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Study on Process Standardization of Paneer from Buffalo Milk of Bihar Origin

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ABSTRACT

Buffalo milk of 4.5 and 6.0% fat were used in study. The other parameters were preheating at 82 and 90°C for 5 minutes, pressing at 1 kg/cm^2 for ½ and 1 hr. The medium for cooling of paneer cubes was chilled water of plain, pasteurized and 1% of NaCl solution. The moisture content of paneer decreased with decreasing preheating and fat content. The protein was also decreased to 15% from 22.1% with increasing preheating. Lowest SPC counts of 90 cfu/ml were observed in control sample with cooling in 1% salt solution in 1:10 dilution. Coliform count in control with cooling in pasteurized water and also for sample cooled in 1% salt solution was found to be nil in 1:10 as well as 1:100 dilutions. It was recommended to use buffalo milk of 6.0% fat, preheating at 82°C for 5 minutes, coagulation temperature 70°C, pressing at 1 kgf/cm^2 for ½ hour and cooling in 1% NaCl solution.

Keywords: Process standardization, Paneer, Preheating temperature, Coagulation temperature, and microbiological study

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INTRODUCTION

India's milk output grew to 210 million tonnes in 2020-21 according to provisional estimates presented in the Lok Sabha as updated on 9th February, 2022 (Dwivedi, 2022). To meet the needs of a growing and rapidly urbanizing Indian population, a commensurate increase in milk production is required to keep pace with demand. AGMARKNET on 1st January, 2022 has projected milk production to increase to 208 million tonnes (MT) in FY21 from 198 MT in FY20 and 187.7 MT in FY19.With the increase in milk production, the per capita availability in India is projected to rise to 428 gm per day in FY21 (FY20: 411 gm per day) from 394 g/day in 2018-19 in India.

There exists a great potential of entrepreneurship development in dairying including indigenous dairy products for rural youths and dairy farmers. Looking into the status of Bihar in regard of profession in dairying, Bihar has secured ninth position with annual production of 9.818 MMT and per capita availability of milk as 251 g/day in the year 2018-19 (NDDB, 2022). Therefore, milk products like indigenous dairy products including paneer (*i.e.,* Cottage cheese) also plays a great role in the development of Indian economy. Paneer is generally used to replenish the proteins in vegetarian dishes in place of non- vegetarian proteins. Therefore, one area of growth of Indian economy is export of paneer and other Indigenous dairy products to the ethnic populations settled in North America, Middle East and South East Asia but the main problem is low shelf life of paneer. Even in frozen condition, its shelf life is reported as 21 days and in vacuum packaging condition, it is 30 days.

In traditional process of paneer making, the bactericidal advantage of heating the milk before coagulation is lost upon subsequent manual handling of the coagulum and treatment with water for cooling, thus limiting the shelf life depending upon the microflora developed before packaging. According to the survey conducted by Rajorhia *et. al.* (1984), the market samples of paneer obtained from Karnal city had total bacterial count of 7614 x10^5, Coliform count of 60805 x10^2 and yeast and mould count of 7918 cfu/g. However, these data for market samples from Delhi were 2021 x10^5, 250637 x 10^2 and 30,100 cfu/g. Storage at ambient temperature for two to three weeks causes the total count increase rapidly to tens of millions cfu/g, the pH of paneer drops from 5.5 to 4.5 with concomitant separation of visible free moisture in pouches. Shelf-life extension for a longer period and mechanization of paneer production process would make its marketing possible at distant places as well as for export. However, at ambient temperature, its shelf life is only 3 to 4 days due to high moisture content and thereby high-water activity. Transportation, distribution and storage of paneer under frozen condition are a difficult task and uneconomical affairs. The sterilization of paneer in normal condition produces paneer of hard body and texture and causes discolouration also. Therefore, a project was envisaged to standardize the manufacturing process of paneer which will facilitate the transportation and distribution without freezing and enhance the shelf life of paneer from buffalo milk of Bihar origin. The needs of cold chain for distribution to consumers can not be omitted even after optimizing the hygienic parameters of processing.

