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Proximate and Mineral Composition of Chicken Giblets from Vojvodina (Northern Serbia)

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***Abstract*—**Proximate (moisture, protein, total fat, total ash) and mineral (K, P, Na, Mg, Ca, Zn, Fe, Cu and Mn) composition of chicken giblets (heart, liver and gizzard) were investigated. Phosphorous content, as well as proximate composition, were determined according to recommended ISO methods. The content of all elements, except phosphorus, of the giblets tissues were determined using inductively coupled plasma-optical emission spectrometry (ICP-OES), after dry ashing mineralization. Regarding proximate composition heart was the highest in total fat content, and the lowest in protein content. Liver was the highest in protein and total ash content, while gizzard was the highest in moisture and the lowest in total fat content. Regarding mineral composition liver was the highest for K, P, Ca, Mg, Fe, Zn, Cu, and Mn, while heart was the highest for Na content. The contents of almost all investigated minerals in analysed giblets tissues of chickens from Vojvodina were similar to values reported in the literature, i.e. in national food composition databases of other countries.

***Keywords*—**Chicken giblets, proximate composition, mineral composition.

I. Introduction

CONSUMPTION of poultry meat and poultry meat products is growing all over the world [1]. Poultry is the world's second most consumed type of meat, and chicken meat dominates the world poultry consumption over 70%. Currently, the annual worldwide growth rate is about 5% [2]. For several reasons, people prefer this kind of meat to beef and pork, at least partly due to the desirable flavour of poultry products [1], [3]. Chicken meat comprises a substantial source of a high quality protein source in most countries [4]. Lean chicken contains more protein than the same amount of lean roast beef and the prices of chicken meat are lower than those of beef or pork [4]. Regarding human nutrition, poultry meat, in addition to large amount of easily assimilated animal protein and vitamins, is a valuable source of minerals [5]. Additionally, chicken by-products are eaten widely due to their low cost, their low content in fat and the short period of time needed in preparation [6].

In the last few decades, the amount of available meat by-products from slaughterhouses, meat processors and wholesalers has increased considerably [7]. From a general perspective, food processors face increasing demands to improve their raw material yield, so as broiler processing companies, because the raw material costs are a considerable part of the overall business costs [2]. Many edible meat by-products are down-graded because of the lack of a profitable market. Since the yield of edible by-products for chickens is from 5 to 6% of the live weight; more attention should be given to edible by-products, especially because the majority of by-products offer a range of foods which are nutritionally attractive, with high protein content and good nutritional properties due to the presence of many essential nutrients and have a wide variety of flavours and textures [8]-[10].

According to Somsen et al. [2] average yield of the chicken giblets (heart, liver and gizzard) at an average live weight prior to slaughtering of 1898 g was 4.36%. Poultry giblets of individual birds may be packed together with the carcass for sale, or the individual tissues retained for further processing or retail sale [11].

The available scientific literature mainly describes sensory, technological and nutritional quality of meat, but little information is available for edible offal, or giblets. Edible offal, is also a form of meat which is used as food, but which is not skeletal muscles, and in general possesses higher concentrations of some micronutrients, especially minerals and vitamins, than muscular tissue [12], [13].

Meat (and edible offal, giblets) quality is the sum of all sensoric, nutritive, hygienic-toxicological and technological factors. The nutritive factors of meat (and edible offal) quality include proteins and their composition, fats and their composition, vitamins, minerals, utilization, digestibility and biological value [14], [15]. Thus, the objective of this study was to determine proximate (moisture, protein, total fat and total ash content) and mineral composition (K, P, Na, Mg, Ca, Zn, Fe, Cu and Mn) of chicken giblets (heart, liver and gizzard) from Vojvodina (northern Serbia).

II. Material and Methods

A. Samples

Chicken giblets samples (n=180) (heart, liver and gizzard) were collected from three slaughterhouses in Vojvodina, by random selection, throughout a period of 3 months.

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The heart, liver and gizzard were removed from the remaining viscera on the slaughter floor. The gall bladder was cut and pulled from the liver and the pericardial sac and arteries were cut from the heart. The gizzard was removed by cutting it in front of the proventriculus and then severing the entering and exiting tracts. The gizzard was then split, emptied and washed, and the lining was removed with a gizzard peeler. After chilling, each sample was homogenized (Waring 8010ES Blender, USA; capacity 1 l, speed 18000 rpm, duration of homogenization 10 s, temperature after homogenization <10°C), vacuum packaged in polyethylene bag and stored at –40°C until determination of proximate and mineral composition.

