American Journal of Food Technology

ISSN 1557-4571

Academic Journals Inc.

www.academicjournals.com

American Journal of Food Technology 7 (4): 192-203, 2012
ISSN 1557-4571 / DOI: 10.3923/ajft.2012.192.203

Effect of Ambient Storage on the Quality Characteristics of Kaladhi: An Acid Coagulated Milk Product

S.A.A. Bukhari, V. Pathak, Z.F. Bhat and S.R. Ahmad
Sher-e-Kashmir, University of Agricultural Sciences and Technology of Jammu, Division of Livestock Products Technology, Faculty of Veterinary Sciences and Animal Husbandry, R.S. Pura, 181-102, India

Corresponding Author: S.A.A. Bukhari, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Division of Livestock Products Technology, Faculty of Veterinary Sciences, R.S. Pura, Jammu and Kashmir, 181-102, India

ABSTRACT

Kaladhi is a hard and dry cheese variety of Jammu and Kashmir which is prepared by directly acidifying the milk with organic acids without the use of rennet and starter. Storage quality of Kaladhi prepared by using different organic acid coagulants at their optimum level viz., 5% acetic acid, 5% citric acid and 5% lactic acid was assessed in terms of physicochemical, proximate, microbiological and sensory properties at ambient temperature (21-25°C) for 28 days. Fresh buffalo milk standardized to 5.5% fat and 9% SNF was used for the preparation of the product using different organic acids as coagulants at 40°C and the Kaladhi prepared traditionally using day old whey as coagulant served as control. The results showed a significant ($p<0.05$) increase in most of the physico-chemical parameters i.e., titratable acidity, free fatty acids (% Oleic acid) and thiobarbituric acid (TBA) value. However, a significant ($p<0.05$) decrease in pH and most of the proximate parameters was observed. Similarly, sensory scores also decreased significantly ($p<0.05$) during the storage period in all the three types of Kaladhi prepared by using different organic acid coagulants. The microbial characters viz. total plate count and yeast and mold count increased significantly ($p<0.05$) throughout the storage period. The yeast and mold counts were observed to increase rather rapidly and incessantly beyond 14 days of storage. Based on various physico-chemical and sensory parameters, Kaladhi prepared from lactic acid at 5% level proved to be optimum with 11.14% yield, 32.54% moisture, 25.45% protein, 50.39% fat (on dry matter basis) and 2.44% ash.

Key words: Kaladhi, acid coagulants, ambient storage, quality attributes

INTRODUCTION

India's market potential and current growth rate of traditional dairy products is unparalleled and all set to boom further under the technology of mass production. This market is the largest in value after liquid milk and is estimated at US $3 billion in India and US $1 billion in North America alone (Aneja, 2002). An estimated 50 to 55% of the milk produced in India is converted into a variety of traditional milk products, using processes such as coagulation (heat and/or acid), desiccation and fermentation (Aneja, 2002).

Dairy products are likely to remain important dietary components because of their nutritional value, flavor and texture. There will continue to be a demand for traditional, high quality dairy products, despite increasing competition from non-dairy based products (Rathore *et al*., 2007). It

is envisaged that development of suitable technological package for the organized production of these products would offer significant value addition and product diversification for Indian dairy industry.

One of the traditional dairy products of the state of Jammu and Kashmir is Kaladhi. It is an acid coagulated dairy product prepared by directly acidifying milk with some easily available organic acids as coagulating agents and working out coagulum into a pat. Small balls made out of the pat are later given a circular shape of varying diameters. The tribal communities in the upper hilly regions and people of the Jammu division of the state of Jammu and Kashmir refer this product as Kaladhi where as it is known as Maush-Kraer in Kashmir division of the state. The product is prepared either from cow's or buffalo's milk or a mixture thereof. The product has a tremendous market potential and is considered a delicacy throughout the state. It is consumed after frying it with some suitable frying medium along with spices and condiments. It is also consumed in the form of culinary dish in combination with vegetables and gravy. Besides being a salubrious food, it is believed to possess antidiarrhoeal, anticold and antitussive properties.

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. The product has immense popularity and public acceptance within the state. It is commonly available at most of the renowned food junctions with great potential of being taken as a commercial venture. Thus, it may become a promising alternative to paneer particularly in areas with inadequate preservation facilities.

The typical acid flavor and preparation procedure differentiate Kaladhi from similar coagulated milk products. Kaladhi, like paneer, does not require the use of rennet or starters during its preparation. It is rather prepared by coagulating milk using various organic acids and has a remarkable shelf life owing to its high ultimate acidity. The most popular coagulant used traditionally for the preparation of Kaladhi is tartaric acid. Other methods of Kaladhi preparation either use citric acid or stored whey to bring about coagulation of either raw or boiled milk. It is mostly prepared as a cottage enterprise with hardly any control over the quality. The technological variations and the quality of milk determining the characteristics of the final product lead to the wide differences in the product yield and quality characteristics. Moreover, the addition of different acid coagulants in varying concentrations results in a non-uniform product quality and yield which is of paramount importance.

