

Comparison of Quality Characteristics of Bone-In and Boneless Chicken Thighs

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ABSTRACT

In this study, the quality characteristics of bone-in and boneless chicken thighs supplied from five different companies were comparatively analyzed. The samples were assessed based on their physical, chemical, microbiological, and sensory attributes. Physicochemical analyses revealed that bone-in products exhibited higher fat content, ash content, and water-holding capacity, whereas boneless products demonstrated higher pH levels ($p<0.05$). Color analysis showed that bone-in products had significantly higher L* values, indicating lighter coloration, whereas boneless products displayed higher b* values ($p<0.05$), indicating greater yellowness. In microbiological evaluations, *Salmonella* spp. and serotypes were found at higher rates, especially in the products of 3rd company. In the sensory analyses, panelists generally rated the boneless products with higher scores. The findings reveal significant quality differences attributable to both product type and manufacturer. They also highlight that improvements in hygiene, packaging, and production processes are critical for ensuring product safety and enhancing consumer satisfaction.

Keywords: Bone-in, boneless, chicken thigh meat, *Salmonella* spp.

Kemikli ve Kemiksiz Piliç Butlarının Kalite Özelliklerinin Karşılaştırılması

ÖZ

Bu çalışmada, beş farklı firmadan temin edilen kemikli ve kemiksiz piliç butlarının kalite özellikleri karşılaştırmalı olarak incelenmiştir. Örnekler fiziksel, kimyasal, mikrobiyolojik ve duyuşal açılarından değerlendirilmiştir. Fizikokimyasal analizler, kemikli ürünlerde daha yüksek yağ, kül ve su tutma kapasitesi değerleri olduğunu; kemiksiz ürünlerin ise daha yüksek pH seviyeleri gösterdiğini ortaya koymuştur ($p<0.05$). Renk analizinde, kemikli ürünler daha açık tonlarda (yüksek L* değeri), kemiksiz ürünler ise daha sarı tonlarda (yüksek b* değeri) bulunmuştur ($p<0.05$). Mikrobiyolojik değerlendirmelerde, özellikle 3. firmaya ait ürünlerde *Salmonella* spp. ve serotiplerine daha yüksek oranda rastlanmıştır. Duyusal analizlerde panelistler genel olarak kemiksiz ürünleri daha yüksek puanlarla değerlendirmiştir. Bulgular, ürün tipi ve üretici firma kaynaklı önemli kalite farkları olduğunu ortaya koymakta; hijyen, ambalajlama ve üretim süreçlerinin iyileştirilmesinin ürün güvenliği ve tüketici memnuniyeti açısından kritik olduğunu göstermektedir.

Anahtar kelimeler: Kemikli, kemiksiz, piliç but eti, *Salmonella* spp.

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INTRODUCTION

Currently, approximately 90% of global meat production is derived from a limited number of mammalian and poultry species, with chicken accounting for 35.4%, pork for 32.6%, and beef for 20.4% of total production (FAO 2022). Chicken meat is a valuable source of animal protein that combines low fat content with a rich composition of high biological value proteins, essential amino acids, polyunsaturated fatty acids, vitamins, and minerals. Due to its nutritional qualities and economic accessibility, chicken meat has become one of the most widely preferred and consumed types of meat worldwide (Chen et al. 2016). Moreover, due to its balanced nutritional composition, regular consumption of chicken meat has been reported to potentially reduce the incidence of certain chronic diseases and contribute positively to overall health (Jayasena et al. 2013). Beyond its nutritional attributes, factors such as affordability, convenience in preparation, and broad acceptability across different religious dietary laws also play a significant role in the widespread consumption and preference for chicken meat (Baldi et al. 2020).

Chicken meat is highly susceptible to microbial spoilage due to its high water activity (a_w), increasing pH levels during storage, and diverse nutritional composition (Cantalejo et al. 2016; Majdinasab et al. 2020). While enzymatic and chemical reactions are primarily responsible for the early stages of meat spoilage, microbial activity predominates as the spoilage process progresses (Shankar et al. 2022). Moreover, the risk of contamination with foodborne pathogens such as *Salmonella* spp. further underscores the public health significance of chicken meat (Woraprayote et al. 2016; Cassar et al. 2019).

