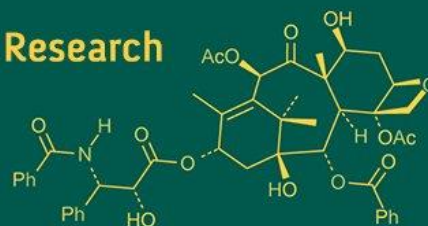
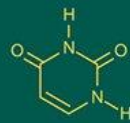


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Quality characteristics of chicken meat cutlets incorporated with oat flour (*Avena sativa*)

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Abstract

The present study was conducted to develop functional chicken cutlets incorporated with oat flour to evaluate their physicochemical, sensory and microbiological characteristics during refrigerated storage. Oat flour was incorporated individually at 5, 10 and 15% levels by replacing lean chicken meat in the formulation. The developed products were evaluated for pH, cooking yield, proximate composition, sensory attributes and storage stability at $4\pm1^{\circ}\text{C}$ for 9 days. Oat incorporation significantly ($P<0.05$) decreased pH from 6.20 to 6.03, while cooking yield increased from 84.80 to 90.09%. Moisture, ash and crude fibre contents increased significantly ($P<0.05$) with increasing levels of oat flour, whereas crude protein and crude fat contents decreased significantly ($P<0.05$). Sensory scores for general appearance, flavour, texture, juiciness and overall acceptability declined with increasing incorporation levels; however, all treatments remained within acceptable sensory limits. During refrigerated storage, pH and sensory scores decreased significantly ($P<0.05$), whereas standard plate count and psychrophilic count increased significantly ($P<0.05$). No coliform organisms were detected throughout the storage period. The findings of the study indicate that oat flour can be successfully incorporated into chicken cutlets to improve dietary fibre content, cooking yield and overall nutritional quality while maintaining acceptable sensory characteristics and microbiological safety during refrigerated storage.

Keywords: Chicken cutlets, oat flour, functional meat products, dietary fibre, refrigerated storage

Introduction

Consumer awareness regarding the relationship between diet and health has increased considerably in recent years, leading to a growing demand for functional foods that provide health benefits beyond basic nutrition. Functional meat products have emerged as an important category of value-added foods due to their potential to combine the nutritional advantages of meat with health-promoting ingredients derived from plant sources. The incorporation of dietary fibre-rich ingredients into meat products has gained significant attention as an effective strategy to improve nutritional quality, enhance technological properties, and meet consumer preferences for healthier food products (Verma *et al.*, 2012).

Chicken meat is widely consumed throughout the world because of its high nutritional value, excellent protein quality, low fat content, and desirable sensory characteristics. It serves as an important source of essential amino acids, vitamins, and minerals, making it an ideal raw material for the development of processed meat products. Among poultry products, chicken cutlets are highly popular owing to their convenience, palatability, and consumer acceptability. However, conventional chicken cutlets contain negligible amounts of dietary fibre, which has encouraged researchers to explore the incorporation of plant-based functional ingredients into meat formulations (Talukder and Sharma, 2010).

Oats (*Avena sativa*) are recognized as one of the most important functional cereal grains because of their rich nutritional composition and health-promoting properties. Oats contain significant amounts of soluble dietary fibre, particularly β -glucan, which has been reported to reduce serum cholesterol levels, improve glycaemic response, and promote gastrointestinal health. In addition, oats are a valuable source of proteins, vitamins, minerals, antioxidants, and bioactive compounds such as avenanthramides (Kumar *et al.*, 2016). Due to their excellent water-holding and fat-binding capacities, oats have been successfully incorporated into various meat products to improve cooking yield, texture, and nutritional quality (Serdaroglu, 2006) [22, 18, 22].

The incorporation of oats into meat products offers several technological and nutritional advantages. Dietary fibre from these cereal grains can improve water-holding capacity, cooking yield, texture, and storage stability while simultaneously reducing fat content and increasing fibre levels. Furthermore, the presence of bioactive compounds and antioxidants may contribute to improved shelf life and product quality during storage (Talukder and Sharma, 2010; Gupta *et al.*, 2017) [18, 6].

