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Storage quality of chicken cutlets incorporated with fish flesh under frozen conditions ($-18\pm 2^\circ\text{C}$)

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Abstract

The present investigation was undertaken to evaluate the storage stability of Chicken cutlets incorporated with Fish flesh under frozen storage ($-18\pm 2^\circ\text{C}$). Chicken cutlets were prepared by replacing lean chicken meat with fish flesh at 30% levels. Chicken cutlets (T_1 and T_2) were aerobically packaged in LDPE pouches and stored at frozen temperature. Samples were analyzed for physico-chemical, microbiological and sensory quality for 60 days at interval of 10 days. Progressive increase in pH, thiobarbituric acid (TBA) value, free fatty acids (FFA) and microbial counts were observed during storage; however, all values remained within acceptable limits. Sensory quality of Chicken cutlets declined gradually and it was remained acceptable up to 60 days. The study showed that Chicken cutlets incorporated with 30% fish flesh could be safely stored at $-18\pm 2^\circ\text{C}$ for up to 60 days without significant deterioration in quality.

Keywords: Chicken cutlets, fish flesh, frozen, storage, sensory

Introduction

Chicken meat and chicken-based convenience products are among the most widely consumed animal-source foods globally due to their favorable nutritional profile, sensory appeal and relatively low cost compared with other red meats. Poultry meat supplies high-quality protein with essential amino acids, beneficial lipids, vitamins, and minerals, making it a preferred choice for diverse population groups worldwide. In India, Chicken meat is particularly popular as it is more economical than mutton and chevon and faces minimal religious or socio-cultural restrictions, thereby contributing to its widespread acceptance and consumption (James *et al.*, 2022) [9]. Processing of chicken into ready-to-cook products like cutlets adds value by offering convenience, improved shelf-stability and enhanced sensory characteristics. Chicken cutlets are meat products typically formulated by blending minced meat with various ingredients such as flours, pulse proteins, vegetables, condiments, and spices, followed by shaping and breading. These products serve as popular snacks and meal components across urban and rural markets due to their versatility and palatability (Gupta *et al.*, 2015) [5]. Low-temperature storage, especially freezing, is a key preservation strategy for maintaining the quality and safety of meat and meat products. Freezing retards the activity of spoilage microorganisms and slows down enzymatic reactions, thus extending shelf-life significantly when compared with storage above the initial freezing point. Proper frozen storage can preserve the nutritional attributes and sensory quality of meat products for extended periods if maintained under controlled conditions. However, frozen storage is also associated with physicochemical changes, such as protein denaturation, ice crystal formation and lipid oxidation, which can influence texture, flavor, and nutritional properties over time (Leygonie *et al.*, 2022; Zhang *et al.*, 2020) [12, 23].

Given the growing consumer demand for convenient, nutritious and stable meat products, there is continued interest in optimizing formulation and storage practices for chicken cutlets. Investigations into ingredient innovations, processing enhancements and storage behavior are essential to ensure product quality and acceptability over prolonged frozen storage, especially as global consumption of frozen poultry products continues to rise. The present investigation was undertaken to evaluate the storage stability of Chicken cutlets incorporated with Fish flesh under frozen storage ($-18\pm 2^\circ\text{C}$).

Materials and Methods

Boneless Chicken meat and Surmai fish (*Scomberomorus guttatus*) were procured from the local market of Navsari, Gujarat, India. Spices, sugar, condiments (onion, ginger, and garlic), food-grade common salt, refined sunflower oil and low-density polyethylene (LDPE, 200-gauge) packaging material were purchased locally. Analytical chemicals and microbiological media were obtained from standard commercial suppliers.

