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Parwez Ali

Department of Dairy
Technology, DSC, KVAFSU,
Bengaluru, Karnataka, India

Venkaresh M

Department of Dairy
Technology, DSC, KVAFSU,
Bengaluru, Karnataka, India

AR Praveen

Department of Dairy
Technology, DSC, KVAFSU,
Bengaluru, Karnataka, India

Shilpashree BG

Department of Dairy Chemistry,
DSC, KVAFSU, Bengaluru,
Karnataka, India

R Prabha

Department of Dairy
Microbiology, DSC, KVAFSU,
Bengaluru, Karnataka, India

Heena Kauser

Department of Dairy Chemistry,
DSC, KVAFSU, Bengaluru,
Karnataka, India

Corresponding Author:

Parwez Ali

Department of Dairy
Technology, DSC, KVAFSU,
Bengaluru, Karnataka, India

Effect of storage on chemical and microbiological quality of functional chhana podo

Parwez Ali, Venkaresh M, AR Praveen, Shilpashree BG, R Prabha and Heena Kauser

Abstract

Functional chhana podo was prepared using cow milk by incorporation of ragi flour, honey and clove. The attempts had been made to study the effect of packaging materials aluminium foil (C), polyethylene terephthalate (P1) and polystyrene (P2), metallic cardboard (P3) for chemical and microbiological analysis. Based on the chemical and microbiological analysis, functional chhana podo packed in polyethylene terephthalate was found superior over the rest of the packaging materials as it did not effect in respect to chemical and microbiological standards. As per microbiological standards (FSSR, 2016), the functional chhana podo packed in polyethylene terephthalate had a shelf life of two days at room temperature (30 °C) and twenty-one days at refrigeration temperature (5 °C).

Keywords: Functional chhana podo, shelf stability, chemical analysis, microbiology analysis

Introduction

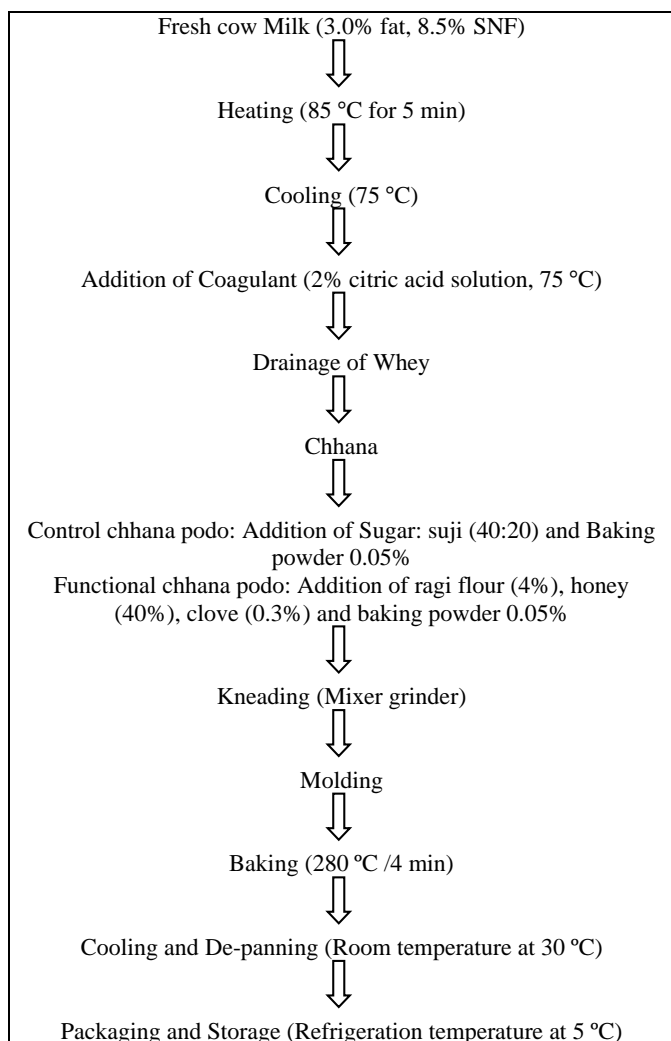
Chhana podo, a popular dairy product of India, is prepared by baking the dough of chhana (heat-acid coagulated milk solids), semolina and sugar. Heat induced moisture loss during baking influences the chain of physico-chemical changes, which in turn determine the quality of the final product (Emerald *et al.*, 2020) [3]. Chhana podo is characterized by a brown crust with white or light brown inner body, has a typical cooked flavour and rich taste. The moist crumb has a moderately spongy cakelike texture and soft body, and is sweet due to the addition of sugar. It is probably the only dairy product prepared by baking. The important step in preparation of Chhana podo is baking. During this step, conductive, convective and radiative heat transfer occurs from the oven chamber to the product surface (Emerald *et al.*, 2020) [3]. Banker (2004) [2] reported that shelf life of chhana podo 2 to 4 days at room temperature. The reduction in pH may be attributed to sharp increase in microbial count during ambient temperature storage. The tremendous increase in SPC as well as yeast and mold count making the product unacceptable which might be due to formation of slime on the surface of the product with formation of green and black mold spots during ambient temperature storage. Storage studies of microwave treated enriched chhana podo revealed that shelf life was 5 day and 6 days for sample treated for 40 and 50 s with corresponding temperature of 75 and 82 °C, respectively as against control samples which showed a shelf-life of 3 days at refrigeration temperature 7 °C (Ashraf, 2006) [1].

