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Proximate Chemical Analysis and Deterioration Criteria of Goose Giblets

Zeinab Mohamed Nagy, Mohamed Mohamed Talaat Emara, Nabil Abdelgaber Yessien, and Hamdy Mohamed Bakry Abdelhady Zaki*

Department of Food Hygiene and Control, Faculty of Veterinary Medicine, Cairo University, Giza, 12211, Egypt

Corresponding author's E-mail: dvm.hamdy@gmail.com, hamdybakry@cu.edu.eg

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ABSTRACT

Goose meat is one of the most common types of meat consumed worldwide. Egyptian goose species, known as *Alopochen aegyptiacus* is one of the first reared poultry species. As meat consumption and the need for animal protein rise globally, edible giblets can serve as abundant protein and fat sources. Recently, edible giblets have become readily available, quick-to-prepare food on the market. This study aimed to reveal the proximate chemical composition (protein, fat, moisture, and ash) as well as the deterioration criteria (pH, Total volatile basic nitrogen [TVBN] value, and thiobarbituric acid reactive substance [TBA] value) of Egyptian goose giblets, including liver, gizzard, and heart. A total of 60 samples of goose giblets, including liver, gizzard, and heart (n = 20 each), were collected from Giza and Cairo cities, Egypt. The results showed a marked variation among each giblet type. The goose's highest protein content (24.48%), moisture content (72.42%), and fat content (12.18%) were recorded for liver, gizzard, and heart, respectively. Moreover, the highest pH (6.72) and TVBN mean value (5.61 mg/100 gm) were indicated in goose's livers, while the highest TBA mean (0.67 mg malonaldehyde/kg) was obtained from goose' hearts. These findings may provide a clear understanding for both consumers and possessors about the nutritional value of goose giblets which could be used as an alternative protein source. Moreover, the obtained data in the current study could help meat technology processors to add nutritional value to goose products using goose giblets.

Keywords: Chemical analysis, Deterioration criteria, Fat, Giblets, Goose, Protein, pH

INTRODUCTION

Meat consumption is rising globally due to population growth, so the way the earth will supply the world's population with the predicted amount of protein it will require in 2050 is a matter of concern (Nijdam et al., 2012; Aiking and de Boer, 2020; Limeneh et al., 2022). Protein originated from the Greek word "proteios", meaning principal or primary, so it fits nutrition as protein is a vital building block for human tissues (Wu, 2021). To sustain development and good health, humans require an adequate amount of high-quality nutritious protein (WHO, 2007). Daily protein intake for adults is about 1% of their body weight, half of which is recommended to be supplied from animal protein sources as it has more beneficial nutritional value than plant ones (Can and Can, 2022).

The Egyptian goose species (*Alopochen aegyptiacus*) is one of the first avian species that had been domesticated for more than 4000 years (Alagawany et al., 2020). It has the fastest growth rate among birds, reaching about 75% of adult weight within 9 weeks of rearing (Tilki et al., 2005; Ashour et al., 2020). Eviscerated goose carcass yields 75.5% and 65.9% of live bird weight with and without giblets, respectively. Therefore, about 10-15% of a bird's live weight is made up of giblets. (Sierra et al., 2022). Generally, edible poultry giblets consist of the liver, gizzard, and heart. However, the neck is not considered a part of the giblets if it is still connected to the carcass, according to Commission Regulation No. 543/2008. Nowadays, edible poultry giblets are offered in markets as a food product for consumption (Barker et al., 2004). Furthermore, the demand for edible poultry giblets

is increasing daily, especially due to their rapid preparation method and high nutritional value (Álvarez-Astorga et al., 2002; Nollet and Toldra, 2011).

Goose liver contains a high ratio of proteins that contain balanced amino acids; moreover, its extracted fat is healthy as it is rich in linoleic polyunsaturated fatty acid (Mitchell and Block, 1946; Li, 2018). Furthermore, edible goose liver, named "foie gras" is a popular French food ingredient made with goose liver fattened by force-feeding (Arroyo et al., 2017). Gizzard is where digestion takes place in poultry and is an edible poultry by-product rich in protein, iron, and zinc (Batah et al., 2012). Gizzard is a popular traditional snack food in Asia (Chang et al., 2013). In addition, the heart is also an edible poultry giblet that is rich in fat (Ho et al., 2008). Adding value to those edible internal organs (giblets) is a promising food technology trend to use these giblets in manufactured meat products, such as liver patties and pickled gizzard (Anandh et al., 2019)

Therefore, the current study focused on the chemical compositional analysis and the deterioration criteria (shelf life) of the edible Egyptian goose (*Alopochen aegyptiacus*) giblets regarding the previously published limited data on this subject.

