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Research Article

Sensory, Textural and Microbial Changes of Kradi Cheese Stored at Refrigeration Temperature Under Vacuum and Non-Vacuum Conditions

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Abstract

This study investigated changes in sensory, textural and microbial properties of *kradi* cheese stored under vacuum and normal conditions at 5oC at weekly intervals. The flavour and overall acceptability of normal packed samples stored at 5oC were acceptable up to 14 weeks of storage whereas in the case of vacuum packed samples, it was acceptable up to 16 weeks of storage. Hardness in normal packed samples decreased more as compared to vacuum packed samples. Chewiness decreased more in vacuum-packed samples. The vacuum packaging retarded textural changes in comparison to normal packaging. The total viable count was significantly affected by the type of package (vacuum/non-vacuum) whereas storage periods had non-significant effects.

Keywords: *Kradi* Cheese; Vacuum Storage; Overall Acceptability; Hardness; Coliform

Introduction

In the world, the tendency of consumption of healthy foods is growing [1]. Due to changes in consumer's lifestyle habits, the significance of artisanal cheeses is increasing globally [3]. Kradi cheese is an artisanal cheese manufactured by Gujjar tribes in Jammu and Kashmir [18] and is considered a healthy food.

The sale of *kradi* cheese is increasing annually but no studies have been reported concerning textural changes during storage. Studies on *kradi* cheese are very limited and there is no data on the textural 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 the product [22].

The literature about *kradi* cheese throughout the last 100 years reports it as milk bread produced in Kashmir Valley. Physicochemical, microbiological, textural and microstructural, chemical properties of *kradi* cheese have been reported [16,17,23].

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 the storage of *kradi* cheese. Thus, vacuum packaging can preserve the textural quality of *kradi* cheese. Therefore present study was aimed at the assessment of sensory, textural and microbiological changes of *kradi* cheese throughout its storage at different periods at refrigeration temperature under vacuum and non-vacuum conditions.

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

Materials and Methods

Preparation of *Kradi* cheese

Kradi cheese was made as per the method [16] described he 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 weekly intervals to monitor changes in sensory, textural and microbial properties.

Packaging material

The packaging material (5-layer Natural PFP, 20 x 20 cm size) was procured from Hitkari Industries Limited, Parwanoo (Solan) Himachal Pradesh. The specification of the packaging material as claimed by the company used in the study has been given in the table.

Property	Unit	Value
Thickness range of films	Micron	(105-175)
Specific gravity	-	9.065
Oxygen transmission rate (OTR)	cc/m^2/day/at 20^0C at 50%RH	20
Moisture vapour transmission rate (MVTR)	gms/m^2/day/at 20^0C at 50%RH	2.6
Tensile strength (MD)	kg/cm^2	745-870
Tensile strength (TD)	kg/cm^2	585-695
Elongation (MD)	%	225-490
Elongation (TD)	%	210-260
Elmendorf Tear (MD)	gm/mil	2900-2600
Strength (TD)	gm/mil	2400-2400
Heal seal strength	kg/15 mm	2.8

Table a: Specifications for the packaging material.

*Based on 175-micron thick film.

Sensory analysis

Stored *Kradi* cheese samples were evaluated sensorily after a certain interval during storage studies by a trained panel of five judges to determine the period of its acceptability. The scorecard used for judging the product had a numerical score of 9 for like extremely, 8 for like very much, 7 for like moderately, 6 for like slightly, 5 for neither like nor dislike, 4 for dislike slightly, 3 for dislike moderately, 2 dislike very much and 1 dislike extremely.

Texture profile analysis (TPA)

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 1h at this temperature. The textural parameters of hardness and chewiness were determined according to the method of [2].

Microbiological methods

The microbiological quality (total viable count, yeast and moulds count and coliform count) of market samples of *kradi* cheese, were analyzed by following the standard procedures [24] as referred to under following sections. Nutrient agar procured from HI MEDIA Laboratories Pvt. Ltd., Mumbai, was used as the medium to determine the total count of viable bacteria in cheese. The plates were prepared, inoculated and incubated at 37°C for 3 to 4 days. Yeasts and moulds were enumerated on Potato Dextrose Agar (PDA) (Oxoid) following the pour-plate method and incubated at 25°C for 5 - 7 days. The plates were inoculated and incubated at 22°C for 48h. Coliform bacteria were enumerated on violet red bile agar (HI MEDIA Laboratories Pvt. Ltd., Mumbai) after incubation at 37°C for 24 h.

