



ISSN: 2456-2912

NAAS Rating (2026): 4.61

VET 2026; 11(8): 102-108

© 2026 VET

www.veterinarypaper.com

Received: 05-06-2026

Accepted: 08-07-2026

Nalini P

Assistant Professor, Department of Livestock Products Technology, Veterinary College and Research Institute, Udumalpet, Tamil Nadu, India

Chandirasekaran V

Department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal, Tamil Nadu, India

Rajkumar R

Department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal, Tamil Nadu, India

Krishnakumar S

Department of Veterinary Public Health and Epidemiology, Veterinary College and Research Institute, Udumalpet, Tamil Nadu, India

Arthanarieswaran M

Department of Veterinary Microbiology, Veterinary College and Research Institute, Udumalpet, Tamil Nadu, India

Muthulakshmi M

Department of Livestock Products Technology (Meat Science), Veterinary College and Research Institute, Namakkal, Tamil Nadu, India

Vasanthi C

Department of Livestock Products Technology, Veterinary College and Research Institute, Tirunelveli, Tamil Nadu, India

Satheesh Raja S

Assistant Professor, Department of Livestock Products Technology, Veterinary College and Research Institute, Udumalpet, Tamil Nadu, India

Corresponding Author:

Nalini P

Assistant Professor, Department of Livestock Products Technology, Veterinary College and Research Institute, Udumalpet, Tamil Nadu, India

Study on the effect of pre-treatment on the colour and proximate composition of freeze-dried chicken breast meat chunks

Nalini P, Chandirasekaran V, Rajkumar R, Krishnakumar S, Arthanarieswaran M, Muthulakshmi M, Vasanthi C and Satheesh Raja S

DOI: <https://www.doi.org/10.22271/veterinary.2026.v11.i8b.3713>

Abstract

The present study was conducted to evaluate the effect of pre-treatment on the colour and proximate composition of freeze-dried chicken breast meat chunks. Boneless chicken breast meat was cut into 2.0 cm chunks and subjected to four pre-treatments, namely control (T₁), treatment with 0.25% turmeric powder (T₂), blanching at 90 °C for 2 min (T₃) and cooking to an internal temperature of 75 °C (T₄). The meat chunks were frozen at -40 °C for 12 h subsequently freeze-dried for 10 h with the condenser maintained between -70 and -80 °C and the chamber pressure below 10 P. The proximate composition and instrumental colour characteristics of the resulting products were evaluated. Significant differences ($P < 0.001$) were observed among the treatments for moisture, crude protein, ether extract, total ash and nitrogen-free extract. Moisture content ranged from 3.22 to 4.05%, with the highest value observed in turmeric-treated samples (T₂), while cooked samples (T₄) recorded the lowest value. Crude protein content was highest in the cooked treatment (92.13%), followed by blanched (90.10%) and turmeric-treated (89.20%) samples, compared with 87.35% in the control. Ether extract decreased from 3.73% in the control to 3.11% in cooked samples, whereas total ash increased from 4.03% to 5.55%. NFE was highest in the control (3.38%) and lowest in cooked samples (0.73%). Crude fibre was not detected in any treatment. Pre-treatment also significantly influenced L*, a*, b* and chroma (C*) values ($P < 0.001$). Turmeric treatment produced the lowest lightness (77.35) but markedly increased redness (8.30), yellowness (44.40) and chroma (45.22), indicating a more intense yellow colour. In contrast, cooked samples exhibited the highest lightness (86.98) and the lowest redness (1.35), yellowness (10.23) and chroma (10.33). Hue angle did not differ significantly among treatments ($P = 0.198$). The findings revealed that pre-treatment significantly affected the nutritional composition and colour characteristics of freeze-dried chicken breast meat chunks. Turmeric treatment enhanced the intensity of yellow colour, while cooking increased protein and ash contents and decreased ether extract and nitrogen-free extract (NFE) contents.

Keywords: Freeze-drying, turmeric, blanching, cooking, proximate, colour

1. Introduction

Chicken is the most widely produced and consumed source of animal protein worldwide, and consumer demand increasingly favours ready-to-cook and ready-to-eat formats that combine nutritional quality with convenience and an extended shelf life (Mancini *et al.*, 2015; Nassar, 2026)^[13, 18]. Dried meat products occupy an important position in this segment, and the type of meat, the ingredients added and the drying technology adopted are all recognised as major determinants of the physicochemical, microbial and sensory quality of the finished product (Mediani *et al.*, 2022)^[14].

Freeze-drying is regarded as the gentlest of the available dehydration routes, since water is removed by sublimation from the frozen state and liquid water is never formed. The process minimises thermal degradation, shrinkage and structural collapse and yields a highly porous product with rapid rehydration, retained nutritional value and good ambient storage stability (Ratti, 2001; Ciurzyńska & Lenart, 2011; Nowak & J akubczyk, 2020)^[21, 4, 20].