B. Proximate Composition

Moisture content was determined by oven-drying at 105°C to constant mass [16]. Protein content was determined according to Kjeldhal method; a factor 6.25 was used for conversion from total nitrogen to crude protein [17]. Total fat content was determined by solvent extraction [18] and total ash content was determined by combustion of the sample at 550°C for 8h [19]. All analyses were performed in duplicate.

A strict analytical quality control programme was applied during the study. The results of the analytical quality control programme for proximate composition are presented in Table I.

TABLE I
RESULTS OF THE ANALYTICAL QUALITY PROGRAMME (N=8) USED IN THE DETERMINATION OF THE PROXIMATE COMPOSITION OF CHICKEN GIBLETS

Quality control	Moisture	Nitrogen	Fat	Ash
Certified concentration (g/kg)	688 ± 2.6	16.3 ± 0.6	143 ± 5.0	26.5 ±1.0
Recovery (%)	99.6	100.4	99.7	100

C. Mineral Composition

The content of all elements [potassium (K), sodium (Na), magnesium (Mg), calcium (Ca), zinc (Zn), iron (Fe), copper (Cu), manganese (Mn)], except phosphorus (P), of the giblets tissues were determined using inductively coupled plasma-optical emission spectrometry (ICP-OES) (iCP 6000 Series, Thermo Scientific, Cambridge, United Kingdom), after dry ashing mineralization. Dry ashing mineralization was performed according to the following procedure: a 3-5g sample was weighed into a porcelain crucible and dried in a laboratory oven at 105°C for 3 h. After drying, the sample was charred on a hot plate and then incinerated in a muffle furnace at 450°C overnight (16 h). When a suitable ash was obtained, it was moistened with little water, treated with hydrochloric acid/deionized water (1:1, v/v), and evaporated to dryness. Finally, the ash was redissolved with hydrochloric acid/deionized water (1:9, v/v), and transferred into a 50 ml volumetric flask, as described in detail by Tomović et al. [20]. The analytical lines used for each mineral, as well as the instrumental parameters of analyses are presented in Table II. The emission lines selected for each mineral are also present in the Table II and were based on tables of known interferences, baseline shifts and experience in work with different samples.

TABLE II
OPERATIONAL ICP-OES PARAMETERS

Flush pump rate	50 rpm
Analysis pump rate	50 rpm
Pump stabilization time	5 s
Pump tubing type	Tygon/Orange White
RF power	1150 W
Nebuliser gas flow	0.7 L/min
Coolant gas flow	12 L/min
Auxiliary gas flow	0.5 L/min
Plasma view	Axial
Detection wavelength	nm
Cu	324.754
Fe	259.940
Mn	257.610
Zn	213.856
Plasma view	Radial
Detection wavelength	nm
Ca	393.366
K	766.490
Mg	280.270
Na	588.995

Detection (LOD) and quantification (LOQ) limits and correlation coefficients of the calibration curve for each mineral are shown in Table III. The total phosphorous (P) content of the giblets tissues was determined by a colorimetric method after dry ashing mineralization of samples, according to ISO method [21]. The results of the analytical quality control programme for P content are presented in detail by Tomović et al. [20]. All analyses were performed in duplicate.

TABLE III
DETECTION (LOD) AND QUANTIFICATION (LOQ) LIMITS AND CORRELATION COEFFICIENTS OF THE CALIBRATION CURVE FOR EACH MINERAL

Element	LOD (mg/100g)	LOQ (mg/100g)	Correlation coefficient
Cu	0.012	0.04	0.9976
Fe	0.012	0.04	0.9958
Mn	0.00075	0.0025	0.9993
Zn	0.012	0.04	0.9985
Ca	0.3	1.0	0.9997
K	0.06	0.2	0.9994
Mg	0.06	0.2	0.9999
Na	0.3	1.0	0.9999

III. RESULTS AND DISCUSSION

Proximate compositions of the experimental chicken giblets are presented in Table IV. Moisture contents ranged from 73.1% (heart) to 81.5% (gizzard). Protein content was highest in liver (15.7%), followed by gizzard (13.6%) and heart (11.3%). Meat moisture content is inversely related to its lipid content, so heart was highest and gizzard was lowest in total fat content (12.5 and 1.5%, respectively).

TABLE IV
PROXIMATE COMPOSITION (G/100G) OF CHICKEN GIBLETS

Sample/Component	Heart	Liver	Gizzard
Moisture	73.1	75.9	81.5
Protein	11.3	15.7	13.6
Total fat	12.5	4.1	1.5
Total ash	0.9	1.3	0.9

Total ash content was at the same level in heart and gizzard (0.9%), and higher in liver (1.3%). Results obtained for protein contents in heart and gizzard were somewhat lower than results reported by Demirbas [22], and results for protein content in liver were lower than repoted in nutrient composition tables [23]. In the present study heart and liver were higher, while gizzard was lower in total fat content than reported results in the literature [22], [23].

