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Effect of storage period on moisture, pH, soluble nitrogen and FFA contents of *Paneer* spread

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Abstract

The present investigation was carried out to study the effect of microwave treated and vacuum treated and both microwave as well as vacuum treated *paneer* spread sample for storage studies. Since *paneer* or *paneer* spreads are perishable dairy products, hence appropriate to adopt processing technologies to enhance shelf life without adding preservatives. Different treatments such as P1-microwave treated, P2-vacuum treated, P3-vacuum and microwave treated samples were studied for pH and important chemical parameters. Control sample recorded highest moisture, SN (Soluble nitrogen), more acidic (low pH) and significantly higher FFA (free fatty acid) contents were recorded compared to treated samples. Whereas, as P3 recorded encouraging values of moisture (59.10), SN(.289), pH(5.11) and FFA(0.916) up to 84 days of storage. Further P3 was found to be significantly ($p < 0.05$) better samples among all the samples.

Keywords: *Paneer*, microwave, vacuum, moisture

Introduction

Paneer is a heat and coagulated dairy product having high moisture content (50-60 per cent). It is generally consumed fresh due to its perishability. According to PFA (1997)^[7], it shall not contain more than 70 per cent moisture and milk fat content shall not be less than 50 per cent of the dry matter. Now, as per FSSR *paneer* shall contain maximum 65 per cent moisture and minimum of 50 per cent fat on dry matter basis. *Paneer* and *Chhana* are the two important Indian traditional coagulated dairy products. Mostly small-scale traders and halwais produce these dairy products by traditional methods. The unhygienic condition maintained during manufacture lead to lower shelf life of these products. The demand for these products is increasing every year. There is great concern to produce new similar product with high quality and high shelf life products employing modern processing technologies, hence microwave treated and vacuum packaging techniques have been promising technology can be adopted.

In India, *paneer* production has been largely confined to small non-organized sectors. It is estimated that one per cent of the country's milk production is converted into *paneer* and the annual production is estimated to be at 150, 000 tonnes (Aneja *et al.*, 2002)^[1], type of coagulating agent plays important role on the quality of *paneer* (Shanaziya *et al.* 2018)^[13] and value added *paneer* can be obtained by using garlic and mint leaves (Puneet *et al.* 2022)^[9] *Paneer* is mainly used as a base material for the production of various culinary dishes. Spreads: There are mainly two types of spreads available in the domestic market, namely, butter and cheese spreads. Since Butter is a high fat, most of the consumer's particularly fat conscious group is hesitant to consume butterfat because of the possibility of coronary heart diseases. High cost of butter in addition to its high-saturated fatty acids, cholesterol contents, high calorific value and poor spreadability at room temperature below 15 °C limits its consumption (Prajapati *et al.*, 1991)^[8]. Cheese spread, though meets all the nutritive requirements of the people of all age groups, is not so popular among Indian population because of its characteristic flavour and religious sentiments of the people (presence of calf rennet in cheese is disliked by vegetarians).

Materials and Methods

Fresh cow's milk was procured from the student's experimental dairy plant (SEDP). The milk was standardized to 4.5% fat and 8.5% MSNF by adding calculated amount of fresh cream and or skim milk powder.

Microwave processor

The continuous type Microwave processor with the following specification was used to

process the *paneer* spread:

| | |
|--------------------------|---|
| Type | : Microwave powered continuous processor |
| Make | : M/s Microwave products (India) Ltd |
| Model | : MPCD/005/2003-04 |
| Input power | : 6 kW |
| No. of magnetrons | : 3 |
| Microwave power | : 3 kW |
| Power of each magnetron | : 1 kW |
| Microwave frequency | : 2450 MHz |
| Power supply | : 415 V AC, 3 phase |
| Conveyor type | : Teflon belt |
| Length of conveyor | : 3 m |
| Speed of conveyor | : 0-6 m/min |
| Dimension of equipment | : 3.2 x 0.6 x 1.4 m (L x W x H) |
| Dimension of cavity | : 2 x 0.2 x 0.9 m (L x W x H), with suitable flanges at both ends |
| Cavity material | : Stainless steel-316 |
| Material of construction | : AISI-304 Stainless steel |

Microwave power generator/processor: The processor is provided with three magnetrons of 1 kW each producing @ 2450 MHz. These magnetrons are located in a metal housing which forms a continuous tunnel. The three magnetrons are located adjacent to each other inside the tunnel. The sector of the tunnel where these magnetrons are located forms the microwave cavity where actually heating/processing takes place. Each of the magnetrons is controlled by an independent switch. One, two or all the three could be operated as desired. The total length of the tunnel is 3.0 m of which 2.0 m forms the cavity where actual microwave heating takes place. The product travels into the cavity inside the tunnel over a conveyor.