Statistical analysis

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

Results and Discussion

Sensory changes

Any newly developed product must have a fairly extended shelf life, so that the product could withstand the long journey during marketing and stay for a long time in the seller's shelf or in consumers household. Foods in general are quite susceptible to quality loss due to chemical instability depending upon the composition and water activity of the product, processing and packaging techniques used and the environmental conditions to which the product is subjected. The shelf-life of the foods is further limited by physical and chemical reactions taking place during storage. In well packaged foods where protection is afforded against extraneous moisture and microflora, ambient temperature is known to be the principal environmental factor influencing the product shelf-life. The higher the temperature, the faster the product loses quality and the shorter the shelf-life. The high-moisture foods when subjected to thermal processing ensure an extended shelf-life. However, certain physicochemical and biochemical changes are bound to occur during storage. The extent of deterioration is further influenced by the temperature and period of storage. These changes are of much significance because they not only affect various milk constituents but also affect the overall acceptability.

The initial mean score (8.5) for colour and appearance of the surface of *Kradi* store at 5°C decreased to 6.0 for samples packed under non-vacuum conditions after 14 weeks of storage whereas for vacuum packed samples it decreased to 6.0 after 16 weeks of storage (Table 1). A consistent decrease in the appearance score of cheese during storage was reported [10]. The results pertaining to statistical analysis (Table 3) showed that the effect of packages (vacuum and normal) was significant whereas the effect of intervals (storage period) was not significant ($p \leq 0.01$) for *Kradi* samples stored at 5°C. For colour and appearance of the bottom of *Kradi* samples stored at 5°C under normal conditions initial mean score (8.5) for this sensory parameter decreased to 6.0 after 14 weeks of storage whereas for vacuum-packed samples it decreased to 6.0 after 16 weeks of storage. ANOVA (Table 3) revealed that the effect of packages was significant ($p \leq 0.01$) whereas the effect of intervals was not significant from the consideration of colour and appearance of the bottom of samples stored at 5°C. The rapid drop in the score of colour and appearance of the bottom of *Kradi* could be attributed to more loss of moisture at refrigeration as compared to deep freeze temperature. The studies revealed that the initial mean score for flavour (8.5) of normal packed samples stored at 5°C decreased to 6.0 after 14 weeks of storage whereas for vacuum-packed samples it decreased to 6.0 after 16 weeks of storage. The results in general are similar to the findings of Alves [25] who also observed that flavour scores decreased significantly with time. ANOVA (Table 3) revealed that the effect of packages was significant ($p \leq 0.01$) whereas the effect of intervals (storage period) non significant on flavour of samples stored at 5°C. The initial mean score for the body and texture of 8.5 of non-vacuum packed samples stored at 5°C decreased to 6.0 after 14 weeks of storage while as initial mean score for vacuum packed samples decreased to 6.0 after 16 weeks of storage. ANOVA (Table 3) revealed that effect of packages (vacuum and normal) was significant ($p \leq 0.01$) whereas the effect of intervals (storage period) not significant. The overall acceptability of samples packed in vacuum and normal packages exhibited a decreasing trend throught the storage period. The overall acceptability of stored samples depends upon several factors like the degree of textural changes and microbial activity. The initial mean score for the overall acceptability of 7.75 of non-vacuum packed samples stored at 5°C decreased to 6.0 after 14 weeks of storage whereas the initial mean score of vacuum-packed samples decreased to 6.0 after 16 weeks of storage. ANOVA (Table 3) revealed that effect of packages was significant ($p \leq 0.01$) whereas the storage period had non significant effect. Vacuum packaging of artisanal goat cheeses represents the possibility of preserving the cheeses for a longer time and thus increasing their shelf life [5]. From the sensorial point of view, for longer storage times, cheese packaging in plastic film under a vacuum is preferable, while for shorter periods, a non-vacuum paper wrapping system is also a viable option [19].

Period of storage (weeks)	Sensory attribute									
	Colour and appearance of surface		Colour and appearance of bottom		Flavour		Body and Texture		Overall acceptability	
	Treatment given to packages									
	VP	NP	VP	NP	VP	NP	VP	NP	VP	NP
0	8.5	8.5	8.5	8.5	8.5	8.5	8.5	8.5	7.75	7.75
1	8.5	8	8.5	8	8	7.5	8	8	7.75	7.5
2	8	8	8	8	7.5	7	7.5	7.5	7.75	7
3	8	7	8	7	7	7	7.5	7	7.5	7
4	8	7	8	7	7	6.5	7.5	7	7.5	6.5
5	7.5	7	7.5	7	7	6	7.5	6.5	7.5	6.5
6	7.5	6.5	7.5	6.5	7	6	7	6	7	6
7	7.5	6.5	7.5	6.5	7	6	7	6	7	6
8	7	6	7	6	7	6	7	6	7	6
9	7	6	7	6	6.5	6	7	6	7	6
10	7	6	7	6	6.5	6	7	6	7	6
11	7	6	7	6	6.5	6	6.5	6	6.5	6
12	6.5	6	6.5	6	6.5	6	6.5	6	6.5	6
13	6.5	6	6.5	6	6	6	6	6	6	6
14	6	6	6	6	6	6	6	6	6	6
15	6	2	6	2	6	2	6	2	6	2
16	6	2	6	2	6	2	6	2	6	2

