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Chemical Composition, Deterioration Criteria and Microbiological Quality of Edible Ostrich Giblets

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Abstract

Giblets of ostriches which comprise 4.2–5.8% of their live weights, can be either consumed directly after cooking or processed to make meat products. Large amounts of these giblets are wasted due to a lack of sufficient studies about their chemical composition, deterioration criteria, and microbiological quality. Consequently, fifty samples of each chilled edible ostrich giblet (liver, stomach, and heart) were obtained from local markets and examined directly to evaluate their chemical analysis, deterioration criteria, and microbiological quality. Chemical analysis showed that heart tissues contain the highest moisture content (82.29 g/100 g). While, stomach and heart tissues contain the highest protein contents (18.39 and 18.00 g/100 g, respectively). Liver samples have the highest fat and ash content, reaching 7.41 and 1.32 g/100 g, respectively. On the other hand, liver samples showed the highest values of pH (6.81), total volatile basic nitrogen (4.90 mg/100 g), and thiobarbituric acid values (0.66 mg malonaldehyde/kg). Furthermore, microbiological examination showed that stomach tissues exhibited the highest aerobic plate count, Enterobacteriaceae, coliform, and fecal coliform counts (5.94, 3.37, 64.67, and 22.33 $\log_{10}$ CFU/g, respectively). Moreover, the highest staphylococci counts were detected in both stomach and liver tissues (4.57 and 5.44 $\log_{10}$ CFU/g, respectively). There were, however, no significant differences in the counts of psychrotrophic bacteria (3.33, 3.42, and 2.95 $\log_{10}$ CFU/g, respectively), yeasts (3.59, 3.23, and 2.93.36 $\log_{10}$ CFU/g, respectively), and molds (2.66, 2.86, and 2.96 log10 CFU/g, respectively) in ostrich livers, stomachs, and hearts. But salmonella could not be detected in all giblets. According to these findings, consumers and processors of ostrich giblets should maximize their benefits as an alternative protein source to produce a highly nutritive diet. As well, they can be used to reduce meat prices and produce different meat products.

Keywords: Ostrich; Heart; Liver; Stomach; Giblets; Deterioration criteria.

1. Introduction

As a result of the world's rapidly increasing population, about 400 million tons of meat will be needed by 2030, up about 44% from now. Furthermore, around 1.2 billion chickens, or 1125 million tons of poultry meat, are consumed annually in Egypt. Therefore, Egypt's poultry meat consumption in 2026 is expected to reach 1156,000 tons, up from 993,000 tons in 2017 [1]. So, rising demand for poultry meat makes it a challenge for the poultry business to be one of the major agricultural sectors in the world [2]. On the other hand, consumers and processors are searching for healthier sources of meat. Ostrich meat is now sold as one of the most nutritious and healthy types of poultry meat. In the 19th century, ostriches were popular as substitute livestock in South Africa. Over the 20th century, it became available throughout the world, from Asia to South and North America, Australia, and most European countries. Currently, there are three types of ostriches that are farmed. One of the most widely distributed is *Struthio camelus var. domesticus* (African Black) [3]. In recent years, ostrich breeding has become increasingly important to obtain its healthy, diet-friendly, and highly nutritive meat, which contains less fat and cholesterol [4]. It also has substantial amounts of protein and iron as well as it is high in polyunsaturated fatty acids, so it is suitable for people suffering from malnutrition and anemia. Moreover, it is healthy for hypertensive people as it contains low levels of sodium [5].

Ostrich carcass yield is high, reaching 58%–59% of live body weight in comparison to chicken and beef [6]. Nonetheless, the edible giblets of the ostrich (liver, heart, and stomach) account for roughly 4.2–5.8% of live body weight and 14.3–18.1% of all recovered edible giblets, which is a substantial yield [7]. Edible giblets are a wholesale by-product that is produced, inspected, cooled, and processed under

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sanitary conditions. They are a valuable source of several important elements, including amino acids, minerals, fatty acids, and vitamins. They have a greater vitamin content than meat. Likewise, the liver has a protein content that is comparable to that of lean meat tissues [8]. It also contains a substantial amount of manganese. In terms of nutritional content for omega-3 PUFA, ostrich liver also ranks first among all the giblets, supplying 100 g with 3.3 times as much as meat, 9.9 times as much as the gizzard, and 3.9 times as much as the amount found in the heart. Also, heart tissues provide a higher level of β-tocopherol, α-tocopherol, and γ-tocopherol [9].

