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Effect of pepper powder on microbiological and sensory quality of enrobed Chhana balls during refrigerated storage at $4 \pm 1^\circ\text{C}$

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Abstract

Enrobing is the process of battering and breading of any food products, enhances the flavor, adds a crispy texture, and helps retain the moisture of the food during cooking. The enrobing of Paneer and Potato slices served as Paneer and Alu pakoda respectively is most common dishes made available in hotels and restaurants. Study was undertaken to know the effect of incorporation of different levels of pepper powder on quality of value added enrobed Chhana balls. Chhana was prepared by acid heat coagulation of milk and later added different levels of powdered ground pepper (0.5%, 1.0% and 1.5% w/w) along with salt (2.0%) at the time of preparation. The balls were enrobed in standardized batter mix and were deep fat fried at $130-140^\circ\text{C}$ for 2-4 min. The products were subjected to microbiological and sensory evaluation during refrigerated storage at $4 \pm 1^\circ\text{C}$. The Enrobed Chhana balls containing 1% pepper powder has lower $\log_{10}$ cfu/gm for Standard Plate Count (SPC) and Yeast and Mould Counts (YMC) than control. The counts for *E. coli* and *Psychrophiles* could not detect during entire storage days. YMC is also could not be detected on day 5 of storage period. The black pepper treated products had higher sensory hedonic scores compared to control. As days proceeds the score for sensory quality of both control and treated samples decreased during storage. The overall effect of 1% pepper treated products was significantly ($p \leq 0.05$) higher for juiciness, texture, flavor and overall acceptability.

Keywords: Enrobing, Chhana balls, pepper, microbiological, sensory evaluation

Introduction

Enrobing is the process of dip coating with a layer of batter or breading followed by deep fat frying. Battering and breading of any food products enhances the flavor, adds a crispy texture, and helps retain the moisture of the food during cooking. Common examples include chicken nuggets, fish fingers, and breaded pork chops. The enrobing of Paneer, onion, potato and capsicum etc. served as pakoda is most common dishes made available in hotels or restaurants. Processing of Chhana into enrobed balls adds value and provide variety dish to consumers. The Chhana ball was prepared from coagulated milk solids, later made into balls, enrobed and fried adds value and provide variety to consumer as a dish. Pepper is used in the form of powder, broken or whole as seasonings and fairly as nutrition (Sung *et al.*, 2011) [9]. The oils and oleoresins components in black pepper (*Piper nigrum*) prevent the growth of microbes in orange juice (Kapoor *et al.*, 2012) [5]. Zou *et al.*, (2015) [12] made report on antibacterial effect of the pepper extracts to inhibit food spoilage. Spices and essential oils have been used extensively as flavor ingredients in wide range of confectionary products. Black pepper was found to be rich in aromatic compounds, polyphenols, flavonoids, alkaloids, amides, and lignans (Abdallah and Abdalla 2018) [1]. Black Pepper adds flavor to almost every food of every nation in the world. Black pepper contains between 2-4% essential oils and the compound "piperine" is responsible for its characteristic spicy heat. The scientific study was made to know the effect of incorporating pepper powder on microbiological and sensory quality of value added Enrobed Chhana balls.

Materials and Methods

Chhana was prepared by heat (82°C) coagulation of whole milk (4.5% fat and 8.5% SNF) with citric acid (2% solution) using standard procedure (De S, 2017) [4].

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Later Chhana balls were prepared by using different levels of pepper (0.5%, 1.0% and 1.5% w/w) along with salt (2.0%). The batter mix comprised of flour of bengal gram: 80g, flour of corn: 20g, salt: 5g, seasoning mix: 5g, eating soda: 0.5g and potable drinking water: 100g (Chidanandaiah *et al.*, 2025) ^[3]. The enrobed Chhana balls were deep fat fried at 130-140 °C for 2-4 min. The packed products were stored at 4 ± 1 °C in a polyethylene pouches. The products were subjected to microbiological and sensory evaluation during refrigerated storage at 4 ± 1 °C at intervals of 0,5,10 and 15 days. The microbiological examination of the Chhana balls were made as per the procedures mentioned in APHA (1984) ^[2] with slight modifications. The microorganisms (log₁₀ cfu/g) studied were Total plate count, Psychrophilic count, Yeast and mould count and *E. coli* count. The Colonies were counted using electronic colony counter. The average number of colonies were multiplied by the reciprocal of the dilution and expressed as log₁₀ colony forming units (cfu)/gm of sample. The sensory evaluation for colour and appearance, juiciness, flavour, texture and overall palatability by an experienced panel members comprising of Professors and research scholars of the Institute based on 7-point hedonic scale. Wherein 7 denoted "extremely desirable" and 1 denoted "extremely undesirable" (Keeton, 2006) ^[6]. Analar grade and Food grade chemicals procured from Qualigens/Merk/BDH/Himedia (INDIA) were used in the study.