Preparation of paneer: *Paneer* was prepared as per the method suggested by Bhattacharya *et al.* (1971) [3] with slight modifications.

Preparation of paneer spread.: The method suggested by Reddy *et al.* (2000) [10] for the preparation of chhana butter spread was adopted for the preparation of *paneer* spread in the study with slight modifications. pH of *paneer* spread sample was determined by blending 10g of *paneer* spread with 10 ml of glass distilled water and dipping the electrode directly into the slurry as per the procedure followed by O' Keeffee *et al.* (1976) [11], Moisture content of *paneer* spread was estimated as per IS: SP18 (Part XI) [5] 1981 procedure, The soluble nitrogen content was determined as per Association of Official Analytical Chemists (AOAC. 33.2.12; 991.21, 1995) procedure, The free fatty acid (FFA) [7] content of *paneer* spread was estimated using the procedure mentioned by Deeth *et al.* (1975) [4], The penetration measurements were made using cone and test rod (probe) weighing 35g. The cone was allowed to penetrate the sample for a fixed time of 5s. For the same sample, reading was recorded at different spots and the average value was recorded as mm/5 s of penetration. The results are the average of four replications was statistically analyzed using ANOVA technique (zar, 2003) [15] for one-way analysis and t-test with independent sample.

Results and Discussions

7 days stored at 7±1 °C

Moisture: Maximum percent of moisture was recorded for the control spread (63.04) and minimum was recorded for the

spread P3 (62.31). The control spread had significantly higher moisture content than those of treated spreads P1 (62.45), P2 (62.62), P3 (62.31) and there is no significant difference between the moisture per cent of all three treated spreads.

Soluble nitrogen (SN %): Control spread recorded highest SN content of 0.136 and least was recorded for the spread P3 (0.127%). The SN content of treated spreads of P1, P2 and P3 are 0.129, 0.131 and 0.127 respectively. The control spread is significantly different from those of all three treated spreads and there is no significant difference between the SN contents of treated spreads.

pH: Highest pH was recorded for the spread P3 (5.64) and lowest was for the control spread (5.40). There is a significant difference between the pH values of control.

Table 1: Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen and FFA contents of milk spread stored at 7±1 °C for different storage days

| a) After 7 days of storage | | | | |
|-----------------------------|--------------------|--------------------|-------------------|--------------------|
| Attribute | Per cent | | pH | FFA (μ equl/g) |
| | Moisture | SN | | |
| Control | 63.04 ^a | 0.136 ^a | 5.40 ^a | 0.651 ^a |
| P1 | 62.45 ^b | 0.129 ^b | 5.63 ^b | 0.567 ^b |
| P2 | 62.62 ^b | 0.131 ^b | 5.42 ^c | 0.578 ^b |
| P3 | 62.31 ^b | 0.127 ^b | 5.64 ^b | 0.551 ^b |
| CD $p < 0.05$ | 0.38 | 0.02 | 0.003 | 0.068 |
| b) After 14 days of storage | | | | |
| Attribute | Per cent | | pH | FFA (μ equl/g) |
| | Moisture | SN | | |
| Control | 62.94 ^a | 0.168 ^a | 5.31 ^a | 0.816 ^a |
| P1 | 62.37 ^b | 0.135 ^b | 5.61 ^b | 0.583 ^b |
| P2 | 62.52 ^b | 0.148 ^b | 5.39 ^c | 0.591 ^b |
| P3 | 62.32 ^b | 0.132 ^b | 5.62 ^b | 0.581 ^b |
| CD $p < 0.05$ | 0.46 | 0.019 | 0.06 | 0.084 |

P₁-Microwave treated.

P₂-vacuum treated.