Frozen deboned chicken meat was thawed under refrigerated conditions, cut into small pieces and minced twice using a 6-mm plate. Fish flesh was prepared similarly. Chicken cutlets were prepared using a standardized method of Patel *et al.* (2019) [15], with fish flesh incorporated at 0% (T₁), and 30% (T₂) levels by replacing lean chicken meat. Chicken cutlets (T₁ and T₂) were aerobically packaged in LDPE pouches, stored at frozen temperature and analyzed for physico-chemical, microbiological and sensory quality for 60 days at

interval of 10 days. PH of Chicken cutlets was measured using a digital pH meter as described by Troutt *et al.*, [21]. Free fatty acid content was estimated following method of Koniecko (1979) [11] and lipid oxidation was assessed by thiobarbituric acid (TBA) value using the method of Witte *et al.* (1970) [22]. Microbiological quality was evaluated by determining standard plate count, psychrotrophic count and coliform count according to the procedures recommended by the American Public Health Association [2]. Sensory evaluation was conducted by a semi-trained panel of seven members using an 8-point descriptive scale to assess general appearance, flavor, texture, juiciness and overall acceptability (Keeton, 1983) [10].

All experiments were performed in five replicates and the data obtained were analyzed statistically using standard methods as described by Snedecor and Cochran (1994) [19].

Results and Discussion

Table 1: Effect of frozen storage on physico-chemical and microbiological properties of chicken cutlets incorporated with fish flesh

Treatment	Frozen storage period (Days)						
	0	10	20	30	40	50	60
pH							
T ₁	6.44±0.011 ^a	6.45±0.01 ^{aA}	6.48±0.009 ^{aA}	6.51±0.007 ^{aA}	6.69±0.05 ^b	6.72±0.05 ^b	6.74±0.05 ^b
T ₂	6.47±0.014 ^a	6.49±0.01 ^{abB}	6.52±0.009 ^{abB}	6.54±0.007 ^{abB}	6.65±0.028 ^c	6.68±0.031 ^c	6.70±0.032 ^c
TBA value (mg malonaldehyde/Kg)							
T ₁	0.304±0.018 ^a	0.309±0.019 ^a	0.322±0.018 ^{aA}	0.312±0.008 ^{aA}	0.345±0.022 ^a	0.442±0.015 ^b	0.452±0.024 ^{bA}
T ₂	0.357±0.024 ^a	0.354±0.022 ^a	0.380±0.025 ^{aB}	0.419±0.024 ^{abB}	0.467±0.077 ^{ab}	0.453±0.023 ^{ab}	0.521±0.034 ^{bB}
FFA%							
T ₁	0.058±0.0019 ^a	0.064±0.0023 ^a	0.067±0.002 ^a	0.077±0.004 ^a	0.079±0.006 ^a	0.107±0.016 ^b	0.120±0.013 ^{bA}
T ₂	0.061±0.002 ^a	0.067±0.001 ^a	0.069±0.002 ^a	0.083±0.010 ^a	0.085±0.011 ^a	0.118±0.018 ^b	0.117±0.017 ^{cB}
Standard plate count (log cfu/gm)							
T ₁	0.76±0.26 ^a	1.26±0.26 ^a	2.13±0.31 ^b	3.73±0.49 ^c	4.97±0.216 ^d	5.05±0.11 ^d	5.17±0.07 ^d
T ₂	0.44±0.23 ^a	1.50±0.29 ^b	1.89±0.36 ^b	4.12±0.50 ^c	4.43±0.22 ^{cd}	5.09±0.07 ^d	5.18±0.04 ^d
Psychrophilic count (log cfu/gm)							
T ₁	0.3±0.15 ^a	1.31±0.23 ^a	1.26±0.34 ^b	1.84±0.11 ^c	1.85±0.14 ^c	2.25±0.039 ^c	2.88±0.037 ^d
T ₂	0.430±0.18 ^a	1.18±0.32 ^{ab}	0.89±0.26 ^b	1.29±0.35 ^b	1.98±0.23 ^c	2.32±0.05 ^d	2.72±0.04 ^d
Coliform count (log cfu/gm)							
T ₁	ND	ND	ND	ND	ND	ND	ND
T ₂	ND	ND	ND	ND	ND	ND	ND

Mean ± S.E. with different superscripts in a row (small alphabet) and column (capital alphabet) differ significantly ($p < 0.05$), $n=10$

