

## Quality Evaluation of Ready-to-Cook Marinated and Enrobed Chicken Drumsticks at Frozen Storage

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**ABSTRACT:** In India, poultry is one of the fastest-growing agricultural sector. The growth in the broiler segment is expected to remain strong due to consumer preference for chicken meat, increasing income levels, and changing food habits. The development of the meat processing industry causes a change in consumer lifestyles and preferences. Our lifestyle habits have shifted toward ready-to-cook products due to the ease of cooking they offer and consumers are not satisfied with traditional meat products. Marinated chicken and enrobed chicken meat is a popular product among consumers. The present study was conducted to evaluate the quality of ready-to-cook marinated and enrobed chicken drumsticks at frozen storage. The quality parameters like physicochemical, microbiological and sensory evaluation were analysed on 0 day and 15, 30, 45 and 60 days under frozen storage at  $-18\pm 0^{\circ}\text{C}$ . Marinated and enrobed chicken drumsticks samples were prepared and packaged in a Polyvinyl chloride tray. It was observed that during frozen storage, pH, TBARS Value and tyrosine value were increased significantly ( $P<0.05$ ). The shear force value between 0 day and during storage days showed a significant ( $P<0.05$ ) difference. There was a significant ( $P<0.05$ ) difference in total plate count (TPC), Psychrophilic count (PC) and yeast and mould count (YMC) during storage of ready-to-cook marinated and enrobed chicken drumsticks. During storage periods at frozen storage, the TPC decreased while the psychrophilic counts increased. *E. coli* and *Salmonella* counts were not detected during entire storage period. The analysis of variance between the storage days exhibited significant ( $P<0.05$ ) difference for sensory scores viz., appearance & colour, flavour, texture, crispiness and coating adhesion, juiciness, and overall acceptability. Based on the findings, it was concluded that at frozen storage ready-to-cook marinated and enrobed chicken drumsticks could be stored for up to 60 days without any deteriorative changes.

**Keywords:** Chicken meat, chicken drumsticks, quality evaluation, frozen storage and convenient meat products.

### INTRODUCTION

Poultry meat is a very popular food commodity around the world because of its high nutritional value and low cost (Barbut, 2002; Muthulakshmi, 2022). Poultry products are available on the market in different forms. There is a significant increase in consumer demand towards ready-to-cook and ready-to-eat food products. Among these products, ready-to-cook marinated chicken products are very popular (Smith and Acton 2001). However, fresh poultry products are highly perishable. They have short shelf lives due to microbial spoilage and lipid oxidation (Patsias *et al.*, 2008). Marination is traditionally used to tenderise and improve meat products' flavour (Smith and Acton 2001). Marination can be applied by adding the natural ingredients by soaking the marinade in food, the main purpose is to increase the shelf life (Yusop *et al.*, 2010).

In addition, the antimicrobial properties of spices, low pH and high NaCl concentration in marinade can be highly significant in preventing the growth of spoilage bacteria. Enrobing is the process of making further

processed products by applying an edible coating to the products. It improves the product's texture, and consumer acceptability and remarkably reduces the product cost. Enrobing also contributes other benefits like preserving the nutritive value, reducing moisture and weight loss, improve juiciness and tenderness. (Biswas and Keshri 2003). These improvements are brought about by coating ingredients that act as sealants and also prevent high oil uptake during the frying of the products. Recently, the quality of emu meat cutlets with beef and chicken meat cutlets was assessed by Karthik *et al.* (2023) which is an enrobed meat products. According to Barbut *et al.*, (2015) freezing meat at temperatures below  $-12^{\circ}\text{C}$  can increase the shelf life of a product by inhibiting microbial growth. Developing methods to increase shelf life and overall safety/quality is required for its commercial production. The objective of the present research is to assess the quality of ready-to-cook marinated and enrobed chicken drumsticks at frozen storage.

