International Journal of Research in Agricultural Sciences
Volume 1, Issue 3, ISSN (Online) : 2348 – 3997)

Evaluation of Efficacy of Lactic Acid as Coagulant in the Preparation of *Kaladhi:* A Hard and Dry Cheese

Bukhari S. A. A., Pathak V., Bhat Z. F., Ahmad S. R.

***Abstract* – Kaladhi was prepared by using lactic acid as a coagulant at three different levels viz. 5%, 7.5% and 10% and assessed in terms of physicochemical, proximate and sensory properties. Fresh buffalo milk standardized to 5.5% fat and 9% SNF was used for the preparation of the product and the Kaladhi prepared traditionally using day old whey as coagulant served as control. pH of the product varied significantly (P<0.05) with highest value for the control samples. Both wet yield (%) as well as dry yield (%) showed a significantly (P<0.05) decreasing trend with increasing level of lactic acid. Titratable acidity (% lactic acid) as well as amount of lactic acid (ml) used for coagulation decreased significantly (P<0.05) with increasing acid level. Moisture percentage decreased significantly (P<0.05) whereas crude protein content showed a non-significant (P>0.05) decreasing trend with increasing lactic acid level. Fat percentage increased significantly (P<0.05) whereas ash content decreased significantly (P<0.05) with increasing level of lactic acid. All the sensory parameters showed a decreasing trend with increasing lactic acid level with highest scores for 5% lactic acid for all the sensory parameters. Based on various physicochemical and sensory parameters, Kaladhi prepared from lactic acid at 5% level proved to be optimum.**

***Keywords* – *Kaladhi*, Lactic Acid, Coagulant, Sensory Analysis, Physicochemical Parameters.**

I. INTRODUCTION

Kaladhi or *Maush-Kraer* is a popular dairy product of Jammu and Kashmir State of India. It is a hard and dry cheese variety which is prepared by directly acidifying the milk with some easily available organic acids as coagulating agents without the use of rennet or starter [4, 5]. The product is prepared either from cow's or buffalo's or sheep's milk or a mixture thereof and has a tremendous market potential and is considered a delicacy throughout the state [9]. It is believed to possess antidiarrhoeal, anticold and antitussive properties [4, 5, 9]. Buttermilk cheeses in Europe, Tibet cheese in Tibet, *Chugga* or *Churpi* in Nepal and native *paneer* are some of the documented products with similarities in characteristics and utilization [4, 5, 9].

Although the product is prepared throughout the state using different organic acids as coagulants, however, no information is available in the literature regarding the use of lactic acid as a coagulant. The use of lactic acid as a coagulant needs to be standardized by optimizing the best level of lactic acid in the preparation of the product. Furthermore, the effect of different levels of lactic acid on the quality characteristics of the product needs to be elucidated as the addition of different acid coagulants in various strengths and proportions result in varying consequences on the product characteristics which is also observed in *paneer* production [2]. Thus, in lieu of all these facts and lack of scientific reports on the same, an attempt was made to study the preparation of *Kaladhi* from buffalo milk using various levels of lactic acid as coagulant with a view to develop this dairy product with most desirable quality characteristics.

II. MATERIALS AND METHODS

Source of milk

Fresh buffalo milk from the local market of Jammu was used in all experiments after suitable standardization as per the Pearson square method. Based on the result of the preliminary trials, the fat percentage of milk was standardized to 5.5% fat with 9% SNF for optimum product characteristics. Thereafter, standardized milk was pasteurized and each batch of *Kaladhi* was prepared from 10 kg of milk.

Acid coagulant

Three different concentrations of lactic acid were used for coagulating the standardized milk for the preparation of *Kaladhi* viz. 5%, 7.5% and 10% with a view to develop this dairy product with most desirable product quality characteristics.

Preparation of Kaladhi

Preliminary trials were conducted for different coagulation temperatures to achieve the desired physicochemical and sensory characteristics of the product. Based on those preliminary trials, fresh buffalo milk standardized to 5.5% fat and 9% SNF with coagulation at 40^{o}C incorporated the desired characteristics. Traditionally the milk is also coagulated at the same temperature to obtain the quality product.

The milk was heated to 40°C, followed by coagulation at this temperature with various levels of lactic acid (5%, 7.5% and 10%) till the attainment of a uniform curd. The curd was immediately drained through muslin cloth without pressing. The curd was then opened, molded into pieces of convenient size and placed in petri plates of uniform size used as moulds. The curd was then taken out of the moulds and allowed to dry at room temperature in bamboo baskets. Regular turning of the product after 5 hr interval was ensured for at least 3 days until sufficient moisture was lost through evaporation. The product was allowed to dry in a clean and moisture free environment abstaining from direct sun drying.