Loskota *et al.* (2023) ^[11] reported final moisture levels of 2-5%, removal of 90-98% of the original water and retention of up to 95% of vitamins, enzymes and other labile constituents in freeze-dried meat, while Ma *et al.* (2018) ^[12] observed that the residual moisture is distributed uniformly through the matrix, which contributes to the extended ambient shelf life obtainable under vacuum or nitrogen packaging.

These advantages are accompanied by a structural consequence. Sublimation vacates the spaces previously occupied by ice crystals, and the porous matrix that remains presents a greatly enlarged surface to atmospheric oxygen. Mediani *et al.* (2022) ^[14] recorded peroxide values of 83.3 mEq per kg in freeze-dried meat as against 20.8 mEq per kg in air-dried material, identifying oxidative rancidity as the characteristic vulnerability of the format. The same porosity governs the appearance of the dried piece, since the colour recorded by an instrument reflects both the light scattered from a dry cavernous surface and the oxidation state of the residual myoglobin. Messina *et al.* (2016) ^[15] obtained highly significant differences in every colour coordinate of freeze-dried bovine muscle across a range of freezing temperatures and drying times, and attributed the rise in lightness to denatured and shrunken myofibrils scattering more light. Yu *et al.* (2026) ^[26], comparing chicken, pork and beef dried under identical conditions, found chicken to be consistently the brightest and the least red of the three.

Compositional changes during freeze-drying arise from a simpler cause. Because drying removes water and leaves the remaining constituents largely unaltered, every non-aqueous fraction is concentrated by the same factor. Lee *et al.* (2021) ^[9] recorded an increase in crude protein from 19.72% in freeze-thawed pork to 70.10% in the corresponding dried powder, while Juknienė *et al.* (2022) ^[8] detected no significant change in either protein or fat attributable to lyophilization itself and concluded that the technique preserves nutritional value. The influence of the step immediately preceding freezing has received considerably less attention. Marination, blanching and pre-cooking are all routine operations in convenience meat manufacture and each acts on the muscle in a different manner, one depositing pigment on the surface, one denaturing the outer layers briefly and one cooking the piece through. Their comparative consequences for the colour and composition of a lyophilized product have not been documented systematically and the available data rest largely on bovine muscle, porcine powders and mixed ready meals, freeze-dried chicken breast being sparsely represented despite the commercial dominance of poultry.

The present study was therefore undertaken with the objective of determining how far and in what direction four commonly applied pre-treatments, namely a turmeric treatment, blanching and cooking, together with an untreated control, alter the CIE L*a*b* colour coordinates and the proximate constituents of freeze-dried chicken breast meat chunks, so that the visual and compositional consequences of each pre-treatment are placed on record.

2. Materials and Methods

2.1 Source of meat

Hygienically slaughtered fresh boneless broiler chicken breast meat was procured from a commercial poultry processing plant near Udumalpet, Tamil Nadu, India.

2.2 Experimental design

Chilled, conditioned boneless breast meat was hand-cut into chunks of 2.0 cm x 2.0 cm. A completely randomised design

was adopted to compare four pre-treatments, each replicated six times (n = 6 per treatment; N = 24 in total):

- **T₁:** control meat chunks that received no pre-treatment and were lyophilized as such.
- **T₂:** meat chunks to which turmeric powder was applied at 0.25 per cent, followed by lyophilization.
- **T₃:** meat chunks given a blanching treatment at 90 °C for 2 min, followed by lyophilization.
- **T₄:** meat chunks heated until a core temperature of 75 °C was attained, followed by lyophilization.

Every sample was dried in one and the same freeze-drying run under identical settings, ensuring that any difference recorded between groups arose solely from the pre-treatment applied.

2.3 Pre-treatment procedures

2.3.1 Fresh meat (T₁)

Untreated fresh boneless broiler breast chunks served as the control. These samples went straight to freezing and were thereafter freeze-dried.

2.3.2 Turmeric treatment (T₂)

Turmeric powder was applied to fresh boneless broiler breast chunks at a level of 0.25 percentage. Turmeric finds frequent use as a natural adjunct in meat processing because of its antioxidant activity and its bearing on colour and cooking loss (Mancini *et al.*, 2015) ^[13]; curcumin, the major bioactive polyphenol of the spice, has likewise been reported to delay oxidative deterioration and to enhance colour stability in products such as vacuum-packaged pork meatloaf (Draszanowska *et al.*, 2022) ^[6]. The treated chunks were then laid out in one uniform layer over freezing trays and frozen ahead of lyophilization.

2.3.3 Blanching (T₃)

Blanching was carried out by dipping fresh boneless broiler breast chunks in hot water held at 90 °C for 2 min, an operation routinely applied to inactivate enzymes and to stabilize colour and texture before subsequent processing (Fellows, 2017) ^[7]. The chunks were thereafter plunged without delay into chilled water at 4 ± 1 °C so as to halt residual heating, drained free of adhering surface moisture and frozen ahead of lyophilization.

2.3.4 Cooking (T₄)

Fresh boneless broiler breast chunks were heated in hot water until a calibrated digital probe thermometer registered a core temperature of 75 °C. Thereafter the chunks were drained, left to equilibrate to ambient temperature, spread on freezing trays and frozen ahead of lyophilization.