MATERIALS AND METHODS

Method of manufacturing the Paneer

The technology of manufacturing paneer from buffalo milk was used of the method of Sachdeva and Singh, 1988. The paneer samples prepared from buffalo milk (6.0% fat and 9.0% SNF) collected from cattle farm, BASU, Patna are referred as

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treatment–I and the Paneer prepared from buffalo milk with chilling of paneer cubes in 1% NaCl solution of chilled distilled water referred as treatment–II. When standard milk (4.5% fat and 8.5% SNF) was heat treated to 82°C for 5 minutes followed by cooling to 70°C and coagulated at 70°C by 2% citric acid solution and cooled with plain chilled water is termed as treatment–III and market sample of paneer is termed as Treatment –IV. The paneer prepared by Treatment-I was said to be control sample.

Physico-Chemical analysis of Paneer

The moisture content in samples was estimated by the gravimetric method (AOAC, 2005). Acidity was determined by the method described by IS-10484 (1983). Fat content was measured by the Gerber method using Cheese butyrometer (AOAC, 2005). Protein of paneer was determined by Kjeldahl method AOAC (2005). The ash content of paneer was estimated by the method of IS-10484 (1983). The lactose content of paneer was estimated by the difference of sum total of the major constituents like moisture content, protein, fat and ash from 100 as described by AOAC (2005).

Microbiological Analysis of Product

SPC, Coliform count and Yeast and moulds count were done by adopting the standard method of AOAC (2015) using 1:10, 1:100 and 1:1000 dilutions as required.

Statistical Analysis

Data were analyzed using the software Statistical Package for Social Sciences (SPSS) at the 0.05 and 0.01 level of significance following the procedure of Snedecor and Cochran (1994). Data were subjected to one way analysis of variance and Duncan's Multiple Range Test (DMRT) for comparing means of treatments to find the effects between treatments.

RESULTS AND DISCUSSION

Chemical Characteristics of Paneer

The chemical characteristics of different treatment of Paneer (I. II. III and IV) are presented in the following Table 1.

Yield

When standard milk (4.5% fat and 8.5% SNF) was heat treated to 82°C for 5 minutes followed by cooling to 70°C and coagulated at 70°C by 2% citric acid solution, the yield of paneer was 160 g per litre of milk. However, when buffalo milk (6.0% Fat and 9.06% SNF) was heat treated to 90°C for 5 minutes and coagulated with 2 % citric acid at 70±1°C, the yield of paneer was 186 g per litre of milk. The paneer prepared from buffalo milk but cooled in 1 % salted distilled water solution had a yield slightly higher value i.e., 191 g/litre of buffalo milk. However, it has been reported by Singh, (2013) that paneer yield with lemon juice coagulant was 170 g per litre of cow milk (Fat 4.0 % and SNF level 8.5 %). It can be inferred that the yield of paneer had increasing effect with the increase of fat content and total solid (TS) content in milk. The yield was slightly increased by cooling in salted solution.

Moisture content and Acidity

The moisture content in control sample was 53.48±0.48% and the moisture content after chilling the control sample in 1% salt (NaCl) solution of distilled water was 53.47±0.62 %, which was slightly lower than the control sample and it resulted in high preserving quality due to low moisture and reduced water activity. The moisture content of paneer with 4.5% fat standard milk was 52.80±0.61 % and that of market sample was 52.25±1.07%. It was observed that the moisture content decreased with decrease in fat content and preheating temperature. As per FSSAI standards, the moisture content shall not be more than 70 % and the average moisture content of paneer as reported by Kanawjia and Singh, 2016 were 53-55%. The moisture contents in treatment-I and II were similar to reported values and within the FSSAI standard (Anonymous 2015). Therefore, buffalo milk with treatment-I and II are suitable parameters. The average acidity of treatment-I and II is 0.36±0.01% lactic acid and 0.39 ± 0.05% lactic acid but the acidity of treatment-III and treatment-IV i.e., paneer from standard milk with low preheating temperature are 0.57±0.05% lactic acid and 0.60±0.05% lactic acid respectively. The acidity is comparatively lower in Treatment I and II due to high preheating temperature and good manufacturing practices.