P₃-vacuum and microwave treated.

Figures with the same superscripts in a column indicates no significant difference and treated spreads. Whereas, there is no significant difference between the treated spreads of P1 (5.63) and P3 (5.64) but spread P2 (5.42) is significantly different from those of spreads P1 and P3.

FFA (μ equl/g): The highest FFA was recorded for the control spread (0.651) and lowest was recorded for the spread P3 (0.551). There is significant difference between the FFA contents of control and treated spreads P1 (0.567), P2 (0.578) and P3 (0.551). Whereas, there is no significant difference between the all three treated spreads.

14 days stored at 7±1 °C

Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen and FFA contents of *paneer* spread stored at 7±1 °C after 14 days are presented in the Table-1b.

Moisture: Control spread recorded highest moisture per cent of 62.94 and lowest was recorded for the spread P3 (62.32). The moisture content of treated spreads P1, P2 and P3 are 62.37, 62.52 and 62.32 respectively. The control spread recorded significantly higher moisture per cent than those of all three treated spreads. Whereas, there is no significant difference between the moisture per cent of treated spreads.

Soluble Nitrogen (SN %): Control spread recorded highest SN content of 0.168 and least was recorded for the spread P3 (0.132%). The SN content of treated spreads of P1, P2 and P3 are 0.135, 0.148 and 0.132 respectively. The control spread is significantly different from those of all three treated spreads and there is no significant difference between the SN contents

of treated spreads.

pH: Highest pH was recorded for the spread P3 (5.63) and lowest was for the control spread (5.31). There is a significant difference between the pH values of control and treated spreads. Whereas, there is no significant difference between the treated spreads of P1 (5.61) and P3 (5.63) but spread P2 (5.39) is significantly different from those of spreads P1 and P3.

FFA (μ equl/g): The highest FFA content was recorded for the control spread (0.816) and lowest for the spread P3 (0.581). There is significant difference between the FFA contents of control and treated spreads P1 (0.583), P2 (0.591) and P3 (0.581). Whereas, there is no significant difference between FFA contents of all three treated spreads.

21 days stored at 7±1 °C

Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen and FFA contents of *paneer* spread stored at 7±1 °C after 21 days are presented in the Table-2.

Moisture: Maximum per cent of moisture was recorded for the control spread (62.70) and minimum was recorded for the P3 (62.11). The control spread had significantly higher moisture per cent than those of other three treated spreads P1 (62.15),

Table 2: Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen and FFA contents of *paneer* spread stored at 7±1 °C for different storage days

| a) After 21 days of storage | | | | |
|-----------------------------|--------------------|--------------------|-------------------|---------------------|
| Attribute | Per cent | | pH | FFA (μ equl/g) |
| | Moisture | SN | | |
| Control (Spoiled) | 62.70 ^a | 0.286 ^a | 5.14 ^a | 1.072 ^a |
| P1 | 62.15 ^b | 0.144 ^b | 5.56 ^b | 0.612 ^b |
| P2 | 62.25 ^b | 0.161 ^b | 5.35 ^c | 0.634 ^b |
| P3 | 62.11 ^b | 0.142 ^b | 5.60 ^b | 0.610 ^b |
| CD $p < 0.05$ | 0.25 | 0.032 | 0.03 | 0.079 |
| b) After 28 days of storage | | | | |
| Attribute | Per cent | | pH | FFA (μ equl/g) |
| | Moisture | SN | | |
| Control | - | - | - | - |
| P1 | 61.80 ^a | 0.168 ^a | 5.52 ^a | 0.664 ^a |
| P2 | 61.86 ^a | 0.183 ^b | 5.31 ^b | 0.682 ^b |
| P3 | 61.74 ^a | 0.165 ^a | 5.56 ^a | 0.662 ^{ba} |
| CD $p < 0.05$ | 0.46 | 0.038 | 0.05 | 0.014 |

P₁-Microwave treated.

P₂-vacuum treated.

P₃-vacuum and microwave treated.

Figures with the same superscripts in a column indicate no significant difference P2 (62.25), P3 (62.11). But there is no significant difference between the moisture per cent of three treated spreads.