2.4 Freezing

Both untreated and pre-treated breast meat samples were spread as a single layer over stainless steel trays that had been lined with butter paper, the lining being used to keep the pieces from sticking to the tray surface. The loaded trays were held in a blast freezer at -40 °C for 12 h so that freezing was complete before lyophilization commenced.

2.5 Freeze-drying

Standardisation of the freeze-drying schedule drew on the principles outlined by Ratti (2001) ^[21] and Fellows (2017) ^[7], with appropriate modifications. Once frozen, the chunks were distributed evenly as a single layer over the trays of a freeze dryer (Model FD50, ANM Industries, Mumbai, India) and shifted without delay into the drying chamber so that thawing was kept to a minimum. Condenser temperature was held

between -70 and -80 °C and chamber pressure below 10 Pa, both falling within the ranges advocated for food-grade freeze-drying (Nowak & Jakubczyk, 2020) [20]. Uniformity of layer thickness and of piece dimensions was maintained across replicates, given that thickness governs the conditions needed to obtain freeze-dried poultry meat matching the quality of the fresh material (Babić *et al.*, 2009) [3]. Drying was continued for 10 h for all samples under these standardised settings.

2.6 Analytical methods

2.6.1 Colour

Colour readings were taken as per Navneet and Kshitij (2011) on a Lovibond LC 100 spectrophotometer (Lovibond, Germany), which was calibrated prior to use against the black and white reference tiles supplied by the manufacturer. Values were recorded in the CIE $L^*a^*b^*$ system, where L^* expresses lightness along a black-to-white scale of 0-100, a^* the green-to-red axis and b^* the blue-to-yellow axis. From a^* and b^* , chroma (C^*) and hue angle (h^*) were derived as $C^* = (a^{*2} + b^{*2})^{0.5}$ and $h^* = \tan^{-1}(b^*/a^*)$, the latter being expressed in degrees.

2.6.2 Proximate composition

Proximate constituents were estimated following the methods of AOAC (1995). Moisture was assessed by overnight oven drying at 105 °C and is expressed on an as-is basis, whereas crude protein, crude fibre, ether extract and total ash are expressed on a dry-matter basis. Nitrogen was determined through Kjeldahl digestion and distillation (FOSS Kjeltac™ 8200, Tecator™ Line), and lipid content through Soxhlet extraction (FOSS ST-243 Soxtec fitted with a CU 2046 control unit, Labtec™ Line). For total ash, samples were incinerated overnight at 550 °C. Nitrogen-free extract (NFE) was arrived at by deducting the combined values of crude protein, ether extract and total ash from 100.

2.7 Statistical analysis

The influence of treatment was examined by one-way analysis of variance suited to a completely randomised design (Snedecor & Cochran, 1994) [25]. Where the F ratio proved significant, means were separated by Tukey's honestly significant difference test; within a given row, means carrying dissimilar superscripts differ significantly at $P < 0.05$. All results are expressed as mean $\pm$ standard error of the mean.

3. Results

3.1 Proximate composition

The effect of different pre-treatments on the proximate composition of freeze-dried chicken breast meat chunks is presented in Table 1. Significant differences ($P < 0.001$) were observed among the treatments for moisture, crude protein, ether extract, total ash and nitrogen-free extract (NFE), whereas crude fibre was not detected in any of the treatments. The moisture content values ranged from $3.22 \pm 0.05\%$ to $4.05 \pm 0.06\%$. The turmeric-treated samples (T_2) recorded the

highest moisture content ($4.05 \pm 0.06\%$), followed by the control (T_1 : $3.62 \pm 0.05\%$). The blanched treatment (T_3) recorded a lower value ($3.30 \pm 0.04\%$), while the cooked treatment (T_4) exhibited the lowest moisture content ($3.22 \pm 0.05\%$), the last two treatments not differing significantly from each other. The significant difference among treatments ($P < 0.001$) suggests that pre-treatment markedly influenced the residual moisture of the freeze-dried chicken meat.

The crude protein values differed significantly ($P < 0.001$) from $87.35 \pm 0.19\%$ to $92.13 \pm 0.24\%$. The cooked treatment (T_4) showed the highest crude protein content ($92.13 \pm 0.24\%$), followed by the blanched treatment (T_3 : $90.10 \pm 0.13\%$) and the turmeric treatment (T_2 : $89.20 \pm 0.19\%$). The control (T_1) recorded the lowest value ($87.35 \pm 0.19\%$), all four treatments differing significantly from one another. The higher crude protein values of the pre-treated samples indicate that pre-treatment increased the proportional share of protein in the dry matter of the freeze-dried product. Crude fibre was not detected (ND) in the control or in any of the pre-treated samples.