The traditional dairy products provide an excellent opportunity for value-added dairy foods and represent an untapped potential for growth in domestic as well as international market. Despite their increasing popularity and potential economic significance, traditional dairy foods are largely produced by small-scale processors employing age-old methods of processing, handling, storage and distribution, which limit the quality and shelf life of the products (Vasavada, 2007).

Traditional Indian dairy products like other traditional foods need attention with regard to technology development. Hence, if traditional foods are proposed to be marketed on commercial scales, it becomes imperative that suitable technologies be developed for their production and packaging. Technology of traditional foods is also relevant to institutional food systems, catering services and cross-continental marketing necessitated by presence of large ethnic groups in foreign countries. While the sensory character continues to linger in the minds of the people, the old technology fast becomes unattractive in the modern manufacturing and marketing context. This is where continued interest in research on the traditional products is generally focused.

Scenario of cheese production in India is quite bright because of the facts that cheese has all the beneficial attributes of an ideal dairy product and the emergence of new global economic

reforms based on globalization and liberalization in the marketing arena that has unfastened the door to the Indian dairy industry to penetrate the international cheese market (Kanawjia, 2007). Technologies have been appropriately standardized for manufacture of various types of cheeses. Cheese and a wide variety at that have evolved to such an extent that most cheese is produced employing modern technology and traditional technologies have largely been replaced by modern manufacturing practices.

The yield, composition and quality characteristics of cheese depend upon various factors like technological variations and the quality of milk (Abd El-Aziz *et al*., 2007; El-Diam and El-Zubeir, 2006). Absence of standard processing methods explains the variations in cheese quality and physicochemical characteristics (Turkoglu *et al*., 2003; Alalade and Adeneye, 2007). The method of manufacture of Kalladhi is traditional, primitive and more or less limited and offers a great scope for development. The efforts are needed to be directed towards modernizing the processing parameters on the scientific lines with respect to the raw material use, processing techniques, end product characteristics, preservation and value addition. In lieu of these facts and lack of scientific reports on the same, an attempt was made to study the shelf life of Kaladhi prepared from buffalo milk using three different organic acid coagulants at their optimum level viz., 5% acetic acid, 5% citric acid and 5% lactic acid with a view to develop this dairy product with most suitable and desirable characteristics.

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 coagulants: Three organic acid coagulants were used for coagulating the standardized milk for the preparation of Kaladhi viz., citric acid, acetic acid and lactic acid at three different concentrations i.e., 5, 7.5 and 10%. Based on the preliminary trials, strengths of the different organic acids used for the preparation of Kaladhi were optimized viz., 5% acetic acid, 5% citric acid and 5% lactic acid for the preparation of the product with a view to develop this dairy product with most desirable product quality characteristics.

Chemicals and media: All the chemicals and media used were of analytical grade and were obtained from standard firms (Qualigens, C.D.H, Hi Media etc.) from the suppliers in the local market of Jammu.

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°C incorporated the desired characteristics. Traditionally the milk is also coagulated at the same temperature to obtain the quality product.

The milk was pasteurized and cooled to 40°C, followed by coagulation at this temperature with optimum levels of different organic acids (5% acetic acid, 5% citric acid and 5% lactic acid) 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 h 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 O'Keeffe *et al.* (1976) by using a digital pH meter (Systronics Digital pH Meter 802, Serial No. 603).

Proximate composition: The moisture, crude protein, ether extract (on dry matter basis) and ash content of Kaladhi were determined by standard methods using hot air oven (Yorco sales Pvt. Ltd. India, Model-YS1-431, S. No. 02B2843), Soxhlet extraction apparatus, Muffle furnace and Kjeldhal assembly, respectively (AOAC, 1995).

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

$$\text{Yield } (\%) = \frac{\text{Weight of Kaladhi}}{\text{Weight of milk}} \times 100$$

Thio Barbituric Acid (TBA) value: Thiobarbituric acid value of Kaladhi, during storage was determined using the method of Witte *et al.* (1970).

Free fatty acids: The method suggested by Koniecko (1979) was followed to measure the free fatty acids in Kaladhi samples.

Titratable acidity: The method as described by AOAC (1995) for cheese was followed to determine the titratable acidity in Kaladhi.

Microbiological profile: Total plate count, yeast and mould count and coliform count in the samples were determined by method described by Marshall (1993) using vertical laminar flow (Thermo Electron Corporation. D-63505 Langenselbold, Robert Boschstr. 1, Germany). Readymade media procured from Hi-Media Laboratories Pvt. Ltd., Mumbai (Code No. M091) from local suppliers were used for the analysis.