The physico-chemical and microbiological characteristics of aerobically packaged chicken cutlets at freezing temperature ($-18 \pm 2^\circ\text{C}$) are presented in Table 1. A progressive increase in pH was observed in all treatments during frozen storage ($-18 \pm 2^\circ\text{C}$), with comparatively higher values recorded in chicken cutlets incorporated with 30% fish flesh (T₂). This increase in pH may be attributed to protein degradation and the formation of basic nitrogenous compounds such as ammonia and amines during storage. Similar findings have been reported in frozen meat products, where residual enzymatic activity and biochemical reactions continue even at low temperatures (Ammar and Aboalfa, 2017; Zhang *et al.*, 2020) [1, 23].

Lipid oxidation, as measured by thiobarbituric acid (TBA) values, increased significantly ($p < 0.05$) during storage in both treatments. However, fish flesh-incorporated cutlets (T₂) exhibited relatively higher TBA values due to the presence of higher levels of polyunsaturated fatty acids (PUFAs), which are more prone to oxidative degradation. Lipid oxidation is a major factor affecting the quality and shelf life of meat products, leading to the formation of secondary oxidation products such as aldehydes and ketones, which contribute to off-flavors (Shahidi and Zhong, 2020) [18]. Free fatty acid (FFA) content showed a gradual increase during storage in both treatments, indicating ongoing lipid hydrolysis. This increase might be due to lipolytic enzymatic activity and

disruption of cellular structures during freezing and thawing. The simultaneous occurrence of lipolysis and lipid oxidation in frozen meat products has been widely documented (Dominguez *et al.*, 2021; Falowo *et al.*, 2021) [3, 4]. Nevertheless, all observed values remained within acceptable limits throughout the storage period, suggesting controlled lipid degradation under frozen conditions.

Microbiological analysis revealed a significant ($p < 0.05$) increase in standard plate count (SPC) and psychrotrophic counts with increasing storage duration. Similar results have been reported by Hossain and Eldaly (2013) [6] in Tilapia fillets and Talab (2014) [20] in fish cutlets stored at $-18 \pm 1^\circ\text{C}$. Although freezing effectively slows microbial growth, it does not completely eliminate microorganisms, and some psychrotrophic bacteria are capable of surviving and growing slowly under frozen conditions (Safari and Yosefian, 2006) [17]. Despite the observed increase, microbial counts remained within permissible limits for cooked meat products, confirming the effectiveness of frozen storage in preserving microbiological quality. Notably, coliform bacteria were not detected at any stage of storage, indicating good hygienic practices during processing and adequate thermal treatment. This absence of coliforms reflects proper sanitation and handling procedures, which are critical for ensuring the safety of ready-to-eat meat products Jay *et al.* (2021) [8].

Table 2: Effect of frozen storage on sensory characteristics of chicken cutlets incorporated with of fish flesh