Consumer preferences for meat products are shaped by many factors, particularly nutritional content, safety and sensory qualities (Petracci 2022). In addition, the physicochemical properties of meat, including water holding capacity, shear force and color, are also recognised as important factors in meat processing and consumer acceptance (Chen et al. 2016). With the increase in production as a result of the increase in demand, there has been a trend from whole carcasses to cut pieces, boneless and skinless meat (Zhuang et al. 2007). In particular, the interest in products which are value-added and suitable for fast consumption, has caused quality control to gain more importance in the production process (Smith 2014).

Although numerous studies in the literature have investigated the physical, chemical, and sensory properties of different carcass regions in red meat products (Arkfeld et al. 2016; Jung et al. 2016; Knecht et al. 2018), similar research on poultry meat has predominantly focused on the breast. Comparative studies evaluating the quality characteristics of bone-in and boneless chicken thighs are quite limited. This study aimed to comparatively examine the

physicochemical, microbiological, and sensory properties of bone-in and boneless chicken thighs obtained from different companies.

MATERIALS and METHODS

A total of 50 chicken thigh samples (bone-in and boneless) were collected in this study, sourced from five different companies, with five samples per company obtained from five separate production batches. The samples were transported to the laboratory in insulated containers under cold chain conditions, and analyses were initiated on the same day.

Physicochemical analyses

The pH measurement of bone-in and boneless thigh samples was performed using a pH meter equipped with a meat-specific probe (Hanna HI 99163 USA). Total acidity was determined according to the AOAC (2016) method, and the results were expressed as grams of oleic acid per 100 g of sample.

The moisture content of the samples was determined using the gravimetric method, with the TS 2400 and ISO 1442 standards taken as a reference. The crude protein content was determined using the Kjeldahl method (ISO 937:1978), while the crude fat content was analysed using the solvent extraction method (ISO 1444:1996). Additionally, the crude ash content of the samples was determined in accordance with the TS 1744 ISO 936 standard.

Color analyses of the meat samples were conducted based on CIE L^* (lightness), a^* (redness), and b^* (yellowness) parameters. A Chroma Meter CR-400 (Minolta Co., Osaka, Japan) was used for the measurements.

For the determination of water-holding capacity (WHC), the samples were first heated in a water bath at 80 °C for 20 minutes, then cooled to room temperature (23 °C), and subsequently centrifuged at 4 °C for 20 minutes at 2000 × g.

$$\text{WHC (\%)} = (\text{Moisture content} - \text{Water loss}) / \text{Moisture content} \times 100$$

Water loss was calculated using the following formula: $\text{Water loss (\%)} = (\text{Pre-centrifugation weight} - \text{Post-centrifugation weight}) / (\text{Sample weight} \times \text{Fat factor}) \times 100$

A correction factor (fat factor) was applied to account for fat content, which does not contribute to water retention, ensuring a more accurate estimation of water-holding capacity.

$$\text{Fat factor} = 1 - (\text{Crude fat (\%)} / 100)$$

Microbiological analyses

Salmonella spp.

A 25 g portion of each sample was aseptically weighed and placed into 225 mL of Buffered Peptone Water

(BPW, Merck) under sterile conditions followed by homogenization. The samples were pre-enriched by incubation at 37 °C for 18 ± 2 hours. Subsequently, 0.1 mL of the pre-enriched culture was transferred into Rappaport-Vassiliadis Soya (RVS, Oxoid) broth and incubated at 42 °C for 24 hours for selective enrichment. A loopful of the selectively enriched culture was then streaked onto XLT4 (Xylose Lysine Tergitol-4) Agar plates and incubated at 37 °C for 24–48 hours. Colonies exhibiting black coloration on XLT4 Agar were regarded as presumptive *Salmonella* spp. (ISO 6579-1:2017). Biochemical tests such as Triple Sugar Iron (TSI), Urease, Lysine Decarboxylase (LDC), and Indole were performed on the purified suspect colonies.

Genotypic confirmation and serovar identification by Polymerase Chain Reaction (PCR)

Genomic DNA was extracted from colonies previously identified as presumptive by biochemical tests, using the QIAamp DNA Mini Kit (Qiagen, Germany), following the manufacturer's instructions. PCR was performed using primers specific to the *iroB* gene for the detection of *Salmonella* spp. The primer sequences used were as follows: Forward primer: 5'-GCAGAAGCTGGGTTGGTGGTATTT-3' and Reverse primer: 5'-AGAAGACGCTTGCGATCAGGTGTA-3' (Nair et al., 2015). The expected amplicon size for the *iroB* gene was 500 bp.