Sensory evaluation: The sensory evaluation of the product was carried for attributes, namely appearance, flavour, juiciness, sourness, texture and the overall acceptability of fresh and stored samples 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 (Seman *et al.*, 1987). The panels were trained for four basic tastes, i.e., recognition and threshold test and hedonic tests routinely performed in the division. Panelists were seated in a room free of noise and odours and suitably illuminated. 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 to find the effects between treatments and storage periods 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 Snedecor and Cochran (1989). There were seven sensory judges for each treatments x replication combination.

RESULTS AND DISCUSSION

Physicochemical parameters: The mean values of various physicochemical characteristics of Kaladhi at different storage periods are presented in Table 1.

pH: A significantly ($p<0.05$) decreasing effect of storage on pH values of Kaladhi prepared from various organic acid coagulants was observed. The values of pH for Kaladhi prepared from control at 0 day of storage were significantly ($p<0.05$) different from 14th day as well as 28th day of storage. A similar trend was followed by Kaladhi prepared from 5% acetic acid. However, in both treatments, the values for pH remained relatively stable from 14th day of storage onwards. A significant ($p<0.05$) difference in the values for pH was observed throughout the storage period for Kaladhi prepared from 5% citric acid and 5% lactic acid and in general, highest values for pH were reported on 0 day of storage. Similar findings were reported by Pal and Garg (1989), Kumar and Bector (1991) and Pal *et al.* (1993) in paneer. Alalade and Adeneye (2007) also reported a decreasing effect of storage on pH values of Wara Cheese under frozen storage.

Table 1: Effect of ambient storage (21-25°C) on physicochemical characteristics of *Kaladhi* prepared with different organic acid coagulants

	Storage period (days)		
Treatments	0	14	28
pH			
Control	5.37 ± 0.06^{aA}	5.06 ± 0.06^{bA}	5.07 ± 0.06^{bA}
5% Acetic acid	4.34 ± 0.04^{aB}	4.04 ± 0.04^{bBD}	4.07 ± 0.03^{bB}
5% Citric acid	4.56 ± 0.02^{aC}	4.26 ± 0.02^{bC}	4.07 ± 0.02^{cB}
5% Lactic acid	4.18 ± 0.008^{aD}	4.00 ± 0.00^{bD}	4.09 ± 0.01^{cB}
Titratable acidity (% Lactic acid)			
Control	0.300 ± 0.002^{aA}	0.340 ± 0.002^{bA}	0.360 ± 0.002^{cA}
5% Acetic acid	0.279 ± 0.006^{aB}	0.319 ± 0.006^{bB}	0.339 ± 0.006^{bB}
5% Citric acid	0.284 ± 0.008^{aAB}	0.324 ± 0.008^{bAB}	0.344 ± 0.008^{bAB}
5% Lactic acid	0.491 ± 0.002^{aD}	0.531 ± 0.002^{bD}	0.551 ± 0.002^{cD}
Free fatty acids (% Oleic acid)			
Control	0.1007 ± 0.0008^{aA}	0.105 ± 0.001^{aA}	0.105 ± 0.002^{aA}
5% Acetic acid	0.0943 ± 0.0008^{aA}	0.0987 ± 0.001^{aB}	0.071 ± 0.030^{aA}
5% Citric acid	0.0770 ± 0.003^{aB}	0.081 ± 0.001^{abC}	0.085 ± 0.002^{bA}
5% Lactic acid	0.0573 ± 0.004^{aC}	0.0620 ± 0.002^{aD}	0.065 ± 0.001^{aA}
TBA (mg mal Kg^{-1})			
Control	0.323 ± 0.01^{aA}	0.450 ± 0.011^{bA}	0.900 ± 0.051^{cA}
5% Acetic acid	0.346 ± 0.01^{aA}	0.470 ± 0.015^{bA}	0.990 ± 0.045^{cAB}
5% Citric acid	0.300 ± 0.005^{aAC}	0.396 ± 0.008^{bAC}	0.813 ± 0.032^{cAC}
5% Lactic acid	0.276 ± 0.008^{aBC}	0.373 ± 0.029^{bBC}	0.790 ± 0.017^{cAC}

Mean±SE with different superscripts in a row wise (small alphabet) and column wise (capital alphabet) differ significantly ($p<0.05$), n = 3 for each treatment

The pH values in Kaladhi were lower than paneer probably because the acid used for coagulation in the present study furnished a higher hydrogen-ion concentration in the final product. Further, the amount of acid used for coagulation of milk for Kaladhi preparation is more than that used in paneer preparation because of lower temperature of coagulation (40°C).

Titratable acidity: The values of titratable acidity for Kaladhi prepared from control at 0 day of storage were significantly ($p<0.05$) different from 14th day as well as 28th day of storage. However, titratable acidity values for all other coagulants used showed non-significant ($p>0.05$) difference from 14th day of storage onwards. A significant ($p<0.05$) difference in the values for titratable acidity was also observed throughout the storage period for Kaladhi prepared from 5% lactic acid. Similar findings were reported by Pal and Garg (1989), Kumar and Bector (1991) and Pal *et al.* (1993) in paneer.

