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Amino Acids Profile of the Organ Meats of the Turkey-hen (*Meleagris gallopavo*)

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ABSTRACT

The levels of amino acids were determined in the gizzard, heart and liver (organ meats); the samples were sourced from turkey-hen (*Meleagris gallopavo*) on dry weight basis. Results showed the total essential amino acids ranged from 37.7-43.2 g/100 g crude protein or 45.9-47.1 % of the total amino acids. The amino acid scores showed that Lys ranged from 1.05-1.10 (on whole hen's egg comparison), 1.18-1.24 (on provisional essential amino acid scoring pattern) and 1.12-1.17 (on suggested requirement of the essential amino acid of a pre-school child). The predicted protein efficiency ratio was 2.21-2.75, the essential amino acid index range was 1.16-1.31 and calculated isoelectric point range was 4.74-5.33. The chi square (X^2) test was low and none of the parameters was significantly different at $\alpha = 0.05$ on all the comparisons made. Results had good comparison with whole hen's egg protein and other standard proteins.

INTRODUCTION

The domesticated turkey is a large poultry bird raised for food. The modern domesticated turkey descends from the wild turkey (*Meleagris gallopavo*), one of the species of turkey (genius *Meleagris*); however, in the past the ocellated turkey (*Meleagrisocellata*) was also domesticated. Thus the scientific classification goes thus: Kingdom (Animalia), Phylum (Chordata), Class (Aves), Order (Galliformes), Family (Meleagrididae, GR Gray: 1840), Genus (*Meleagris*, Linnaeus: 1758), Species (*M. gallopavo* [modern], *M. ocellata* [historical]).

The turkey is reared throughout the temperate parts of the World, and is a popular form of poultry, partially because industrialized farming has made it very cheap for the amount of meat it produces. The female domesticated turkey is referred to as *hen* and the chick as *poult*. In the United States, the male is referred to as a *tom*, whilst in Europe, the male is a stag[1]. Turkeys are traditionally eaten at Christmas in Britain and Thanksgiving in the United States. In Nigeria, turkey meat is becoming a delicacy particularly at Christmas.

Fornias[2] have published the main characteristics, recovery and preparation, microbiology and shelf-life as well s utilization of edible by-products in meat products. In many developing countries meat animals are frequently slaughtered only for the carcass, whereas a number of by-products, which can be obtained quite easily, could help to improve the supply of low-cost, high-protein foods for people. They are generally consumed either as main ingredients in traditional dishes or as ingredients in meat products. The so-called red viscera: liver, heart, kidneys, tongue and neck sweetbread (thymus) are normally obtained and marketed as "fancy meats"[2]. In Spain, the visceral organs are used in many traditional dishes. In some Latin American countries, such as Mexico, almost all internal parts and organs are consumed regularly. Chicken hearts, gizzards and livers are usually eaten fried or boiled, either alone, or in broth. In Brazil, *churrasco* (barbecue) often includes chicken hearts, roasted on a big skewer. Gizzard stews used to be more popular dishes in the past, but are nonetheless still consumed. In Bangladesh, chickens' heart, gizzard (*gi-la*) and liver are also enjoyed. In Nepal, chickens' heart and liver are also enjoyed but it is chickens' gizzards that are truly prized. No literature report is available on the amino acids profile of the turkey visceral organs. This work was therefore set out to evaluate the amino acids profile of the gizzard, heart and liver of the turkey-hen, the information derived here would also likely improve the information on food composition Tables.

MATERIALS AND METHODS

Sample Collection and Treatment

Turkey-hen matured sample was used. Prior to butchering, food was withheld for a day to help ensure the digestive system was empty. Head was held on the stump and the turkey's head removed with an axe. After bleeding, the turkey was plucked. After plucking the feathers, the turkey's anus was rinsed to remove any residue, then a sharp knife was inserted just below the hip bone without puncturing any of the internal organs. The turkey was then opened up, rinsed properly and the internal organs removed, rinsed and dried in the oven until constant weight. The dried samples were ground, sieved and kept in freezer in McCartney bottles pending analysis.

Crude Protein Determination and Fat Extraction

The micro-Kjeldahl method as described by Pearson[3] was followed to determine the fat-free crude protein. The fat was extracted with a chloroform/methanol (2:1 v/v) mixture using Soxhlet extraction apparatus [4].

Amino Acid Analysis

About 30 mg defatted samples were weighed into glass ampoules, 7 ml of 6 MHCl added and hydrolysed in an oven preset at 105±5 °C for 22 h. Oxygen was expelled in the ampoule by passing nitrogen gas into it. Amino acid analysis was done by ion-exchange chromatography[5] using a Technicon Sequential Multisampling Amino Acid Analyser (Technicon Instruments Corporation, New York, USA). The period of analysis was 76 min, with a gas flow rate of 0.50 ml/min at 60 °C, and the reproducibility was ± 3 %. Tryptophan was not determined due to cost.