Materials and Methods

Fresh raw milk was procured from the Students Experimental Dairy Plant (SEDP) of Dairy science college, Hebbal, Bengaluru. Used for the preparation of Chhana podo. Ragi flour, honey, clove, suji and baking powder were purchased from local market in Bengaluru.

Method adopted

The product was prepared as per the procedure followed by Mukhopadhyay *et al.*, 2015 [7] with slight modification. Fresh cow milk was heated taken to 85 °C for 5 min. and then cooled to 75 °C. Slowly add a 2 percent citric acid solution at 75 °C as a coagulant till complete coagulation and drainage of whey. Sugar of 40%, suji (20%) and 0.05% baking powder on a chhana basis was the mixture was kneaded, baked it and cooled chhana podo and removed it from the cooking utensil (de-panning). This chhana podo was subjected to judging and packaging.



Preparation of chhana podo (control and functional chhana podo)

Chemical analysis of chhana podo

The methods described were followed for analysing the fat, moisture, pH, ash, acidity, total solids, FFA (ISI: SP: 18 (Part XI) – 1981).

Microbiological analysis

The microbiological analysis of the product for total bacterial count (TBC or SPC), coliforms, yeast & mold were carried out as per the standard methods described by Harrigan (1998) [5].

Statistical analysis

Significant difference between the values was verified by one way analysis of variance (ANOVA) and comparison between means was made by critical difference value by using R software [R. version 4.1.2 (2021-11-01), copyright © 2021, R foundation].

Result and Discussion

Effect of different packaging material on the chemical quality of chhana podo at ambient temperature (30 °C)

On the day of preparation, there was significant difference (P=.05) in pH content of control (6.41) and other treated samples (6.27, 6.28 and 6.30, respectively) and there was decrease in pH content during storage are presented in Table 1. On day 2nd, there was decrease in pH content during storage. On day 0, there was significant difference (P=.05) in titratable acidity content of control (0.24) and other treated samples

(0.17, 0.18 and 0.19 percent LA, respectively) and there was increase in titratable acidity content during storage. On day 2nd, there was increase in titratable acidity content during storage. On day 0, there was significant difference (P=.05) in total solid content of control (76.3) and other treated samples (75.6, 75.5 and 75.4 percent, respectively) and there was increase in total solid content during storage. On day 2nd, there was increase in total solid content during storage. On day 0, there was significant difference in fat content of control (22.5) and other treated samples (21.4, 21.3 and 21.2 percent, respectively) and observed significant difference (P=.05) increase in fat content during storage period. On day 2nd, there was increase in fat content during storage. On day 0, there was significant difference (P=.05) in ash content of control (1.54) and other treated samples (1.64, 1.63 and 1.62 percent, respectively) and there was increase in ash content during storage. On day 2nd, there was increase in ash content during storage. On day 0, there was significant difference (P=.05) in FFA content of control (1.15) and other treated samples (1.11, 1.12 and 1.13 percent OA, respectively) and there was increase in FFA content during storage. On day 2nd, there was increase in FFA content during storage.

