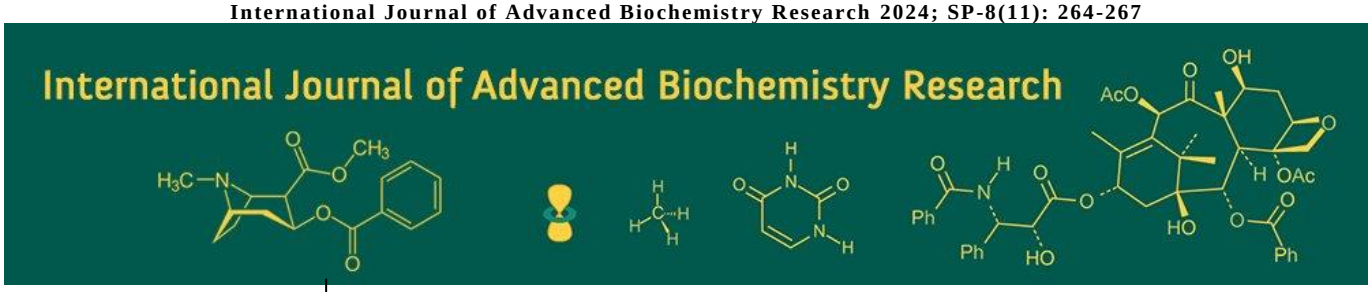


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# Standardisation of giblet replacement in restructured chicken breast fillets with spent chicken meat and broiler meat

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**Abstract**
This study explores the incorporation of giblets (heart and gizzard) into restructured chicken breast fillets, standardised with 65 percent spent chicken meat (SCM) and 35 percent broiler chicken meat (BCM). The primary objective was to assess the feasibility of replacing SCM with giblets and evaluating the effect on physico-chemical and sensory attributes of the fillet. Six formulations were developed, including two control groups: whole broiler breast meat (C1) and a restructured product with 65 percent SCM and 35 percent BCM (C2). Treatment formulations were prepared with varying levels of giblet inclusion (10%, 20%, 30% and 40% of SCM). The pH, colour attributes, grill loss and sensory characteristics of raw and cooked control and treatment fillets were analysed. The pH significantly increased with level of giblet incorporation. The a* value was significantly lower and b* value was significantly higher in C1. There was no significant difference in grill loss and sensory attributes of controls and treatments except for overall acceptability of cooked fillets. Results showed that giblet inclusion at 40 percent level resulted in significantly lower overall acceptability score when compared to other treatment formulations. Considering the cost effectiveness and quality characteristics it was concluded that giblet incorporation upto 30 percent level is feasible in the preparation of restructured breast fillet. The findings indicated that giblets could be effectively incorporated into restructured breast fillets to create high quality, cost-effective poultry products while minimising waste.

**Keywords:** Restructured chicken breast fillets, giblets, spent chicken meat, broiler chicken meat, quality characteristics

## Introduction
The poultry industry increasingly seeks sustainable approaches to address food waste and improve resource utilisation, particularly with spent chickens and byproducts like giblets. Spent chicken meat (SCM), often overlooked due to its tougher texture, can be repurposed into restructured products when combined with broiler meat. Giblets, especially the heart and gizzard, are nutrient-rich but underutilised in mainstream processing, despite their potential to enhance protein content and functionality in processed meats. This study investigates the replacement of SCM with varying levels of giblets in restructured chicken breast fillets, aiming to assess the effect of this substitution on the quality of the final product of high quality with cost effectiveness. This study provides valuable insights into producing a sustainable and economical restructured poultry product, offering a practical solution to resource efficiency and waste reduction in meat processing.

## Materials and Methods
Deboned meat from spent chicken (SCM) and broiler chicken (BCM), giblets (heart and gizzard), eggs and common salt were sourced from local markets at Vythiri in Wayanad district of Kerala.

### Preparation of deboned meat strips and giblet mince
The deboned meats were washed, drained and cut into strips of approximately 2 cm in length and 0.5 cm in width, the size of which was standardised by preliminary trials to optimise the texture and ensure uniform mixing during the restructuring process.