Estimation of Isoelectric Point (pi)

The theoretical estimation of isoelectric point (pI) was determined using the equation of Olaofe and Akintayo[6] and information provided by Finar[7].

Estimation of Predicted Protein Efficiency Ratio (P-PER)

The predicted protein efficiency ratio (P-PER) was estimated by using the equation of the form[8]:

$$P\text{-}PER = -0.468 + 0.454\ (Leu) - 0.105\ (Tyr).$$

Estimation of Dietary Protein Quality

The amino acid scores were calculated using three different procedures:

(i) Scores based on amino acid values compared with whole hen's egg amino acid profile[9];
(ii) Scores based on essential amino acid scoring pattern[10];
(iii) Scores based on essential amino acid suggested pattern of requirements for preschool child[11].

Estimation of Essential Amino Acid Index (EAAI)

The essential amino acid index (EAAI) was determined using the method of Steinke et al[12].

Leucine/Isoleucine Ratio

The leucine/isoleucine ratios, their differences and their percentage differences were calculated.

Statistical Analysis

The coefficients of variation per cent (CV %) were calculated for the parameters investigated. Also calculated was the chi-square (X^2) test for all the parameters and subjected to table standards to test for significance difference, the level of probability was set at 0.05 at n-1 degrees of freedom[13].

RESULTS AND DISCUSSION

In Table 1 is presented the amino acids composition of the samples. Glu and Asp were the most concentrated amino acid (AA) in all the samples with respective values of 12.7-14.1 g/100 g crude protein (cp) (Glu) and 7.60-9.64 g/100 g cp (Asp). A look at

Table 1 will reveal that the essential amino acid (EAA) of the samples were mostly concentrated (on pair wise comparisons) in the liver; the trend being: Lys, Val, Ile, Leu and Phe (five EAA, 5/9 or 55.6 %) in liver; His (one EAA, 1/9 or 11.1 %) in heart; Arg, Thr and Met (three EAA, 3/9 or 33.3 %) in gizzard. The most concentrated EAA in the samples were (g/100 g): liver, Lys (6.80), Phe (5.59) and Leu (7.91); gizzard, Arg (6.20), Thr (4.19) and Met (2.37); heart, Lys (6.74) and Leu (6.69). The coefficient of variation per cent (CV %) ranged between 2.29-34.7 in the AA, with Lys having the least CV %. From literature, the EAA together with Cys and Tyr had been given for the heart, kidney, liver and tongue of cattle, pig and sheep[2]. In the red viscera of the three animals mentioned above, the EAA with Cys and Tyr for them were (g/100 g cp): His (2.2-2.7); Thr (4.1-4.8); Val (4.8-6.2); Met (2.0-2.6); Ile (3.9-5.3); Leu (7.1-9.4); Phe (3.7-5.3); Tyr (2.9-3.8) and Cys (0.8-2.2). With these literature values, the present results could be said to be very favourably comparable to them, as (g/100 g): His (2.08-2.32); Thr (3.86-4.19); Val (3.05-5.84); Met (2.05-2.37); Ile (3.06-4.04); Leu (6.69-7.91); Phe (4.15-5.59); Tyr (3.17-3.51) and Cys (0.81- 1.19). The comparisons showed that Phe was better concentrated in the turkey-hen than in cattle, pig and sheep viscera whereas the present samples were also better than the minimum in Met, Tyr and Cys. Total EAA (without Try which was not determined in the present work) from literature for cattle, pig and sheep red viscera were (g/100 g): heart (42.7-46.5); kidney (42.5-46.7); liver (41.5-47.7) and tongue (39.4-49.0); where the present results had heart (37.7); liver (43.2) and gizzard (38.1) which were all favourably comparable to the literature values respectively.

Table 1: The amino acid composition (g/100 g crude protein) of turkey-hen samples (dry weight)

Amino acid	Gizzard	Heart	Liver	Mean	SD	CV%
Lysine (Lys)	6.51	6.74	6.80	6.68	0.153	2.29
Histidine (His)	2.08	2.32	2.30	2.23	0.133	5.97
Arginine (Arg)	6.20	5.79	6.19	6.06	0.234	3.86
Aspartic acid (Asp)	8.61	7.60	9.64	8.62	1.02	11.8
Threonine (Thr)	4.19	3.86	4.00	4.02	0.166	4.12
Serine (Ser)	3.71	4.14	3.80	3.88	0.227	5.85
Glutamic acid (Glu)	14.1	14.0	12.7	13.6	0.760	5.59
Proline (Pro)	4.04	3.29	4.44	3.92	0.584	14.9
Glycine (Gly)	4.43	4.15	7.50	5.36	1.86	34.7
Alanine (Ala)	3.79	5.18	4.24	4.40	0.709	16.1
Cystine (Cys)	0.81	1.19	1.14	1.05	0.206	19.7
Valine (Val)	4.38	3.05	5.84	4.42	1.40	31.6
Methionine (Met)	2.37	2.25	2.05	2.22	0.162	7.28
Isoleucine (Ile)	3.06	3.99	4.04	3.70	0.552	14.9
Leucine (Leu)	7.05	6.69	7.91	7.22	0.627	8.68
Tyrosine (Tyr)	3.17	3.41	3.51	3.36	0.175	5.20
Phenylalanine (Phe)	4.51	4.15	5.59	4.75	0.749	15.8
Tryptophan (Try)	-	-	-	-	-	-
Protein (fat free)	76.1	81.1	88.8	82.0	6.40	7.80