Fat

The fat content of control sample was 27.03 ± 0.15% and that of control sample cooled in 1 % salt solution was 28.07 ± 0.21%. While the fat content of paneer prepared from standard milk was 20.37±0.15% and that of market paneer sample was 25.63±0.15%. From the results, it can be inferred that the fat content of paneer is a function of fat in raw milk. With the dipping in salt solution, the moisture content of paneer was decreased and TS as well as fat content of paneer was also increased. The hygienically dipping of paneer in chilled distilled water having 1% salt (NaCl) has reduced the microorganisms and increased TS and fat content due to reduction in moisture content. It will have high preserving quality and shelf life.

Protein

The protein content of control sample was 14.97± 0.15% and that of control sample cooled in 1 % salt solution was 15.40±0.10%. While the protein content of paneer prepared from standard milk was 22.10±0.20% and that of the market

Table 1: Chemical quality of Paneer of different treatment

Items (%)	Treatment–I	Treatment–II	Treatment – III	Treatment–IV
Yield of Paneer	186 g per litre of milk	191 g per litre of milk	160 g per litre of milk	-
Moisture content	53.48 ± 0.48	53.47± 0.62	52.80± 0.61	52.25±1.07
Acidity	0.36± 0.01	0.39± 0.05	0.57± 0.05	0.60± 0.05
Fat	27.03± 0.15	28.07± 0.21	20.37± 0.15	25.63± 0.15
Protein	14.97± 0.15	15.4 0± 0.10	22.10± 0.20	18.42± 0.49
Lactose	3.29± 0.45	1.20± 0.43	2.79± 0.38	1.40±0.63
Ash	1.23± 0.15	1.87± 0.43	1.94± 0.27	2.27±0.66

*Data presented in table are average of 3 replicates ± SD.

paneer sample was 18.42±0.49 %. The protein content was decreased to 14.97±0.15% with preheating temperature of 90°C in comparison to that required in paneer in the range of 18-23%. In the case of preheating temperature of 82°C, the protein content was 22.1%. It was recommended to have preheating temperature of 80-82°C with holding time of less than 5 minutes.

Lactose

Lactose per cent was obtained higher in control sample prepared from buffalo milk, which was 3.29±0.45% in comparison to 2.79±0.38% in paneer from Standard milk of Treatment-III and 1.40 ±0.63% in market sample of paneer.

Ash

Ash content in control sample cooled in chilled distilled water was 1.23±0.15%, while those paneer cubes of control sample cooled in 1% salt solution of distilled water had ash content of 1.87±0.43% due to absorbed content of NaCl during cooling at a temperature less than 4°C. The difference of 0.64% indicated the absorbed salt percentage in paneer. It would be helpful in enhancement of shelf life. The ash content of control sample was measured as 1.23±0.15% and in paneer from standard milk was 1.94±0.27%. The factors affecting ash contents are temperature of preheating and coagulation temperature. Higher the preheating temperature resulted in lower values of ash content. Therefore, 82°C preheating temperature and 70°C coagulation temperature is superior, which must be optimized in all processes using buffalo milk.

Microbiological Characteristics of Paneer

The microbiological characteristics are important with the view of hygienic practices adopted and use of preservatives from the beginning to end of production so that the external contamination is completely prevented. It was also recommended from the observation that cooling of paneer by dipping in 1% salt solution of pasteurized/distilled chilled water was even better than that of plain pasteurized/distilled chilled water. The observation of SPC, coliform and yeasts and moulds count were presented in table 2.

Standard Plate Count

Lowest SPC counts of 90cfu/ml was observed in control sample of paneer with cooling of paneer cubes in 1 % salt solution of chilled distilled water (i.e. Pasteurized chilled water in Industry) in 1:10 dilution. However, SPC count in control sample with dipping of paneer cubes in chilled distilled water was observed as 180 cfu/ml in 1: 10 dilution (Table 4). The SPC count for cooling of paneer cubes in raw chilled water was 8000 Cfu/ml and that in market sample of Paneer was 140,000 Cfu/ml in 1:100 dilutions (Table 5). However, Rajorhia *et. al*. (1984) reported total viable count as 7614 x 10^5 in Karnal City market and as 2025 x 10^5 Cfu/ml in Delhi market. The prepared samples in research had comparatively low bacterial count. Singh et al., (1989) reported a shelf life of 36 days at room temperature when sorbic acid at a rate of 0.15% was added to milk and the product was wrapped in sorbic acid-coated paper. Further work on sorbic acid needs to be performed with microbial analysis.