Soluble Nitrogen (SN %): Highest SN content was recorded for Control (0.286) and lowest for P3 (0.142%). The SN content of treated spreads of P1, P2 and P3 are 0.144, 0.161 and 0.142 respectively. The control spread is significantly higher SN content than other three treated spreads. But there is no significant difference between the SN contents of treated spreads.

pH: Highest pH was recorded for the spread P3 (5.60) and lowest was for control spread (5.14). There is significant difference between the pH of control and treated spreads. Whereas, there is no significant difference between the treated spreads of P1 (5.56) and P3 (5.60). However P2 (5.35) is significantly lower from those treated spreads of P1 and P3.

FFA (μ equl/g): The FFA content was highest (1.072) recorded for the control spread and lowest of (0.610) was recorded for the treated spread P3. There is significant difference between the FFA contents of control and treated spreads P1 (0.612), P2 (0.634) and P3 (0.610). Whereas, there is no significant difference between FFA contents of three

treated spreads.

28 days stored at 7±1 °C

Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen and FFA contents of *paneer* spread stored at 7±1 °C after 28 days are presented in the Table-2b.

Moisture: Highest per cent of moisture was recorded for the treated spread P2 and lowest was recorded for the spread P3. The moisture per cent of treated spreads P1, P2 and P3 are 61.80, 91.86 and 61.74 respectively. Between the treatments, there is no significant difference in the moisture per cent.

Soluble Nitrogen (SN%): The soluble nitrogen content of the spread P2 was recorded maximum of 0.183 and lowest of 0.165 recorded for the spread P3. There is significant difference between the SN per cent of P2 and P1 as well as P2 and P3. But there is no significant difference between P1 and P3.

pH: Highest pH was recorded for the spread P3 (5.56) and lowest for the spread P1 (5.52). There is no significant difference in the pH values of P1 and P3, but pH of P2 is significantly different from those of P1 and P3.

FFA (μ equl/g): The highest FFA content of 0.682 was recorded for P2 and lowest (0.662) was recorded for P3. There is no significant difference between the FFA contents of the spread P1 and P3. But FFA content of P2 is significantly higher than those of P1 as well as P3.

35 days stored at 7±1 °C

Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen and FFA contents of *paneer* spread stored at 7±1 °C after 35 days are presented in the Table-3.

Moisture: Highest moisture per cent was recorded for the spread P2 (61.41) and lowest was 61.28 was recorded for the spread P3. There is no significant difference between the moisture per cent of the spreads P1, P2 and P3.

Soluble Nitrogen (SN%): The maximum SN per cent of 0.223 content was recorded for the spread P2 and lowest (0.175%) recorded for the spread P3. The SN content of P2 is significantly different from those of P1 and P3.

pH: Highest pH was recorded for the spread P3 (5.50) and lowest was P2 (5.30). Whereas, there is no significant difference between the spreads of P1 (5.47) and P3 (5.50), but pH of P2 significantly different from those of P1 and P3.

FFA (μ equl/g): The maximum FFA content was recorded for the spread P2 (0.776) and lowest was recorded for the P3 (0.683). There is a significant difference between the FFA contents of P2 and P1 and as well as between P2 and P3. But, there is no significant difference between the spreads P1 and P3.

42 days stored at 7±1 °C

Table 3: Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen (SN) and FFA contents of *paneer* spread stored at 7±1 °C for different storage days

| a) After 35 days of storage | | | | |
|-----------------------------|--------------------|--------------------|-------------------|---------------------|
| Attribute | Per cent | | pH | FFA (μ equl/g) |
| | Moisture | SN | | |
| Control | - | - | - | - |
| P1 | 61.34 ^a | 0.181 ^a | 5.47 ^a | 0.685 ^a |
| P2 | 61.41 ^a | 0.223 ^b | 5.30 ^b | 0.776 ^b |
| P3 | 61.28 ^a | 0.175 ^a | 5.50 ^a | 0.683 ^a |
| CD $p < 0.05$ | 0.58 | 0.013 | 0.07 | 0.083 |
| b) After 42 days of storage | | | | |
| Attribute | Per cent | | pH | FFA (μ equl/g) |
| | Moisture | SN | | |
| Control | - | - | - | - |
| P1 | 60.96 ^a | 0.196 ^a | 5.44 ^a | 0.714 ^a |
| P2 | 61.10 ^a | 0.266 ^b | 5.25 ^b | 0.823 ^b |
| P3 | 60.88 ^a | 0.194 ^a | 5.47 ^a | 0.709 ^a |
| CD $p < 0.05$ | 0.64 | 0.011 | 0.04 | 0.033 |

P₁-Microwave treated.