Statistical analysis

The data were analyzed on computer using statistical software packages developed by following the procedures of Snedecor and Cochran (1989) ^[8]. There were seven sensory judges for each treatments x replication combination. Data were subjected to two way analysis of variance and means were compared by Duncan's multiple range tests at 5% significance level.

Results and Discussion

The microbiological evaluation: The microbiological profile of Enrobed Chhana balls during refrigerated storage has presented in Table 1. The Enrobed Chhana balls containing 1% pepper powder has lower log₁₀ cfu/gm for Standard Plate Count (SPC) and Yeast and Mould Counts (YMC) than control. However, there is no significance difference between control and treatment on day 0, 5, 10 and 15. There was highly significant difference ($p \leq 0.05$) between overall days of storage on the log counts of SPC and Yeast and mould count as day's proceeds. The counts for *E. coli* and *Psychrophiles* could not detect during entire storage days. YMC is also could not be detected on day 5 of storage period. The reason for decrease in the counts with respect to Standard Plate count and yeast and mould count might be due to the content of Piperine exhibited antibacterial activity. The same was reported by (Zarai *et al.*, 2013) wherein he mentioned minimum inhibitory concentration (<325 µg/mL) of Piperine against wide range of bacterial strains. The antibacterial effect of pepper is more than ginger has been reported by (Udensi, *et al.*, 2012). The antifungal property of black pepper against

Aspergillus flavus is also reported by (Zhang *et al.*, 2021). The antimicrobial action of phenolic compound which effect on cellular membrane as it causes structural and functional damage to plasma membrane, it arrests the growth of microorganisms. Black pepper possesses more antimicrobial properties than ginger used in soy-milk and kunun-zaki at 0.4-1% and used as a natural antimicrobial preservative to extend the shelf life of food. The antibacterial activities of piperine were investigated against a group of Gram-positive bacteria, including *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Bacillus subtilis*, *Enterococcus faecalis*, and Gram-negative bacteria, such as *Salmonella enterica*, *Klebsiella pneumonia*, and *Escherichia coli*.

The sensory evaluation: The sensory evaluation of Enrobed Chhana balls during refrigerated storage has presented in Table 2. The black pepper treated products had higher sensory hedonic scores compared to control. As days proceeds the score for sensory quality of both control and treated samples decreased during storage. The storage days effect was significant ($p \leq 0.05$) between day 0 and 10 and day 0 and day15 with respect to (w.r.t.) colour and appearance; between day 0 and day 5 & day 10 and day 15 w.r.t. juiciness; between day 0 and day 10 w.r.t. texture; between day 0 and day 5 & day 0 and day 10, day 0 and day 15 & between day 10 and 15 w.r.t. flavor and overall acceptability. The overall effect of 1% pepper treated products was significantly ($p \leq 0.05$) higher for juiciness, texture, flavor and overall acceptability. Improvement in colour and appearance could be due to the large number of fine black pepper particles and slightly hard or dry body. (Murlidhar and Goswami, 2012) ^[7]. The cheese coated with mixed spice oil was organoleptically highly acceptable than uncoated sample has been reported by Wendoref and Wee, (1997) ^[11]. Spices and essential oils have been used extensively as flavor ingredients in wide range of confectionary products. Black pepper was found to be rich in aromatic compounds, polyphenols, flavonoids, alkaloids, amides, and lignans (Abdallah *et al.*, 2018) ^[1]. Black Pepper adds flavor to almost every food of every nation in the world. Black pepper contains between 2-4% essential oils and the compound "piperine" is responsible for its characteristic spicy heat. Differences in age, territory and maturity can lead to variations in pepper flavor. Tellicherry pepper (from India) is widely considered to be the highest quality and most flavorful variety of black pepper. (Swahn, 1991) ^[10]. Spices are used on surface of some chesses to impart flavour and to improve the shelf life by arresting the growth of spoilage causing organisms (Wendoref and Wee, 1997) ^[11]. Murlidhar and Goswami (2012) ^[7] reported that the black pepper had antioxidant phenolic compound and contain main flavour ingredient is piperine. Wendoref and Wee (1997) ^[11] reported that coating of cheese with mixed spice oil was organoleptically highly acceptable than the uncoated cheese. Essential oils or spices have been used extensively as flavour ingredients in wide variety of beverages and confectionery products.

