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SHORT COMMUNICATION

Effect of vacuum packaging on hardness of *Kradi* cheese stored at different temperatures

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Abstract: This study investigated changes in hardness property of *kradi* cheese stored under vacuum and normal conditions at 25°C, 5°C and -20°C at different intervals. At 25°C storage temperature hardness was affected by atmosphere whereas storage periods did not affect hardness of samples. At 5°C storage temperature both atmospheres as well as storage periods affected the hardness of samples. At -20°C storage temperature, it was observed that both atmosphere as well as storage periods affected the hardness of stored samples. Hardness in normal packed samples decreased more as compared to vacuum packed samples. The vacuum packaging retarded textural changes related to hardness in comparison to normal packaging.

Keywords: *Kradi* cheese; Vacuum storage; Hardness.

The consumption of organic foods is increasing (Akarca, 2020). Artisanal cheese are good sources of nutrients (Herman-Laraet al.. 2019). Demand for artisanal cheeses is growing at national and international level (Cagri-Mehmetoglu, 2018). Kradi cheese is an organic artisanal cheese of Jammu Kashmir manufactured by Gujjar tribes. The sale of *kradi* cheese is increasing annually but no studies has been reported with respect to hardness changes during storage. Studies on *kradi* cheese are very limited and there is no data on the hardness changes which take place during the storage.

The textural degradation of cheese is not desired during storage. Such textural changes induced during storage can alter the quality of product (Foxet al., 2004). Physico chemical, microbiological, microstructural properties, descriptive sensory analysis and chemical changes during storage of *kradi* cheese have been reported (Punoo,et al.. 2018a; Punoo,et al.. 2018b, Punoo,et al.. 2018c, Punoo, H.A, 2020).

As compared to ordinary packaging, vacuum packaging can reduce textural deterioration. The alteration in packaging condition by vacuum packaging can either accelerate or inhibit textural changes during storage of *kradi* cheese. Thus vacuum packaging can be a way of preserving textural quality of *kradi* cheese. The present study was aimed at assessment of hardness quality of textural changes of *kradi* cheese throughout its storage at different periods at refrigeration temperature under vacuum and non vacuum conditions.

It would be immensely interesting, therefore, to know as to how packaging conditions influence the textural properties of *Kradi*. There is no appropriate information available on any of the aspects of this product. The need to undertake the research to study the manufacturing process of *Kradi* on scientific basis with an aim to improve the overall quality of the product in terms of textural properties is immensely felt.

Kradi cheese was made as per the method described (Punooet al.. 2018a). The fresh product was packed in multilayer laminates under vacuum and normal conditions and stored at refrigeration temperature (5±1°C). The products stored were evaluated at one day interval at 25°C, on weekly interval at 5°C and on monthly interval at -20°C to monitor changes in textural properties.

The textural profile of *kradi* cheese was performed using TAXT-2i (Stable Micro System, UK) fitted with a 25 kg load cell. The cubes of *kradi* cheese samples 1x1x1 cm^2 were subjected to mono-axial compression up to 80% of its original height on the textural analyzer. The TPA was carried out at 25°C after tempering the sample for 1 h at this temperature. The textural parameters of hardness was determined according to the method of Bourne (1978).

The data obtained during the present investigation was compared by one-way analysis of variance (ANOVA) with the application of SYSTAT software, version 6.0.1 copyright © 1996, SPSS INC

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and also by Microsoft® Excel StatPro™ (Palaside Corporation, Newfield, NY). Significant difference ($p<0.05$) among treatments were detected using Duncan's multiple range tests.

Texture profile analysis (TPA) reveals the texture of cheeses. The compression of molar teeth during mastication is simulated by Texture profile analysis (TPA). Texture profile analysis (TPA) predicts the texture characteristic of cheese before consumption (Delgadoet al.. 2011). Textural parameters hardness, adhesiveness, cohesiveness, springiness, elasticity, and gumminess are generated by TPA. The force applied by the molar teeth to compress the food is described by hardness. Cheese consumers and manufacturers give importance to textural property of cheese. Consumers perceive texture as one of the indicators of cheese quality. The changes occurred in hardness of *Kradi* cheese samples packed in two types of atmospheres (vacuum and normal) and stored in different temperatures at 25 °C, 5 °C and - 20°C for different periods (Table 1). The hardness of samples exhibited a decreasing trend throughout the entire storage period in all the samples packed in two types of atmospheres (vacuum and normal) and stored at three different temperatures for different periods. It can be observed that initial value of hardness 151.54 N in normal packed samples decreased to 121.52 N on 15th day of storage while in vacuum packed samples it decreased to 132.1N on 20th day of storage at 25°C. This indicates that decrease in hardness was slow under vacuum conditions as compared to normal conditions. The estimation of hardness at 25°C was stopped after 15th day of storage in normal packaging as the samples were not sensorialy accepted while in samples packed under vacuum hardness measurement was continued till 20th day of storage as the samples were sensorialy acceptable. ANOVA (Table 2) revealed that packages had highly significant (pd"0.01) effect whereas storage periods had not significant effect on the hardness of samples stored at 25°C. Patil, G.R and Rao, K.J. (2006) reported decrease in hardness in ready to eat canned paneer cury during storage at 30°C for 90 days. Mohamed, A.G and Shalaby, S.M. (2016) reported decrease in hardness in analogue process cheese stored at 25°C for three months. Punoo,et al.. (2017) reported decrease in hardness in soy paneer prepared from admixtures of skim cow milk and soymilk stored at 25°C for