Analytical procedures

pH

The pH of *Kaladhi* was determined as per the method of [8] by using a digital pH meter (Systronics Digital pH Meter 802, Serial No. 603).

Proximate Composition

The moisture, crude protein, fat and ash content of *Kaladhi* were determined by standard methods [1].

Yield

The weight of each *Kaladhi* was recorded and the yield was calculated and expressed as percentage by a formula:

$$\text{Yield percent} = \frac{\text{Weight of } Kaladhi}{\text{Weight of milk}} \times 100$$

Titratable acidity

The method as described by [1] for cheese was followed to determine the titratable acidity in *Kaladhi*.

Sensory Evaluation

The sensory evaluation of the product was carried for attributes, namely appearance, flavour, juiciness, sourness, texture and the overall acceptability by a panel of trained members composed of scientists and research scholars of the division based on a 8-point hedonic scale, wherein 8 denoted "extremely desirable" and 1 denoted "extremely undesirable" [14]. Coded samples for sensory evaluation were prepared by shallow frying of *Kaladhi* in oil and served warm to panelists. Water was provided for oral rinsing between the samples.

Statistical Analysis

The data obtained were subjected to statistical analysis for analysis of variance, critical difference and Duncan's multiple range tests for comparing the means for various parameters in different experiments at a 5% significant level and data were analyzed on a computer using statistical software packages developed by following the procedures of [17].

III. Results and Discussion

The mean values of various physicochemical characteristics of *Kaladhi* are presented in Table-1.

Physicochemical parameters

pH

A significant ($p<0.05$) effect of lactic acid was recorded. The mean value of pH of *Kaladhi* prepared from 5% lactic acid was significantly ($p<0.05$) lower than 7.5% lactic acid, 10% lactic acid and control samples. However, the values for pH were highest for control (5.37). pH of the product ranged from 4.18 to 5.37. Perusal of the data indicates that the pH values don't fall within the range of reported values for similar coagulated milk products. Bhattacharya et al. [3] reported pH values of 5.9 in *paneer* made from buffalo milk having 5% fat which is much higher than the values reported for *Kaladhi*. The probable reason could be an increased concentration of coagulating acid used in the present study which furnished a higher hydrogen-ion concentration in the final product as compared to other similar products. Bukhari et al. [4] also reported a similar effect on the pH of the *Kaladhi* while using various levels of citric acid.

Yield

A significant ($p<0.05$) effect of lactic acid on the wet yield as well as dry yield of the product was observed. The values for wet yield and dry yield ranged from 18.77% to 21.10% and 8.99% to 11.14% respectively. However, the wet yield of *Kaladhi* prepared from 10% lactic acid was significantly lower than all other treatments ($p<0.05$). Pal et al. [10] attained a yield of 17.7% and 19.75% from mixed buffalo and cow milk which was standardized to 3.5% fat and heated to 90°C and 118°C prior to coagulation at 70°C. Singh and Kanawjia [15] reported that buffalo milk resulted in 21.40% yield of *paneer*. The lower wet yield of the product reported in the present study can be attributed to a much lower temperature of coagulation (40°C) which might have lead to incomplete coagulation of milk. Similarly, loss of moisture due to evaporation might be the probable cause for a lower dry yield in comparison to *paneer* which is on the contrary usually kept in water to decrease its temperature. Similar results were also reported by Bukhari et al. [4] who used the various levels of citric acid as a coagulant in the preparation of the *Kaladhi*.

Amount of Coagulant

A significant ($p<0.05$) effect of lactic acid was observed on the coagulation. The amount of coagulant required for 10% lactic acid was significantly ($p<0.05$) lower than all other treatments. The mean values for the amount of coagulant required ranged from 36.61ml to 134.55ml. In general, the amount of coagulant required was lowest for 10% lactic acid followed in order by 7.5% lactic acid, 5% lactic acid and control. Generally, the amount of coagulant required depends on the temperature of coagulation. Sachdeva and Singh [12] has advocated the use of 2.1 g of citric acid per kg of buffalo milk to prepare best quality *paneer* while Chawla et al. [6] have recommended the use of 1.95 g of citric acid per kg of buffalo milk for making *paneer*. However, the present study reports a much higher amount of coagulant used for coagulation which could be attributed to a lower temperature of coagulation (40°C) of *Kaladhi*, which necessitates a higher amount of coagulant to bring about coagulation. Similar observation was also reported by Bukhari et al. [4] who used the various levels of citric acid as a coagulant in the preparation of the *Kaladhi*.