P₂-vacuum treated.

P₃-vacuum and microwave treated.

Figures with the same superscripts in a column indicate no significant difference.

Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen and FFA contents of *paneer* spread stored at 7±1 °C on 42 days are presented in the Table-32b

Moisture: Spread P2 was recorded highest moisture per cent of 61.10 and lowest was P3 (60.88). There is no significant difference between the moisture per cent of the all treated spreads P1, P2 and P3.

Soluble Nitrogen (SN%): Highest SN of 0.266 was recorded for P2 and lowest 0.194 was recorded for P3. But there is no significant difference in SN contents of P1 and P3. SN content of P2 is significantly higher than those of P1 and P3

pH: Treated spread P3 recorded highest pH of 5.47 and lowest pH was recorded for P2 (5.25). There is no significant difference between the pH of spreads P1 and P3 but there is a significant difference between the spreads P2 and P1 and as well as spreads P2 and P3.

FFA (μ equl/g): The maximum FFA content was recorded for the spread P2 (0.823) and lowest was recorded for the P3 (0.709). There is no significant difference between the FFA contents P1 and P3. But FFA content of P2 is significantly higher than those of P1, as well as P3

49 days stored at 7±1 °C

Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen and FFA contents of *paneer* spread stored at 7±1 °C after 49 days are presented in the Table-4.

Moisture: The moisture per cent of the spreads P1 and P3 are 60.51 and 60.29 respectively.

Soluble nitrogen (SN): Highest SN per cent was recorded for the spread P2 (0.312) and lowest was P3 (0.208). There is no significant difference between the P1 and P3. The SN content

of the spread P2 is significantly different from those of spreads P1 and P3.

pH: The pH of spread P2 was recorded 4.81 and this has significantly lower pH than those of the spreads P1 (5.42) and P3 (5.44). There is no significant difference between the spreads P1 and P3.

FFA ($\mu\text{ equl/g}$): The maximum FFA content was recorded for the spread P2 (0.911) and lowest was recorded for the P3 (0.821). There is a significant difference between the FFA contents of P2 and P1, as well as between P2 and P3. But, there is no significant difference in the FFA contents of spreads P1 and P3.

Table 4: Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen (SN) and FFA contents of *paneer* spread stored at $7\pm 1\text{ }^\circ\text{C}$ for different storage days

| a) After 49 days of storage | | | | |
|-----------------------------|----------|-------|------|-----------------------------|
| Attributes | Per cent | | pH | FFA ($\mu\text{ equl/g}$) |
| | Moisture | SN | | |
| P1 | 60.51 | 0.212 | 5.42 | 0.836 |
| P2 (Spoiled) | - | - | - | - |
| P3 | 60.29 | 0.208 | 5.44 | 0.821 |
| $p < 0.05$ t-test | NS | NS | NS | NS |
| b) After 56 days of storage | | | | |
| Attributes | Per cent | | pH | FFA ($\mu\text{ equl/g}$) |
| | Moisture | SN | | |
| P1 | 60.22 | 0.221 | 5.40 | 0.855 |
| P3 | 60.13 | 0.218 | 5.43 | 0.849 |
| $P > 0.05$ t-test | NS | NS | NS | NS |

P₁-Microwave treated.
 P₂-Vacuum treated.
 P₃-Vacuum and microwave treated.

56 days stored at $7\pm 1\text{ }^\circ\text{C}$

Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen and FFA contents of *paneer* spread stored at $7\pm 1\text{ }^\circ\text{C}$ after 56 days are presented in the Table-4b.

There is no significant difference between the moisture per cent of spreads P1 (60.22) and P3 (60.13). Similarly, there is no significant difference between the SN content of the spreads P1 (0.221) and P3 (0.218). The pH of spreads P1 and P3 are 5.40 and 5.43 respectively but there is no significant difference in SN content of P1 and P3. There is no significant difference between the FFA contents of the spreads P1 (0.855) and P3 (0.849).