The ether extract (fat) values ranged from $3.11 \pm 0.04\%$ to $3.73 \pm 0.03\%$ ($P < 0.001$). The control (T_1) recorded the highest ether extract content ($3.73 \pm 0.03\%$), followed by the turmeric treatment (T_2 : $3.41 \pm 0.03\%$) and the blanched treatment (T_3 : $3.28 \pm 0.05\%$), which did not differ significantly from each other. The cooked treatment (T_4) exhibited the lowest value ($3.11 \pm 0.04\%$). The lower ether extract content of the heat-treated samples indicates that thermal pre-treatment reduced the fat fraction of the freeze-dried chicken meat.

The total ash showed the most consistent treatment effect, with values ranging from $4.03 \pm 0.01\%$ to $5.55 \pm 0.01\%$ ($P < 0.001$). The cooked treatment (T_4) recorded a markedly higher ash content ($5.55 \pm 0.01\%$) than the control ($4.03 \pm 0.01\%$) and the turmeric treatment (T_2 : $4.15 \pm 0.01\%$), and did not differ significantly from the blanched treatment (T_3 : $5.52 \pm 0.02\%$). This substantial increase in ash can be attributed to the greater proportional concentration of mineral matter in the dry matter of the samples subjected to hot-water treatment.

The nitrogen-free extract (NFE) values differed significantly ($P < 0.001$) from $0.73 \pm 0.26\%$ to $3.38 \pm 0.17\%$. The control (T_1) recorded the highest NFE value ($3.38 \pm 0.17\%$), followed by the blanched (T_3 : $2.47 \pm 0.15\%$) and turmeric-treated (T_2 : $1.88 \pm 0.20\%$) samples, which did not differ significantly from each other. The cooked treatment (T_4) exhibited the lowest NFE content ($0.73 \pm 0.26\%$). As NFE is obtained by difference, its decline in the pre-treated samples corresponds to the increases recorded in crude protein and total ash.

Thus, pre-treatment substantially altered the proximate profile of the freeze-dried chicken breast meat chunks. Cooking gave the highest crude protein and total ash together with the lowest moisture, ether extract and NFE; blanching produced a closely comparable profile; and turmeric treatment retained the highest residual moisture while giving intermediate values for the remaining constituents.

Table 1: Effect of pre-treatment on the proximate composition of freeze-dried chicken breast meat chunks (mean $\pm$ SEM; n = 6)

Constituent	T ₁ (control)	T ₂ (turmeric)	T ₃ (blanched)	T ₄ (cooked)	F (3, 20)	P
Moisture (%) [*]	3.62 ± 0.05^b	4.05 ± 0.06^a	3.30 ± 0.04^c	3.22 ± 0.05^c	63.02	<0.001
Crude protein (%)	87.35 ± 0.19^d	89.20 ± 0.19^c	90.10 ± 0.13^b	92.13 ± 0.24^a	104.71	<0.001
Crude fibre (%)	ND	ND	ND	ND	-	-
Ether extract (%)	3.73 ± 0.03^a	3.41 ± 0.03^b	3.28 ± 0.05^b	3.11 ± 0.04^c	49.55	<0.001
Total ash (%)	4.03 ± 0.01^c	4.15 ± 0.01^b	5.52 ± 0.02^a	5.55 ± 0.01^a	7092.26	<0.001
NFE by difference (%)	3.38 ± 0.17^a	1.88 ± 0.20^b	2.47 ± 0.15^b	0.73 ± 0.26^c	31.01	<0.001

Within a row, means bearing different superscripts differ significantly at $P < 0.05$ (Tukey). ND, not detected. NFE, nitrogen-free extract obtained by difference. ^{*}Moisture is expressed on an as-is basis; all remaining constituents are expressed on a dry-matter basis.

3.2 Colour

The effect of different pre-treatments on the colour characteristics of freeze-dried chicken breast meat chunks is presented in Table 2. Significant differences ($P < 0.001$) were observed among the treatments for lightness (L^*), redness (a^*), yellowness (b^*) and chroma (C^*), whereas hue angle (h°) did not differ significantly ($P = 0.198$).

The lightness (L^*) values ranged from 77.35 ± 1.08 to 86.98 ± 0.76 . The cooked treatment (T_4) recorded the highest L^* value (86.98 ± 0.76), followed by the blanched treatment (T_3 : 83.60 ± 1.09) and control (T_1 : 83.13 ± 0.96). The turmeric-treated samples (T_2) exhibited the lowest L^* value (77.35 ± 1.08), indicating a comparatively darker appearance. The significant difference among treatments ($P < 0.001$) suggests that pre-treatment markedly influenced the lightness of the freeze-dried chicken meat.

The redness (a^*) values differed significantly ($P < 0.001$) from 1.35 ± 0.19 to 8.30 ± 0.75 . The turmeric-treated samples (T_2) showed the highest redness value (8.30 ± 0.75), followed by the control (T_1 : 3.70 ± 0.55). Blanching (T_3) resulted in a lower redness value (2.20 ± 0.40), while the cooked treatment (T_4) recorded the lowest value (1.35 ± 0.19). The higher a^* value in turmeric-treated samples indicates that turmeric pre-treatment contributed to a more reddish colour compared with the other treatments.