Effect of different packaging materials on the microbiological quality of chhana podo stored at ambient temperature (30 °C)
Effect of different packaging materials on the microbial are presented in Table 2. The coliform and yeast and molds counts were absent in C, P1, P2 and P3 samples on 0 day. The SPC count in the functional chhana podo control, P1, P2 and P3 samples (nil log₁₀ cfu/g) on 0 day of storage at room temperature. On 2nd day yeast and molds counts were observed. Yeast and molds counts were within microbiological standards till 2nd day. The SPC count in the control chhana podo and functional chhana podo P1 on 2nd day of storage at room temperature was 1.25 and 3.20 log₁₀ cfu/ g, respectively. On 3rd day all samples of chhana podo were unacceptable. It was observed that there was visible mold growth in these samples with off-flavour development; hence they were considered as spoiled indicating unsafe for consumption on 3rd day of storage studies at ambient temperature (30 °C) hence they were considered as spoiled.

Effect of different packaging material on the chemical quality of chhana podo at refrigeration temperature (5 °C)

The control chhana podo and samples of developed ragi flour, honey and clove enriched chhana podo packed in different packaging materials at refrigeration temperature were analysed for their chemical quality at 7 day interval. The effect of different packaging materials on the chemical quality of control chhana podo and developed with ragi flour, honey and clove enriched chhana podo stored in refrigeration temperature are presented in table 3 and table 4.

It was recorded that ash content had significant difference (P=.05) in the percent of ash content of all samples was observed and there was significant increase in total solids content in all samples during storage period. Functional chhana podo had higher ash content than control chhana podo this could be due to ragi flour content abundant source of minerals. It was recorded that FFA content had significant difference (P=.05) in the percent of FFA content of all samples was observed and there was significant increase in FFA in all samples during storage period. The FFA content in retort processed chhana podo increased from an initial value of 1.16-1.36 percent OA after 30 days of storage (Pal *et al.*, 2019) [8].

It was recorded that titratable acidity had significant difference ($P=0.05$) in the percent of titratable acidity of all samples was observed and there was significant increase in acidity in all samples during storage period. The rate of increase of acidity in refrigerated storage condition was observed to be less than ambient storage. Acidity of retort processed chhana podo increased from an initial value of 0.3 to 0.55 percent LA after 30 days in refrigerated condition (Pal *et al.*, 2019)^[8]. On 28th day of storage control, P1, P2 and P3 were unacceptable, since it was observed that there was visible mold growth and increase acidity in all the samples with off-flavour development, hence they were considered as spoiled.

Effect of different packaging material on the microbiological quality of chhana podo at refrigeration temperature (5 °C)

The control chhana podo packed in aluminium foil box (C) and developed ragi flour, honey and clove enriched chhana podo was packed in Polyethylene terephthalate (P1), polystyrene (P2) and metallic cardboard (P3) boxes, were stored at refrigeration temperature, were analysed for microbial quality at seven day of interval. Effects of different packaging materials on the microbiological quality of the samples during storage 5 °C are presented in table 5.