Table 1: Effect of vacuum packaging on Sensory characteristics[1] of *kradi* cheese stored at 5 ± 1°c.

[1] Values are mean of three trials.NP=Non-vacuum pack (air), VP=Vacuum pack.

Changes in textural properties

The initial hardness of 151.54 N in normal packed *kradi* samples decreased to 97.52 N after the 14th week while in vacuum packed samples it decreased to 109.61N after the 14th week of storage (Table 2). Hardness increased in both unpackaged cheese and cheese packaged with perforated film stored at 8±1°C for a period of 84 days respectively [14]. The effect of packages was highly significant ($p \leq 0.01$) whereas the effect of storage periods was non-significant from the consideration of the hardness of samples (Table 3). The results in general are in accordance with other findings [9,13] with the inference that values for hardness decreased significantly with time. It has been reported that Serra da Estrela cheeses vacuum-packed in plastic film have significantly lower hardness than non-vacuum paper-wrapped cheeses at 0 months of storage [19].

The initial chewiness of 52.41 N.mm in normal packed *kradi* samples decreased to 17.45 N.mm after 14th week of storage while in vacuum-packed samples it decreased to 17.21 N.mm after the 14th week of storage (Table 2). Table 3 revealed that the type of packages had a highly significant ($p \leq 0.01$) effect on the chewiness of samples stored at 5°C whereas the effect of storage periods was non-significant. The textural analysis was discontinued at 5°C after 14 weeks of storage under normal packaging and after 16 weeks of storage under vacuum packaging, as the samples lost texture.

Period of storage (weeks)	Textural attribute				Microbial attribute					
	Hardness (N)		Chewiness(N.mm)		Yeast and mold (log cfu/g)		Coliform (log cfu/g)		Total viable count (log cfu/g)	
	Treatment given to packages									
	VP	NP	VP	NP	VP	NP	VP	NP	VP	NP
0	151.54	151.54	52.41	52.41	0	0	0	0	0	0
1	151.54	149.44	52.41	45.32	1.6	1.7	1	1	2.07	2.19
2	148.21	144.25	51.12	41.25	2.45	2.55	1.65	1.95	2.51	2.85
3	145.31	137.87	48.48	37.33	2.33	2.95	2.21	2.66	3.11	3.74
4	142.21	131.02	45.74	33.25	2.49	3.47	2.32	2.85	3.15	4.23
5	139.52	126.99	41.42	29.56	2.62	3.75	2.34	2.94	3.39	4.95
6	135.31	121.09	37.41	26.45	2.71	3.94	2.34	3.11	3.41	5.38
7	132.21	117.84	34.15	24.74	3.6	4.47	2.35	3.21	3.75	5.56
8	129.65	113.02	31.12	21.56	3.7	4.92	2.55	3.54	3.95	5.78
9	127.52	109.11	28.45	18.59	3.76	5.21	2.66	3.66	4.11	5.89
10	124.21	105.65	26.41	16.47	3.81	5.45	2.68	3.75	4.28	5.99
11	121.11	103.22	25.11	14.25	3.82	5.58	2.69	3.99	4.38	6.12
12	118.52	99.85	23.98	11.23	3.83	5.69	2.71	4.41	4.56	6.21
13	115.42	95.24	22.21	9.25	3.89	5.79	2.73	4.68	4.74	6.29
14	113.21	93.23	21.12	8.26	3.93	5.97	2.75	4.75	4.89	6.31

Table 2: Effect of vacuum packaging on textural and microbial characteristics[1] of *kradi* cheese storedat 5±1°c.