63 days stored at $7\pm 1\text{ }^\circ\text{C}$

Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen and FFA contents of *paneer* spread stored at $7\pm 1\text{ }^\circ\text{C}$ on 63 days are presented in the Table-5a.

There is no significant difference between the moisture per cent of the spreads P1 (59.83) and P3 (59.75). But, There is a significant difference between the SN per cent of the spreads P1 (0.251) and P3 (0.246). The pH of the spreads P1 and P3 are 5.32 and 5.40 respectively. There is significant difference in pH spreads P1 and P3. The FFA content of P1 and P3 are 0.871 and 0.853 and they are significantly higher.

70 days stored at $7\pm 1\text{ }^\circ\text{C}$

Effect of microwave, vacuum packaging and their

combination on moisture, pH, soluble nitrogen and FFA contents of *paneer* spread stored at $7\pm 1\text{ }^\circ\text{C}$ after 70 days are presented.

Moisture per cent of the spreads P1 and P3 are 59.62 and 59.54 respectively, which were found to not significantly different. But there is a significant difference between the SN per cent of the spreads P1 (0.287) and P3 (0.257). There is a significant difference between the pH of spreads P1 (4.87) and P3 (5.31). The FFA contents of the spreads P1 (0.968) and P3 (0.864) were also found to be significant different.

77 and 84 days stored at $7\pm 1\text{ }^\circ\text{C}$

Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen and FFA contents of *paneer* spread stored at $7\pm 1\text{ }^\circ\text{C}$ after 77 and 84 days are presented in the Table-5c and 5d.

After 77 days of storage spread P3 recorded moisture, SN, pH and FFA content of 59.36 per cent, 0.263 per cent, 5.29 and 0.887 respectively. Similarly, after 84 days of storage the moisture, SN, pH and FFA contents were 59.10 per cent, 0.289 per cent, 5.11 and 0.916 respectively for the P3 spread.

Table 5: Effect of microwave, vacuum packaging and their combination on moisture, pH, soluble nitrogen (SN) and FFA contents of *paneer* spread stored at $7\pm 1\text{ }^\circ\text{C}$ for different storage days

| a) After 63 days of storage | | | | |
|-----------------------------|----------|-------|------|-----------------------------|
| Attribute | Per cent | | pH | FFA ($\mu\text{ equl/g}$) |
| | Moisture | SN | | |
| P1 | 59.83 | 0.251 | 5.32 | 0.871 |
| P3 | 59.75 | 0.246 | 5.40 | 0.853 |
| $p < 0.05$ t-test | NS | * | * | * |
| b) After 70 days of storage | | | | |
| Attribute | Per cent | | pH | FFA ($\mu\text{ equl/g}$) |
| | Moisture | SN | | |
| P1 | 59.62 | 0.287 | 4.87 | 0.968 |
| P3 | 59.54 | 0.257 | 5.31 | 0.864 |
| $p < 0.05$ t-test | NS | * | * | * |
| c) After 77 days of storage | | | | |
| Attribute | Per cent | | pH | FFA ($\mu\text{ equl/g}$) |
| | Moisture | SN | | |
| P3 | 59.36 | 0.263 | 5.29 | 0.887 |
| d) After 84 days of storage | | | | |
| Attribute | Per cent | | pH | FFA ($\mu\text{ equl/g}$) |
| | Moisture | SN | | |
| P3 | 59.10 | 0.289 | 5.11 | 0.916 |

P₁-Microwave treated; P₃-vacuum and microwave treated.



Fig 1: Vacuum packaging machine used in the study

Reasons for Changes in *paneer* spread stored at refrigerated temperature

The untreated (control) spread showed significantly higher moisture per cent as compared to treated spreads P1, P2 and