In addition, the liver and kidneys provide 5–10 times as much riboflavin as lean meat. The largest concentrations of ascorbic acid, niacin, vitamin B12, folacin, and vitamin B6 are found in them. Besides, liver and cardiac tissues contain low levels of monounsaturated fatty acids and high levels of polyunsaturated fatty acids [10]. Since these edible byproducts have an impact on the price of meat as well as meat-related products, the efficient utilization of those byproducts remains crucial to the meat processing industry. As such, the return derived from those can be used to lower the consumer price of meat and reduce the environmental pollution [11]. Additionally, they can be used to produce different meat products.

On the other hand, giblets are subjected to significant bacterial contamination during different food chain steps such as processing, handling, slaughtering, preparation, and storage, which makes them highly perishable and results in both human health hazards and economic losses [12, 35]. In these regards, Salmonella spp. was detected in poultry giblets with a high prevalence (71.15, 59.4, and 60 % in the liver, gizzard, and heart, respectively) [13]. Moreover, the incidence of E. coli, Salmonella spp., and Listeria monocytogenes was high in frozen chicken giblets at a rate of 52, 16, and 14%, respectively [14]. These microorganisms may result in gastroenteritis, food infections, and intoxication, as well as severe human outbreaks that threaten human health worldwide [15]. Furthermore, consumers nowadays seek natural, safe, and highly nutritious food. The microbial safety of ostrich giblets, however, has been examined in limited studies.

Numerous studies assessed some meat products' microbial load, quality criteria, and shelf life [16, 17, 18]. Still, there isn't enough information about the microbial safety, chemical composition, and shelf life indicators of ostrich giblets so large amounts of them are wasted and not effectively incorporated in meat processing industries for the production of new meat products or eaten extensively by consumers. As a result, the current study focuses on chemical composition, deterioration criteria, and microbiological examination of ostrich (Struthio camelus) edible giblets (liver, heart, and stomach).

2. Material and methods

Ethical approval

The Faculty of Veterinary Medicine at Cairo University in Giza, Egypt, gave its approval to the research plan. It was going along with the recommendations and regulations of the animal welfare and ethics committee. The edible giblets of ostrich were obtained from local markets in chilled condition without using animals.

Preparation of giblet sample*s*

Fifty samples of each chilled edible giblet (liver, stomach, and heart) of the ostrich *(Struthio camelus*) were purchased from local markets in Cairo and Giza and transported in an insulated ice box to the lab at the food hygiene and control department, college of veterinary medicine, Cairo University. Then, each giblet was ground twice on a laboratory grinding machine and mixed individually to obtain representative and homogenous giblet samples. The following tests were then performed on the samples:

Chemical composition

Moisture, total protein, total fat, and ash contents in edible giblets (liver, stomach, and heart) were determined in accordance with the method stated in AOAC [19]. Moisture content was analyzed through the drying of samples in an oven overnight at 105 ℃ until acquiring two equal successive weights. Fat contents were determined by extracting them for 6-8 hours in a Soxhlet device. for determination of total protein content through digestion in the Kjeldahl apparatus at 420 ℃ for 45 minutes, followed by distillation and titration with HCL 0.02 N. The ash contents were calculated after the ignition of samples at 600 ℃ for three hours.

Deterioration criteria (shelf life indicators)

For measuring the pH values, 5 grams of each sample and twenty ml of distilled water were homogenized, and a pH meter was used for getting the results after its calibration using two buffer solutions (4.00 and 7.00) [20]. The Total volatile basic nitrogen (TVBN) values were measured by distillation of five grams of each sample with magnesium oxide and distilled water followed by titration with H_2SO_4 0.01N [21]. Thiobarbituric acid (TBA) values were determined following the technique detailed by Du and Ahn [22] by homogenizing 5 g of examined samples with fifteen ml of distilled water, followed by filtration, and then boiling the filtrate with thiobarbituric acid, trichloroacetic acid, and butylated hydroxytoluene (BHT), followed by cooling and reading the absorbance of each sample by spectrophotometer at 531 nm.