The yellowness (b^*) showed the most pronounced treatment effect, with values ranging from 10.23 ± 1.05 to 44.40 ± 1.23

($P < 0.001$). Turmeric treatment (T_2) recorded a markedly higher b^* value (44.40 ± 1.23) than the control (17.13 ± 1.63), blanched (14.82 ± 1.04) and cooked (10.23 ± 1.05) treatments. This substantial increase in yellowness can be attributed to the characteristic yellow pigments of turmeric, particularly curcuminoids, which impart a distinct yellow colour to the meat surface.

In contrast, the hue angle (h°) values ranged from $81.92 \pm 1.38^\circ$ to $85.45 \pm 1.54^\circ$, with no significant difference among the treatments ($P = 0.198$). Although turmeric treatment showed a slightly lower hue angle ($79.40 \pm 0.92^\circ$) compared with the other treatments, the differences were statistically non-significant. This indicates that the pre-treatments did not significantly alter the overall hue position despite their significant effects on colour intensity, lightness, redness and yellowness.

The chroma (C^*), which represents the intensity or saturation of colour, also differed significantly among treatments ($P < 0.001$). The turmeric-treated samples exhibited the highest chroma value (45.22 ± 1.24), indicating a more intense and vivid colour. The control had a moderate chroma value (17.62 ± 1.56), whereas the blanched (15.03 ± 1.06) and cooked (10.33 ± 1.05) treatments showed considerably lower colour intensity. Thus, incorporation of turmeric substantially enhanced the overall colour intensity of the freeze-dried chicken breast meat.

Table 2: Effect of pre-treatment on the colour coordinates of freeze-dried chicken breast meat chunks (mean $\pm$ SEM; $n = 6$)

Parameter	T ₁ (control)	T ₂ (turmeric)	T ₃ (blanched)	T ₄ (cooked)	F (3, 20)	P
Lightness (L^*)	83.13 ± 0.96^a	77.35 ± 1.08^b	83.60 ± 1.09^a	86.98 ± 0.76^a	16.54	<0.001
Redness (a^*)	3.70 ± 0.55^b	8.30 ± 0.75^a	2.20 ± 0.40^{bc}	1.35 ± 0.19^c	35.93	<0.001
Yellowness (b^*)	17.13 ± 1.63^b	44.40 ± 1.23^a	14.82 ± 1.04^{bc}	10.23 ± 1.05^c	149.80	<0.001
Hue angle (h°)	77.05 ± 2.55^a	79.40 ± 0.92^a	81.45 ± 1.54^a	81.92 ± 1.38^a	1.70	0.198
Chroma (C^*)	17.62 ± 1.56^b	45.22 ± 1.24^a	15.03 ± 1.06^{bc}	10.33 ± 1.03^c	161.45	<0.001

Within a row, means bearing different superscripts differ significantly at $P < 0.05$ (Tukey). C^* and h^* are computed from a^* and b^* and do not constitute independent observations.

4. Discussion

The final moisture content of 3.22 to 4.05% obtained in the present study places all four treatments within the 2-5% window that Loskota *et al.* (2023) [11] associate with freeze-dried meat, and is comparable with the 4.41% reported by Mediani *et al.* (2022) [14] for freeze-dried lamb strips. Lower values have been reported, notably 1.34% for freeze-dried pork powder (Lee *et al.*, 2021) [9], but such comparisons are not strictly valid, since a powder offers essentially no resistance to vapour diffusion whereas a 2 cm chunk must transport vapour through a considerable thickness of already-dried tissue. When set against hot-air and microwave-assisted drying of buffalo meat, which retained 11.66 to 12.80% moisture (Sivaranjani *et al.*, 2023) [24], the effectiveness of sublimation in removing bound water is evident.

Turmeric-treated chunks retained significantly more moisture than any other treatment, whereas the two heat-treated materials were the driest. The higher residual moisture of the turmeric-treated chunks is consistent with the observation of Mancini *et al.* (2015) [13] that dissolved solids and interactions between turmeric constituents and water may hinder moisture diffusion during drying. The lower moisture of the blanched and cooked chunks may be explained mechanically: heat unfolds myofibrillar proteins and disrupts membranes before freezing, converting water that would otherwise remain protein-bound into water available for sublimation. That blanching and cooking arrived at the same endpoint ($P =$

0.611) suggests that this effect plateaus once denaturation is essentially complete, two minutes at 90°C proving as effective in this respect as raising the core to 75°C . Yu *et al.* (2026) [26] advanced comparable reasoning in attributing species differences in drying behaviour to variation in tissue architecture and water-binding capacity.