Free fatty acids (% Oleic acid): The difference between the values of free fatty acids for Kaladhi prepared from all types of coagulants throughout the storage period were non-significant ($p>0.05$). However, free fatty acid values for Kaladhi prepared from 5% citric acid at 0 day showed significant ($p<0.05$) difference when compared with 28th day of storage. Irrespective of the type of coagulant used, the difference between values of free fatty acids for all coagulants used for product preparation were non-significant ($p>0.05$) at 28th day of storage when compared with each other. Similar trends were reported by Pal and Garg (1989), Kumar and Bector (1991) and Pal *et al.* (1993) in paneer.

Thiobarbituric acid value (mg malonaldehyde/Kg): The difference between the thiobarbituric acid values for Kaladhi prepared from all types of coagulants was significant ($p<0.05$) throughout the storage period. However, thiobarbituric acid values for Kaladhi prepared from all coagulants at 0 day showed significantly ($p<0.05$) lower values when compared with 14th day and 28th day of storage. A non-significant ($p>0.05$) difference was also observed between the individual values of thiobarbituric acid for control and 5% acetic acid throughout the storage period.

These findings could be supported by the fact that the product was exposed to spoilage causing micro-organisms since it was stored at temperatures most suitable for the growth of such invasive microorganisms. Therefore, all the changes during storage reported in the present study were probably due to the growth of spoilage organisms. Similar findings were reported by a number of other workers in paneer as well Pal and Garg (1989), Kumar and Bector (1991) and Pal *et al.* (1993).

Proximate composition: Mean proximate values of Kaladhi at ambient storage are presented in Table 2. A significant ($p<0.05$) decrease in the moisture and ether extract content of the product was observed with an increase in the period of storage, while the crude protein content values dropped rather slowly. However, the ash content of Kaladhi prepared from various organic acids proved to increase non-significantly ($p>0.05$) with increase in the storage period.

Moisture: The difference between the moisture content of Kaladhi prepared from control and 5% acetic acid was significant ($p<0.05$) upto 14th day of storage However, a non-significant ($p>0.05$) difference in the values of protein content for Kaladhi prepared from 5% citric acid and 5% lactic acid was observed throughout the storage period. In general, a non-significant ($p>0.05$) decrease

Table 2: Effect of ambient storage (21-25°C) on proximate composition of Kaladhi prepared with different organic acid coagulants

	Storage period (days)		
Treatments	0	14	28
Moisture (%)			
Control	29.6±0.38^{aA}	27.9±0.38^{bA}	26.7±0.38^{bA}
5% Acetic acid	28.6±0.42^{aA}	26.9±0.42^{bA}	25.7±0.42^{bA}
5% Citric acid	30.0±1.38^{aAB}	28.4±1.38^{aAB}	27.3±1.38^{aAB}
5% Lactic acid	32.0±0.94^{aB}	30.60.94^{aB}±	29.5±0.94^{aB}
Ether extract (%) (on dry matter basis)			
Control	54.6±0.36^{aA}	53.6±0.36^{aA}	52.7±0.36^{abA}
5% Acetic acid	55.3±0.14^{aAB}	54.3±0.14^{bAB}	53.4±0.14^{cAB}
5% Citric acid	52.1±0.20^{aC}	51.1±0.20^{bC}	50.2±0.20^{cC}
5% Lactic acid	50.5±0.24^{aD}	49.6±0.24^{bD}	48.8±0.24^{bcD}
Crnde protein (%)			
Control	23.5±0.15^{aA}	23.1±0.15^{abA}	22.6±0.15^{bA}
5% Acetic acid	25.4±0.31^{aB}	25.0±0.31^{aB}	24.5±0.31^{aB}
5% Citric acid	25.3±0.20^{aB}	24.9±0.20^{abB}	24.4±0.20^{bB}
5% Lactic acid	25.0±0.64^{aB}	24.6±0.64^{aB}	24.2±0.64^{aB}
Ash (%)			
Control	2.4±0.02^{aA}	2.4±0.02^{aA}	2.4±0.02^{aA}
5% Acetic acid	2.6±0.07^{aB}	2.6±0.09^{aB}	2.7±0.10^{aB}
5% Citric acid	2.6±0.03^{aB}	2.6±0.03^{aB}	2.6±0.03^{aB}
5% Lactic acid	2.5±.0.01^{aAB}	2.5±0.01^{aAB}	2.5±0.01^{aAB}

Mean±SE with different superscripts in a row wise (small alphabet) and column wise (capital alphabet) differ significantly ($p<0.05$), n = 3 for each treatment

in the moisture content of Kaladhi prepared from various organic acids was observed from 0 day to 28th day of storage. The decrease in moisture content over the storage period might be due to loss of some amount of moisture by evaporation as the product was exposed to open ambient environment. Similar trends were also reported by Sanyal *et al.* (2006), Rao *et al.* (1984) and Arora and Gupta (1980) in paneer.