Microbiological examination

For sample homogenate preparation, 10 grams of each of the prepared samples and 90 ml of ringer's solution were homogenized for two minutes. The original homogenate's diluents were used to make ten-fold decimal dilutions [23]. Aseptically, 0.01 ml of each dilution of the previously prepared homogenate was spread on a double set of plate count agar. For enumeration of aerobic plate counts, the inoculated plates were kept in an incubator at 32°C for 48 hours [24]. For psychotropic counts, the plates were incubated at 7°C and counted after seven days [25]. The number of staphylococci was counted using Baird parker agar medium incubated at 37 ºC for 48 hours [24]. Total Enterobacteriaceae counts were also determined using violet red bile glucose agar after incubation at 37 ºC for 18-24 hours [24]. In lauryl sulphate broth, total coliforms and fecal coliforms were detected using inverted Durham's tubes incubated at 37 ºC for 18- 24 hours and 44.5 ºC + 0.5 ºC for 24-48 hours, respectively [24]. For yeast and mold counts, Sabroud dextrose agar medium was used at 25°C for 5 days and 7 days, respectively [26]. To isolate and identify Salmonellae, 25 g of each giblets were pre-enriched on buffered peptone water at 35 ºC for 24 hours, then enriched on Rappaport-Vasiliadis broth at 42 ºC for 18-24 hours, and a loopful of each sample was streaked over xylose-lysine-deoxycholate agar at 35 ºC for 18-24 hours. Suspected Salmonellae colonies were identified morphologically and biochemically [24].

Statistical analysis

Using SPSS version 19.0, the mean and standard error of the values for the deterioration criterion, chemical analysis, and microbiological investigation was calculated. Also, the least significant difference (LSD) between the means of the edible ostrich giblets (liver, stomach, and heart) was discovered using a one-way ANOVA ($P<0.05$).

3. Results and discussion

Animals' edible internal organs are a profitable byproduct in the meat industry, either being marketed directly or being applied as raw materials in the poultry service industry. Ostrich giblets are the stomach, liver, and heart.

Chemical composition of chilled edible ostrich giblets

Giblets of poultry contribute a significant proportion of their whole-body weight to edible by-products. Many of these edible by-products are sources of protein with different structures, chemical compositions, and sensory properties [27]. Therefore, it is very important to know their chemical composition.

The moisture contents of the examined samples are presented in Figure (1). Results revealed that heart tissues contain the highest moisture content (82.29 g/100 g), followed by stomach tissues (79.90 g/100 g), and the lowest moisture percentage was detected in liver tissues (75.28 g/100 g). Our results agreed with those of Adamczak et al. [28], who noticed that the moisture contents of ostrich stomachs and hearts were 79.5 and 78.6 g/100 g, respectively. But livers contain low moisture contents (64.20 g/100 g). Also, Buclaw et al. [29] found nearly similar moisture contents in the gizzard, heart, and liver tissues of emu's bird (80.23, 79.61, and 73.05 g/100 g, respectively). Moreover, chicken hearts have lower moisture contents (70.49 g/100 g) than livers and gizzards (75.38 and 79.50 g/100 g, respectively) [30].

The total protein contents of the analysed samples are shown in Figure (2). Stomach and heart tissues contain the highest significant levels of protein contents, reaching 18.39 and 18.00 g/100 g, respectively. However, the lowest protein content was found in liver samples, where it was 16.24 g/100 g. Our results agreed with those of Adamczak et al. [28], who found that liver tissues contain low protein content (16.6 g/100 g) when compared with hearts (18.1 g/100 g) and stomachs (19.0 g/100 g). All giblets of the emu's bird contain similar protein contents (18.62, 19.12, and 18.45 g/100 g in gizzard, liver, and heart tissues, respectively) [29]. On the other hand, protein contents in chicken livers ranged from 15.70 to 18.20 g/100 g, while gizzards ranged from 7.26 to 18.20 g/100 g [27, 31, 32] and heart tissues were 10.83 g/100 [30].