## MATERIAL AND METHODS

Chicken drumsticks and ingredients for marination were purchased from a local supermarket. Chicken drumsticks were dipped in a marinade at 4°C for 12 h. For the one Kg of chicken drumstick, the marinade was prepared by mixing curd (50 g) salt (10 g) fresh ginger garlic paste (100 g) coriander powder (2 g), spice mix (6 g), rice flour (3 g), lemon 5 drops. After marinating the samples were coated with batter containing beaten egg -2 nos, salt- 0.75 g spice mix -1.5 g, sesame seed- 5 g suji- 12.5 g and breaded with corn flax -30 g. After completion of batter and breading the samples were frozen individually and packed into polystyrene tray pack. The packed samples were stored at -18±1°C and analysed for physico-chemical, microbial and sensory qualities on the 15<sup>th</sup>, 30<sup>th</sup>, 45<sup>th</sup> and 60<sup>th</sup> day.

### Physico-chemical characteristics

**pH.** The assessment of pH of the marinated and enrobed chicken drumsticks samples was determined as per Trout *et al.* (1992). About 5g of were homogenised with 45 ml of distilled water in a laboratory blender for about one minute. The pH was recorded by immersing the combined glass electrode of a digital pH meter (Model 361, M/s Systronics, India).

**Cooking loss.** The weight of frozen and thawed samples was recorded before and after cooking and the loss was expressed in percentage .

Cooking loss (per cent) =

$$\frac{\text{Initial weight} \times \text{Weight after cooking}}{\text{Initial weight}} \times 100$$

**Shear force value.** The shear force values of marinated and enrobed chicken drumsticks were assessed at three different points using Warner - Bratzler meat shear (M/s G. R. Electric manufacturing company, Model No.04347, Manhattan, USA). Three readings were taken from each core. The average of the five readings was recorded as the mean shear force required shearing through the core and expressed in kg/cm<sup>2</sup>.

### Thiobarbituric acid reactive substance (TBARS).

The TBARS of marinated and enrobed chicken drumsticks were determined by using the extraction method as per Witte *et al.* (1970) with slight modifications. 50 ml of chilled 20% TCA was added to 20g of meat sample. The absorbance value was measured at 532 nm using a spectrophotometer. TBARS value was expressed as mg malonaldehyde /Kg of meat. The 1,1,3,3-tetraethoxypropane (TEP) was used as standard in the concentration of standard 1µg/ml to 5 µg/ml).

**Tyrosine value.** The procedure of Strange *et al.* (1977) was followed with slight modifications for estimation of tyrosine value. 2 g of meat was added to 10 ml of chilled 20% TCA, homogenized in a vortex mixer for 2 min, allowed to stand for 10 min and then filtered through Whatmann filter paper No. 42. 2.5 ml of filtrate was added to 2.5 ml of distilled water and 10 ml freshly prepared 0.5 N NaOH. The tubes were allowed to stand for 10 min. 3 ml of Folin Ciocalteu reagent was added and allowed to stand for 30 min for the development of dark colour. The optical density

was measured at 730 nm and tyrosine value was calculated using the following formula

Tyroside (mg pr 100 g) =

$$\frac{\text{O.D. of unknown} \times \text{Conc. of standard} \times 10 \times 100}{\text{O.D. of standard} \times 2.5 \times 2 \times 1000}$$

**Microbial quality.** Total viable count & Psychrophilic, Yeast and mould count, *Salmonella spp*, *E.coli* and *Staphylococcus aureus* count were estimated using Plate Count Agar, Sabouraud dextrose agar, Xylose-Lysine Deoxycholate Agar (XLD), Eosin-Methylene Blue, and Mannitol salt agar, respectively, in raw and cooked meat samples as per APHA (1984). A 10g of meat sample was added with 90 ml of buffered peptone water and triturated by pestle and mortar. One millilitre of this triturated sample was taken and added to 9 ml of peptone water in a test tube and ten fold serial dilutions were made. Duplicate 0.1 ml volume of inoculum of suitable dilutions were spread using sterile 'L' shaped spreader over the surface of pre-poured Petri dishes. The plates were incubated, then the colonies were counted and expressed as log<sub>10</sub>cfu/gram of meat sample.

**Sensory quality.** Sensory evaluation of deep fat fried marinated and enrobed chicken drumsticks was conducted by semitrained panellists at the Department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal, Tamil Nadu-637 002 by using the eight-point hedonic scale. Panellists were instructed to cleanse their palates with water between analysis of samples.