Titratable acidity (T.A)

A significant ($p<0.05$) effect of lactic acid on titratable acidity of the product was observed and the values ranged from 0.386 to 0.485%. Product samples prepared from 5% lactic acid had highest values for titratable acidity as compared to 7.5% and 10% lactic acid and control and followed in order by 5% lactic acid, 7.5% lactic acid, 10% lactic acid and control. The values were comparable with the findings of Bhattacharya et al. [3] who reported T.A values of 0.47 in *paneer* made from buffalo milk having 5% fat. This could be explained by the fact that since T.A is a measure of % lactic acid, the use of lactic acid itself in present study might have resulted in high T.A values of the final product.

Proximate composition

The mean values of various proximate parameters of *Kaladhi* are presented in Table-2. The moisture content of the product ranged from 22.54% to 20.14%. Similar results were reported by Bukhari et al. [4] for *Kaladhi* prepared by using citric acid as a coagulating agent. These values, however, are much lower than those reported for *paneer*. Sachdeva and Singh [13] noted that a good quality *paneer* never retains more than 60% moisture. Indian Standards [7] also permit a moisture content of not more

than 60% in *paneer*. Since in market practice, *paneer* is kept in water whereas *Kaladhi* is regularly turned during storage to allow for maximum evaporative loss of moisture, it can be the most appropriate reason for such a variation.

Protein content in *Kaladhi* ranged from 25.45% to 23.13% which is in agreement with the protein values of *Kaladhi* reported by Bukhari et al. [4] by using citric acid as a coagulating agent. The values, however, are higher as compared to the values of 15.92 and 15.23% reported in *paneer* prepared from citric acid and malic acid respectively [10]. This may be attributed to a reasonably lower moisture content of *Kaladhi* as compared to *paneer*.

Fat content of *Kaladhi* ranged from 54.11% to 50.39% (on dry matter basis) which appear to be much higher than the values reported by [3, 11, 12, 16] for *paneer*. The values, however, were in agreement with the values of *Kaladhi* prepared by Bukhari et al. [4] by using citric acid as a coagulant. A higher fat content of *Kaladhi* may be attributed to a much lower moisture content of the final product.

The ash values for the product were also reported higher than in *paneer*. The values for ash content ranged between 2.44% to 2.12%. The extra minerals furnished by a higher amount of coagulant used in the present study could be a possible reason for increased ash content. Similar results were reported by Bukhari et al. [4] for *Kaladhi* prepared by using citric acid as a coagulant.

Sensory attributes

The Mean ± SE values for various sensory attributes of *Kaladhi* are presented in Table 3.

Appearance

A significant ($p<0.05$) effect of lactic acid on appearance and color of *Kaladhi* was observed. The values for appearance and colour ranged from 7.66 to 6.61. The scores of appearance and colour for control were significantly ($p<0.05$) lower than all other treatments. However, the *Kaladhi* prepared from 5%, 7.5% and 10% lactic acid levels were comparable ($p>0.05$) to each other. Highest scores were reported for *Kaladhi* prepared from 5% lactic acid and in general, control had the lowest scores followed in order by, 10% lactic acid, 7.5% lactic acid and 5% lactic acid. Similar results were reported by Bukhari et al. [4] for *Kaladhi* prepared by using citric acid as a coagulant.

Flavour

A significant ($p<0.05$) effect of lactic acid was observed on the flavour of *Kaladhi*. The values for flavour ranged between 6.71 to 7.66. The scores of flavour for *Kaladhi* prepared from 5% lactic acid, 7.5% lactic acid and 10% lactic acid were comparable. Highest scores were reported for *Kaladhi* prepared from 5% lactic acid and in general, control had the lowest scores followed in order by 10% lactic acid, 7.5% lactic acid and 5% lactic acid. The results are in agreement with the results reported by Bukhari et al. [4] for *Kaladhi* prepared by using citric acid as a coagulant.

Texture

A significant ($p<0.05$) effect of lactic acid on texture of *Kaladhi* was observed. The values for texture ranged from 6.95 to 7.61. There was a non-significant ($p>0.05$) difference between texture scores for *Kaladhi* prepared from control, 7.5% lactic acid and 10% lactic acid levels when compared with each other. Highest scores were reported for *Kaladhi* prepared from 5% lactic acid. In general, control samples had the lowest scores followed in order by, 10% lactic acid, 7.5% lactic acid and 5% lactic acid. Similar scores were reported by Bukhari et al. [4] for texture in case of *Kaladhi*.