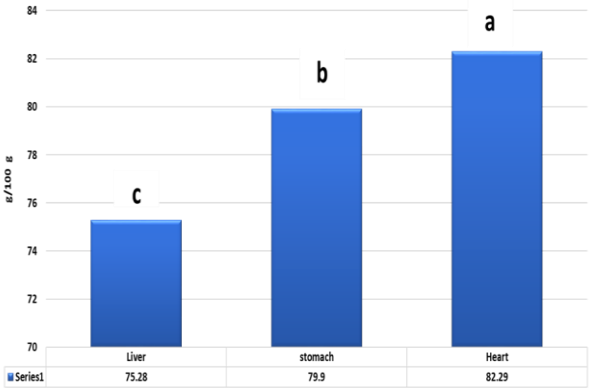

Fig. 1. Mean values of moisture content (g/100 g) in chilled edible ostrich giblets

Total fat levels in ostrich edible giblets were shown in Figure (3) revealing that the highest significant fat content was detected in liver samples, reaching 7.41 g/100 g. In contrast, stomach and heart tissues were leaner, containing 0.89 and 0.68 g/100 g on a wet basis, respectively. Our findings agreed with Antunes et al. [9], who noticed that the liver tissues of the ostrich were the fattest organ, containing 4.63 g/100 g on a wet basis, followed by the heart (1.69

g/100 g). While the stomach tissues were leaner, containing 0.50 g/100 g. In addition, Adamczak et al. [28] found high fat content in liver tissues (14.3 g/100 g) and low content in heart and stomach muscles (2.00 and 0.90 g/100 g, respectively). Conversely, Buclaw et al. [29] confirmed that the liver of the emu bird contained lower fat content, ranging from 2.15 to 5.59 g/100 g, but more fat content was detected in the gizzard and heart tissues (1.62 and 1.17 g/100 g, respectively) than in the ostrich giblets. Likewise, chicken giblets contain similar amounts of high fat in the liver (2.89–4.10 g/100 g) and low levels in the gizzard (0.81–1.50 g/100 g) [27, 31].

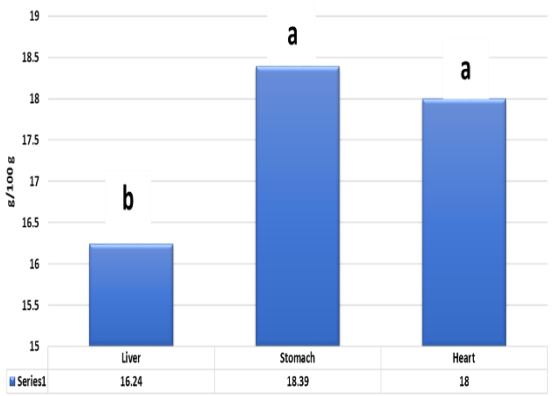

Fig. 2. Mean values of total protein content (g/100 g) in chilled edible ostrich giblets

Figure (4) depicts the ash contents in the examined giblets. Liver tissues recorded the highest significant ash levels, reaching 1.32 g/100 g. However, nearly similar ash percentage was found in the stomach and heart, recording 0.74 and 0.76, respectively. The results were nearly identical to those obtained by Adamczak et al. [28], who found that the ash contents in ostrich liver, heart, and gizzard samples were 1.1, 1.2, and 1.1 g/100 g, respectively. However, higher ash contents were found by Bucław et al. [29] in the giblets of emu bird, where the livers contain the highest levels (1.74 g/100 g), followed by the hearts (1.20 g/100 g), and the gizzards (0.95 g/100 g). A similar order was found in chicken giblets: livers contain the highest ash content (1.29 g/100 g), followed by hearts and gizzards (0.65 and 0.66 percent, respectively) [30]. In a similar, Jokanović et al. [31] found ash content in chicken livers, gizzards, and hearts to be 1.3, 0.9, and 0.9 g/100 g, respectively.