The progressive increase in crude protein from 87.35% in untreated chunks to 92.13% in cooked chunks does not indicate that protein was gained. On a dry-matter basis every constituent represents a share of a common total, so the removal of any non-protein fraction necessarily raises the protein share. This is what the remaining columns of Table 1 record: relative to the control, the cooked chunks were lower in ether extract by 0.62 percentage points and in nitrogen-free extract by 2.65 percentage points, and the fractions that survive heating, namely protein and mineral matter, correspondingly claimed a larger share of the dry matter. The same relationship holds, in attenuated form, for the blanched and turmeric-treated chunks. This is the mechanism identified by Lee *et al.* (2021) [9], whose pork protein rose from 19.72 to 70.10% on freeze-drying, differing here only in scale, since the present comparison is between materials that have all already been dried. Read in this way, the protein gradient measures the quantity of heat-labile and soluble non-protein dry matter that each pre-treatment removed, and ranks the treatments accordingly, cooking having removed the most and the turmeric rub the least. The finding does not conflict with

Jukniene *et al.* (2022) [8], who reported that lyophilization itself leaves protein unchanged, since it is the pre-treatment and not the drying that varies here. It should also be noted that, because these are proportions, a higher protein percentage does not by itself indicate a greater absolute quantity of protein per chunk, the latter depending additionally on the freeze-drying yield.

Ether extract declined steadily as protein rose, from 3.73% in the control to 3.11% in cooked chunks, and the inverse relationship between the two series is consistent with redistribution within a dry matter from which non-protein constituents had been removed. Part of the decline is a genuine loss, since heating renders fat and the cooked chunks drained visibly during processing, and part is proportional, arising from the larger share claimed by protein and mineral matter. The absolute values are unremarkable for the species, corresponding closely with the 3.54% reported by Mediani *et al.* (2022) [14] for freeze-dried lamb and falling an order of magnitude below their value of 23.90% for freeze-dried beef, chicken breast being naturally lean. Sivaranjani *et al.* (2023) [24] reached a similar conclusion from values of 4.62 to 5.23% in dried buffalo meat, arguing that the composition of the raw material constrains the fat content of a dried product at least as strongly as the drying method does.

Total ash moved in the opposite direction to ether extract and nitrogen-free extract and for that reason it helps to identify the mechanism organising the dataset as a whole. The two treatments, heated the meat in water, blanching and cooking, each raised the mineral fraction by approximately 1.5 percentage points above the control and did not differ from one another (5.52 and 5.55%), whereas the turmeric treatment, which never exposes the chunk to hot water, left ash close to the control value (4.15 against 4.03%). Since mineral matter is neither created nor destroyed by heating, this rise is a concentration effect: the heat-treated chunks lost water, part of their lipid and the greater part of their soluble non-protein organic matter, so that the incombustible residue accounted for a larger share of a smaller dry mass. The counterpart of this relationship was documented by Mediani *et al.* (2022) [14], in whose material ash increased from 1.17 to 7.80% as salt inclusion increased from zero to ten per cent, which confirms how sensitively the mineral fraction tracks the composition of the matrix in which it is measured. It must be emphasised, however, that ash determined in this way expresses the proportion and not the absolute quantity of minerals retained; some leaching of potassium, sodium, phosphate and chloride into the blanching and cooking medium is to be expected, and a determination of mineral content per unit weight of raw meat would be required to separate loss from concentration. Nitrogen-free extract, being obtained by subtraction, is likewise best interpreted as an index of what the other three determinations did not account for rather than as a measurement of carbohydrate, which is a minor constituent of lean muscle in any case and which Mediani *et al.* (2022) [14] note is frequently left unreported for freeze-dried products. Muthulakshmi *et al.* (2025) [17], Alugwu *et al.*, (2023 and Saqib *et al.*, (2021) [1, 23] similarly demonstrated that processing and cooking conditions can alter the proximate composition of chicken meat through changes in moisture and nutrient distribution.

The L^* values observed in the present study (77.35-86.98) were considerably higher than the range of 20-50 reported for dried meat products by Mediani *et al.* (2022) [14], but were comparable to the values of 74.66-87.67 reported for freeze-dried bovine muscle by Messina *et al.* (2016) [15]. The

relatively high lightness observed in freeze-dried meat may be attributed to the structural changes induced by sublimation, which generates a highly porous matrix with numerous internal cavities that enhance light scattering. This effect may be further intensified by the denaturation and contraction of myofibrillar proteins during processing, contributing to the characteristic lighter appearance of freeze-dried meat.

The a^* values were relatively low in the control (3.70) and decreased further following cooking (1.35), indicating reduced redness after thermal pre-treatment. This observation is consistent with the findings of Yu *et al.* (2026) [26], who reported low or slightly negative a^* values in chicken meat subjected to different drying treatments. The reduction in redness following cooking can be associated with thermal denaturation of myoglobin and the subsequent formation of globin haemichrome, resulting in a shift from the red colour of native myoglobin towards grey-brown tones. Similarly, Lee *et al.* (2021) [9] reported a reduction in a^* values in freeze-dried pork gels and attributed this change to irreversible myoglobin denaturation, while Loskota *et al.* (2023) [11] identified metmyoglobin formation as an important contributor to colour deterioration in lyophilized meat. Considering the inherently low myoglobin concentration of chicken breast muscle, thermal pre-treatment may further reduce the measurable redness, resulting in a^* values approaching the lower detection range of the colour measurement system. These changes are consistent with the effects of thermal processing on chicken meat reported by Salakova *et al.* (2009) [22] and Muthulakshmi *et al.* (2022) [16], who demonstrated that heat treatment can modify meat quality through changes in muscle proteins and pigments.

