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Effect of storage studies on rheological characteristics of paneer (An Indian soft cheese) spread during storage

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Abstract
An attempt has been made to find out the few important rheological properties like firmness, spreadability, stickiness, and adhesiveness of paneer spread which has been previously treated with microwave and vacuum and combined effect. There was a significant ($p \leq 0.05$) increase in the firmness (4.891) of the product P3 was observed compared to control (3.213). Similarly, spreadability of P3 sample recorded highest value (3.729) than control (1.803). Whereas, stickiness and adhesiveness values are significantly lower in all treated samples could be increase in the firmness values of the product again this could be due to slight reduction of moisture content was observed after microwave treatment. The P3 recorded lowest stickiness and adhesiveness values of 5.661 and 0.471 respectively. Further during storage up 3 days at room temperature sample P1, P2 and P3 recorded lower trend values for firmness, spreadability, stickiness and adhesiveness.

Keywords: Paneer, rheology, spread, acuum, microwave

Introduction
Paneer may be considered as one of the semi soft varieties of cheese having high moisture content (50-60 per cent). Typically paneer is a marble to light creamy white in appearance. It must have firm and cohesive body with slight sponginess. The texture should be more compact (close knit), smooth and velvety. The flavour should be pleasingly mild acidic, slightly sweet and nutty [1-2]. It is generally consumed fresh; however, it may be held for periods of two weeks to two months before consumption. According to FSSAI (food safety and standards authority of India) it shall not contain more than 65 per cent moisture and milk fat content shall not be less than 50 per cent of the dry matter. Since paneer and paneer based spreads are highly perishable in nature it has to subject for advanced processing technique/s to enhance its shelf life. So, vacuum packaging and microwave techniques are the prominent few methods can adopted to increase the shelf life without adding any preservatives.
Microwave heating is an important novel technique available for thermal processing of food and dairy products. Microwaves (Electromagnetic waves) when penetrate products, heat is generated instantaneously within the product by friction among water molecules. Now-a-days, conventional thermal ovens are replaced by Microwave ovens in various food processing and preservation operations for extension of shelf life of the foods [3]. This process can be successfully applied to products containing low and intermediate moisture contents. The products with higher moisture, fat and sugar will have great affinity to microwave energy and hence gets heated instantaneously. Compared to conventional heating, microwave heating provides several advantages in terms of voluminous and instantaneous heating that yields products with higher qualities in terms of nutrition, taste, texture, flavour, increased production and keeping quality. Vacuum packaging explores the possibility of improvement in the body and texture of the paneer like products plus preserving the products for a longer time and thus increasing their shelf life [4]. On other hand decreases the moisture content of product is economic benefit to the consumers.

Materials and Methods
Preparation of paneer
Paneer was prepared by following standard method with slight modifications [5]. The standardized milk (4.5% fat and 8.5% MSNF) was heated to 90 °C (No holding) in a stainless steel vessel followed by cooling to 70 °C. Then hot solution (70 °C) of one percent citric acid was added to the milk (70 °C) with vigorous agitation initially and gentle stirring later till clear whey was separated out. Then the coagulum was allowed to settle down for 5 minutes.

The whey was drained out through a muslin cloth and collected paneer curd was used for preparation of paneer-spread.

Preparation of paneer spread

The method suggested for the preparation of chhana butter spread was adopted for the preparation of paneer spread in the study with slight modifications [6]. The final procedure is shown in the flow chart-1. About 0.25 kg of freshly prepared paneer curd was transferred to the mixer jar, various levels of common salt (NaCl) and tri sodium citrate was added to the paneer curd at the rate of 0.5 per cent. Then calculated amount of pasteurized potable water was added to adjust the moisture content of the product to 63.5 per cent (to facilitate proper grinding/mixing process). The jar contents were subjected grinding to obtain smooth spreadable product.