For serotyping, the following primer sequences were used: *S. Enteritidis* (*sefA* gene): forward 5'-GTGGTTCAGGCAGCAGTTACT-3' and reverse 5'-CAGGGACATTTAGCGTTTCTTGAG-3'; *S. Typhimurium* (*fljC* gene): forward 5'-CCCCGCTTACAGGTGGACTAC-3' and reverse 5'-AGCGGGTTTTTCGGTGGTTGT-3' (O'Regan et al. 2008). The expected amplicon size was 334 bp for *S. Enteritidis* (*sefA*) and 433 bp for *S. Typhimurium* (*fljC*).

Gene amplification was performed using a thermal cycler (Thermo Scientific, Finland). The annealing temperature and extension time were determined based on the melting temperatures of the primers and the expected amplicon sizes. PCR products were stained with ethidium bromide (0.5 µg/mL), run on a 1.5% agarose gel, visualized under UV light using a Vilber Lourmat (Quantum ST4 1100/26MX Xpress UV Table, France) imaging system. *S. Enteritidis* ATCC 13076 and *S. Typhimurium* ATCC 14028 were used as a reference strains, and nuclease-free water served as the negative control. The specificity of amplification was confirmed by the presence of single bands corresponding to the expected amplicon sizes on agarose gels.

Sensory analysis

A total of 10 trained panelists of both sexes, aged between 18 and 55 years, carried out sensory evaluations. The samples were evaluated for color,

odour, and overall acceptability, and scored using a hedonic scale ranging from 1 to 9 (1 = very poor; 9 = very good). The sensory evaluation was conducted on raw samples under controlled hygienic conditions to assess freshness-related appearance attributes. All samples were presented in sterile food containers labelled with randomly selected three-digit numbers, and were delivered simultaneously to the panellists for comparative evaluation. The sensory analysis was conducted in a quiet environment with standard lighting to avoid affecting the panelists' perception (ISO 13299:2016).

Statistical analysis

One-way analysis of variance (ANOVA) was used to examine all measured variables, and the Tukey HSD test was applied to determine differences between groups using the SPSS 25.0 program. All measurements were performed in triplicate, and results are presented as mean values with statistical significance set at $p < 0.05$.

RESULTS

The results of the physicochemical analysis of the bone-in and boneless chicken thigh samples are presented in Table 1. The pH values of the samples ranged from 6.11 to 6.41. In the comparison by company, boneless products generally exhibited higher pH values than bone-in products.

The total acidity of the samples varied between 0.13 g and 0.14 g oleic acid/100 g. Bone-in products typically showed higher total acidity than boneless ones, and this difference was statistically significant for some companies ($p < 0.05$). The moisture content of the samples ranged from 74.82% to 81.68%. Products from the third company—both bone-in and boneless—had significantly higher moisture levels than those from the other companies ($p < 0.05$). WAC values ranged from 79.25% to 86.51%, with the highest WAC observed in the boneless products of the third company (86.51%). Overall, bone-in products had significantly higher WAC values than boneless ones ($p < 0.05$).

The total protein content of the bone-in and boneless thigh meat samples analysed in the study ranged from 18.93% to 20.32%. Bone-in samples had significantly higher protein levels than boneless products ($p < 0.05$). The total fat content of the samples varied between 4.65% and 7.03%, with bone-in products consistently showing significantly higher fat content across all companies ($p < 0.05$). Similarly, the ash content ranged from 0.99% to 1.21%, and was significantly higher in bone-in products than in boneless ones for all companies ($p < 0.05$).

In our study, the CIE L* values of the bone-in products were significantly higher than those of the boneless products, for all samples from all companies ($p < 0.05$). Higher b* values were obtained in most of