Coliform

Coliform count in Control sample with cooling in chilled distilled water and also for sample of paneer cubes cooled in 1 % salt solution of chilled distilled water was found to be nil in 1:10 as well as 1:100 dilution. The use of pasteurized chilled water for chilling paneer cubes was recommended as chilled distilled water cooling has good result in reduction of coliform count. The coliform count in paneer sample cooled in raw chilled water was high to 40 and coliform count was uncountable or higher than 300 in market paneer sample. In Delhi market and Karnal city market, it was reported as 250637x10^2 and 60805x10^2, respectively. In control sample prepared in research lab, the coliform count was nil when pasteurized chilled water was recommended and distilled water was used for cooling of paneer cubes. In cooling with raw /tap chilled water also the coliform count was not very much high as reported in literature.

Yeast and Mould

Yeast and moulds count counts in control sample with cooling in chilled distilled water as well as sample by cooling in chilled 1 % salt solution was found to be nil in 1:10 as well as 1:100 dilution. The yeast and moulds count in paneer sample cooled in raw chilled water was higher than 10 and that was nil in market paneer sample. The contamination by cooling by tap water was observed in paneer having yeast and moulds count greater than 10. However, it was lower than that reported as 30,100 in Delhi market (Kahlon and Grover, 1984).

CONCLUSION

The aseptic and hygienic environment with good manufacturing practices during manufacturing of paneer has reduced SPC count, coliform count and yeasts and moulds count. Apart from this, the preheating at 82°C with holding time of less than 5 minutes and coagulation temperature of 70 °C (Treatment -III) was recommended along with citric acid also at 70°C while coagulating. But it is recommended to use the cooling in the pasteurized/distilled chilled 1% salted water. Still the future work is suggested with different concentration and different preservative such as sorbic acid and Nisin. Another recommendation was to use buffalo milk for paneer preparation of 5.8 to 6.0% fat and 9.0-9.1% SNF. The chilling of paneer cubes in pasteurized or distilled chilled water with 1% salt solution for half an hour was found better in respect of microbial, chemical and sensory characteristics. In dairy industry, the hygienically dipping of paneer in chilled pasteurized water having 1 to 2% salt solution will reduce

Table 2 : Microbiological qualities of different sample of Paneer

Items	Treatment-I*	Treatment-II**	Treatment-III*	Treatment-IV**
SPC count 1/10 dil.	18x10 =180 cfu/ml	9 x 10 =90 cfu/ml	8 x1000 =8000 cfu/ml	140 x 1000 =140, 000 cfu/ml
Coliform count 1/100 dil.	nil	nil	40	Uncountable or more than 300
Yeast and Mould count 1/100 dil.	nil	nil	>10	nil

*Data presented in table are average of 3 replicates

microorganisms; increase TS and fat content due to reduction in moisture content. It would suppress the water activity and enhance the shelf life of paneer. Microbiological and sensory evaluation study have reflected the same results of treatment II for high flavor and body and texture score. Higher the preheating temperature resulted in lower values of ash content. Therefore, 82°C preheating temperature and 70°C coagulation temperature is superior, which must be optimized in all processes using buffalo milk.

The pressing at not more than 1 kgf/cm^2 for 30 minutes resulted better body and texture in experiment of standard milk paneer in comparison to pressing for one hour period. Use of pasteurized chilled water and hygienic manufacturing practices of mask and hand gloves along with hygienic equipments and muslin cloths etc. were resulted paneer of nil coliform count, nil yeast and moulds count and 90 to 180 cfu/ml of SPC counts. The need to maintain cold chain below 10°C, right from the manufacture point to retail sale point cannot be omitted in any case to maintain quality of paneer Still, more work is needed to delineate the effect of packaging paneer cubes with NaCl solution/whey in lacquered tin container as well as in retortable pouches followed by sterilization of in packaged paneer cubes in a table top horizontal sterilizer/rotary horizontal autoclave/vertical autoclave at 12°C for 15 minutes or at higher temperatures of 131°C for 5 minutes and in between these operating values.

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