## RESULT AND DISCUSSION

### Physico chemical characteristics of marinated and enrobed chicken drumsticks stored at -18±1°C

**Ph.** In frozen storage, the mean ± SE of pH of marinated and enrobed chicken drumsticks stored on 0, 15, 30, 45, and 60 days were 5.59±0.01, 5.72±0.01, 5.78±0.01, 5.90±0.01 and 6.07±0.02, respectively. The results showed a significant difference (p<0.05) in pH value of marinated and enrobed chicken drumsticks between storage periods. The increasing in pH value during storage periods may be due to the increasing level of the bacterial population in marinated and enrobed chicken drumsticks. The increase of pH is related to the release of bound water to be free water and promote the growth of microorganisms. According to Sharma *et al.* (2017), the higher value of pH indicates an increase in the population of microorganisms in meat. Moreover during prolonged frozen storage, pH increase was noticed due to the release of free amino acids and dipeptides as a result of proteolysis and due to changes in solutes concentration caused by icer ecrystallization . In concurrent with the results of present study, many researchers (Fletcher *et al.*, 2000; Abinaya, 2016) reported increase in the pH of various meat products with the progress of the storage period.

**SFV.** In frozen storage, the mean ± SE of SFV of marinated and enrobed chicken drumsticks stored on 0, 15, 30, 45, and 60 days were 2.62±0.01, 2.57±0.01, 2.56±0.01, 2.55±0.01 and 2.55±0.01, respectively. The results showed a significant difference (p<0.05) in SFV

value of marinated and enrobed chicken drumsticks between 0 day and storage periods. Aziz *et al.* (2020) studied the effect of storage temperatures (4°C, -10°C, -18°C and -40°C) for two different storage durations on shear force values (kg) of *pectoralis major* muscle in broiler chickens at 24 hours were 1.652, 1.636, 1.628, 1.594 and 72 hours were 1.48, 1.458, 1.446, 1.43, respectively. A decrease in the shear force value of 0.19 (kg/cm<sup>2</sup>) was noticed upon comparison of fresh

meat with 12 months stored broiler meat by Sivakumar (2021) Physical damage caused lower shear force values in frozen pork meat than in unfrozen control meat (Tippala *et al.*, 2021; Yun, Young-Chan *et al.*, 2021). However, the decrease in shear force with the freezing rate was not explained by physical damage because the damage was believed to be attributed to ice crystal size.

**Table 1: Physico chemical characteristics of marinated and enrobed chicken drumsticks stored at -18±1°C.**

Physico chemical characteristics	0 day	15 <sup>th</sup> day	30 <sup>th</sup> day	45 <sup>th</sup> day	60 <sup>th</sup> day	Overall treatment mean
pH	5.59±0.01 <sup>a</sup>	5.72±0.01 <sup>b</sup>	5.78±0.01 <sup>c</sup>	5.90±0.01 <sup>d</sup>	6.07±0.02 <sup>e</sup>	5.81±0.03
SFV (Kg/cm <sup>2</sup> )	2.62±0.01 <sup>b</sup>	2.57±0.01 <sup>a</sup>	2.56±0.01 <sup>a</sup>	2.55±0.01 <sup>a</sup>	2.55±0.01 <sup>a</sup>	2.57±0.01
TBARS Value (mg malonaldehyde /kg)	0.110.00 <sup>a</sup>	0.17±0.01 <sup>b</sup>	0.24±0.01 <sup>c</sup>	0.41±0.02 <sup>d</sup>	0.60±0.01 <sup>e</sup>	0.30±0.03
Tyrosine value (mg/100g)	3.21±0.02 <sup>a</sup>	4.71±0.01 <sup>b</sup>	5.18±0.06 <sup>c</sup>	5.82±0.01 <sup>d</sup>	6.30±0.03 <sup>e</sup>	5.02±0.03

Mean ± SE with at least one common superscript within classes do not differ significantly (p>0.05). n =6 for each treatment.