Table 1. Physicochemical properties of bone-in and boneless thighs

Parameter	1		2		3		4		5	
	Boneless	Bone-in	Boneless	Bone-in	Boneless	Bone-in	Boneless	Bone-in	Boneless	Bone-in
pH	6.41 ^a	6.22 ^{efg}	6.33 ^{bc}	6.25 ^{def}	6.30 ^{cd}	6.16 ^{gh}	6.39 ^{ab}	6.11 ^h	6.28 ^{ede}	6.20 ^{fg}
Total acidity (g oleic acid/100 g)	0.13 ^b	0.14 ^a	0.13 ^b	0.13 ^b	0.13 ^b	0.14 ^a	0.13 ^b	0.14 ^a	0.13 ^b	0.14 ^a
Moisture (%)	75.28 ^g	75.44 ^f	76.96 ^d	77.48 ^c	81.48 ^b	81.68 ^a	75.65 ^e	75.56 ^e	74.82 ⁱ	74.93 ^h
Total protein (%)	19.42 ^g	19.82 ^d	19.65 ^e	19.94 ^c	18.93 ⁱ	19.10 ^h	20.08 ^b	20.32 ^a	19.56 ^f	19.92 ^c
Total fat (%)	4.92 ^f	6.85 ^b	5.21 ^d	7.03 ^a	4.81 ^g	6.56 ^c	4.65 ^h	6.78 ^b	5.02 ^e	6.51 ^c
Ash (%)	1.15 ^{abcd}	1.21 ^a	1.12 ^{bcde}	1.19 ^{ab}	1.05 ^{ef}	1.16 ^{abc}	0.99	1.07 ^{def}	1.01 ^f	1.1 ^{cde}
WHC (%)	79.51 ^h	80.12 ^g	81.16 ^d	81.93 ^c	86.51 ^a	86.03 ^b	79.25 ⁱ	79.57 ^h	80.32 ^f	80.74 ^c
CIE L*	54.86 ^g	60.84 ^a	55.12 ^f	59.82 ^b	50.56 ⁱ	58.70 ^d	49.89 ^j	59.36 ^c	52.70 ^h	57.60 ^e
CIE a*	5.95 ^f	7.50 ^a	5.69 ^g	5.25 ^h	6.56 ^d	7.04 ^b	3.87 ⁱ	6.13 ^e	2.23 ^j	6.78 ^c
CIE b*	11.84 ^f	7.14 ^h	16.67 ^a	8.72 ^g	14.76 ^e	13.49 ^d	12.67 ^e	15.51 ^b	13.42 ^d	11.78 ^f

1–5 indicate the company codes.

Values are presented as means (n = 3).

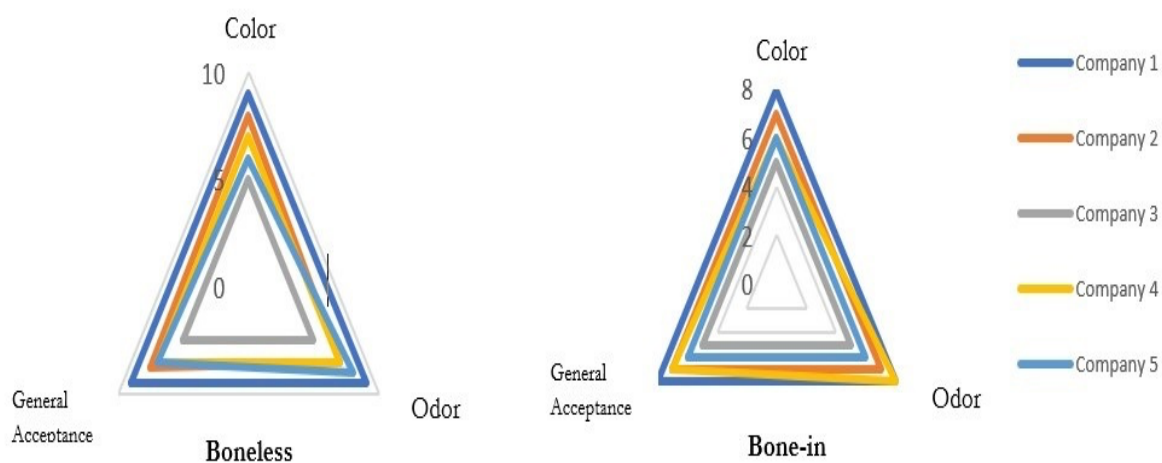
^{a-j} Values with different superscript letters in the same row are significantly different.

WHC: water holding capacity.

the boneless thighs. When CIE a* (redness) values were analysed, statistically significant differences were found between bone-in and boneless products ($p < 0.05$). However, these differences did not show a regular increase or decrease trend.