Crude protein: The difference between the crude protein content of Kaladhi prepared from all types of coagulants was significant ($p<0.05$) throughout the storage period except for Kaladhi prepared from 5% acetic acid and 5% lactic acid which showed a non-significant ($p>0.05$) change from 0 day to 28th day of storage. However, significantly ($p<0.05$) lower values of protein content for control were observed between treatments of all types of coagulants used to prepare Kaladhi throughout the storage period when compared with each other. The decrease in the protein content during the period of storage can be attributed to high microbial load in the product which might have caused proteolysis to a greater extent. Similar findings were also reported by Sanyal *et al.* (2006), Rao *et al.* (1984) and Arora and Gupta (1980) in paneer. Kilic *et al.* (2004) also reported a similar decrease in protein content of Turkish fresh goat cheese during storage.

Ether extract (on dry matter basis): The difference between the ether extract content of Kaladhi prepared from all types of coagulants was significant ($p<0.05$) throughout the storage period except for control which showed a non-significant ($p>0.05$) difference in the values during

the period of storage from 0 day to 28th day. However, significantly ($p<0.05$) lower values of ether extract for 5% lactic acid were observed between treatments of all types of coagulants used to prepare Kaladhi throughout the storage period. Decrease in the ether extract values of the product stored at ambient temperature might be a result of depletion of fat globules during storage. Similar findings were also reported by Sanyal *et al.* (2006), Rao *et al.* (1984) and Arora and Gupta (1980) in paneer.

Ash: The difference between the ash content of Kaladhi prepared from all types of coagulants was non-significant ($p>0.05$) throughout the storage period. However, significantly ($p<0.05$) lower values of ash content for control were observed between treatments of all types of coagulants used to prepare Kaladhi throughout the storage period when compared with each other. Similar trends were reported by Sanyal *et al.* (2006), Rao *et al.* (1984), Arora and Gupta (1980) in paneer.

Microbiological characters: The mean values of various microbiological characteristics of Kaladhi are presented in Table 3. In general, total plate count, coliform count and yeast and mold count, all were found to increase significantly during the storage period.

Total plate count (log cfu g^{-1}) A significant ($p<0.05$) effect of storage was observed on total plate count of Kaladhi prepared from various organic acid coagulants. The total plate count was also found significantly ($p<0.01$) different between various types of coagulants used for product preparation. Irrespective of the days of storage, Kaladhi prepared from 5% lactic acid had significantly ($p<0.05$) lower counts than that of all other coagulants used for product preparation. It was seen that both in case of control as well as Kaladhi prepared from various organic acids, the counts continued to increase with the increase in storage period. Regardless of the treatment, 28th day counts were significantly ($p<0.05$) higher than 0th day counts, which in turn were significantly ($p<0.05$) lower than 14th day counts for Kaladhi prepared from 5% acetic acid.

The increase in total plate count in the present study might be a result of growth of micro-organisms at ambient temperature and the subsequent decrease in pH values during the storage period which might have aided in providing an optimum growth environment. Similar findings have been reported by Sachdeva *et al.* (1985), Sanyal *et al.* (2006), Kumar and Bector (1991) and Pal *et al.* (1993) in paneer.

Table 3: Effect of ambient storage (21-25°C) on microbial characteristics of Kaladhi prepared with different organic acid coagulants

	Storage period (days)		
Treatments	0	14	28
Total plate count (log cfu g^{-1})			
Control	2.16 ± 0.30^{aA}	3.00 ± 0.25^{bA}	3.66 ± 0.49^{cA}
5% Acetic acid	0.83 ± 0.16^{aBC}	1.83 ± 0.30^{bB}	2.83 ± 0.30^{cAB}
5% Citric acid	1.50 ± 0.34^{aAB}	1.83 ± 0.16^{bB}	2.83 ± 0.30^{cAB}
5% Lactic acid	0.33 ± 0.21^{aC}	0.83 ± 0.40^{bC}	1.83 ± 0.40^{cC}
Yeast and mold count (log cfu g^{-1})			
Control	0.83 ± 0.30^{a}	1.00 ± 0.36^{bA}	1.00 ± 0.25^{cA}
5% Acetic acid	1.50 ± 0.34^{a}	2.16 ± 0.40^{bAB}	3.00 ± 0.25^{cB}
5% Citric acid	1.00 ± 0.36^{a}	1.50 ± 0.34^{bAB}	2.50 ± 0.42^{cB}
5% Lactic acid	1.83 ± 0.56^{a}	2.50 ± 0.56^{bB}	3.33 ± 0.33^{cB}

Mean±SE with different superscripts in a row wise (small alphabet) and column wise (capital alphabet) differ significantly ($p<0.05$), n = 6 for each treatment

Yeast and mold count (log cfu g^{-1}): A significant ($p<0.05$) effect of storage on yeast and mold count of Kaladhi prepared from various organic acid coagulants was observed. A highly significant ($p<0.01$) effect of treatments (types of coagulants used for product preparation) was also found. The yeast and mold counts were reported maximum in Kaladhi prepared from 5% lactic acid owing to its low pH and high moisture content. Both control as well as the Kaladhi prepared from various organic acids showed a continuous increase in counts with the increase in storage period. Counts at 28th day were significantly ($p<0.05$) higher than 0th day counts for Kaladhi prepared from 5% citric acid and 5% lactic acid, which in turn were significantly ($p<0.05$) lower than 14th day counts for Kaladhi prepared from the same coagulants. Regardless of the storage period, a non-significant ($p>0.05$) effect was observed as far as yeast and mold counts is concerned for Kaladhi prepared from control and 5% lactic acid.