The coliforms were absent in control, P1, P2 and P3 samples during the storage period this may be due to hygienic practices followed during chhana podo preparation and also may be due to baking temperature. Until 21st day microbiological standards of control, P1, P2 and P3 were within the limits. The yeast and mold count were observed in all sample on 21st day of storage which increased during further storage but were within the standards. On 28th day control sample, P1, P2 and P3 sample were spoiled. The standard plate count, yeast and mold counts were lower in functional chhana podo which might be attributed to the addition of clove powder that contained phenolic and flavonoid compounds that are primarily (Eugenol) responsible for their antimicrobial property. Results are in agreement with Pal *et al.* (2019)^[8] reported that the rate of increase of yeast and mold count in refrigerated storage condition (7 °C) was observed to be less than ambient storage. Yeast and mold count of retort processed chhana podo increased from an initial value of 0 to 6×10^4 cfu/g (0 to 4.78 log₁₀cfu/g) after 30 days of storage. Total plate count of retort processed chhana podo increased from an initial value of 4×10^4 to 8×10^6 cfu/g (4.60 to 6.90 log₁₀cfu/g) after 30 days of storage.

Table 1: Effect of different packaging materials on chemical quality of chhana podo stored at ambient temperature (30 °C)

| Sample | Days of Storage | | | | | | | | | | | | |
|-------------|--------------------|--------------------|--------------------|--------------------|-------------------|--------------------|---------------------|--------------------|--------------------|--------------------|-------------------|--------------------|---------------------|
| | 0 Day | | | | | | 2 nd Day | | | | | | 3 rd Day |
| | pH | Acidity (% LA) | TS (%) | Fat (%) | Ash (%) | FFA (% OA) | pH | Acidity (% LA) | TS (%) | Fat (%) | Ash (%) | FFA (% OA) | |
| C | 6.41 ^a | 0.24 ^a | 76.3 ^a | 22.5 ^a | 1.54 ^b | 1.15 ^a | 6.37 ^a | 0.31 ^a | 76.5 ^a | 22.7 ^a | 1.56 ^b | 1.35 ^a | Spoiled |
| P1 | 6.27 ^{da} | 0.17 ^{da} | 75.6 ^b | 21.4 ^b | 1.64 ^a | 1.11 ^{da} | 6.22 ^b | 0.22 ^d | 75.8 ^b | 21.6 ^b | 1.66 ^a | 1.29 ^{da} | |
| P2 | 6.28 ^c | 0.18 ^{ca} | 75.5 ^{ca} | 21.3 ^{ca} | 1.63 ^a | 1.12 ^{ca} | 6.21 ^{ca} | 0.24 ^{ca} | 75.7 ^{ca} | 21.5 ^{ca} | 1.65 ^a | 1.30 ^c | |
| P3 | 6.30 ^b | 0.19 ^b | 75.4 ^{da} | 21.2 ^{da} | 1.62 ^a | 1.13 ^b | 6.20 ^{da} | 0.25 ^b | 75.6 ^{da} | 21.4 ^b | 1.64 ^a | 1.32 ^b | |
| CD (P= .05) | 0.01 | 0.01 | 0.48 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.68 | 0.01 | 0.02 | 0.01 | |

Note:

C - Control of chhana podo packed in aluminium foil box

P1 -Functional chhana podo packed in polyethylene terephthalate box

P2 - Functional chhana podo packed in polystyrene box

P3 – Functional chhana podo packed in metallic cardboard box

CD-Critical difference

All the value are average of three trails

Different superscripts with in the column indicate significant difference ($P=0.05$)

Table 2: Effect of different packaging materials on microbiological quality of chhana podo stored at ambient temperature (30 °C)

| Sample | Storage Day log ₁₀ cfu/g | | | | | | | | |
|-------------|-------------------------------------|-----------|-----------------|---------------------|-----------|-----------------|---------------------|-----------|-------------------|
| | 0 day | | | 2 nd day | | | 3 rd day | | |
| | SPC | Coliforms | Yeast and molds | SPC | Coliforms | Yeast and molds | SPC | Coliforms | Yeast and molds |
| C | Nil | Nil | Nil | 3.20 ^a | Nil | 2.10 | 4.32 ^a | Nil | 2.43 ^a |
| P1 | Nil | Nil | Nil | 1.25 ^{da} | Nil | Nil | 3.25 ^d | Nil | 2.23 ^d |
| P2 | Nil | Nil | Nil | 1.27 ^{ca} | Nil | Nil | 3.27 ^{ca} | Nil | 2.25 ^c |
| P3 | Nil | Nil | Nil | 1.29 ^b | Nil | Nil | 3.28 ^b | Nil | 2.27 ^b |
| CD (P= .05) | NA | NA | NA | 0.09 | NA | NA | 0.01 | NA | 0.01 |