According to the panelist evaluations, it was observed that the samples from company 1 in both product groups received the highest overall scores. In boneless products, groups 1 and 2 stood out in terms

of color and odor, while especially boneless product from company 1 had the highest average in the general acceptance parameter. On the other hand, the boneless product from company 3 was evaluated with the lowest scores in all criteria. For the bone-in products, the samples numbered 1 and 2 received high scores in terms of color, while the group numbered 3 had the lowest values in terms of both color, odor and general acceptance (Figures 1 and 2)

**Figure 1:** Sensory analysis graphs of the samples taken from the companies

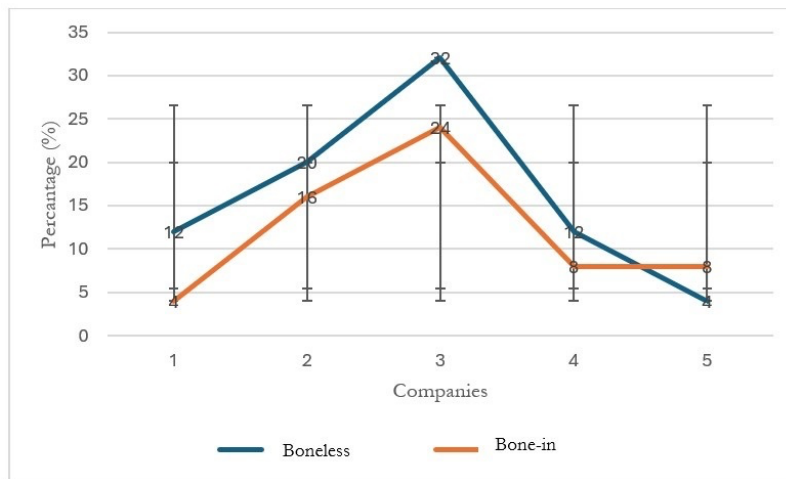


Figure 2: Percentage of *Salmonella* spp. detected in samples taken from the companies.

The microbiological evaluation of bone-in and boneless chicken thigh samples revealed the presence of *Salmonella* spp. at certain rates in all products. Notably, the products of third company exhibited the highest *Salmonella* spp. positivity rates, with 32% of the boneless samples and 24% of the boned samples testing positive (Figure 3). Furthermore, *S. Enteritidis*

and *S. Typhimurium* serotypes, which are of particular concern to public health, were identified at the highest rate in the products of third company. A limited level of serotypes were detected in the products of second company, and these strains were not found in other companies.

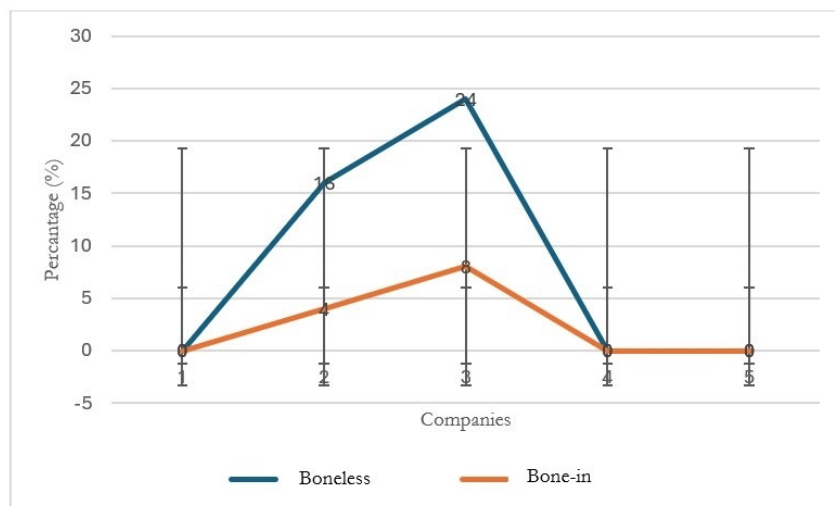


Figure 3: Percentage of *S. Enteritidis* and *S. Typhimurium* detected in samples taken from the companies.

