0.47	8.60±0.60	14.70±0.17	11.10±0.95	5.53±0.35	6.90±0.26	5.40±0.15	2.43±0.20	63.26±0.20	58.86±0.51	42.16±2.70

Value represents Mean± Standard deviation Level of significance at P<0.01 & P<0.05 both MAP = Modified Atmospheric Packaging

an interval of 7 days stored at three different temperatures (5, 10 and 25°C) with gas concentration (60% CO_2:40%N_2) and MAP packed for microbial changes. Table 3 depicts the total TPC, YMC and coliform count obtained for the *paneer tikka* samples packed under MAP stored at three different temperatures. Among MAP samples, the general trend in the TPC and YMC was 5°C<10°C< 25°C, during the storage period of 28 days. No coliforms were detected in any of the samples. However, it was observed that the samples stored at 60% CO_2:40% N_2, inhibited the microbial growth with great efficiency. This could be attributed to the combined benefits of N_2 and CO_2 as reported by several earlier workers (Daniels *et al*., 1985; Banks and Annis, 1990; Davis, 1998; Devlieghere and Debevere, 2000, Arvanitoyannis *et al*., 2011; Ghayal *et al*., 2013; Jha *et al*., 2013).

Table 3. Microbial changes in *Paneer Tikka* packed under MAP and stored at 5, 10 and 25°C

Study	Total Plate Count(log CFU/g)			Coliform count(log CFU/g)			Yeast & Mold(log CFU/g)		
Period Days	5°C	10°C	25°C	5°C	10°C	25°C	5°C	10°C	25°C
0	1.13±0.20	1.26±0.32	1.13±0.20	ND	ND	ND	1.10±0.26	1.13±0.20	1.16±0.23
7	1.16±0.25	1.36±0.15	1.56±0.20	ND	ND	ND	1.13±0.20	1.20±0.30	1.36±0.15
14	1.12±0.30	1.86±0.05	2.70±0.34	ND	ND	ND	1.16±0.25	1.30±0.26	2.50±0.17
21	2.60±0.10	4.16±0.05	4.66±0.05	ND	ND	ND	1.23±0.30	3.43±0.20	4.33±0.15
28	3.66±0.20	4.73±0.20	5.60±0.26	ND	ND	ND	1.43±0.05	4.40±0.10	5.80±0.10

Value represents Mean± Standard deviation
Level of significance at P<0.01 & P<0.05 both
ND = Not Detected, MAP = Modified Atmospheric Packaging

CONCLUSION

It was observed that the samples stored under MAP have an improved shelf life and acceptable upto 28 days. Therefore, MAP could be considered as a better option for the storage of *paneer tikka*. This study could also be helpful in preservation of other traditional dairy products of Indian sub-continent using modified atmosphere packaging. As MAP is also considering being a technology using minimal processing, it can be helpful in preservation of indigenous dairy foods with minimum loss of the product quality.

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