TABLE V
MINERAL COMPOSITION (MG/KG) OF CHICKEN GIBLETS

Sample/Mineral	Heart	Liver	Gizzard
K	2210	2676	1947
P	1665	2235	1191
Na	1146	815	796
Mg	258	263	254
Ca	117	131	110
Fe	31.54	82.42	19.61
Zn	18.61	23.22	19.54
Cu	4.06	5.56	2.18
Mn	0.650	2.75	0.653

Mineral compositions of the experimental chicken giblets are presented in Table V. The order of the minerals in all tree analysed tissues was K > P > Na > Mg > Ca >Fe > Zn > Cu > Mn. Similar to other meat species, potassium was quantitatively the most abundant mineral in chicken giblets, ranging from 1947 (gizzard) to 2676 mg/kg (liver), followed by phosphorous and sodium which ranged from 1191 in gizzard to 2235 mg/kg in liver and from 796 in gizzard to 1146 mg/kg in liver, respectively. According to our calculations (Table VI), the potassium contents in 100 g of giblets represented minimally 5.56% (gizzard) up to 7.65% (liver) of the RDI value, while phosphorous and sodium contents represented from 11.91% to 22.35% and from 3.32% to 4.78 of the RDI value, respectively. Next two most important minerals in analysed tissues were magnesium and calcium, with an average contents ranging between 254 (gizzard) and 263 mg/kg (liver), and between 110 (gizzard) and 131 mg/kg (liver), respectively. From our data the contribution of Mg and Ca intakes for the consumption of 100 g of giblets are around 6.5% and 1.2% of the RDI value, respectively. Iron, as considered to be the most important minor mineral in meat [23], was highest in liver (82.42 mg/kg) and lowest in gizzard (19.61 mg/kg), what represented 45.79% and 10.89% of the RDI value, respectively, when 100g of giblets is consumed. The highest zinc content was determined in the liver and lowest in heart (23.22 and 18.61 mg/kg, respectively). Again, liver was the highest in copper and manganese content (5.56 and 2.75 mg/kg, respectively). The lowest in copper content was gizzard (2.18 mg/kg), while both heart and gizzard were at the same level regarding manganese content (0.65 mg/kg). Our calculated values of dietary daily intake for zinc, based on consumption of 100 g of giblets represented between 12.41 and 15.48% of the RDI value. Furthermore, calculated values of dietary daily intake for copper and manganese, based on consumption of 100 g of giblets, represented between 10.9 and 27.8%, and between 3.25 and 13.75% of the RDI value, respectively.

TABLE VI
CONTRIBUTION (%) OF THE ANALYZED ELEMENTS TO DIETARY DAILY INTAKE *; VALUES FOR THE CONSUMPTION OF ONE SERVING (100 G OF HEART, LIVER OR GIZZARD)

Mineral	RDI** (mg/day)	Sample		
		Heart	Liver	Gizzard
K	3500	6.31	7.65	5.56
P	1000	16.65	22.35	11.91
Na	2400	4.78	3.4	3.32
Mg	400	6.45	6.58	6.35
Ca	1000	1.17	1.31	1.10
Fe	18	17.52	45.79	10.89
Zn	15	12.41	15.48	13.03
Cu	2	20.3	27.8	10.9
Mn	2	3.25	13.75	3.27

* The following table lists the daily values based on a caloric intake of 2.000 calories for adults and children four or more years of age [24]
** RDI = Reference Daily Intake

The average contents of minerals, except for Na which was higher and Fe and Zn which were lower, found in this study for heart were in accordance with data presented in national food composition databases of Denmark [25]. Contents of analyzed minerals found for liver in the present study were in accordance with data presented in national food composition databases of the other countries [23], [25]. Also, contents of analyzed minerals found for gizzard in the present study were in accordance with data presented in national food composition databases of Denmark [25]. As expected, mineral contents of chicken giblets were, in most cases, higher than data presented in the literature for chicken meat, or meats of different farm animals [5], [26]. The level of minerals in tissue may vary not only according to the mineral content of feeds but also according to the way animals are housed, their breed, sex and health, slaughter procedures, and type of tissue [27]. According to Greenfield and Southgate [28] meat, exhibits natural variations in the amounts of nutrients contained, and the limits of the natural nutrient variations are not defined.

IV. CONCLUSION

The contents of all investigated minerals, so as the proximate composition, in analysed giblets tissues of chickens from Vojvodina were in most cases similar to values reported in the literature for other countries. Generally, the contents of minerals found in this study confirmed that chicken giblets are good sources of several essential elements, particularly phosphorous, iron, zinc and copper.

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