DISCUSSION

pH value

The pH values of the samples in this study are within the standard limits reported in previous studies (Jayasena et al. 2013; Jayasena et al. 2014; Barido et al. 2022, Lee et al. 2023). Similar findings have been reported in other studies on boneless chicken thighs. For instance, Savio et al. (2018) reported pH values ranging from 6.38 to 6.53, while Racanicci et al. (2008) reported values ranging from 5.93 to 6.02. Vaskoska et al. (2021) stated that thigh muscles are rich in type I fibres, and that the low glycogen content of these fibres limits the pH decrease after slaughter, which may explain the higher pH value of boned chicken meat. In our study, it was found that the pH levels of boneless products were statistically significantly higher than those of bone-in products ($p < 0.05$). This may be

due to factors such as greater stress to the muscle structure during processing or longer cooling times. Holmer et al. (2009) reported that high pH levels may adversely affect the microbial resistance of meat and shorten its shelf life.

Moisture content and WHC

During physical examination of the products before opening, the accumulation of free water on the packaging was consistent with the high moisture content of the third company's products. The presence of free water in the packaging may be due to inadequate drainage during packaging or improper handling in the cold chain. Barido et al. (2022) reported moisture contents in thigh meat ranging from 72.14% to 77.14% in different chicken breeds. Oliveira et al.

(2015) found moisture contents ranging from 73.90% to 75.92% in breast meat obtained using different thawing methods. The third company's products had a higher moisture content than that reported in the literature. This presents critical issues in terms of both product quality and microbial safety.

WHC is an important indicator of how much water meat can retain during processing. It directly affects cooking losses, product texture, and sensory quality (Barido et al. 2021; Barido & Lee 2021). In this study, the higher WHC values observed in bone-in products can be explained by the structural support provided by the skin and bone, which reduces water loss. However, despite the high WHC values of the third company's products, free water was present in the packaging, suggesting that the muscle structure was unable to bind water effectively, which negatively impacted product quality.

Total protein content

Barido et al. (2022) reported a range of 18.89% and 20.15% in their study of thigh meat from various chicken breeds, a result that is very similar to that obtained in this study. It is considered that the protein content differences observed in the products of different companies are due to the breed of the animal, feeding, production conditions and post-slaughter practices. Various studies have demonstrated that factors such as breed, age at slaughter and cooling method affect the protein content of chicken meat (Díaz et al. 2010; Baéza et al. 2012; Chang et al. 2024). Furthermore, the structural composition of the product, particularly the density of muscle tissue close to the bone and the presence of skin, can affect the protein content (Wattanachant et al. 2004).

Total fat content

The higher fat content in bone-in products in the study may be because bone-in meats usually include the skin, subcutaneous adipose tissue and fatty areas around the bone. In contrast, boneless products are more processed and are typically derived from lean, skinless cuts. Similarly, Chen et al. (2016) reported that the anatomical structure of the product and its processing method both affect fat content. More recently, Schumacher et al. (2022) emphasized that fat deposition in poultry meat directly influences not only yield but also sensory attributes such as juiciness and flavor, linking fat distribution patterns to both anatomical location and processing intensity.

Ash content

The high ash content of bone-in products may be attributed to the presence of mineral-rich structural components, such as subcutaneous tissue and regions adjacent to the bone. This finding aligns with previous reports indicating that mineral content can vary depending on processing methods and dietary factors, with higher ash levels often observed near bone surfaces (Shirley & Parsons 2001; Mlaga et al. 2022).

Color values

The surface color of meat is one of the most significant parameters affecting consumers' initial purchase intention during retail display (Jeon et al. 2010). As Bae et al. (2014) demonstrate, the color of meat is influenced by a number of factors, including the age and sex of the animal, its genetic structure, the pH level and the anatomical area from which the meat is obtained. The significantly higher CIE L* values of the bone-in products in all samples examined in this study can be attributed to the lighter appearance of the surface in relation to the presence of skin in the bone-in products.

The higher b* values obtained in most of the boneless thighs may be related to the effect of muscle structure and faster lipid oxidation in skinless products. In a related study, Orkusz et al. (2017) reported that lipid oxidation led to an increase in b* values.

Differences in CIE a* (redness) values may have been affected by company-based production and processing differences rather than product type alone. Taken together, these findings suggest that both processing conditions and the physical structure of the product influence meat color. Consistent with this, Augustyńska-Prejsnar et al. (2023) reported that storage temperature and duration significantly affect L*, a*, and b* color coordinates in poultry meat, thereby influencing perceived freshness and consumer acceptance.