The subsequent decrease in pH values during the storage period might have aided in providing an optimum growth environment for yeast and mold. Thus, optimum pH and moisture content might be the cause of increased yeast and mold count in the product during the storage period. Similar trends have been reported by Sachdeva *et al.* (1985), Sanyal *et al.* (2006), Kumar and Bector (1991) and Pal *et al.* (1993) in paneer. El-Diam and El-Zubeir (2006) also reported a significant ($p<0.05$) increase in yeast and mold counts of processed Sudanese white cheese during storage.

Sensory parameters: Mean sensory scores of Kaladhi during storage at ambient temperature are presented in Table 4. All the sensory parameters namely appearance, flavour, juiciness, texture, sourness and overall acceptability of the Kaladhi showed significant ($p<0.05$) decline during the storage period. These changes are sequel to factors such as the loss of moisture, change in color, change in functional properties of proteins and fats and an increase in microbial count of the product during the storage period.

The mean scores of Kaladhi for appearance at 0 day of storage were significantly ($p<0.05$) higher than 14th and 28th day of storage. However, the scores of Kaladhi prepared from 5% acetic acid and control were comparable from 14th day onwards. Kaladhi prepared 5% lactic acid showed a significantly ($p<0.05$) higher scores for appearance than the Kaladhi prepared from 5% citric acid throughout the period of storage. Similar results were reported by Arora and Gupta (1980) and Sanyal *et al.* (2006) in paneer.

The mean flavor scores of Kaladhi prepared from 5% acetic acid and 5% lactic acid showed a significant ($p<0.05$) decrease throughout the storage period whereas control and 5% citric acid showed comparable ($p>0.05$) scores upto 14th day of storage. However, significantly ($p<0.05$) lower flavor scores at 28th day of storage was observed for Kaladhi prepared from 5% acetic acid and 5% lactic acid. Arora and Gupta (1980) and Sanyal *et al.* (2006) also reported similar decrease in flavour scores with storage in paneer. Foda *et al.* (2008) also observed a decreasing trend in flavor scores with storage in white herby cheese.

A significantly ($p<0.05$) decreasing trend of the texture scores of Kaladhi prepared from 5% acetic acid and 5% lactic acid was observed throughout the storage period. However, control showed comparable ($p>0.05$) texture scores upto 14tth day of storage whereas texture scores for 5% citric acid were stable from 14th day of storage onwards. In general, significantly ($p<0.05$) lower texture scores were observed for Kaladhi prepared from all types of coagulants at 28th day of storage. Similar trend for texture scores were reported by Arora and Gupta (1980) and Sanyal *et al.* (2006) during storage studies of paneer. Foda *et al.* (2008) also observed a decreasing trend in texture scores with storage in white herby cheese.

Table 4: Effect of ambient storage (21-25°C) on sensory attributes of Kaladhi prepared with different organic acid coagulants