Treatment	Frozen storage period (Days)						
	0	10	20	30	40	50	60
General appearance							
T ₁	7.31±0.05 ^d	7.16±0.04 ^c	6.94±0.05 ^b	6.92±0.03 ^b	6.90±0.18 ^b	6.84±0.03 ^b	6.60±0.064 ^a
T ₂	7.308±0.053 ^c	7.09±0.02 ^d	6.95±0.05 ^c	6.89±0.03 ^{bc}	6.91±0.02 ^{bc}	6.80±0.05 ^b	6.60±0.07 ^a
Flavour							
T ₁	7.20±0.043 ^c	7.13±0.03 ^c	6.96±0.05 ^b	6.91±0.03 ^b	6.91±0.02 ^b	6.88±0.03 ^b	6.55±0.05 ^a
T ₂	7.23±0.05 ^d	7.05±0.025 ^c	6.95±0.044 ^{bc}	6.89±0.035 ^b	6.90±0.02 ^b	6.83±0.04 ^b	6.59±0.07 ^a
Texture							
T ₁	7.19±0.04 ^d	7.07±0.02 ^c	6.96±0.04 ^b	6.89±0.03 ^b	6.89±0.02 ^b	6.87±0.03 ^b	6.49±0.06 ^a
T ₂	7.19±0.06 ^d	7.06±0.03 ^c	6.96±0.04 ^{bc}	6.87±0.03 ^b	6.90±0.02 ^b	6.83±0.04 ^b	6.52±0.06 ^a
Juiciness							
T ₁	7.06±0.05 ^{cA}	7.07±0.02 ^{cA}	6.92±0.006 ^b	6.88±0.03 ^b	6.86±0.02 ^b	6.86±0.03 ^b	6.36±0.06 ^a
T ₂	7.23±0.047 ^{dB}	7.148±0.035 ^{dB}	6.988±0.04 ^c	6.894±0.04 ^{bc}	6.91±0.02 ^{bc}	6.85±0.04 ^b	6.5±0.07 ^a
Overall acceptability							
T ₁	7.17±0.03 ^c	7.09±0.02 ^c	6.95±0.04 ^b	6.90±0.03 ^b	6.91±0.01 ^b	6.89±0.03 ^b	6.47±0.06 ^a
T ₂	7.25±0.05 ^d	7.05±0.02 ^c	6.95±0.04 ^{bc}	6.89±0.03 ^b	6.905±0.02 ^b	6.84±0.04 ^b	6.59±0.06 ^a

Mean ± S.E. with different superscripts in a row (small alphabet) and column (capital alphabet) differ significantly ($p < 0.05$), $n = 35$

The sensory characteristics of aerobically packaged chicken cutlets during frozen storage (-18 ± 2 °C) are presented in Table 2. Sensory scores for general appearance showed a gradual decline with increasing storage period in both control (T₁) and fish flesh-incorporated (T₂) chicken cutlets. In T₁, scores remained relatively stable between 20 and 50 days of storage. The reduction in appearance and color attributes during frozen storage might be attributed to pigment oxidation and surface dehydration, as reported in earlier studies (Mahmoudzadeh *et al.* 2010; Pilankar *et al.*, 2016) [13, 16]. Flavour and juiciness scores exhibited a non-significant decline up to 10 days, followed by a significant ($p < 0.05$) decrease on the 20th day in both treatments. Juiciness scores of T₂ were significantly higher than T₁ on 0 and 10 days, likely due to improved moisture retention associated with fish flesh incorporation. Thereafter, flavour and juiciness scores remained comparable between treatments from 20 to 50 days. The decline in juiciness during storage might be attributed to moisture loss caused by ice crystal formation and drip loss during thawing (Martino *et al.*, 1998) [14]. Izci *et al.* (2011) [7] also reported decrease in flavor scores of fish fingers during frozen storage. Texture scores decreased significantly ($p < 0.05$) with storage duration in both treatments, possibly due to dehydration-induced hardening and protein denaturation. Freezing can disrupt muscle fiber structure, resulting in a firmer texture upon thawing. However, no significant differences were observed between T₁ and T₂ from 20 to 50 days, indicating that fish flesh incorporation did not adversely affect textural stability (Zhang *et al.*, 2022) [23]. Overall acceptability declined progressively with storage time. A significant ($p < 0.05$) reduction was observed on the 20th day, followed by a non-significant decrease up to 50 days. On the 60th day, all sensory attributes showed a significant decline, which might be attributed to cumulative effects of lipid oxidation, protein degradation and formation of volatile compounds responsible for off-flavors and rancidity (Dominguez *et al.*, 2021; Shahidi and Zhong 2020) [3,18].

Despite the observed physicochemical, microbiological and sensory changes during frozen storage, Chicken cutlets in both treatments maintained acceptable quality throughout the study period. Incorporation of 30% Fish flesh in Chicken cutlets did not negatively affect product stability under frozen storage.

Conclusion

The study demonstrated that Chicken cutlets packaged in LDPE pouches and stored at frozen temperature (-18 ± 2 °C) could be safely preserved for 60 days without unacceptable deterioration in quality. Thus, frozen storage effectively extends the shelf life of meat products while maintaining acceptable quality attributes.

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