MATERIALS AND METHODS

Ethical approval

The Faculty of Veterinary Medicine at Cairo University, Giza, Egypt, accepted the study design following the regulations and recommendations of the committee on animal welfare and ethics. There were no live animals utilized in the current investigation. All goose-edible giblet samples used in this study were collected from local markets as chilled products.

Sampling collection

A total of 60 chilled edible Egyptian goose giblets (*Alopochen aegyptiacus*), including livers, gizzards, and hearts (n = 20 each), were collected randomly from different markets all over Giza and Cairo cities (30 samples from each city), Egypt, from January to March 2022. Previously, giblet samples were freshly collected after the halal slaughter of goose, and evisceration occurred within 30 minutes in the commercial slaughterhouse. After Salvaging giblets, they were put in plastic bags. Samples were transferred immediately via cooled iceboxes within 1 hour to the Food Hygiene and Control Department Laboratory in the Veterinary Medicine Faculty, Cairo University, Egypt, to perform further analysis.

Sample preparation

Goose liver was trimmed of all excessive fat. Meanwhile, the gizzard was cut into halves with the removal of its content and inner cuticle layers. The heart was also opened, and the blood was washed out. After that, each giblet (liver, gizzard, heart) has been minced and mixed separately to obtain a homogenous representative sample for analysis. The time of sample preparation did not exceed one hour.

Physio-chemical analysis

Proximate compositional chemical analysis

Moisture, protein, extracted fat, and remaining ash content was evaluated by AOAC (2005). Moisture content was evaluated using 10 g of the prepared sample, which was taken in aluminum moisture cans -2-1/2 diameter and then put in a hot air oven (Heraeus UT6 Oven, Germany) at 103^{o}C for 16 hours until obtaining two successive weights. Protein content was evaluated by measuring the nitrogen content in the Kjeldahl digestion unit (VELP Scientifica F30110182 Model DK 6). Samples were digested using concentrated sulfuric acid at 420°C for 45 minutes. After that, distillation was performed on a steam distillation Kjeldahl unit (VELP Scientifica UDK 126D), and titration was done using 0.02N Hydrochloric acid. Finally, the conversion protein factor (6.25) was calculated. Fat was extracted using petroleum ether 20-40^{o}C in the Soxhlet extraction apparatus for 6-8 hours. Ash content was analyzed in a crucible containing a 5 g sample and then put in Muffle Furnaces (Thermolyne ™ IFD1540M-33, United States) at 550°C for 3.5 hours.

Deterioration analysis

At this stage, 5 g of the prepared giblet sample was homogenized with 20 ml of distilled water in Stomacher (Lab-Blender 400, Tekmar Corporation, England). The calibration of the pH meter (Lovibond Type 330) was done using chem lab buffer solution at pH 4.00 and 7.00. Then, the pH in the homogenate was measured by taking three reading for each sample, as described by Zaki et al. (2021). Thiobarbituric acid value was examined as described by Ali et al. (2007) in screw-capped tubes by adding 1 ml of sample homogenate, 1 ml Thiobarbituric acid (TBA), 1 ml Trichloroacetic acid (TCA), and 50 µl Butylated hydroxytoluene (BHT). The tubes were put in a boiling water bath for 15 minutes. Afterwards, they were cooled and centrifuged (Jouan Indust 220, France), then the absorbance of the supernatant was read at 531 nm on a

spectrophotometer (UNICO, SKU S-1200E, USA). Total volatile basic nitrogen.

Total Volatile Basic Nitrogen (TVB-N) value was measured following the distillation method as described by Kearsley et al. (1983)**,** in which the steam distillation Kjeldahl unit (Velp Scientifica UDK 126D, Germany) and Velp tube were used. The Velp tube contained 10 g of prepared giblet sample with 2 g of MgO and 150 ml of distilled water, while the receiving flask contained 25 ml of boric acid. After that, titration was carried out using 0.1 N sulfuric acid until the change of methyl red indicator color from blue to faint pink was considered the endpoint.

Statistical analysis

Descriptive statistical analysis was applied to the data collected using SPSS version 19.0 software to show the mean and standard error of the finding results. One-way ANOVA was used to compare the means of edible goose giblets, and the significance threshold was established at $p < 0.05$ using the least significant difference test (LSD).

RESULTS AND DISCUSSION

The proximate chemical analysis of the Egyptian goose's internal edible organs (giblets) is shown in Table 1. Among the examined giblets, extensive variations in the moisture content were detected, where the highest significant value was in the gizzard (72.42%, $p < 0.05$). In contrast, the lowest value (66.47%) was obtained from the heart. As reported by Abdullah and Buchtová (2022), the moisture content is higher in chicken giblets with percentages of 76.68%, 79.94%, and 77.36% for liver gizzard, and heart, respectively.