Table1: Effect of vacuum packaging on hardness characteristic of Kradi cheese stored at 25°C and 5°C

Period of storage (Days)	Temperature of storage (25°C)		Period of storage (weeks)	Temperature of storage (5°C)		Period of storage (months)	Temperature of storage (5°C)	
	Hardness			Hardness			Hardness	
	VP	NP		VP	NP		VP	NP
1	151.54	151.54	1	151.54	151.54	1	151.54	151.54
2	150.31	149.23	2	148.21	145.54	2	146.35	144.52
3	149.21	147.52	3	145.31	139.54	3	142.15	137.40
4	148.11	145.21	4	142.21	132.54	4	138.32	132.52
5	147.25	143.45	5	139.52	128.54	5	134.10	128.20
6	146.11	141.45	6	135.31	123.47	6	127.25	123.21
7	145.21	139.47	7	132.21	119.75			
8	144.36	137.70	8	129.65	115.41			
9	143.63	135.24	9	127.52	111.14			
10	142.58	133.52	10	124.21	107.42			
11	141.65	131.21	11	121.11	105.21			
12	140.25	128.90	12	118.52	103.2			
13	139.62	126.11	13	115.42	98.96			
14	138.52	123.75	14	113.21	97.52			
15	137.52	121.52	15	111.11	-			
16	136.22	-	16	109.61	-			
17	135.41	-						
18	134.11	-						
19	133.51	-						
20	132.11	-						

Table 2: Analysis of variance for hardness characteristic of *Kradi* stored at 25°C, 5°C and - 20°C

Attribute	df (between packaging systems)	Mean sum of squares Packaging system	Time interval	F- Value
Hardness (at 25°C)	1	3461.47	442.05	9.30**
Hardness (at 5°C)	1	1326.12	549.48	98.94**
Hardness (at -20°C)	1	43.33	240.89	17.71**

* * Significant at 1% level of probability

fifteen days. At 5°C of storage temperature, the initial hardness of 151.54 N in air packed samples decreased to 97.52 N after 14th week while in vacuum packed samples it decreased to 109.61N after 16th week of storage. The hardness measurement at 5°C was stopped after 14th week of storage in normal packaging as the samples were not sensorialy accepted while samples packed under vacuum hardness measurement was continued till 16th day of storage as the samples were sensorialy acceptable. ANOVA (Table 2) revealed that effect of packages and storage periods was highly significant (pd"0.01) from the consideration of the hardness of samples stored at 5°C. Mohamed, A.G and shalaby, S.M. (2016) reported decrease in hardness in analogue process cheese stored at 5°C for three months. Dimitreli,Get al.. (2017)) reported decrease in hardness in white soft cheese made from buffalo and cow milk mixtures at 4°C during three month storage. Alamet al.. (2016) reported decrease in hardness of mozzarella cheese at all atmospheres at 7°C throughout entire storage period. Punoo,et al., (2017) reported decrease in hardness in soy paneer prepared from admixtures of skim cow milk and soymilk stored at 5°C for ninety days. Decrease in hardness was reported in vacuum packed ewe's cheese during 90 days storage at 4°C by Caro, A, D.,et al. (2016). Ghisoni, F,et al.. (2022) reported decrease in hardness in taleggio cheese (an Italian cheese) in micro-perforated packaging during 28 days of storage. Mileriene, J,et al.. (2021) reported decrease in hardness in Eastern European curd cheese coated in antimicrobial protein-based (5%, wt/wt) edible coating, during 31 days of storage. Szkolnicka,et al. (2021) found decrease in hardness in quark cheese made from buttermilk during 3-week refrigerated (4°C) storage. At -20°C of storage temperature, the initial hardness of 151.54 N in normal packed samples decreased to 123.21 N after 6 months whereas in vacuum packed samples it decreased to 127.25 N after 6 months of storage. This indicates that decrease in hardness was slow at deep freeze as compared to refrigeration temperature. The results in general are in accordance with the findings of Ghosh (1987), Olson and Johnson (1990) and Lawrenceet al.. (1987), who inferred that values for hardness decreased significantly with time. ANOVA (Table 2) revealed that packages and storage periods had highly significant (pd"0.01) effect on the hardness of samples stored at -20°C. Punoo,et al., (2017) reported decrease in hardness in soy paneer prepared from admixtures of skim cow milk and soymilk stored at -20°C for five months. Decrease in hardness in kradi cheese can be due to increased proteolysis during storage (Punoo, 2020).

Conclusion

The effects of vacuum packaging on *kradi* cheese revealed that decrease in hardness values were retarded as compared to ordinary packaging. Textural quality of product was better maintained at refrigeration temperature of 5°C. Therefore, vacuum packaging could be an alternative to conventional normal storage for fresh *kradi* cheese production by obtaining better hardness score. Therefore, vacuum packaging of *kradi* cheese can maintain the hardness of this traditional regional product and can guarantee the consumers a quality product. Vacuum packaging will therefore offer manufacturers to store the product for longer time with maintained hardness quality.

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