The colour response of the turmeric-treated chunks provides further insight into the influence of pre-treatment on colour attributes. Chroma (C^*) increased markedly following turmeric treatment, whereas the hue angle (h°) remained at approximately 79.40° and did not differ significantly from the control ($P = 0.765$). This indicates that turmeric primarily enhanced colour saturation or intensity without substantially altering the predominant hue. Thus, the increase in chroma can be interpreted as an intensification of the existing yellow colour rather than a displacement towards a distinctly different hue. Reporting C^* and h° in conjunction with the primary tristimulus coordinates (L^* , a^* and b^*) is therefore important for accurately characterizing colour changes in pre-treated freeze-dried meat, as recommended by Messina *et al.* (2016) [15]. The marked increase in b^* and C^* can be attributed to the yellow-orange curcuminoid pigments present in turmeric, particularly curcumin, which are deposited onto or incorporated into the meat matrix during pre-treatment. This observation agrees with Lorenzo *et al.* (2021) [10], who reported that turmeric addition modified the colour characteristics of beef meatballs. Similarly, Domiguez *et al.* (2021) [5] reported significant effects of turmeric incorporation on the colour parameters of healthy beef pate, supporting the ability of turmeric to enhance the characteristic yellow colour and colour intensity of meat products.

The absence of significant differences in hue angle across all treatments further demonstrates that the applied pre-treatments modified the lightness and intensity of colour rather than the fundamental hue of the freeze-dried chicken breast meat. Notably, blanching produced no significant alteration in any of the measured colour parameters compared with the untreated control, indicating that blanching at 90°C for 2 min did not adversely affect the visual colour characteristics of the freeze-dried product. This suggests that

blanching may be employed as a pre-treatment for purposes such as enzyme inactivation and microbial load reduction without causing appreciable changes in colour; its effect on the dry-matter composition, in particular the higher proportional protein and ash contents and the lower ether extract and nitrogen-free extract contents, should nevertheless be taken into account when selecting the processing condition.

5. Conclusion

The present study demonstrated that pre-treatment significantly influenced the proximate composition and colour characteristics of freeze-dried chicken breast meat chunks. Cooking gave the highest crude protein (92.13%) and total ash (5.55%) contents together with the lowest moisture, ether extract and nitrogen-free extract, and blanching produced a closely comparable compositional profile, whereas turmeric treatment retained the highest residual moisture (4.05%) and gave intermediate values for the remaining constituents. Turmeric treatment produced a distinctive and intense yellow colour, as evidenced by the highest yellowness (b^*), chroma (C^*) and redness (a^*) and the lowest lightness (L^*), while blanching produced colour characteristics comparable to the untreated control and hue angle remained unaffected by pre-treatment. Overall, turmeric treatment appears promising for enhancing the visual appeal of freeze-dried chicken meat chunks, whereas cooking may be advantageous for obtaining a product with a higher proportional protein and mineral content and a lower fat content. These findings suggest opportunities to optimize the quality attributes of value-added freeze-dried chicken meat products.

Acknowledgements

The authors thank the Tamil Nadu Veterinary and Animal Sciences University and the Veterinary College and Research Institute, Udumalpet, for the facilities provided for the conduct of this study.

Conflict of Interest

The authors declare no conflict of interest.