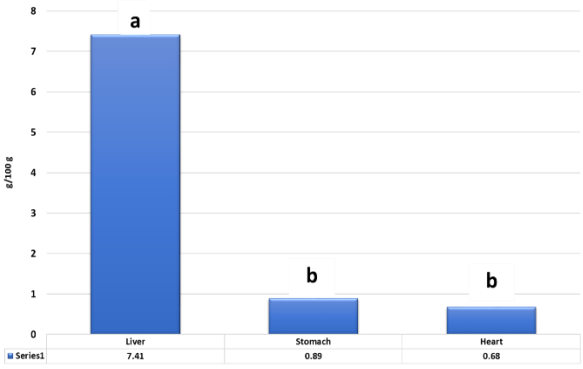

Fig. 3. Mean values of total fat content (g/100 g) in chilled edible ostrich giblets

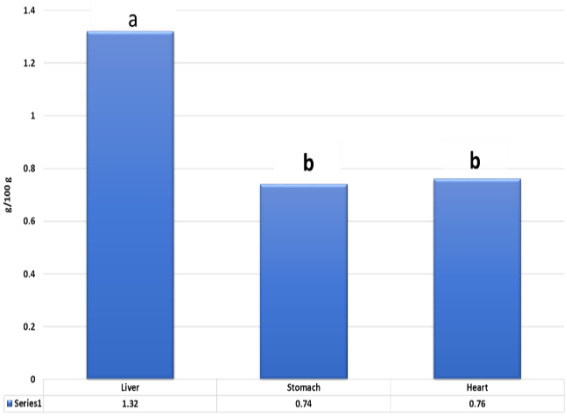

Fig. 4. Mean values of ash content (g/100 g) in chilled edible ostrich giblets

Deterioration criteria of chilled edible ostrich giblets

When an animal is slaughtered, enzymatic mechanisms that resist oxidation reactions during life become less active, permitting the meat oxidation process to proceed, which degrades its sensory and nutritional qualities [11, 33]. Furthermore, ostrich giblets are rapidly spoiled due to their high protein, moisture, and fat contents. Accordingly, it is of great importance to measure their freshness. TBA (thiobarbituric acid) and TVBN (total volatile base nitrogen) are considered biomarkers for fat and protein degradation [34] because fat and protein oxidation are the major causes of the deterioration of meat [35].As well as pH, which is important for evaluation of meat quality and an indication of early decomposition [36].

Table (1) shows the pH, TVBN, and TBA values of the ostrich edible giblets that were tested. The highest pH values were measured in liver samples (6.81), compared to the heart (6.03) and stomach (5.28). Similar pH values of ostrich livers (6.40 ± 0.1) were reported by Fernández-López et al. [37]. Nonetheless, fresh chicken livers had a pH of 6.50 [38, 39]. The high glycogen content of livers may explain their high pH values when compared to other giblets

[40]. The total volatile basic nitrogen (TVBN) test is applied to measure the rate of protein breakdown and the subsequent release of ammonia and nitrogen compounds by bacteria and their associated enzymes [41]. The TVBN values of liver tissues were higher (4.90 mg/100 g) compared with those of stomach and heart tissues (4.06 and 4.01 mg/100 g, respectively). The activity of the liver's endogenous enzymes may be connected to high TVBN levels in liver samples. The TVBN values of ostrich giblets did not exceed the permissible limits (20 mg/100 g) termed by EOS [42]. In contrast, Mohamed et al. [43] explored high TVBN values in chicken liver, heart, and gizzard (13.3, 14.87, and 14.61 mg/100 g, respectively).

TBA values (mg mal/kg) are an indicator for fat peroxidation. The low TBA values are a good sign for food freshness. Measurement of TBA values of ostrich giblets revealed that the highest TBA values were measured in the ostrich liver (0.66 mg mal/kg), followed by heart values (0.50 mg malonaldehyde/kg) and stomach values (0.17 mg mal/kg). High TBA values were found in ostrich liver, as there was a strong correlation between TBA values and high fat levels in the liver (Figure 3). In general, all TBA values of ostrich giblets did not exceed the Egyptian standards specifications (0.9 mg mal/kg) [42]. Moreover, Antunes et al. [9] explained that gizzard and heart tissues possessed the highest vitamin E content among all tissues compared, which has antioxidant activity against lipid oxidation. Although Mohamed et al. [43] recorded higher TBA values in chickens' giblets than ostriches' giblets that were in the liver, heart, and gizzard (12.40, 13.90, and 13.40 mg malonaldehyde/kg, respectively), which could be correlated to the species variation in the degree of saturation of their fatty acids.