Note:

C - Control of chhana podo packed in aluminium foil box

P1 -Functional chhana podo packed in polyethylene terephthalate box

P2 - Functional chhana podo packed in polystyrene box

P3 – Functional chhana podo packed in metallic cardboard box

CD-Critical difference

All the value are average of three trails

Different superscripts with in the column indicate significant difference ($P=0.05$)

Annexure II (Microbiological standards (FSSR, 2016) for chhana based sweet

Table 3: Effect of different packaging material on chemical quality of chhana podo at refrigeration temperature (5 °C)

| Sample | Days of Storage | | | | | | | | | | | |
|-------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|---------------------|--------------------|-------------------|-------------------|-------------------|--------------------|
| | 0 Day | | | | | | 7 th Day | | | | | |
| | pH | Acidity (% LA) | TS (%) | Fat (%) | Ash (%) | FFA (% OA) | pH | Acidity (% LA) | TS (%) | Fat (%) | Ash (%) | FFA (% OA) |
| C | 6.41 ^a | 0.24 ^a | 76.3 ^a | 22.5 ^a | 1.54 ^b | 1.15 ^a | 6.30 ^a | 0.22 ^a | 76.5 ^a | 22.7 ^a | 1.57 ^b | 1.22 ^a |
| P1 | 6.27 ^{da} | 0.17 ^{da} | 75.6 ^b | 21.4 ^b | 1.64 ^a | 1.11 ^{da} | 6.21 ^{da} | 0.19 ^{da} | 75.8 ^a | 21.6 ^a | 1.66 ^a | 1.16 ^{da} |
| P2 | 6.28 ^c | 0.18 ^{ca} | 75.5 ^b | 21.3 ^{ca} | 1.63 ^{ca} | 1.12 ^{ca} | 6.22 ^{ca} | 0.20 ^{ca} | 75.7 ^a | 21.5 ^a | 1.65 ^a | 1.17 ^{ca} |
| P3 | 6.30 ^b | 0.19 ^b | 75.4 ^{da} | 21.2 ^{da} | 1.62 ^{da} | 1.13 ^b | 6.23 ^b | 0.21 ^b | 75.6 ^a | 21.2 ^a | 1.64 ^a | 1.19 ^b |
| CD (P= .05) | 0.01 | 0.01 | 0.48 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.17 | 0.17 | 0.01 | 0.01 |

Note:

C - Control of chhana podo packed in aluminium foil box

P1 -Functional chhana podo packed in polyethylene terephthalate box

P2 - Functional chhana podo packed in polystyrene box

P3 – Functional chhana podo packed in metallic cardboard box

CD-Critical difference

All the value are average of three trails

Different superscripts with in the column indicate significant difference (P=.05)

Table 4: Effect of different packaging material on chemical quality of chhana podo at refrigeration temperature (5 °C)