Juiciness

A significant ($p<0.05$) effect of lactic acid was observed on the juiciness of *Kaladhi*. The values for juiciness ranged between 7.33 and 7.76. A non-significant ($p>0.05$) difference between the scores of juiciness for *Kaladhi* prepared from 7.5% lactic acid, 10% lactic acid and control was seen. Highest scores were reported for *Kaladhi* prepared from 5% lactic acid and in general, 10% lactic acid had the lowest scores followed in order by, control, 7.5% lactic acid and 5% lactic acid. Similar scores for the juiciness were reported by Bukhari et al. [4] for *Kaladhi.*

Sourness

A significant ($p<0.05$) effect of lactic acid on sourness of *Kaladhi* was observed. The values ranged from 6.52 to 7.71. The scores for control were significantly ($p<0.05$) lower than all other treatments. Highest scores were reported for *Kaladhi* prepared from 5% lactic acid. In general, control had the lowest scores followed in order by, 10% lactic acid and 7.5% lactic acid. Similar sourness scores were reported by Bukhari et al. [4] for *Kaladhi* prepared by using citric acid as a coagulant.

Overall acceptability

A significant ($p<0.05$) effect of lactic acid was observed on the overall acceptability of *Kaladhi*. The values for overall acceptability ranged between 6.85 and 7.80. Highest scores were reported for *Kaladhi* prepared from 5% lactic acid. In general, control had the lowest scores followed in order by, 10% lactic acid and 7.5% lactic acid. Similar results were reported by Bukhari et al. [4] for *Kaladhi* prepared by using citric acid as a coagulant.

IV. CONCLUSION

Processing technology for the preparation of *Kaladhi* using lactic acid as coagulant was standardized. Based on various physicochemical and sensory parameters, *Kaladhi* prepared from 5% lactic acid proved to be optimum.

REFERENCES

[1] AOAC, *Official Methods of Analysis*, 16th Edition, Association of Official Analytical Chemists, Washington DC, USA, 1995.

[2] A. Ara, M. L. Ali, M. S. Islam, and M. N. Islam, 2002. Manufacture of cheese from skim milk with addition of different levels of vegetable oil. *Journal of Biological Science*, 2:734-736.

[3] D. C. Bhattacharya, O. N. Mathur, M. R. Srinivasan, and O. Samlik, 1971. Studies on the methods of production and self life of *paneer*. *Journal of Food Science and Technology*, 8: 117.

[4] S. A. A. Bukhari, V. Pathak, Z. F. Bhat, and S. R. Ahmed, 2011. Evaluation of efficacy of citric acid as coagulant in the preparation of *Kaladhi*-a hard and dry cheese. *Beverage and Food World*, 38: 61-64.

[5] S. A. A. Bukhari, V. Pathak, Z. F. Bhat, and S. R. Ahmed, 2012. Effect of ambient storage on the quality characteristics of *Kaladhi*-an acid coagulated milk product. *American Journal of Food Technology*, 7: 192-203.
[6] A. K. Chawla, S. Singh, and S. K. Kanawjia, 1987. Effect of fat levels, additives and process modifications on composition and quality of *paneer* and whey. *Asian Journal of Dairy Research*, 6: 87-92.
[7] Indian Standards 1983. IS: 10484, *Specifications for Paneer*. Bureau of Indian Standards, New Delhi.
[8] R. B. O'keeffe, P. F. Fox, and C. Daly, 1976. Contribution of rennet and starter proteases to proteolysis in cheddar cheese. *Journal of Dairy Research*, 43: 97.
[9] M. A. Pal, S. A. Wani, A. H. Malik, S. D. Mir, and Ishrat, 2003. Maush Kraer-A hitherto undocumented Traditional Dairy Product of Kashmir. *Beverage and Food World*, 30: 55-56.
[10] M. A. Pal, P. L. Yadav, and M. K. Sanyal, 1991. Physicochemical and sensory characteristics of low-fat *paneer* from high heated milk. *Indian Journal of Dairy Science*, 44: 437-441.
[11] M. N. Rao, B. V. R. Rao, and T. J. Rao, 1984. *Paneer* from buffalo milk. *Indian Journal of Dairy Science*, 37: 50-53.
[12] S. Sachdeva, and S. Singh, 1988. Incorporation of hydrocolloids to improve yield; solid recovery and quality of *paneer*. *Indian Journal of Dairy Science*, 41: 189.
[13] S. Sachdeva, and S. Singh, 1988. Incorporation of hydrocolloids to improve the yield, solids recovery and quality of *paneer*. *Indian Journal of Dairy Science*, 41: 189-193.
[14] D. L. Semen, W. G. Moody, J. D. Fox, and N. Gay, 1987. Influence of hot and cold deboning on the palatability, textural and economic traits of restructured beef steaks. *Journal of Food Science*, 52: 879-882.
[15] S. Singh, and S. K. Kanawjia, 1990. Effect of admixing cow and buffalo milk on composition and sensory characteristics of *paneer*. *Asian Journal of Dairy Research*, 9: 1-4.
[16] S. Singh, and S. K. Kanawjia, 1991. Manufacturing technique for *paneer* from recombined milk using cow skim milk powder and butter oil. *Indian Journal of Dairy Science*, 44: 76-79.
[17] G. W. Snedecor, and W. G. Cochran, 1989. *Statistical methods*, 8th Edition. Iowa State University Press, Ames, Iowa.