The giblets (heart and gizzard in 1:1 ratio) were washed and minced in a meat mincer (Sirman, Italy) using a 4.5 mm mincer plate.

**Preparation of restructured breast fillets**

The meat strips and giblet mince were processed in a vacuum tumbler to extract proteins for enhancing binding and texture. Salt (1%) and whipped egg albumen (1%) were added as binding agents. The tumbling process consisted of three cycles, with each cycle comprising 5 minutes of continuous tumbling followed by a 1-minute rest, repeated three times for uniform ingredient distribution. After mixing, the meat mixes were stuffed into breast fillet-shaped moulds made from poly lactic acid. The filled moulds were frozen at -18±1 °C overnight, unmoulded and packed in LDPE pouches and stored in freezer (-18±1 °C) till further analyses.

**Standardisation of giblet inclusion**

Preliminary trials were conducted to standardise giblet inclusion, using the heart and gizzard in a 1:1 ratio. The formulations are as shown in Table 1.

Whole broiler breast meat (C1) and a restructured product with 65 percent SCM and 35 percent BCM (C2) acted as controls. The two controls and four treatment breast fillets were evaluated for certain physico-chemical and sensory characteristics

**Evaluation of physico-chemical and sensory characteristics**

The formulations, C1 (whole broiler breast fillet), C2 (restructured breast fillet with 65 percent SCM and 35 percent BCM) and the four formulations with varying levels of giblets (formulations 1, 2, 3 and 4) were evaluated for pH, colour (L*, a*, b*) values, grill loss and sensory attributes in both raw and cooked products.

pH of the samples was measured by using a digital pH meter as per the method described by AOAC (2012) [1]. Ten grams of sample was blended with 50 ml distilled water for one min using a tissue homogeniser (Kinematica, Switzerland) at the speed of 4000 rpm. The pH of the homogenate was recorded by immersing the combined glass electrode of a digital pH meter (EUTECH instruments pH 510, Singapore).

Colour values of the breast fillet slices were determined objectively as per Page *et al.* (2001) [8] using Hunter Lab Mini Scan XE Plus Spectrophotometer (Hunter Lab, Virginia, USA) with diffuse illumination. The instrument was set to measure L*, a* and b* colour values using illuminant 45/0 and10$^{o}$ standard observer with an aperture size of 2.54 cm. For grill loss determination meat slices weighing approximately 60 g were shallow-fried in a pan with oil till the core temperature of slices reached 70 °C. The fried slices were cooled to room temperature, weighed and the difference in weight of the slices with respect to raw weight was expressed as grill loss.

Sensory evaluation of raw restructured breast fillets was conducted for attributes like colour, odour and raw bind and evaluation of cooked restructured breast fillets was conducted for attributes like appearance, flavour, juiciness, tenderness and overall acceptability on a hedonic scale using semi-trained panellists.

Statistical analyses were performed using SPSS version 24.0.In the case of pH, colour parameters and grill loss one way ANOVA followed by Duncan Multiple range test (DMRT) was done In the case of sensory parameters, Kruskal Walli's ANOVA followed by pairwise comparison using Mann Whitney U test was carried out.

**Results and Discussion**

The pH values of the formulations (Table 2) varied significantly. Formulation 3 and 4, with 30 and 40 percent giblet inclusion, exhibited significantly ($p$<0.01) higher pH values when compared to other samples. Higher pH in formulations containing giblets might be attributed to the presence of connective tissues and lipids, which altered the biochemical composition of meat. Rhee *et al.* (1996) [9] found similar trends in meat products enriched with organ meats, where higher pH contributed to improved water-holding capacity, thus influencing moisture retention and texture during storage and cooking.