P3 up to 21 days of storage. But, there was no significant difference between the moisture per cent of treated spreads up to 70 days of storage (Table-32). In untreated spreads (control) the SN, and FFA contents increased and pH decreased gradually on 7th, 14th and 21st days of storage and these changes were significantly higher than P1, P2 and P3 spreads. The significant increase in the above chemical parameters in untreated spread (control) might be associated with the increase in the microbial load. The present study on storage changes of *paneer* spread is in agreement with findings of Pal (1998)^[6] and Sachdeva and Singh (1990)^[12]. The untreated spread (control) found to be acceptable up to 14 days of storage at 7±1 °C. Vishweshwaraiah and Anantkrishnana (1985)^[14] recorded keeping quality of 7 days for *paneer* stored at 5 °C in polyethylene bags. The treated spread P2 (vacuum packed) had significantly higher per cent of SN on 28, 35, 42 and 49th day of storage as compared to other treated spreads P1 and P3. This may be due to the exposure of P1 to microwave and P3 to vacuum packaging followed by microwave treatments that would have contributed to less microbial action as compared to vacuum package alone. The pH of P2 spread decreased significantly up to 49 day of storage as compared to P1 and P3. Though the pH of P1 and P3 declined 56th day, the decline was statistically non-significant. However, there was a significant decline in pH of P1 and P3 on 63rd and 70th day of storage. The FFA of content of treated spreads P1, and P3 remained non-significant difference up to 56 days of storage. The significant increase in the above chemical parameters (increase in SN and FFA contents and decrease in pH) in untreated spread (control) and vacuum treated spread (P2) might be ascribed to increase in the bacterial population. The P2 (vacuum packed) spread was found acceptable up to 35 days of storage at 7±1 °C.

Summery and conclusion

The novel techniques such as microwave and vacuum packaging process can be successfully adopted to extend the shelf life of *paneer* spread without adding any preservatives. In tern this method of extension of shelf life of foods can be extended to other foods to check the stability in shelf life. Hence these techniques has great potentiality in extension of shelf life of perishable dairy foods at commercial scale also brings consumer confidence.

Conflict of interest: None.

Reference

1. Aneja RP, Mathur BN, Chandan RC, Banerjee AK. Technology of Indian Milk Products. Dairy India Pub., Delhi; c2002. p. 134-142.
2. AOAC. Official methods of analysis, 16th Ed. Assoc. Official Analytical Chemist, Washington; c1995.
3. Bhattacharya DC, Mathur ON, Srinivasan MR, Samlik OL. Studies on the method of production and shelf life of Paneer. J Food Sci. Technol. 1971;8(5):117-20.
4. Deeth HC, Fitz GCH, Wood AF. A convenient method for determining the extent of lypolysis in milk. Aust. J Dairy Technol. 1975;30:109-11.
5. IS: SP18, Part XI., ISI handbook of food analysis, Dairy products, Bureau of Indian standard, New Delhi, India; c1981.
6. Pal D. Heat and acid coagulated products, Advances in

traditional dairy products. Lecture compendium, NDRI, Karnal; c1998. p. 12.

7. PFA. Prevention of Food Adulteration Act, 1954, Asia Law House, Hyderabad; c1983.
8. Prajapati PS, Gupta GR, Patel AA. Cost estimation of butter flavoured low fat spread. Indian J Dairy Sci. 1991;44:6-9.
9. Puneet A, Prasad SGM, John D. Development of value added paneer with different ratios of herbs like garlic and mint leaf and its physicochemical analysis. J of pharmacognosy and photochemistry. 2022;11(4):216-219.
10. Reddy KY, Lakshminarayana M, Sarma KS, Ranganadham M, Shiva Kumar. Characteristics of low fat Channa based butter spread. J Food Sci. Technol. 2000;37(1):45-47.
11. O' Keeffee BR, Fox FP, Daly C. Contribution of rennet and starter proteases to proteolysis in cheddar cheese. J Dairy Res. 1976;43:97.
12. Sachdeva S, Singh S. Optimization of processing parameters in the manufacture of paneer, J Food Sci. Technol. 1990;25(3):142-145.
13. Shanaziya ASF, Mangalika VLP, Nayananjalie. Effect of different coagulants on the quality of paneer made from cow milk. Intl. journal of scientific and research publications. 2018;8(4):189-194.
14. Vishweshwaraiah L, Ananthkrishnanan CP. A study on technological aspects of preparing Paneer from cows milk, Asian J Dairy Res. 1985;4(3):171-176.
15. Zar JH. Biostatistical Analysis. Edited by Zar JH. Pub. Pearson Edu. Pvt. Ltd., New Delhi, 2003, 231-242.