Table 1: Changes in the microbiological profile of Enrobed Chhana balls during refrigerated storage

Treatments	Storage days				
	0 day	Day 5	Day 10	Day 15	
Standard Plate Count (SPC) log ₁₀ cfu/gm					Over all treatment
C	2.18 ± 0.85	2.90 ± 0.93	3.30 ± 1.05	4.43 ± 1.21	3.14 ± 0.51
T	1.99 ± 0.81	2.83 ± 0.97	3.56 ± 1.08	4.94 ± 1.28	3.33 ± 0.52
Overall days	2.09 ^a ± 0.59	2.73 ^b ± 0.67	3.44 ^c ± 0.75	4.69 ^d ± 0.86	
Yeast and Mould Count (YMC) log ₁₀ cfu/gm					
C	1.00 ± 0.60	ND	1.76 ± 0.76	2.26 ± 0.86	1.28 ± 0.32
T	1.10 ± 0.60	ND	1.39 ± 0.68	1.92 ± 0.80	1.11 ± 0.30
Overall days	1.10 ^a ± 0.43	ND	1.57 ^{ab} ± 0.51	2.09 ^b ± 0.59	
Note: The counts for <i>E. coli</i> and <i>Psychrophiles</i> could not detected during storage					

Note: The counts for *E. coli* and *Psychrophiles* could not detected during storage

C: Control-Chhana balls without pepper treatment T: 1% Pepper treated Chhana balls

Mean ± SE with lower case letter row wise and upper case letter column wise bearing different superscripts differ significantly ($p \leq 0.05$)

Table 2: Changes in Sensory quality of Enrobed Chhana balls during refrigerated storage

Treatments	Storage days				
	Day 0	Day 5	Day 10	Day 15	
Appearance and Colour					Overall treatment
C	6.00 ± 0.26	5.50 ± 0.24	5.00 ± 0.24	5.00 ± 0.24	5.38 ± 0.14
1% Pepper	6.00 ± 0.21	5.75 ± 0.30	5.50 ± 0.30	5.50 ± 0.21	5.69 ± 0.13
Overall storage days	6.00 ^a ± 0.16	5.63 ^{ab} ± 0.19	5.25 ^b ±	5.25 ^b ± 0.17	
Juiciness					
C	7.00 ± 0.15	6.00 ± 0.36	6.00 ± 0.36	5.00 ± 0.32	6.00 ^A ± 0.20
1% Pepper	7.00 ± 0.14	6.50 ± 0.15	6.25 ± 0.20	6.00 ± 0.40	6.47 ^B ± 0.14
Overall storage days	7.03 ^a ± 0.10	6.25 ^b ± 0.20	6.16 ^b ± 0.20	5.5 °C ± 0.28	
Texture					
C	7.00 ± 0.15	6.50 ± 0.15	6.00 ± 0.36	5.50 ± 0.30	6.25 ^A ± 0.16
T	7.00 ± 0.15	7.00 ± 0.14	6.50 ± 0.15	6.00 ± 0.36	6.64 ^B ± 0.13
Overall days	7.00 ^a ± 0.10	6.78 ^{ab} ± 0.12	6.25 ^{bc} ± 0.20	5.75 ^c ± 0.23	
Flavour					
C	7.00 ± 0.15	6.00 ± 0.36	5.50 ± 0.21	5.00 ± 0.24	5.88 ^A ± 0.18
T	7.50 ± 0.15	7.00 ± 0.14	7.00 ± 0.14	6.50 ± 0.15	7.05 ^B ± 0.09
Overall storage days	7.25 ^a ± 0.12	6.53 ^b ± 0.23	6.32 ^b ± 0.26	5.75 ^c ± 0.25	
Saltiness					
C	5.50 ± 0.30	5.82 ± 0.27	5.50 ± 0.21	5.50 ± 0.30	5.58 ± 0.13
T	6.00 ± 0.36	6.00 ± 0.26	6.00 ± 0.30	6.00 ± 0.32	6.00 ± 0.14
Overall storage days	5.75 ± 0.26	5.90 ± 0.18	5.75 ± 0.19	5.75 ± 0.22	
Overall acceptability					
C	7.00 ± 0.15	6.00 ± 0.32	5.50 ± 0.30	5.00 ± 0.32	5.88 ^A ± 0.19
T	7.50 ± 0.15	7.07 ± 0.14	6.50 ± 0.15	5.50 ± 0.37	6.64 ^B ± 0.18
Overall storage days	7.25 ^a ± 0.12	6.53 ^b ± 0.22	6.00 ^b ± 0.21	5.25 ^c ± 0.25	

C: Control-Chhana balls without pepper treatment T: 1% Pepper treated Chhana balls

Mean ± SE with lower case letter row wise and upper case letter column wise bearing different superscripts differ significantly ($p \leq 0.05$)

Conclusion

The Enrobed Chhana balls containing 1% pepper powder has lower log₁₀ cfu/gm for Standard Plate Count (SPC) and Yeast and Mould Counts (YMC) than control. The reason for decrease in the counts with respect to Standard Plate count and yeast and mould count might be due to the content of Piperine in black pepper, exhibited antibacterial activity. The overall effect of 1% pepper treated products was significantly ($p \leq 0.05$) higher for juiciness, texture, flavor and overall acceptability indicates that incorporation of Pepper improves sensory quality of the Chhana balls.

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