**TBARS Value.** The major threat to the quality of chicken meat has been recognized as lipid oxidation (Min *et al.*, 2008). Lipid oxidation affects the changes of aroma, colour, texture, taste, and it is responsible for reducing shelf life, which are important reasons for consumer rejection (Lima *et al.*, 2013). In frozen storage, the mean ± SE of TBARS Value of marinated and enrobed chicken drumsticks stored on 0, 15, 30, 45, and 60 days were 0.11, 0.17±0.01, 0.24±0.01, 0.41±0.02 and 0.60±0.01, respectively between storage periods. During storage, increase in TBARS of products could be due to increased oxidation of lipids and volatile metabolites production in the presence of oxygen during aerobic storage (Sharma *et al.*, 2014). Similar results were observed in chicken tikka (Bharti *et al.*, 2011), dietary fibre enriched chicken meat balls Santhi (2014) chicken meat blocks (Malav *et al.*, 2014), chicken balls (Vasanthi, 2021) chicken breast (Febrianta, 2021) and chicken pickle (Muthulakshmi *et al.*, 2022).

**Tyrosine value.** In frozen storage, the mean ± SE of TBARS Value of marinated and enrobed chicken drumsticks stored on 0, 15, 30, 45, and 60 days were 3.21±0.02, 4.71±0.01, 5.18±0.06, 5.82±0.01 and 6.30±0.03, respectively between storage periods. Sonale *et al.* (2014); Sivakumar (2021) reported that tyrosine values of frozen stored quail breast meat and chicken meat had increased gradually up to 60<sup>th</sup> day and 12 months of storage period, respectively. Similar trends were observed in quail tandoori (Abinaya, 2016), buffalo meat sausages (Muthulakshmi *et al.*, 2020) and chicken balls (Vasanthi, 2021).

**Microbial quality of marinated and enrobed chicken drumsticks stored at -18±1°C.** In the present study, there was significant (P≤0.01) decrease in TVC between 0 day and storage period. The results were in agreement with buffalo meat sausage (Muthulakshmi *et al.*, 2020); Praveen Kumar *et al.*, 2020). The number of psychrophiles in fresh marinated and enrobed chicken drumsticks was estimated to be 2.23±0.02 (log<sub>10</sub> cfu/g) of meat.

**Table 2: Microbial quality (log<sub>10</sub> cfu/g) of marinated and enrobed chicken drumsticks stored at -18±1°C.**

Microbial quality	0 day	15 <sup>th</sup> day	30 <sup>th</sup> day	45 <sup>th</sup> day	60 <sup>th</sup> day	Overall treatment mean
Total plate count	3.13±0.02 <sup>b</sup>	2.91±0.01 <sup>a</sup>	2.91±0.02 <sup>a</sup>	2.93±0.02 <sup>a</sup>	2.98±0.01 <sup>a</sup>	2.97±0.02
Psychrophilic count	2.23±0.02	2.29±0.04	2.65±0.02	2.91±0.01	3.11±0.01	2.64±0.06
Yeast and mould count	1.54±0.01 <sup>a</sup>	1.80±0.01 <sup>b</sup>	2.07±0.02 <sup>c</sup>	2.44±0.01 <sup>d</sup>	2.69±0.01 <sup>e</sup>	2.11
<i>Staphylococcus</i> count	ND	ND	ND	ND	ND	ND
<i>Salmonella</i>	ND	ND	ND	ND	ND	ND
<i>E. coli</i>	ND	ND	ND	ND	ND	ND

Mean ± SE with at least one common superscript within classes do not differ significantly (p>0.05). n =6 for each treatment

During frozen storage study, the *psychrophilic* count increased from 2.23±0.02 (log<sub>10</sub> cfu/g) to 3.11±0.01 (log<sub>10</sub> cfu/g) of marinated and enrobed chicken drumsticks at the end of frozen storage period (Table 3). Present study result concurred with results of Praveen Kumar *et al.* (2020). Psychrophilic and

psychrotrophic microorganisms are generally more tolerant to freezing and frozen storage due to their ability to synthesize larger amounts of enzymes to compensate for reduced enzymic activity at low temperatures, and their reduced susceptibility to cold shock in comparison to thermophiles and mesophiles

(James and James 2014).