Considering the increasing consumer preference for healthier meat products and the nutritional potential of oats, the present investigation was undertaken to develop functional chicken cutlets incorporated with oat flour. The study aimed to evaluate the effects of different incorporation levels on physicochemical characteristics, proximate composition, sensory quality, microbiological quality, and refrigerated storage stability of the developed products.

2. Materials and methods

2.1 Procurement of Raw Materials

Broiler birds were culled and slaughtered by using halal method in the slaughter house. The dressed broiler carcasses were deboned by removing fat, tendons and connective tissue and the boneless chicken was used for the further use. The frozen deboned meat was drawn as per requirement and thawed overnight in a refrigerator (4±1°C) and were used for further study.

Oats (*Avena sativa*) were purchased from the local market of Anand and were grinded and made a fine powder in the department of Livestock Products Technology and was used for the further use and the other condiments and spices were also purchased from the local market of Anand. All the chemicals used in the study were purchased from standard firms (Hi media). Condiments mix was prepared by peeling off onion, ginger and garlic, cutting in to small pieces and mixing it in mixer in the ratio of 4:2:1.

2.2 Methodology for preparation of chicken meat cutlets

Frozen deboned chicken meat was thawed, trimmed, and cut into small pieces before being minced twice through a meat mincer fitted with a 6 mm diameter plate. The minced meat was subsequently used for the preparation of chicken cutlets. The formulation and preparation procedure were adopted with slight modifications from the method described by Singh *et al.*, (2014). Oat flour was incorporated separately at 5%, 10%, and 15% levels by partially replacing lean chicken meat in the cutlet formulation.

2.3 pH

The pH of chicken meat cutlets was determined by method of Trout *et al.*, (1992) [20].

2.4 Product yield

The product yield was calculated as:

$$\text{Cooking yield (\%)} = \frac{\text{Weight of cooked chicken cutlets}}{\text{Weight of raw chicken cutlets}} \times 100$$

2.5 Proximate composition

Moisture, crude protein, crude fat, crude fiber, ash and calcium content of chicken meat cutlets were determined by

standard procedure of Association of Office Chemist (AOAC, 1995) [1].

2.6 Microbiological analysis

Standard plate counts, Psychrophilic counts and Coliform counts were enumerated following the method described by American Public Health Association (APHA, 2001) [2].

2.7 Sensory evaluation

The sensory evaluation of the chicken meat cutlets was carried out by a panel of seven members from the College of Veterinary Science and Animal Husbandry, Anand. The samples were assessed for general appearance, flavour, juiciness, texture, and overall acceptability following the 8-point descriptive sensory scale described by Keeton (1983) [7], where a score of 8 indicated "extremely desirable" and a score of 1 indicated "extremely undesirable." Sensory evaluation was conducted in a well-illuminated room free from distracting noise and odours to ensure unbiased assessment. Plain drinking water was provided to the panelists for rinsing their mouths between successive samples to minimize any carry-over effects.

2.8 Statistical analysis

The experimental data generated from each trial were subjected to statistical analysis using Analysis of Variance (ANOVA), and treatment means were compared using Duncan's Multiple Range Test (DMRT) following the procedures described by Snedecor and Cochran (1994) [17]. Each experiment was conducted in three independent replicates, and all physicochemical and microbiological analyses were performed in duplicate, except for sensory evaluation, which was carried out by the sensory panel.

3. Results and discussion

Table 3.1: Effect of different levels of Oat on the quality parameters of the chicken cutlets

Treatment	pH%	Cooking yield%
T ₁	6.20±0.01 ^a	84.80±0.36 ^a
T ₂	6.14±0.01 ^{ab}	85.97±0.48 ^{ab}
T ₃	6.14±0.02 ^{ab}	87.43±0.62 ^b
T ₄	6.03±0.01 ^b	90.09±1.10 ^c
SEm±	0.01	0.511
F Value	7.84	9.701
P Value	<0.05	<0.05

Means bearing different superscripts within a column differ significantly ($P < 0.05$).

T₁- Control, T₂- Chicken cutlets with 5% Oats, T₃- Chicken cutlets with 10% Oats, T₄- Chicken cutlets with 15% Oats.