Texture profile analysis

Texture profile analysis (TPA) parameters were determined by using the Stable Micro-Systems TA-XT2 Texture Analyser (UK) in fig-3 fitted with 25 kg load cell was used for two-stage liner compression of paneer spread samples. A cone type probe was attached to the moving cross-head. Various textural parameters determined include firmness, stickness, spreadability and adhesiveness. The hardness/ firmness is the maximum peak force (F) during the first compression cycle (first bite) and the unit is Newton. The stickiness is the negative peak force (F) during the second compression cycle (second bite) and the unit is Newton. The spreadability is the area of positive curve (Area 1:2) and the adhesiveness is the area of negative curve (Area 3:4). The unit of spreadability and adhesiveness is Newton/s.

Penetration measurement

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 5 s. For the same sample, reading was recorded at different spots and the average value was recorded as mm/5 s of penetration.

Results and discussion

Fresh paneer spread

The effect of microwave, vacuum treatment and their combination on the rheological characteristics of fresh paneer spread is presented in the Table-1 and 2. The highest firmness value (N) was recorded for the spread P3 (4.891) and lowest was recorded for control (3.213). The increase in the hardness in the treated spread may be due to significant decrease in the moisture content as well as other heat induced changes may brought about in the protein network in the sample. The findings of the study related to control paneer are in accordance the rheological properties of market paneer.

The highest spreadability value N (s) was recorded for the spread P3 (3.729) and lowest was recorded for the control (1.803). Fresh control had significantly lower spreadability (1.803NS^{-1}) than treated P1 (3.726 NS^{-1}), P2 (3.714 NS^{-1}) and P3 (3.729 NS^{-1}). The higher spreadability values of treated spreads may be because of more firmness due to microwave and vacuum treatment (lower the spreadability values higher will be the spreading nature of the product i.e less force is required for spreading less firmer product and vice versa). The control had significantly higher stickiness and adhesiveness than those of treated spreads.

The highest stickiness value (N) was recorded for the control (7.422) and lowest was recorded for the spread P3 (5.661) and the highest adhesiveness value N (s) was recorded for the control spread (0.696) and lowest was for P3 (0.471). There is significant difference between the control and all treated spreads in rheological properties, but there is no significant difference between the rheological values of treated spreads. Texture of paneer is important attribute [7]. Modified atmospheric packaging (MAP) also finds alternative to vacuum packaging in extruded products [8] and refrigerated storage of cheese [9].

Stored at ambient temperature

The effect of microwave, vacuum treatment and their combination on the rheological characteristics of stored paneer spread at 30 ± 1° C are presented in the Table-2

Firmness (N): The highest firmness value was recorded for the treated spread P3 (3.429) and lowest of 2.882 was recorded for the control spread on day 1. There is a significant difference between the firmness values of control and treated spreads P1, P2 and P3. But between the treatments there is no significant difference in the firmness values.

Highest firmness value was recorded on day 2 for P3 (2.923) and lowest of 2.547 was recorded for the control. There is a significant difference between the firmness values of control and treated spread P1 (2.912), P2 (2.908) and P3 (2.923). But between the treatments there is no significant difference in the firmness values.

On day 3, there is a significant difference between the firmness values of control (1.872) and treated spread P1 (1.317), P2 (1.308) and P3 (1.325). But between the treatments there is no significant difference in the firmness values.

Spreadability N(s): The highest spreadability value was recorded for the treated spread P3 (2.337) and lowest of 1.697 was recorded for the control on day 1. There is a significant difference between the spreadability values of control and treated spreads P1, P2 and P3. But among the treatments there is no significant difference in the spreadability values. On day 2, the highest spreadability value was recorded for P3 (2.232) and lowest of 1.514 was recorded for the control. There is a significant difference between the spreadability values of control and treated P1 (2.225), P2 (2.216) and P3 (2.232). But among the treatments there is no significant difference in the spreadability values. Similarly on day 3, there is a significant difference between the spreadability values of control (1.396) and treated P1 (2.107), P2 (2.103) and P3 (2.113). But among the treatments there is no significant difference

Stickiness (N): The highest stickiness value was recorded for the control spread (7.212) and lowest of 5.410 was recorded for the P3 on day 1. There is a significant difference between the spreadability values of control and treated spreads P1, P2 and P3. But within the treated spreads, there is no significant difference in the stickiness values.