Table 1. Proximate compositional chemical analysis of edible Egyptian goose giblets

Item (g/100 g)	Liver	Gizzard	Heart
Moisture	70.34 ± 0.01^{b}	72.42 ± 0.02^{a}	66.47 ± 0.02^{c}
Protein	24.48 ± 0.01^{a}	24.11 ± 0.02^{a}	20.46 ± 0.02^{b}
Fat	3.63 ± 0.02^{b}	2.20 ± 0.02^{c}	12.18 ± 0.02^{a}
Ash	1.49 ± 0.02^{a}	1.27 ± 0.01^{a}	0.84 ± 0.02^{b}

Data in the table includes Mean ± standard error. ^{a,b,c} Within the same row with different superscripts are significantly different ($p < 0.05$).

Furthermore, results of protein analysis showed that goose liver and gizzard had a significantly ($p < 0.05$) higher protein (24.24 and 24.11 g/100 g, respectively) than the heart (20.46 g/100 g, Table 1). Compared to the obtained results in the current study, the chicken giblets analyzed by Abdullah and Buchtová (2022) indicated lower protein content in the liver (17.70%), gizzard (17.26%), and heart (13.83%). Although both goose meat and the gizzard are classified as muscles, the difference is that the first is striated, and the last is smooth in muscle fiber (Tokunaga et al., 2022; Wu et al., 2022). The mean protein value of the gizzard (24.11 g/100g) in the current study was higher than those reported by Geldenhuys et al. (2013) in the breast (20.18%) and the thigh (19.44%). However, the protein value can reach 22.3% in goose meat (Ding et al., 2014). Zouari et al. (2011) revealed that the protein content in turkey liver was relatively close to that of present findings, as turkey liver showed a protein value of 21.90%. Moreover, the goose giblet's protein is significantly higher than those found in chicken or duck giblets (Seong et al., 2015; Abdullah and Buchtová, 2022). This makes goose giblets a promising alternative protein source.

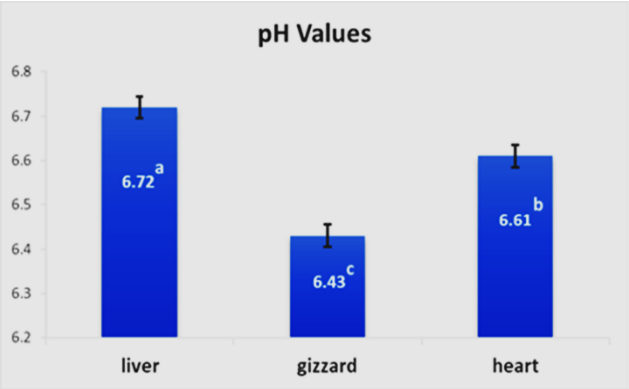
Regarding the fat content presented in Table 1, the fat content of the liver and gizzard had significantly low values of 3.63 g/100 g and 2.2 g/100 g, respectively ($p < 0.05$). Similarly, Zouari et al. (2011) reported a fat content of 2.9% in turkey liver. The highest significant fat content was obtained from the goose heart (12.18 g/100 g), which was probably due to the presence of coronary fat in the homogenized heart minced samples ($p < 0.05$). Moreover, the results of Ash analysis showed that goose liver and gizzard had a significantly ($p < 0.05$) higher ash content (1.49 and 1.27%, respectively) than the heart (0.84 g/100g, Table 1).

Poultry by-products are highly perishable; therefore, it is important to determine their freshness (Ozdemir and Yetilmezsoy, 2020). Freshness parameters, including TVBN and TBA values, are biomarkers for both protein and fat degradability (Mottram, 1998; Li et al., 2019). The pH value might serve as a guide for the early stages of decomposition (Yamanaka et al., 1987). Results shown in Graph 1 revealed that the pH mean value was significantly ($p < 0.05$) higher for the liver (6.72), compared to the heart (6.61) and gizzard (6.41), which could be regarded as the high glycogen content stored in hepatocytes (Baycumendur and Ergün, 2022).

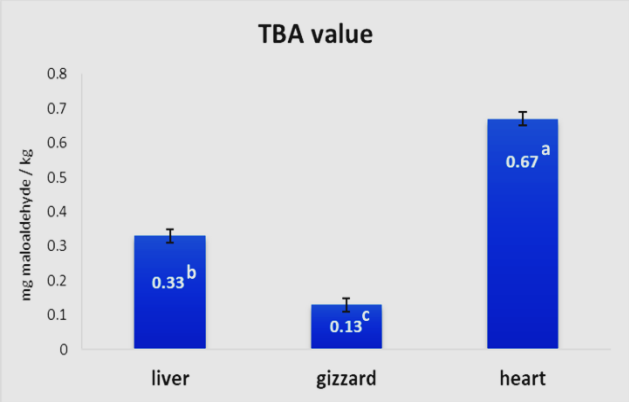
Freshness TBA value measures malonaldehyde, a secondary product of oxidative rancidity (Dahle et al., 1962; Pryor et al., 1976). Generally, a low TBA value gives a good integration of the shelf life of food items. As outlined by Egyptian standards, the TBA limit should not