The number of yeast and mould count in fresh marinated and enrobed chicken drumsticks was estimated to be  $1.54 \pm 0.01$  ( $\log_{10}$  cfu/g). During frozen storage study, the yeast and mould count increased from  $1.54 \pm 0.01$  ( $\log_{10}$  cfu/g) to  $2.69 \pm 0.01$  ( $\log_{10}$  cfu/g) of marinated and enrobed chicken drumsticks at the end of frozen storage period (Table 2). International Commission on Microbiological Specifications for Foods confirmed that frozen poultry typically does not undergo microbial spoilage. They also determined that

storage temperature should be controlled to prevent fluctuation, which directly affects microbial growth (ICMSF, 2011). As per the Food Safety Standards Authority of India, the yeast and mould count in frozen meat should be less than  $3 \log_{10}$  cfu/g (FSSAI, 2012). In the present study, the yeast and mould count was within the limits of the Food Safety and Standard Authority of India. In the present study, the *Staphylococcus* count, *Salmonella* and *E. coli* was not detected in fresh meat and also through the storage period of 60 days.

**Table 3: Sensory qualities of marinated and enrobed chicken drumsticks stored at  $-18 \pm 1^\circ\text{C}$ .**

Sensory quality	Storage period (day)					Overall treatment mean
	0	15	30	45	60	
Appearance	$7.53 \pm 0.02^d$	$7.18 \pm 0.01^c$	$7.08 \pm 0.01^b$	$7.02 \pm 0.01^a$	$7.01 \pm 0.01^a$	$7.17 \pm 0.04$
Flavour	$7.3 \pm 0.02^d$	$7.33 \pm 0.02^d$	$7.19 \pm 0.02^c$	$7.02 \pm 0.01^b$	$6.87 \pm 0.01^a$	$7.14 \pm 0.03$
Juiciness	$7.51 \pm 0.01^e$	$7.37 \pm 0.04^d$	$7.15 \pm 0.02^c$	$6.84 \pm 0.01^b$	$6.7 \pm 0.03^a$	$7.11 \pm 0.06$
Texture	$7.12 \pm 0.05^c$	$7.22 \pm 0.04^b$	$7.08 \pm 0.02^b$	$7.06 \pm 0.02^b$	$6.93 \pm 0.03^a$	$7.08 \pm 0.02$
Crispiness	$7.55 \pm 0.03^e$	$7.38 \pm 0.06^d$	$7.26 \pm 0.02^c$	$6.96 \pm 0.04^b$	$6.77 \pm 0.04^a$	$7.19 \pm 0.05$
Over all acceptability	$7.47 \pm 0.08^c$	$7.34 \pm 0.04^c$	$7.07 \pm 0.02^b$	$6.85 \pm 0.06^a$	$6.76 \pm 0.08^a$	$7.1 \pm 0.06$

Mean  $\pm$  SE with at least one common superscript within classes do not differ significantly ( $p > 0.05$ ).  $n = 6$  for each treatment

The sensory qualities of marinated and enrobed chicken drumsticks are presented in table 3. The analysis of variance between the storage days exhibited significant ( $P < 0.05$ ) difference for sensory scores viz., appearance & colour, flavour, texture, crispiness and coating adhesion, juiciness, and overall acceptability. Similar results were observed in chicken tikka (Bhattacharyya *et al.*, 2013) chicken meat rings (Mishra *et al.*, 2015) dietary fibre enriched chicken meat balls Santhi (2014) chicken meat blocks (Malav *et al.*, 2014), chicken balls (Vasanthi, 2021) chicken breast (Febrianta 2021) and chicken pickle (Muthulakshmi *et al.*, 2022).

## CONCLUSIONS

From this study, frozen storage of ready-to-cook marinated and enrobed chicken drumsticks would be recommended in order to preserve physico-chemical, microbiological and sensory qualities for up to 60 days. However, it was accompanied by good handling processes and maintained at hygienic conditions.

## FUTURE SCOPE

Chicken meat and meat products are a very popular food commodity worldwide, as chicken meat is characterized by rich protein, low fat, low cholesterol content and high biological value. Due to consequence of urbanization, an increase in the number of working women folks, lack of time for cooking and less preference for traditional meat products at home lead to demand for ready-to-cook chicken meat products. The scope of this research project covers all aspects of the commercial development of marinated and enrobed chicken drumsticks including stability and sensory properties. Present results are sufficient for the commercial processing of marinated and enrobed chicken drumsticks.

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**Conflict of Interest.** None.

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