Highest Stickiness value was recorded on day 2 for control (6.984) and lowest of 5.171 was recorded for the P3. There is a significant difference between the stickiness values of control and treated spreads P1 (5.174), P2 (5.192) and P3 (5.171). But between the treatments, there is no significant difference in the stickiness values.

Values recorded for on day 3 indicated that, there is a significant difference between the stickiness values of control (6.572) and treated spreads P1 (4.815), P2 (4.623) and P3 (4.809). But between the treatments, there is no significant difference in the stickiness values

Adhesiveness N (S): The highest adhesiveness value was recorded for control (0.651) and lowest of 0.403 was recorded for the P3 on day 1. There is a significant difference between the Stickiness values of control and treated P1 (0.411), P2 (0.416 and P3 (0.403). However, there is no significant difference in the adhesiveness values of treated spreads. Highest adhesiveness value was recorded for the control spread (0.647) and lowest of 0.379 was recorded for P3. There is a significant difference between the adhesiveness values of control and treated spreads P1 (0.384), P2 (0.398) and P3 (0.379). But among the treatments there is no significant difference in the adhesiveness values.

Values for the adhesiveness recorded on day 3 indicated that, there is a significant difference between control (0.561) and treated spreads P1 (0.261), P2 (0.226) and P3 (0.260). But among the treatments, there is no significant difference in the adhesiveness values. Control showed significantly lower firmness (2.882 N), spreadabilty (1.697 NS^{-1}) and higher stickiness (7.212 N), adhesiveness (0.651 NS^{-1}) values than that of treated spread on day 1 at 30±1° C and similar trend was observed on 2 and 3rd day of storage also. The lower firmness, spreadability and higher stickiness and adhesiveness of control spread may be attributed to higher moisture and higher chemical changes than the treated spreads.

Table 1: Effect of microwave, vacuum packaging and their combinations on the rheological characteristics of fresh paneer spread at 30 ± 1° C

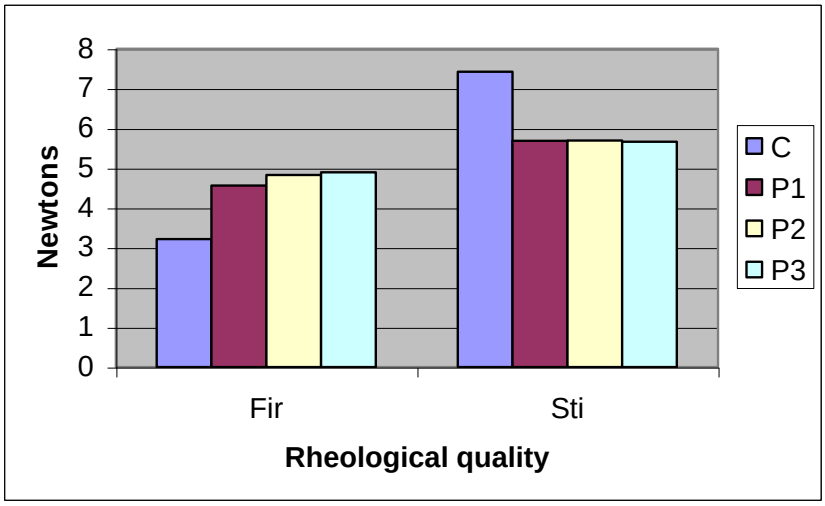
Attributes	Fresh paneer spread			
	Firmness (N)	**Spreadability N (S)**	**Stickiness(N)**	**Adhesiveness N (S)**
Control	3.213[a]	1.803[a]	7.422[a]	0.696[a]
P1	4.862[b]	3.726[b]	5.683[b]	0.475[b]
P2	4.826[b]	3.714[b]	5.694[b]	0.478[b]
P3	4.891[b]	3.729[b]	5.661[b]	0.471[b]
CD $p<0.05$	0.106	0.086	0.076	0.021

P1-Microwave treated
P2-Vacuum treated
P3-Vacuum and microwave treated
Figures with the same superscripts in a column

Table 2: Effect of microwave, vacuum packaging and their combination on the rheological characteristics of stored paneer spread at 30 ± 1º C for different days of storage