Total acidity

The higher acidity values observed in bone-in products may be associated with factors such as increased cellular breakdown in tissues close to the bone or the release of free acid from bone marrow. In addition, bone-in products are exposed to a higher risk of contamination during processing, which may trigger microbial activity and increase acidity levels. Savio et al. (2018) reported a total acidity value of 0.12 g oleic acid/100 g in a study conducted with boneless chicken thighs. This result is close to the value of 0.13 g obtained in boneless samples in our study and supports our findings that boneless products have lower acidity. Accordingly, it is understood that the total acidity parameter may vary depending on the processing method and anatomical structure of the product.

Sensory analysis

The elevated scores assigned by the panelists to boneless products suggest that consumers perceive these products as more practical, clean, and homogeneous in appearance. The absence of elements such as skin and bones has been demonstrated to positively affect the perception of aesthetics and hygiene, especially in raw products. In the post-analysis survey, the panelists were asked to indicate their preference for a particular product type. The majority of the panelists reported a preference for boneless products. A similar study by Cardona et al. (2023)

reported that consumers evaluated factors such as appearance, odor, and ease of use as determining factors in meat preference.

Company 3 received the lowest scores in all sensory parameters for both bone-in and boneless products, which is consistent with the indications of watering, low color brightness (L), and potential spoilage identified in the physical analysis. The presence of free water within the packaging may have induced changes in the product's color and odor, which subsequently led to a negative evaluation by the panelists. Furthermore, the low L values in the products of this company may have adversely impacted consumer perceptions of quality by creating a perception of pale or dark color.

Microbiological findings

The detection of *Salmonella* spp. in both bone-in and boneless chicken thigh samples highlights the persistence of microbial contamination risks throughout poultry production and processing stages. The particularly high *Salmonella* positivity observed in Company 3 products was associated with the physical and physicochemical deficiencies identified in the same samples, such as excessive moisture and the presence of free water within the packaging. Similar observations have been reported by Savio et al. (2018), Finn et al. (2013), and Morasi et al. (2022), as these conditions provide a favorable environment for *Salmonella* proliferation.

The identification of *S. Enteritidis* and *S. Typhimurium* serotypes, which are among the most prevalent causes of foodborne salmonellosis worldwide, further underscores the public health relevance of these findings. Their predominance in products from a single company suggests that contamination may be process-dependent rather than random—possibly arising from cross-contamination during deboning, inadequate sanitation of cutting surfaces, or insufficient temperature control during packaging and storage. Previous studies have documented that deboning and trimming stages are critical points where bacteria can spread through contact with contaminated equipment or personnel (Oh et al. 2023). Furthermore, the higher contamination rates observed in boneless products compared with bone-in samples are consistent with the findings of Rouger et al. (2017), who reported that additional handling and increased surface contact during deboning can elevate the likelihood of cross-contamination.

The findings demonstrate that high moisture content, inadequate packaging conditions, and deficiencies in production hygiene—particularly during processing and handling—substantially contribute to *Salmonella* contamination. Ensuring proper drying, improving packaging integrity, and maintaining strict hygiene protocols are therefore essential to minimize microbiological risks throughout the processing chain.

CONCLUSION

In this study, the physical, chemical, microbiological, and sensory characteristics of bone-in and boneless chicken thighs from different companies were comparatively evaluated. The results revealed that structural composition and processing differences between bone-in and boneless forms significantly influenced fat, protein, color, and water-holding properties. Bone-in products contained higher fat, ash, and moisture retention, whereas boneless products exhibited higher pH and greater yellowness (b*). Microbiological findings indicated that inadequate packaging and insufficient hygienic control—particularly during deboning and subsequent handling—played a critical role in increasing *Salmonella* contamination risks. Overall, hygienic management and packaging conditions are key determinants of both product safety and consumer perception. Future studies should focus on evaluating storage duration, microbial growth kinetics, and process interventions to improve product stability and ensure broader industrial relevance.

Conflict of interest: The authors have no conflicts of interest to report.

Authors' Contributions: RÜÇ contributed to the project idea, design and execution of the study. RÜÇ and ZK contributed to the acquisition of data. NES and HT analysed the data. NES and HT drafted and wrote the manuscript. RÜÇ, NES, ZK and HT reviewed the manuscript critically. All authors have read and approved the finalized manuscript.

Ethical approval: This study is not subject to the permission of HADYЕК in accordance with the “Regulation on Working Procedures and Principles of Animal Experiments Ethics Committees” 8 (k). The data, information and documents presented in this article were obtained within the framework of academic and ethical rules.

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