exceed 0.9 mg malonaldehyde/kg of the sample (EOS 1090/2019). As can be seen in Graph 2, TBA value of edible internal goose giblets was significantly higher ($p < 0.05$) in the heart (0.67 mg mal/kg), compared to the liver (0.33 mg mal/kg), and gizzard (0.13 mg mal/kg). The freshness TBA parameter had the highest significant value in goose hearts ($p < 0.05$) as there was a strongly linked relationship between TBA value and fat content (Table 1). The unsaturated type of fat is more prone to oxidize and undergo rancidity (Ratrinia and Komala, 2022; Shehata et al., 2022). Mohamed et al. (2017) reported that chicken giblets' TBA is higher than TBA in goose giblets.

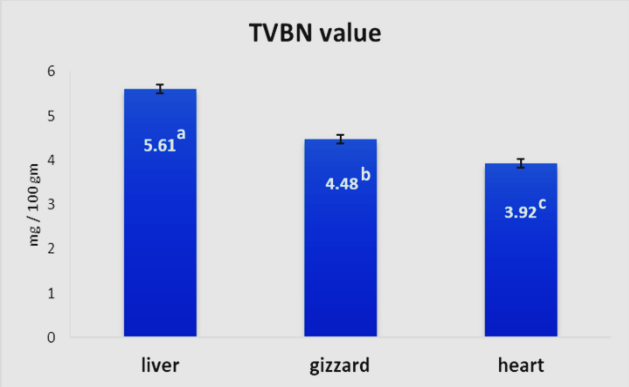
Freshness TVBN test measures the destruction of protein and releasing ammonia and its derivatives nitrogenous compounds, resulting from transamination or decarboxylation, which are returned to bacterial or related enzymes (Fan et al., 2009; Hopkins and Geesink, 2009; Khulal et al., 2016). The freshness TVBN limit should not exceed 20 mg/100 g of the sample as outlined by Egyptian standards (EOS 1090/2019). Graph 3 shows the TVBN of the Egyptian goose' edible giblets. The goose liver showed the highest value (5.61 mg/100 g), followed by the gizzard (4.48 mg/100 g), and the least value was in the heart (3.92 mg/100 g). The elevation in TVBN in the liver may be associated with endogenous enzymatic activity. The obtained TVBN values in this study were different from the results of chicken giblets explained by Mohamed et al. (2017) as they reported liver, gizzard, and heart TVBN values of 13.3 mg/100 g, 14.61 mg/100 g, and 14.87 mg/100 g, respectively. This difference could be attributed to the species variation.



Graph 1. Mean values of pH in edible Egyptian goose giblets ([a,b,c] Values within columns with different superscripts are significantly different ($p < 0.05$)).



Graph 2. Mean values of thiobarbituric acid in edible Egyptian goose giblets ([a,b,c] Values within columns with different superscripts are significantly different ($p < 0.05$).



Graph 3. Mean values of total volatile basic nitrogen in edible Egyptian goose giblets ([a,b,c] Values within columns with different superscripts are significantly different ($p < 0.05$).

CONCLUSION

Goose giblets can be considered a high protein source instead of other poultry species as well as it has low-fat content, making them an excellent nutritional source. The obtained data in the current study could be used as a reliable index for identifying the proximate chemical composition of edible giblets of the Egyptian goose (*Alopochen aegyptiacus*). Moreover, this study presents new insight into the Egyptian goose's shelf-life indicators for edible giblets since the previously published data on goose giblets is very scarce. Finally, it is recommended to maximize the benefits of goose giblets by considering them in processing goose food products.

DECLARATIONS

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Authors' contribution

Zeinab Mohamed Nagy performed the practical laboratory test. Mohamed Mohamed Talaat Emara supervised the work and designed the study. Nabil Abdelgaber Yassien supervised the work and revised the manuscript. Hamdy Mohamed Bakry Abdelhady Zaki: supervised the work, designed the experiment, and data analysis, revised the final manuscript version, and handled the correspondence for the publication process. All authors read and approved the final version of the manuscript for publishing in the present journal.

Competing interests

According to the researchers, the contents of this study are not influenced by or subject to bias due to any financial conflicts of interest or conflicts with other persons or organizations.

Ethical consideration

Ethical issues, all Authors have reviewed and approved the manuscript for ethical concerns, such as plagiarism, misconduct, data fabrication, and redundancy. Authors confirm that the data is original and have not been published elsewhere.

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