Oat flour incorporation significantly ($P < 0.05$) affected the pH and cooking yield of chicken cutlets (Table 3.1). The pH decreased from 6.20 in the control to 6.03 in the 15% oat treatment, whereas cooking yield increased from 84.80 to 90.09%. The reduction in pH may be attributed to the naturally occurring acidic constituents of oats, while the improvement in cooking yield is associated with the high water-binding capacity of oat β -glucan, which minimized moisture loss during cooking. Similar findings were reported by Talukder and Sharma (2010), Serdaroğlu (2006), Kumar *et al.*, (2011), and Gamit *et al.*, (2020) [18, 13, 8, 5].

Table 3.2: Effect of different levels of oats on the proximate composition of chicken cutlets

Treatment	Parameter				
	Moisture (%)	Crude Protein (%)	Crude Fat (%)	Ash (%)	Crude Fibre (%)
T ₁	61.70±0.21	20.83±0.44	11.90±0.06	2.02±0.04	0.19±0.01
T ₂	63.10±0.12	20.47±0.43	11.27 ^{bc} ±0.15	2.12±0.05	0.60 ^b ±0.04
T ₃	64.20±0.17	20.90±0.23	10.70 ^b ±0.17	2.28 ^b ±0.04	1.72 ^c ±0.04
T ₄	64.97 ^d ±0.15	19.81 ^b ±0.16	9.97 ^a ±0.18	2.43 ^c ±0.03	2.50 ^d ±0.02
SEm±	0.12	0.17	0.08	0.03	0.05
F value	33.139	27.701	22.992	30.829	97.244
P value	<0.05	<0.05	<0.05	<0.05	<0.05

Means bearing different superscripts within rows differ significantly ($P<0.05$).

T₁- Control, T₂- Chicken cutlets with 5% Oats, T₃- Chicken cutlets with 10% Oats, T₄- Chicken cutlets with 15% Oats. Significant ($P<0.05$) differences were observed in the proximate composition of oat-incorporated chicken cutlets (Table 3.2). Moisture, ash and crude fibre contents increased significantly with increasing levels of oat flour, whereas crude protein and crude fat decreased. The increase in moisture content can be attributed to the excellent water-holding capacity of oat dietary fibre, particularly β -glucan.

The reduction in protein and fat was mainly due to the replacement of lean meat with oat flour, while the increase in ash reflected the mineral-rich nature of oats. A marked increase in crude fibre demonstrated the nutritional enhancement of the developed product. Similar observations were reported by Kumar *et al.*, (2011), Verma *et al.*, (2012), Modi *et al.*, (2009), Naveen *et al.*, (2017), and Gamit *et al.*, (2020) [8, 22, 10, 12, 5].

Table 3.3: Effect of different levels of oat on the sensory characteristics of chicken cutlets

Treatment	Parameter				
	General appearance	Flavour	Texture	Juiciness	Overall acceptability
T ₁	8.00±0.05 ^a	8.00±0.04 ^a	7.90±0.06 ^a	8.00±0.04 ^a	7.95±0.05 ^a
T ₂	7.86±0.06 ^b	7.38±0.05 ^b	7.71±0.05 ^b	7.95±0.05 ^b	7.90±0.06 ^b
T ₃	6.71±0.07 ^c	7.24±0.06 ^c	7.33±0.06 ^c	7.76±0.06 ^c	7.50±0.05 ^c
T ₄	6.19±0.08 ^d	6.81±0.07 ^d	6.38±0.07 ^d	6.71±0.07 ^d	7.19±0.07 ^d
SEm±	0.06	0.05	0.06	0.06	0.05
F value	19.82	18.46	17.94	16.72	18.21
P value	$P<0.05$	$P<0.05$	$P<0.05$	$P<0.05$	$P<0.05$

Means bearing different superscripts within rows differ significantly ($P<0.05$).