Microbiological quality (log_{10} CFU/g) of chilled edible ostrich giblets

Ostrich edible giblets are vehicles for many pathogenic microorganisms, so they are spoiled quickly. This may be due to unhygienic practices, inadequate temperature control during collection and processing, as well as poor handling of tissues, which may affect the tissues' intrinsic characteristics [35]. Therefore, the microbiological quality of ostrich edible giblets is very important for determining their acceptability for consumers. According to our knowledge, this is the first study for microbiological information on ostrich giblets. As a result, offal samples can also be assessed using the same standards, according to the International Commission on Microbiological Standards for Foods [44].

The results of the microbiological examination conducted on chilled edible ostrich giblets (liver, heart, and stomach) are described in Table (2). Findings indicated that stomach tissues exhibited the highest significant aerobic plate count (APC) ($p<0.05$, 5.94 log_{10} CFU/g). While there was no difference in the mean values of the APC in liver and heart tissues, they reached 4.07 and 3.58 log_{10} CFU/g, respectively. Generally, the numbers of APC in chilled livers and hearts were not more than the permissible limits, while the counts that were detected in stomachs were slightly higher than the permissible limits described by EOS [42], in which the APC in raw poultry parts should not exceed 10^5 CFU/g. The APC counts in fresh ostrich liver were previously examined by Fernández-López [37], who found higher counts (5.30 Vs 4.07 log_{10} CFU/g). In contrast, our results were lower than those obtained by Hassanin et al. [45], who found that the APC was 4.86 log_{10} CFU/g in chicken liver and 7.73 log_{10} CFU/g in gizzard. As well, Mohamed et al. [43] found higher counts of the APC in chilled chicken livers and hearts (4.53 and 4.63 log_{10} CFU/g, respectively) and low counts in chilled chicken gizzards (4.66 log_{10} CFU/g).

Table 1 Mean values of deterioration criteria (Shelf life indicators) of chilled edible ostrich giblets

	Liver	Stomach	Heart
pH	6.81^{a}±0.04	5.28^{c}±0.05	6.03^{b}±0.08
TVBN (mg/100 g)	4.90^{a}±0.40	4.06^{b}±0.37	4.01^{b}±0.33
TBA (mg malonaldehyde/kg)	0.66^{a}±0.04	0.17^{c}±0.04	0.50^{b}±0.03

a–c Means with different superscripts within the same row significantly (P< 0.05) different.
* Values represent the mean of 3 independent replicates ± SE.

Table 2 Mean values of microbiological examination (log_{10} CFU/g) of chilled edible ostrich giblets

	Liver	stomach	Heart
Aerobic plate count	4.07^{b}±0.20	5.92^{a}±0.04	3.58^{b}±0.56
Psychrotrophes	3.33^{a}±0.08	3.42^{a}±0.12	2.95^{a}±0.33
Enterobacteriaceae	2.68^{b}±0.11	4.37^{a}±0.05	2.88^{b}±0.10
Staphylococci	4.57^{bc}±0.36	5.44^{ac}±0.65	3.74^{b}±0.34
Total coliforms	14.13^{b}±0.13	64.67^{a}±0.33	3.47^{c}±0.13
Fecal coliforms	3.20^{b}±0.20	22.33^{a}±0.33	3.40^{b}±0.20
Salmonellae	ND	ND	ND
Yeast	4.16^{a}±0.13	4.78^{a}±0.04	4.62^{a}±0.36
Mould	3.77^{a}±0.39	5.33^{a}±0.76	4.90^{a}±0.35

$^{a–c}$ Means with different superscripts within the same row significantly (P< 0.05) different. Values are the mean of 3 independent replicates ± SE.
ND: not detected

However, in the liver, stomach, and heart, there was no difference in the counts of psychrotrophic bacterial (3.33, 3.42, and 2.95 $\log_{10}$ CFU/g, respectively). Additionally, the results were like those published by Hassanin et al. [45], who found that the psychrotrophic bacterial counts of ostrich livers were 4.6 $\log_{10}$ CFU/g. A low psychrotrophic bacterial count in the examined giblets may be due to the distinctive feature of meat produced in tropical areas in comparison with meat from the coldest areas [46]. In contrast, the counts of Enterobacteriaceae were considerably high in the stomach tissues ($p < 0.05$, 3.37 $\log_{10}$ CFU/g), whereas there was no difference in their count in the liver or heart samples (2.68 and 2.88 $\log_{10}$ CFU/g, respectively). Conversely, the presence of Enterobacteriaceae in ostrich giblets was lower than that detected by Mohamed et al. [43] in chicken giblets (5.37, 5.14, and 5.34 $\log_{10}$ CFU/g in liver, heart, and stomach, respectively).