Colour plays a crucial role in consumer perception of meat quality. Lightness (L*) values were significantly ($p$<0.01) lower in formulations 2 and 3, while formulation 2 had the highest redness (a*) value and C1 which consisted of broiler breast muscl*e* exhibited the lowest a* value (Table 3). Anjaneyulu *et al.* (1995) [3] and Aberle *et al.* (2001) [2] also reported similar effects of giblet inclusion on meat colour, with offals contributing to reduced lightness but enhanced redness due to the presence of iron-rich myoglobin. The b* value, which indicates yellowness, was similar for all samples except for C1, which showed a significantly ($p$<0.01) higher value. This higher b* value in breast muscle aligned with findings from Rindhe *et al.* (2018) [10], who observed that breast meat generally exhibited higher yellowness compared to other parts of the chicken, possibly due to the lower fat content and lighter muscle structure.

Grill loss (Table 4) is an important factor in determining the juiciness and moisture retention of cooked meat products and it did not show any significant difference between samples. Higher collagen content in giblets may contribute to moisture retention by forming a gel-like matrix during cooking. Contrary to this, Mandal *et al.* (2002) [6] and Gadekar *et al.* (2014) [5] reported enhanced moisture retention in restructured meat products containing offals and they attributed it to the higher collagen content in giblets that formed a gel like matrix on cooking which retained moisture.

On sensory evaluation of raw fillets (Table 5), it was observed that there was no significant difference in appearance, odour or raw bind scores, indicating that formulations containing giblets were equally appreciable as control breast muscle or restructured breast fillet with SCM and BCM. However, Anjaneyulu *et al.* (1995) [3] and Mendiratta *et al.* (2013) [7] reported improved cohesiveness and binding in restructured meat products containing offal components.

On sensory evaluation of cooked breast fillets (Table 6) it was revealed that C1, C2 and all four formulations with giblets had similar scores for appearance, flavour, juiciness and tenderness and similar cooked bind scores were observed in C2 and all treatment formulations with giblets. However, overall acceptability scores were significantly ($p$<0.05) higher for formulations1, 2 and 3, which were comparable with scores of C1 and C2. Formulation 4 with 40 percent giblet replacement had the lowest overall acceptability score. This indicated that higher levels of giblets may adversely affect sensory qualities. Similar

findings were reported by Biswas *et al.* (2004) [4], who found that offal inclusion beyond certain levels negatively impacted the sensory attributes of meat products.

**Table 1:** Control and treatment breast fillet formulations

| Samples | Description | Giblet inclusion | Heart and gizzard ratio |
|---|---|---|---|
| C1 | Broiler breast meat (whole fillet) | 0% | N/A |
| C2 | 65% spent chicken meat and 35% broiler chicken meat | 0% | N/A |
| Formulation 1 | Restructured fillet with 10% giblets (heart and gizzard) | 10% | 1:1 |
| Formulation 2 | Restructured fillet with 20% giblets (heart and gizzard) | 20% | 1:1 |
| Formulation 3 | Restructured fillet with 30% giblets (heart and gizzard) | 30% | 1:1 |
| Formulation 4 | Restructured fillet with 40% giblets (heart and gizzard) | 40% | 1:1 |

**Table 2:** pH of control and treatment restructured breast fillets

| Samples | pH |
|---|---|
| C1 | $5.74\pm0.022^{c}$ |
| C2 | $5.84\pm0.013^{b}$ |
| 1 | $5.82\pm0.018^{b}$ |
| 2 | $5.84\pm0.013^{b}$ |
| 3 | $5.90\pm0.023^{a}$ |
| 4 | $5.89\pm0.009^{a}$ |
| F-value (P-value) | 11.301** (<0.001) |

** Significant at 0.01 level
Means having different letters as superscript differ significantly within a column

**Table 3:** Colour values (L*, a* and b*) of control and treatment restructured breast fillets

| Samples | L* | a* | b* |
|---|---|---|---|
| C1 | $48.71\pm0.54^{a}$ | $7.55\pm0.33^{d}$ | $23.18\pm0.63^{a}$ |
| C2 | $47.68\pm0.67^{a}$ | $9.37\pm0.28^{c}$ | $19.55\pm0.84^{b}$ |
| 1 | $48.01\pm0.60^{a}$ | $9.90\pm0.14^{bc}$ | $19.93\pm0.28^{b}$ |
| 2 | $44.33\pm0.38^{b}$ | $12.16\pm0.57^{a}$ | $19.00\pm0.36^{b}$ |
| 3 | $45.73\pm0.58^{b}$ | $10.96\pm0.44^{b}$ | $19.34\pm0.30^{b}$ |
| 4 | $47.98\pm0.61^{a}$ | $10.58\pm0.18^{b}$ | $20.16\pm0.33^{b}$ |
| F-value (P-value) | 8.764** (<0.001) | 19.375** (<0.001) | 9.135** (<0.001) |