T₁- Control, T₂- Chicken cutlets with 5% Oats, T₃- Chicken cutlets with 10% Oats, T₄- Chicken cutlets with 15% Oats. Sensory attributes were significantly ($P<0.05$) influenced by oat flour incorporation (Table 3.3). Although all treatments remained within the acceptable sensory range, scores for general appearance, flavour, texture, juiciness and overall acceptability decreased with increasing oat levels. The reduction in sensory scores at higher incorporation levels may be attributed to changes in colour, flavour profile and texture caused by the increased fibre content of oats. Nevertheless,

the 5% oat treatment exhibited sensory scores comparable to the control, indicating good consumer acceptability. Similar findings were reported by Talukder and Sharma (2010), Gupta *et al.*, (2017), and Gamit *et al.*, (2020) [18, 6, 5], who observed slight reductions in sensory scores with increasing cereal incorporation while maintaining acceptable product quality.

Effect of refrigerated storage ($4 \pm 1^\circ\text{C}$) on the quality of oat-incorporated chicken cutlets

Table 3.4: Effect of Oats on pH of chicken cutlets during refrigerated storage ($4 \pm 1^\circ\text{C}$)

Treatment	Refrigerated storage period(days)				Mean
	0	3	6	9	
	pH				
T ₁	6.20±0.01 ^a	6.18±0.01 ^a	6.13±0.01 ^b	6.09±0.01 ^c	6.15
T ₂	6.14±0.01 ^a	6.12±0.01 ^{ab}	6.08±0.02 ^b	6.02±0.01 ^c	6.09
T ₃	6.14±0.02 ^a	6.05±0.01 ^b	6.05±0.01 ^b	6.05±0.01 ^b	6.07
T ₄	6.03±0.01 ^a	6.03±0.01 ^a	6.02±0.01 ^a	5.95±0.01 ^b	6.01
Mean	6.13	6.10	6.07	6.03	6.08
	Days (A)		Treatment (B)		A X B
SEm±	0.01		0.02		0.03
F value	8.74		16.92		2.11
P value	$P<0.05$		$P<0.05$		$P<0.05$

Means bearing different superscripts within rows and column differ significantly ($P<0.05$).

T₁- Control, T₂- Chicken cutlets with 5% Oats, T₃- Chicken cutlets with 10% Oats, T₄- Chicken cutlets with 15% Oats. Refrigerated storage significantly ($P<0.05$) influenced the pH of oat-incorporated chicken cutlets (Table 3.4). A gradual

decline in pH was observed in all treatments from day 0 to day 9, with T₄ consistently exhibiting the lowest pH values. The decrease in pH during storage may be attributed to the production of acidic metabolites by spoilage microorganisms

and biochemical changes occurring within the meat matrix. Similar observations have been reported by Talukder and Sharma (2010), Kumar *et al.*, (2016), and Gupta *et al.*, (2017)

[18, 6] during refrigerated storage of fibre-enriched chicken product.

Table 3.5: Effect of oats on microbiological characteristics of chicken cutlets during refrigerated storage ($4\pm 1^\circ\text{C}$)

Treatment	Refrigerated storage period(days)				
	0	3	6	9	Mean
Standard plate count					
T ₁	2.58±0.02 ^d	3.28±0.03 ^c	3.87±0.03 ^b	4.14±0.04 ^a	3.47
T ₂	2.39±0.02 ^d	3.11±0.03 ^c	3.72±0.03 ^b	3.97±0.03 ^a	3.30
T ₃	2.36±0.02 ^d	3.08±0.03 ^c	3.66±0.03 ^b	3.92±0.03 ^a	3.25
T ₄	2.20±0.02 ^d	3.01±0.03 ^c	3.60±0.03 ^b	3.86±0.03 ^a	3.17
Mean	2.38	3.12	3.71	3.97	3.30
	Days (A)		Treatment (B)		A X B
SEm±	0.03		0.04		0.06
F value	87.66		84.16		3.28
P value	P<0.05		P<0.05		P<0.05
Psychrophilic count					
T ₁	2.58±0.02 ^d	3.28±0.03 ^c	3.87±0.03 ^b	4.14±0.04 ^a	3.47
T ₂	0.36±0.01 ^d	1.05±0.02 ^c	1.65±0.03 ^b	1.95±0.03 ^a	1.25
T ₃	0.20±0.01 ^d	0.99±0.02 ^c	1.59±0.03 ^b	1.89±0.03 ^a	1.17
T ₄	0.10±0.01 ^d	0.91±0.02 ^c	1.54±0.03 ^b	1.83±0.03 ^a	1.10
	Days (A)		Treatment (B)		A X B
SEm±	0.02		0.03		0.05
F value	92.84		48.61		3.47
P value	P<0.05		P<0.05		P<0.05
Coliform count					
T ₁	ND	ND	ND	ND	ND
T ₂	ND	ND	ND	ND	ND
T ₃	ND	ND	ND	ND	ND
T ₄	ND	ND	ND	ND	ND