The highest staphylococci counts were found in the stomach and liver tissues (4.57 and 5.44 $\log_{10}$ CFU/g, respectively), while the lowest count was found in the heart tissues (3.74 $\log_{10}$ CFU/g). Like this, the stomach tissues had the highest total coliform counts (64.67 $\log_{10}$ CFU/g), followed by the liver tissues (14.13 $\log_{10}$ CFU/g), and the heart tissues (3.47 $\log_{10}$ CFU/g). Additionally, stomach tissues have the highest significant level of fecal coliforms ($p < 0.05$, 22.33 $\log_{10}$ CFU/g). The coliform counts were greater than the acceptable limits described by EOS [42], in which the coliform counts in giblets should not be more than 10^2 CFU/g. These high results could be attributed to contamination from workers either during handling or processing as well as insufficient washing of giblets after evisceration of ostriches. In contrast, Mohamed et al. [43] found that coliform counts were higher in ostrich livers and hearts compared to chicken giblets. In chicken hearts and livers, the coliform counts were (5.76 and 5.09 $\log_{10}$ CFU/g, respectively), but chicken gizzards (5.02 $\log_{10}$ CFU/g) were significantly greater than that in ostrich stomach tissues.

Salmonellae could not be detected in all examined samples, either in livers, stomach tissues, and heart samples. So, they were like the limits stated by EOS [42], according to which poultry giblets should be free from Salmonella. However, Mohamed et al. [43] detected a high level of salmonella in chicken liver, heart, and gizzard tissues (16.67%, 13.33 %, and 20%, respectively). The yeast (4.16, 4.78, and 4.62 $\log_{10}$ CFU/g, respectively) and mold (3.7, 5.33, and 4.90 $\log_{10}$ CFU/g, respectively) counts in liver, stomach, and heart samples did not differ significantly. Nevertheless, yeast and mold counts did not comply with the limits described by EOS [42], which declared that giblets should not contain any yeasts or molds. Yeast counts in ostrich giblets were higher than in giblets of chicken studied by Mohamed et al. [43], which included liver, heart, and gizzard (3.59, 3.23, and 2.93.36 $\log_{10}$ CFU/g, respectively). Likewise, the mold counts in ostrich giblets were higher than those in chicken giblets, reaching the liver, heart, and gizzard (2.66, 2.86, and 2.96 $\log_{10}$ CFU/g, respectively). High yeast and mold counts detected in ostrich giblets could be due to either high moisture content or unsuitable chilling temperatures [47].

4. Conclusion

Large amounts of ostrich giblets are wasted and are not effective incorporated into the meat processing industry to produce new meat products or eaten extensively by consumers since the previous data on ostrich giblets (*Struthio camelus*) is very rare. As a result, the current study focuses on the chemical composition, deterioration criteria, and microbiological examination of ostrich edible giblets (liver, heart, and stomach). According to this study's findings, ostrich giblets are believed to be a highly nutritional source of protein and low in fat. The stomach and heart tissues have the highest levels of protein content. As well, liver samples have the highest fat and ash contents. Moreover, shelf-life indicators of ostrich giblets were within the limits specified by EOS. Among ostrich giblets, liver samples revealed the highest pH, TVBN, and TBA values. Likewise, microbiological examination of ostriches' giblets showed that stomach tissues exhibited the highest aerobic plate count, Enterobacteriaceae, coliform, and fecal coliform counts. According to these findings, consumers and the poultry processing industry can maximize the advantages of ostrich giblets as an alternative protein source to produce highly nutritious ostrich meat products.

5. **Conflict of interest:** There are no conflicts to declare.

6. Acknowledgments

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