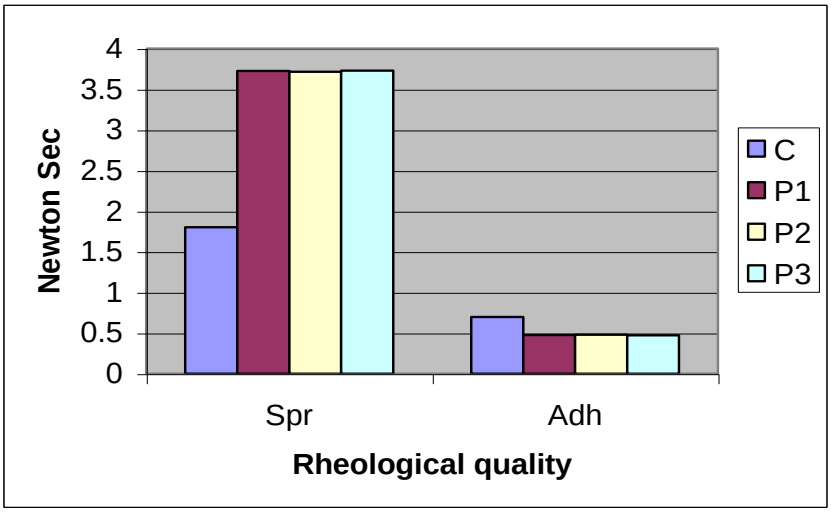
Attributes	a) After 1 day of storage			
	Firmness (N)	**Spreadability N (S)**	**Stickiness (N)**	**Adhesiveness N (S)**
Control	2.882[a]	1.697[a]	7.212[a]	0.651[a]
P1	3.426[b]	2.329[b]	5.426[b]	0.411[b]
P2	3.417[b]	2.323[b]	5.457[b]	0.416[b]
P3	3.429[b]	2.337[b]	5.410[b]	0.403[b]
CD $p<0.05$	0.048	0.061	0.051	0.037
Attributes	**b) After 2 days of storage**			
	Firmness (N)	**Spreadability N (S)**	**Stickiness (N)**	**Adhesiveness N (S)**
Control	2.547[a]	1.514[a]	6.984[a]	0.647[a]
P1	2.912[b]	2.225[b]	5.174[b]	0.384[b]
P2	2.908[b]	2.216[b]	5.192[b]	0.398[b]
P3	2.923[b]	2.232[b]	5.171[b]	0.379[b]
CD $p<0.05$	0.071	0.018	0.082	0.023
Attributes	**c) After 3 days of storage**			
	Firmness (N)	**Spreadability N (S)**	**Stickiness (N)**	**Adhesiveness N (S)**
Control	1.872[a]	1.396[a]	6.572[a]	0.561[a]
P1	1.317[b]	2.107[b]	4.815[b]	0.261[b]
P2	1.208[c]	2.003[c]	4.623[c]	0.226[c]
P3	1.325[b]	2.113[b]	4.809[b]	0.260[b]
CD $p<0.05$	0.051	0.013	0.076	0.047

P1-Microwave treated
P2-Vacuum treated
P3-Vacuum and microwave treated
Figures with the same superscripts in a column indicate no significant difference



Fir- Firmness; Sti- Stickiness
C-Control; P1-Microwave treated; P2-Vacuum treated
P3-Vacuum and microwave treated

Fig 1: Rheological quality of fresh paneer spread



Spr-Spreadability; Adh- Adhesiveness
C-Control; P1-Microwave treated; P2-Vacuum treated

Fig 2: Rheological quality of fresh paneer spread

Fig 3: Texture analyzer

Conclusion

The application of microwave heating or vacuum packaging process are critical factors influencing the rheological properties of the product paneer spread. A significant degree of rheological value variations was evident between the control and treated samples. Spreadability is successfully identified as it requires more pressure to spread indicates it's more stable in its body and texture compare to control. Whereas, firmness, stickiness, adhesiveness found better values than control sample suggests that they more resistant. There is a great scope for the dairy sector to exploit this newly developed paneer based spreads (paneeer psread) as a best alternative for cheese and butter spreads in the market with improved rheological characterstics.

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