	Storage period (days)		
Treatments	0	14	28
Appearance			
Control	6.6 ± 0.16^{aA}	6.2 ± 0.15^{abA}	6.0 ± 0.16^{bA}
5% Acetic acid	7.3 ± 0.18^{aBC}	6.6 ± 0.18^{bA}	6.2 ± 0.18^{bA}
5% Citric acid	7.0 ± 0.16^{aAC}	6.5 ± 0.11^{bA}	6.0 ± 0.13^{cAB}
5% Lactic acid	7.7 ± 0.10^{aB}	7.1 ± 0.13^{bB}	6.5 ± 0.17^{cAC}
Flavor			
Control	6.6 ± 0.14^{aA}	6.3 ± 0.18^{aA}	5.7 ± 0.14^{bA}
5% Acetic acid	7.4 ± 0.10^{aB}	6.9 ± 0.13^{bBC}	6.2 ± 0.13^{cB}
5% Citric acid	6.9 ± 0.13^{aA}	6.4 ± 0.21^{abAC}	6.2 ± 0.19^{bB}
5% Lactic acid	7.7 ± 0.10^{aB}	6.9 ± 0.11^{bC}	6.4 ± 0.11^{cB}
Texture			
Control	6.8 ± 0.17^{aA}	6.6 ± 0.14^{aA}	6.0 ± 0.14^{bA}
5% Acetic acid	7.4 ± 0.14^{aB}	6.8 ± 0.14^{bAC}	6.4 ± 0.13^{cB}
5% Citric acid	6.2 ± 0.08^{aC}	5.8 ± 0.11^{bB}	5.6 ± 0.11^{bC}
5% Lactic acid	7.6 ± 0.12^{aB}	7.1 ± 0.11^{bC}	6.7 ± 0.10^{cB}
Juiciness			
Control	7.2 ± 0.16^{aA}	6.6 ± 0.13^{bA}	6.1 ± 0.15^{bA}
5% Acetic acid	7.5 ± 0.14^{aA}	7.0 ± 0.13^{bB}	6.6 ± 0.11^{cB}
5% Citric acid	6.8 ± 0.15^{aB}	6.4 ± 0.14^{abA}	6.0 ± 0.16^{bA}
5% Lactic acid	7.8 ± 0.09^{aAC}	7.3 ± 0.12^{bB}	6.6 ± 0.10^{cB}
Sourness			
Control	6.5 ± 0.14^{aA}	6.2 ± 0.13^{abA}	6.0 ± 0.12^{bAB}
5% Acetic acid	6.8 ± 0.16^{aA}	6.4 ± 0.11^{abA}	6.4 ± 0.12^{bA}
5% Citric acid	6.7 ± 0.15^{aA}	6.2 ± 0.15^{bA}	5.7 ± 0.14^{cB}
5% Lactic acid	7.7 ± 0.10^{aB}	7.2 ± 0.08^{bB}	6.3 ± 0.15^{cA}
Overall acceptability			
Control	6.8 ± 0.13^{aA}	6.4 ± 0.12^{abA}	6.0 ± 0.14^{bA}
5% Acetic acid	7.4 ± 0.11^{aB}	6.8 ± 0.13^{bB}	6.4 ± 0.10^{cAC}
5% Citric acid	6.3 ± 0.10^{aC}	5.9 ± 0.13^{bA}	5.8 ± 0.15^{bAB}
5% Lactic acid	7.8 ± 0.08^{aD}	7.0 ± 0.10^{bC}	6.6 ± 0.14^{cC}

Mean±SE with different superscripts in a row wise (small alphabet) and column wise (capital alphabets) differ significantly ($p<0.05$), n = 21 for each treatment

The juiciness scores of Kaladhi prepared from 5% acetic acid and 5% lactic acid decreased significantly ($p<0.05$) throughout the storage period except for 5% citric acid which showed comparable scores upto 14th day of storage. Juiciness scores for control showed a non-significant ($p>0.05$) decrease from 14th day of storage onwards. Irrespective of the type of coagulant used for preparing Kaladhi, significantly ($p<0.05$) lower juiciness scores at 28th day of storage were observed. Arora and Gupta (1980) and Sanyal *et al.* (2006) also observed similar decrease in juiciness scores of paneer during storage.

The sourness scores of Kaladhi prepared from 5% citric acid and 5% lactic acid decreased significantly ($p<0.05$) throughout the storage period. However, sourness scores for control and 5% acetic acid at 0 day of storage were comparable to scores on 14th day which were comparable to the scores of sourness on 28th day of storage. Scores for Kaladhi prepared from 5% lactic acid were significantly ($p<0.05$) higher among all treatments throughout the period of storage. In general,

sourness scores for Kaladhi prepared from 5% acetic acid and 5% lactic acid were significantly ($p<0.05$) lower at 28th day of storage. However, the sourness scores remained relatively stable from 14th day of storage onwards in Kaladhi prepared from control and 5% citric acid. Similar trend was reported by Arora and Gupta (1980) and Sanyal *et al.* (2006) during storage studies of paneer.

The overall acceptability scores of Kaladhi prepared from 5% acetic acid and 5% lactic acid showed significant ($p<0.05$) decline throughout the storage period. In general, overall acceptability scores for Kaladhi prepared from 5% acetic acid and 5% lactic acid were significantly ($p<0.05$) lower at 28th day of storage. However, the scores for overall acceptability remained relatively stable from 14th day of storage for Kaladhi prepared from control and 5% citric acid. Relatively lower overall acceptability scores for Kaladhi prepared from 5% citric acid were due to lower scores for other sensory attributes. However, overall acceptability scores for control and 5% lactic acid at 0 day of storage were significantly ($p<0.05$) lower from 14th day and 28th day of storage. Overall acceptability scores for Kaladhi prepared from 5% lactic acid were significantly ($p<0.05$) higher among all treatments throughout the period of storage. Thus, on the basis of analysis of different physicochemical and sensory parameters, lactic acid at 5% level proved to be optimum in the preparation of Kaladhi.