Means bearing different superscripts within rows and column differ significantly ($P<0.05$).

T₁- Control, T₂- Chicken cutlets with 5% Oats, T₃- Chicken cutlets with 10% Oats, T₄- Chicken cutlets with 15% Oats. Standard Plate Count (SPC) and psychrophilic count increased significantly ($P<0.05$) throughout refrigerated storage (Table 3.5), indicating gradual microbial proliferation. The comparatively lower microbial load in oat-containing products may be attributed to the presence of phenolic compounds and antioxidant constituents naturally present in oats, which could have contributed to delayed microbial growth. Similar trends have been reported by Najeeb *et al.*, (2014), Bhat *et al.*, (2015), and Thomas *et al.*, (2007) [11, 4, 19], who observed progressive increases in

microbial counts during refrigerated storage of chicken products.

Coliform bacteria were not detected in any treatment throughout the refrigerated storage period. The absence of coliforms indicates satisfactory hygienic quality of the product and effectiveness of the cooking process in eliminating these microorganisms. Proper sanitation during processing, handling, packaging, and storage also contributed to maintaining microbiological safety. Similar findings have been reported by Bhat *et al.*, (2014) and Malav *et al.*, (2015) [3, 9], who observed no detectable coliforms in refrigerated meat products prepared under hygienic processing conditions.

Table 3.6: Effect of oats on general appearance of chicken cutlets during refrigerated storage ($4\pm 1^\circ\text{C}$)

Treatment	Refrigerated storage period(days)				Mean
	0	3	6	9	
T ₁	8.00 $\pm$ 0.00 ^a	7.90 $\pm$ 0.22 ^a	6.90 $\pm$ 0.31 ^b	6.20 $\pm$ 0.41 ^c	7.25
T ₂	8.00 $\pm$ 0.00 ^a	8.00 $\pm$ 0.00 ^a	7.20 $\pm$ 0.35 ^{ab}	6.40 $\pm$ 0.38 ^{bc}	7.40
T ₃	7.70 $\pm$ 0.22 ^b	7.30 $\pm$ 0.34 ^b	7.10 $\pm$ 0.28 ^b	6.10 $\pm$ 0.44 ^c	7.05
T ₄	8.00 $\pm$ 0.00 ^a	8.00 $\pm$ 0.00 ^a	7.50 $\pm$ 0.26 ^a	6.60 $\pm$ 0.30 ^b	7.53
Mean	7.93	7.80	7.18	6.33	7.31
Days (A) Treatment (B) A X B					
SEm $\pm$	0.08	0.09	0.03		
F value	42.61	5.94	2.84		
P value	<0.05	<0.05	<0.05		

Means bearing different superscripts within rows and columns differ significantly ($P<0.05$). T₁- Control, T₂-

Chicken cutlets with 5% Oats, T₃- Chicken cutlets with 10% Oats, T₄- Chicken cutlets with 15% Oats.

Sensory scores decreased significantly ($P<0.05$) during refrigerated storage (Table 3.6). General appearance, flavour, texture, juiciness, and overall acceptability gradually declined from day 0 to day 9, although all treatments remained within the acceptable sensory range. The reduction in sensory quality may be attributed to progressive physicochemical and microbiological changes occurring during storage, including moisture loss, lipid oxidation, and microbial activity. Similar observations have been reported by Talukder and Sharma (2010), Gupta *et al.*, (2017), and Kumar *et al.*, (2016)^[18, 6], who reported a gradual decline in sensory acceptability of oat-incorporated chicken products during refrigerated storage.

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