References

- Alugwu SU, Okonkwo TM, Ngadi MO. Impact of cooking conditions on proximate composition and textural properties of chicken breast meat. *European Journal of Nutrition & Food Safety*. 2023;15(6):14-30. doi:10.9734/ejnsf/2023/v15i69770.
- Association of Official Analytical Chemists. *Official Methods of Analysis*. 16th ed. Washington, DC: Association of Official Analytical Chemists; 1995.
- Babic J, Cantalejo MJ, Arroqui C. The effects of freeze-drying process parameters on broiler chicken breast meat. *LWT - Food Science and Technology*. 2009;42(8):1325-1334. doi:10.1016/j.lwt.2009.03.020.
- Ciurzynska A, Lenart A. Freeze-drying - application in food processing and biotechnology - a review. *Polish Journal of Food and Nutrition Sciences*. 2011;61(3):165-171.
- Dominguez R, Pateiro M, Echegaray N, Bermudez R, Vargas-Ramella M, Munekata PES, *et al.* Influence of the addition of turmeric on the color and texture parameters of healthy beef pate. In: *Proceedings of the 67th International Congress of Meat Science and Technology*; 2021.
- Draszanowska A, Karpinska-Tymoszyk M, Simoes M, Olszewska MA. The effect of turmeric rhizome on the inhibition of lipid oxidation and the quality of vacuum-packed pork meatloaf. *Applied Sciences*. 2022;12(20):10641. doi:10.3390/app122010641.
- Fellows PJ. *Food Processing Technology: Principles and Practice*. 4th ed. Duxford, UK: Woodhead Publishing, Elsevier; 2017.
- Jukniene I, Zaborskiene G, Jankauskiene A, Kabasinskiene A, Zakariene G, Bliznikas S. Effect of lyophilization process on nutritional value of meat by-products. *Applied Sciences*. 2022;12(24):12984. doi:10.3390/app122412984.
- Lee S, Choi YS, Jo K, Jeong HG, Yong HI, Kim TK, *et al.* Processing characteristics of freeze-dried pork powder for meat emulsion gel. *Food Science of Animal Resources*. 2021;41(6):997-1011.
- Lorenzo JM, Bermudez R, Munekata PES, Echegaray N, Vargas-Ramella M, Dominguez R, *et al.* Effect of turmeric addition on colour and lipid oxidation of beef meatballs. In: *Proceedings of the 67th International Congress of Meat Science and Technology*; 2021.
- Loskota E, Gramatina I, Kince T. A review: Application of freeze-drying in meat processing. *Research for Rural Development*. 2023;38:76-81.
- Ma Y, Wu X, Zhang Q, Giovanni V, Meng X. Key composition optimization of meat processed protein source by vacuum freeze-drying technology. *Saudi Journal of Biological Sciences*. 2018;25(4):724-732.
- Mancini S, Preziuso G, Dal Bosco A, Roscini V, Szendro Z, Fratini F, *et al.* Effect of turmeric powder (*Curcuma longa* L.) and ascorbic acid on physical characteristics and oxidative status of fresh and stored rabbit burgers. *Meat Science*. 2015;110:93-100. doi:10.1016/j.meatsci.2015.07.005.
- Mediani A, Hamezah HS, Jam FA, Mahadi NF, Chan SXY, Rohani ER, *et al.* A comprehensive review of drying meat products and the associated effects and changes. *Frontiers in Nutrition*. 2022;9:1057366. doi:10.3389/fnut.2022.1057366.
- Messina V, Pieniazek F, Sancho A. Effect of different freeze drying cycle in Semimembranosus and Gluteus medius bovine muscles: changes on microstructure, colour, texture and physicochemical parameters. *International Journal of Food Science and Technology*. 2016;51(5):1268-1275.
- Muthulakshmi MM, Chandirasekaran V, Kalaikannan A, Jagadeeswaran A, Selvaraju G, Muthukumar M, *et al.* Influence of heat on protein degradation, histology and eating quality indicators of chicken meat. *International Journal of Bio-resource and Stress Management*. 2022;13(3):205-212. doi:10.23910/1.2022.2729.
- Muthulakshmi MM, Chandirasekaran V, Vasanthi C, Irshad A. Impact of moist and dry cooking on nutritional qualities of chicken meat. *International Journal of Agriculture and Food Science*. 2025;7(7):576-583.
- Nassar FS. Strategic role of poultry production sciences in shaping the future of global food security and strengthen sustainability. *Poultry Science*. 2026;105(5):106617. doi:10.1016/j.psj.2026.106617.
- Navneet K, Kshitij S. Development of carrot pomace and wheat flour based cookies. *Journal of Pure and Applied Science and Technology*. 2011;1(1):5-11.
- Nowak D, Jakubczyk E. The freeze-drying of foods - the characteristic of the process course and the effect of its parameters on the physical properties of food materials.

- Foods. 2020;9(10):1488. doi:10.3390/foods9101488.
21. Ratti C. Hot air and freeze-drying of high-value foods: a review. *Journal of Food Engineering*. 2001;49(4):311-319. doi:10.1016/S0260-8774(00)00228-4.
 22. Salakova A, Strakova E, Valkova V, Buchtova H, Steinhauserova I. Quality indicators of chicken broiler raw and cooked meat depending on their sex. *Acta Veterinaria Brno*. 2009;78:497-504. doi:10.2754/avb200978030497.
 23. Saqib M, Khan MI, Ahmad B, Waseem M, Akhtar S, Ismail T, *et al*. Comparative evaluation of different cooking techniques for biochemical, physico-chemical and sensorial quality of various brands of chicken meat. *Southern Journal of Research*. 2021;1(2).
 24. Sivaranjani M, Nayar R, Rajagopal K, Vasudevan VN, Bashir BP. Nutritive and sensory quality of buffalo meat dried by hot air and combination of hot air-microwave stored under different packaging systems. *Journal of Animal Research*. 2023;13(1):153-160.
 25. Snedecor GW, Cochran WG. *Statistical Methods*. 8th ed. Ames, Iowa: Iowa State University Press; 1994.
 26. Yu H, Chen L, Jin Z. Comparative analysis of quality attributes in restructured steam-cooked chicken, pork, and beef system as affected by freeze-drying duration. *Foods*. 2026;15(6):989.

How to Cite This Article

Nalini P, Chandirasekaran V, Rajkumar R, Krishnakumar S, Arthanarieswaran M, Muthulakshmi M *et al*. Study on the effect of pre-treatment on the colour and proximate composition of freeze-dried chicken breast meat chunks. *International Journal of Veterinary Sciences and Animal Husbandry*. 2026;11(8):102-108.

Creative Commons (CC) License

This is an open-access journal, and articles are distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 International (CC BY-NC-SA 4.0) License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.