| Sample | Days of Storage | | | | | | | | | | | | 28 th Day |
|-------------|----------------------|-------------------|-------------------|-------------------|-------------------|-------------------|----------------------|--------------------|-------------------|-------------------|-------------------|-------------------|----------------------|
| | 14 th Day | | | | | | 21 st Day | | | | | | |
| | pH | Acidity (%LA) | TS (%) | Fat (%) | Ash (%) | FFA (% OA) | pH | Acidity (%LA) | TS (%) | Fat (%) | Ash (%) | FFA (% OA) | |
| C | 6.27 ^a | 0.24 ^a | 76.7 ^a | 22.9 ^a | 1.59 ^b | 1.25 ^a | 6.12 ^a | 0.33 ^a | 76.9 ^a | 23.1 ^a | 1.61 ^b | 1.32 ^a | Spoiled |
| P1 | 6.18 ^{da} | 0.21 ^a | 76.0 ^a | 21.8 ^a | 1.68 ^a | 1.18 ^d | 6.10 ^a | 0.26 ^{da} | 76.2 ^a | 22.0 ^a | 1.70 ^a | 1.28 ^b | |
| P2 | 6.19 ^{ca} | 0.22 ^a | 75.9 ^a | 21.7 ^a | 1.67 ^a | 1.20 ^c | 6.11 ^a | 0.28 ^{ca} | 76.1 ^a | 21.9 ^a | 1.69 ^a | 1.30 ^a | |
| P3 | 6.20 ^b | 0.23 ^a | 75.8 ^a | 21.4 ^a | 1.66 ^a | 1.22 ^b | 6.13 ^a | 0.29 ^b | 76.0 ^a | 21.6 ^a | 1.68 ^a | 1.31 ^a | |
| CD (P= .05) | 0.01 | 0.02 | 0.17 | 0.17 | 0.01 | 0.01 | 0.01 | 0.01 | 0.17 | 0.16 | 0.01 | 0.01 | |

Note:

C - Control of chhana podo packed in aluminium foil box

P1 -Functional chhana podo packed in polyethylene terephthalate box

P2 - Functional chhana podo packed in polystyrene box

P3 – Functional chhana podo packed in metallic cardboard box

CD-Critical difference

All the value are average of three trails

Different superscripts with in the column indicate significant difference (P=.05)

Table 5: Effect of different packaging and microbiological qualities of chhana podo stored at refrigeration temperature (5 °C)

| Sample | Storage Day log ₁₀ cfu/g | | | | | | | | | | | | | | |
|-------------|-------------------------------------|----------|----------------|---------------------|----------|----------------|----------------------|----------|----------------|----------------------|----------|--------------------|----------------------|----------|--------------------|
| | 0 day | | | 7 th day | | | 14 th day | | | 21 st day | | | 28 th day | | |
| | SPC | Coliform | Yeast and mold | SPC | Coliform | Yeast and mold | SPC | Coliform | Yeast and mold | SPC | Coliform | Yeast and mold | SPC | Coliform | Yeast and mold |
| C | Nil | Nil | Nil | 1.37 | Nil | Nil | 1.59 | Nil | Nil | 3.82 ^a | Nil | 2.13 ^a | 4.23 ^a | Nil | 2.86 ^a |
| P1 | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | 1.22 ^b | Nil | 1.86 ^{da} | 3.29 ^{da} | Nil | 2.54 ^{da} |
| P2 | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | 1.25 ^{da} | Nil | 1.90 ^{ca} | 3.33 ^{ca} | Nil | 2.56 ^{ca} |
| P3 | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | Nil | 1.27 ^{ca} | Nil | 1.92 ^b | 3.38 ^b | Nil | 2.59 ^b |
| CD (P= .05) | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0.09 | NA | 0.09 | 0.09 | NA | 0.09 |

Note:

C - Control of chhana podo packed in aluminium foil box

P1 - Functional chhana podo packed in polyethylene terephthalate box

P2 - Functional chhana podo packed in polystyrene box

P3 – Functional chhana podo packed in metallic cardboard box

CD-Critical difference

All the value are average of three trails

Different superscripts with in the column indicate significant difference (P=.05)

Annexure II (Microbiological standards (FSSR, 2016) for chhana based sweet)

Conclusion

Shelf stability of functional chhana podo and control chhana podo. In chemical analysis such as fat, total solid, ash, FFA, pH and acidity, microbiology analysis such as standard plate count, coliform and yeast and mold count and sensory parameter analysis in packed in aluminium foil (C), polyethylene terephthalate (P1) and polystyrene (P2), metallic cardboard

(P3). Microbiological standards (FSSR, 2016) for chhana based sweet when used to compare with the functional chhana podo packed in polyethylene terephthalate had a shelf life of two days at room temperature (30 °C) and twenty-one days at refrigeration temperature (5 °C).

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