** Significant at 0.01 level
Means having different letters as superscript differ significantly within a column

**Table 4:** Grill loss (%) of control and treatment restructured breast fillets

| Samples | Grill loss (%) |
|---|---|
| C1 | 28.81±8.32 |
| C2 | 21.56±3.57 |
| 1 | 14.17±0.64 |
| 2 | 11.29±0.51 |
| 3 | 18.61±6.42 |
| 4 | 16.56±2.96 |
| F-value (P-value) | $1.725^{ns}$ (0.198) |

ns non-significant

**Table 5:** Sensory scores of raw control and treatment restructured breast fillets

| Samples | Appearance | Odour | Raw bind |
|---|---|---|---|
| C1 | 8.78±0.15 | 10±0 | |
| C2 | 8.4±0.16 | 10±0 | 5±0.21 |
| 1 | 8.55±0.11 | 10±0 | 5.05±0.15 |
| 2 | 8.50±0.12 | 10±0 | 4.90±0.12 |
| 3 | 8.27±0.12 | 9.73±0.18 | 5.07±0.15 |
| 4 | 8.53±0.13 | 10±0 | 5.20±0.15 |
| $\chi^2$-value (P-value) | $6.625^{ns}$ (0.250) | $9.980^{ns}$ (0.076) | $2.204^{ns}$ (0.698) |

ns non-significant

**Table 6:** Sensory scores of cooked control and treatment restructured breast fillets

| Samples | Appearance | Flavour | Juiciness | Tenderness | Overall acceptability | Cooked bind |
|---|---|---|---|---|---|---|
| C1 | 8.89±0.11 | 8.00±0.33 | 8.56±0.18 | 8.78±0.15 | $8.33\pm0.17^{ab}$ | |
| C2 | 8.20±0.20 | 8.30±0.15 | 8.80±0.13 | 8.4±0.16 | $8.60\pm0.16^{a}$ | 5.80±0.13 |
| 1 | 8.60±0.15 | 8.50±0.15 | 8.60±0.15 | 8.60±0.15 | $8.50\pm0.15^{a}$ | 5.80±0.09 |
| 2 | 8.60±0.15 | 8.40±0.15 | 8.60±0.21 | 8.50±0.21 | $8.60\pm0.21^{a}$ | 5.8±0.09 |
| 3 | 8.47±0.19 | 8.33±0.19 | 8.47±0.24 | 8.47±0.19 | $8.53\pm0.19^{a}$ | 5.67±0.13 |
| 4 | 8.33±0.16 | 8.27±0.18 | 8.67±0.23 | 8.07±0.21 | $7.87\pm0.26^{b}$ | 5.73±0.12 |
| $\chi^2$-value (P-value) | $9.202^{ns}$ (0.101) | $2.916^{ns}$ (0.713) | $2.423^{ns}$ (0.788) | $9.334^{ns}$ (0.096) | 11.243* (0.047) | $1.204^{ns}$ (0.877) |

* Significant at 0.05 level; ns non-significant
Means having different letters as superscript differ significantly within a column

## Conclusion

This study successfully standardised the replacement of spent chicken meat with giblets (heart and gizzard) in restructured chicken breast fillets. The incorporation of upto 30 percent giblets provided optimal physico-chemical and sensory properties. These formulations also demonstrated cost-effectiveness and improved sustainability by making use of underutilised poultry byproducts.

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## Conflict of interest

The authors declare that they have no conflict of interest.

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