CONCLUSIONS

Processing technology for the preparation of Kaladhi was standardized. The Kaladhi prepared from various organic acids got acceptable scores for various physicochemical properties and sensory scores. On the basis of analysis of different physicochemical and sensory parameters, lactic acid at 5% level proved to be optimum in the preparation of Kaladhi from buffalo milk at 40°C because it imparted the maximum desired characteristics in the product. The microbial profile of the product namely total plate count and yeast and mold count, all were in the acceptable limits for at least 14 days of ambient temperature. The sensory scores for Kaladhi were most acceptable upto 14 days of ambient storage.

REFERENCES

AOAC, 1995. Official Methods of Analysis. 16th Edn., Association of Official Analytical Chemists, Washington, DC., USA.

Abd El-Aziz, M., A.M. Kholif and A.F. Sayed, 2007. Evaluation of domiati cheese quality during storage as affected by live selenized yeast supplementation to rations of lactating buffaloes. Int. J. Dairy Sci., 2: 152-158.

Alalade, O.A. and J.A. Adeneye, 2007. The effect of short-term frozen storage on the chemical composition and Coliform Microflora of Wara Cheese Wara Cheese under frozen storage. Am. J. Food Technol., 2: 44-47.

Aneja, R.P., B.N. Mathur, R.C. Chandan and A.K. Banerjee, 2002. Technology of Indian Milk Products. Dairy India Publication, Delhi, India, ISBN-10: 81-901603-0-3.

Arora, V.K. and S.K. Gupta, 1980. Effect of low temperature storage on paneer. Indian J. Dairy Sci., 33: 374-380.

El-Diam, M.S.A.N. and I.E.M. El-Zubeir, 2006. Comparison of microbiological quality of processed and Non processed Sudanese white cheese. Res. J. Microbiol., 1: 273-279.

Foda, M.I., F.L. Seleet and A.H. El-Ghorab, 2008. Sensory evaluation and related volatile components of white herby cheese. Int. J. Dairy. Sci., 3: 160-169.

Kanawjia, S.K., 2007. Cheeses from buffalo milk. Proceedings of the Souvenir International Conference on Traditional Dairy Products, April 27-29, 2007, Bangalore, pp: 14-17.

Kilic, S., H. Uysal., G. Kavas., N. Akbulut and H. Kesenka, 2004. Manufacture and some properties of Turkish fresh goat cheese. Pak. J. Biol. Sci., 7: 1037-1039.

Koniecko, E.S., 1979. Handbook for Meat Chemists. Avery Pub. Group Inc., Wayne, New Jersey, USA., pp: 68-69.

Kumar, P. and B.S. Bector, 1991. Enhancement of shelf-life of paneer with food additives. Indian J. Dairy Sci., 44: 577-584.

Marshall, R.T., 1993. Standard Methods for the Examination of Dairy Products. 16th Edn., American Public Health Association, Washington, DC. USA., ISBN-13: 9780875532103, pp: 550.

O'Keeffe, R.B., P.F. Fox and C. Daly, 1976. Contribution of rennet and starter proteases to proteolysis in Cheddar cheese. J. Dairy Res., 43: 97-107.

Pal, D. and F.C. Garg, 1989. Utilization of sour buttermilk in the manufacture of paneer. Indian J. Dairy Sci., 42: 589-594.

Pal, M.A., P.L. Yadav and M.K. Sanyal, 1993. Effect of paraffining on the physico-chemical, microbiological and sensory characteristics of low fat paneer at low temperature storage. Indian J. Dairy Sci., 46: 519-524.

Rao, M.N., B.V.R. Rao and T.J. Rao, 1984. Paneer from buffalo milk. Indian J. Dairy Sci., 37: 50-53.

Rathore, R., S. Middha and V. Dunkwal, 2007. Microbial safety while handling milk products. Proceedings of the Souvenir, International Conference on Traditional Dairy Products November 14-17, 2007, NDRI, Karnal, India, pp: 90-95.

Sachdeva, S., S. Singh and S.K. Kanawjia, 1985. Recent development in paneer technology. Indian Dairyman., 37: 501-505.

Sanyal, M.K., P.L. Yadav, S.K. Gangopadhyay and S.C. Paul, 2006. Effect of coagulation temperature of buffalo milk added with sodium chloride on the quality of reduced fat paneer. Beverage Food World, 33: 45-48.

Seman, D.L., 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. J. Food Sci., 52: 879-882.

Snedecor, G.W. and W.G. Cochan, 1989. Statistical Methods. 8th Edn., Iowa State University Press, Ames, IA., Pages: 503.

Turkoglu, H., Z.G. Ceylan and K.S. Dayisoylu, 2003. The microbiology and chemical quality of orgu cheese produced in Turkey. Pak. J. Nutr., 2: 92-94.

Vasavada, P.C., 2007. Assuring safety and quality of milk and dairy foods. Proceedings of the Souvenir, International Conference on Traditional Dairy Products, November 14-17, 2007, NDRI, Karnal India, pp: 66-76.

Witte, V.C., G.F. Krause and M.E. Bailey, 1970. A new extraction method for determining 2-thiobarbituric acid value of pork and beef during storage. J. Food Sci., 35: 582-585.