AUTHOR'S PROFILE

S. A. A. Bukhari
M.V.Sc., Division of Livestock Products Technology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, R. S. Pura, Jammu, Jammu and Kashmir, India 181102.
E-mail: adilvet@gmail.com

V. Pathak
Professor and Head, Division of Livestock Products Technology, DUVASU, Mathura, U.P., India
Email: pathakvet@gmail.com

Z. F. Bhat
Assistant Professor, Division of Livestock Products Technology, Faculty of Veterinary Sciences and Animal Husbandry, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, R. S. Pura, Jammu, Jammu and Kashmir, India, 181102.
Email: zuhaibbhat@yahoo.co.in

S. R. Ahmad
Ph.D. Scholar, Division of Livestock Products Technology, IVRI, Izatnagar, U.P., India.
Email: rafehvet@yahoomail.com

Table 1: Effect of different levels of lactic acid on physicochemical characteristics of *Kaladhi* (Mean±SE)*

	Lactic acid levels (%)			
Parameters	**Control**	**5%**	**7.5%**	**10%**
pH	5.37^{a}±0.95	4.18^{b}±0.08	4.41^{c}±0.28	4.36^{c}±0.19
Wet yield (%)	19.23^{a}±0.28	21.10^{b}±0.30	19.62^{a}±0.26	18.77^{a}±0.31
Dry Yield (%)	8.99^{a}±0.51	11.14^{b}±0.18	10.51^{c}±0.13	10.35^{c}±0.18
Amount of coagulant (ml)	134.55^{a}±0.56	57.83^{b}±0.30	40.00^{c}±0.14	36.61^{d}±0.18
Titratable acidity (% lactic acid)	0.288^{a}±0.39	0.485^{b}±0.003	0.432^{c}±0.004	0.386^{d}±0.002

*Mean ± SE with different superscripts in a row differs significantly (P<0.05).
n = 6 for each treatment

Table 2: Effect of different levels of lactic acid on proximate composition of *Kaladhi* (Mean ±SE)*

	Lactic acid levels (%)			
Parameters	**Control**	**5%**	**7.5%**	**10%**
Moisture (%)	20.14^{a}±0.42	22.54^{b}±0.50	21.29^{a}±0.35	20.37^{a}±0.28
Protein (%)	23.13^{a}±0.19	25.45^{b}±0.39	25.22^{b}±0.49	24.87^{b}±0.30
Fat (%) (on dry matter basis)	54.11^{a}±0.38	50.39^{b}±0.16	51.65^{c}±0.30	52.28^{c}±0.41
Ash (%)	2.32^{a}±0.22	2.44^{b}±0.26	2.26^{a}±0.22	2.12^{c}±0.10

*Mean ±SE with different superscripts in a row differs significantly (P<0.05).
n = 6 for each treatment

Table 3: Effect of different levels of lactic acid on sensory attributes of *Kaladhi* (Mean ±SE)*

	Lactic acid levels (%)			
Parameters	**Control**	**5%**	**7.5%**	**10%**
Appearance	6.61^{a}±0.16	7.66^{b}±0.10	7.57^{b}±0.11	7.38^{b}±0.12
Flavour	6.71^{a}±0.15	7.66^{b}±0.10	7.38^{b}±0.10	7.28^{b}±0.14
Texture	6.95^{a}±0.16	7.61^{bc}±0.12	7.33^{ac}±0.12	7.19^{ac}±0.13
Juiciness	7.33^{a}±0.15	7.76^{b}±0.95	7.71^{ab}±0.10	7.28^{a}±0.17
Sourness	6.52^{a}±0.14	7.71^{b}±0.10	7.57^{bc}±0.11	7.33^{c}±0.12
Overall acceptability	6.85^{a}±0.14	7.80^{b}±0.08	7.33^{c}±0.10	7.19^{c}±0.13

*Mean ± SE with different superscripts in a row differs significantly ($P<0.05$).
n = 21 for each treatment