[1] Values are mean of three trials

NP=Non-vacuum pack (air), VP=Vacuum pack

Changes in microbiological profiles

At 5°C of storage temperature, the initial count for yeast and mould of 1.6 log cfu/g in normal packed samples increased to 3.91 log cfu/g after the 14th week (Table 2) while in vacuum packed samples it increased to 2.11 log cfu/g after 14th week of storage (Table 2). The inhibition of yeasts in vacuum packed Requeijao cheese (whey cheese) than in normal-packed cheese, stored at 4°C has been reported [15]. More increase in yeast and mould count for manchego cheese (Spanish cheese) stored at 4°C under non-vacuum conditions as compared to vacuum conditions has been reported [12]. During that storage of stracchino cheese (Italian cheese) under vacuum conditions stored at 4°C decreased yeast growth and reduced population attained at the end of the exponential phase of growth has been reported [26]. The prevalence for yeasts and moulds increased to 29.1% for yeast (2.88 ± 0.59 log10 cfu/g) and to 22.2% for moulds (2.36 ± 0.37 log10 cfu/g) during refrigerated storage of ricotta cheese has been reported [4]. ANOVA (Table 3) revealed that packages had highly significant ($p \leq 0.01$) effect on

this microbial count of samples stored at 5°C whereas the effect of storage periods was non-significant. Coliform in any dairy product indicate the hygienic conditions maintained during production and packaging. At 5°C of storage temperature, the initial count for coliform of 1 log cfu/g in normal packed samples increased to 3.61 log cfu/g after 14th week of storage (Table 2) while in vacuum packed samples it increased to 1.91 log cfu/g on 14th week of storage. More increase in coliform count for manchego cheese (Spanish cheese) stored at 4°C under non-vacuum conditions as compared to vacuum conditions has been reported [12]. For Serra da Estrela cheeses vacuum-packed in plastic film, high pressure processing caused 1 log cycle reduction at 0 months storage for coliform count has been reported [19]. ANOVA (Table 3) revealed that the type of packages had a highly significant ($p \leq 0.01$) effect on the count of samples stored at 5°C whereas the effect of storage periods was non-significant. At 5°C of storage temperature, the initial count for the total viable count of 2.07 log cfu/g in normal packed samples increased to 5.01 log cfu/g after 14th week of storage (Table 2) while in vacuum packed samples it increased to 4.79 log cfu/g on 14th week of storage. The total bacterial count in mozzarella cheese stored at 4°C increased and was greater than 10^7 cfu/g after one week of storage [27]. For mozzarella cheese stored at -20°C for 24h, the total bacterial count increased by about 2 log unit [28]. The results are in agreement with the experiments of Asperger [27]. More increase in TVC counts for manchego cheese (Spanish cheese) stored at 4°C under non-vacuum conditions as compared to vacuum conditions has been reported [12]. The inhibition of viable counts in vacuum-packed Requeijao cheese (whey cheese) than in normal-packed cheese, stored at 4°C has been reported [15]. ANOVA (Table 3) revealed that packages had a significant effect ($p \leq 0.01$) whereas storage periods had a non-significant effect on the total viable count of samples stored at 5°C.

Attributes	df (between packaging system)	Mean sum of squares		F-value
		Packaging System	Time interval	
Colour and appearance of surface	1	9.52**	1.88**	5.04
Colour and appearance of bottom	1	9.52**	1.88**	5.04
Flavour	1	7.06**	1.58**	4.46
Body and Texture	1	7.52**	1.73**	4.34
Overall Acceptability	1	9.00**	1.45**	6.20
Hardness	1	1282.23**	275.33	4.56
Chewiness	1	766.28**	161.26	4.75
Yeast and mold	1	6.52**	2.10**	4.51
Coliform	1	6.09**	1.64**	5.23
Total viable count	1	12.27**	2.49**	4.91

Table 3: Analysis of variance for Sensory, Textural and microbial characteristics of *kradi* cheese stored at 5 ± 1°C.

** Significant at 1%, * Significant at 5%, ns Non-significant.

Conclusion

On the basis of sensory analysis, it is concluded that the shelf-life of normal packed samples stored at 5°C was found to be 14 weeks whereas vacuum-packed samples had a shelf-life of 16 weeks. The microbiological analysis revealed that the atmosphere affected the coliform and yeast and mould count whereas storage periods affected coliform, yeast and mould and total viable count. The effects of vacuum packaging of *kradi* cheese revealed that the decrease in hardness and chewiness values were retarded as compared to ordinary packaging. The textural quality of the product was better maintained at a refrigeration temperature of 5°C. Therefore vacuum packaging could be an alternative to conventional treatments for fresh *kradi* cheese production by obtaining longer shelf-life through maintenance of sensory score. Therefore vacuum packaging of *kradi* cheese can extend the shelf life of this traditional regional product and can guarantee the consumers a quality product. Vacuum packaging will therefore allow manufacturers to store the product for a longer time with maintained quality.

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