The FAO/WHO/UNU[11] standards for pre-school children (2-5 years) are (g/100 g protein): Leu (6.6), Phe +Tyr (6.3), Thr (3.4), Try (1.1), Val (3.5), Ile (2.8), Lys (5.8), Met +Cys (2.5), His (1.9) and total (33.9 with His) and 32.0 (no His). Based on this information, both liver and gizzard would provide individually enough or even more than enough of Leu,Phe +Tyr,Thr, Val,Ile, Lys,Met +Cys,His and total EAA, whereas heart satisfied all the requirements except in Val (3.05<3.5g/100g).Histidine is a semi-essential amino acid particularly useful for children growth.It is the precursor of histamine present in small quantities in cells. When allergens enter the tissues it is liberated in larger quantities and is responsible for nettle rash [14] .The value of Ile was 3.06 -4.04g/100g cp in the samples.It is an EAA for both old and young. Maple Syrup Urine Disease is an Inborn Error of Metabolism in which brain damage and early death can be avoided by a diet low in Ile and two other EAA, Leu and Val. Both Ile, Leu and Val were high in concentration in the samples. However, the concentrations were not at dangerous levels. Methionine is an EAA with value range of 2.05-2.37 g/100 g cp in this report or 3.18-3.44 g/100 g cp with Cys. Methionine is needed for the synthesis of choline. Choline forms lecithin and other phospholipids in the body. When the diet is low in protein, for instance in alcoholism and kwashiorkor, insufficient choline may be formed; this may cause accumulation of fat in the liver[14]. Phenylalanine made a value range of 4.15-5.59 g/100 g cp of the samples. It is the precursor of some hormones and the pigment melanin in hair, eyes and tanned skin. Phenylketonuria is the commonest Inborn Error of Metabolism successfully treated by diet. The absence of an enzyme in the liver blocks the normal metabolism of phenylalanine and the brain is irreversibly damaged unless a diet low in Phe is given in the first few weeks of life. Tyrosine is the precursor of some hormones (like the thyroid hormones) and the brown pigment melanin formed in hair, eyes and tanned skin. It reduces the requirement of Phe. Permanent deficiency of the enzyme-hypertyrosinaemia, a rear Inborn Error of Metabolism-can cause liver and kidney failure unless treated with a synthetic diet low in Phe and Tyr[14].Valine, an EAA is restricted in the treatment of Maple Syrup Urine Disease. When the present results were compared to amino acids profile of the muscle and skin of the turkey-hen it was observed that the following AA were all (in most of the samples) more concentrated in the organ meats than in the muscle and skin [1] (g/100 g cp): Asp, Pro, Cys, Leu, Thr, Ala and Val.

Table 2 presents parameters on the quality of the protein of the samples. The EAA ranged 37.7-43.2 g/100 g cp with a variation of 8.88 %. These values were more than half the average of 56.6 g/100 g cp of the egg reference protein [9]. The total

sulphur AA (TSAA) of the samples were 3.18-3.44 g/100 g cp. These values were close to the 5.8 g/100 g cp recommended for infants [11]. The aromatic AA (ArAA) range suggested for infant protein (6.8 -11.8 g/100 g cp)[11] was very favourably comparable with the present report of 9.76-11.4 g/100 g cp showing that the samples protein could be used to supplement cereal flowers[15]. The percentage ratio of EAA to the total AA (TAA) in the samples ranged between 45.9-47.1. These values were well above the 39 % considered adequate for ideal protein food for infants, 26 % for children and 11 % for adults[11]. The percentage EAA/TAA for the samples could be favourably compared with other animal protein sources: 46.2 % in *Zonocerusvariegatus*[16], 43.7 % in *Macrotermes bellicossus*[17], 54.8 % in *Gymnarchusniloticus*(Trunk fish)[18] and 48.1-49.9 % in brain and eyes of African giant pouch rat [19] whereas it is 50 % for egg [20]. The TEAA in these results were close to the value of 44.4 g/100 g cp in soybean [21], melon and gourd oilseeds with respective values of 53.4 g/100 g cp and 53.6 g/100 g cp[22]. The percentage of total neutral AA (TNAA) ranged from 54.8-59.0, indicating that these formed the bulk of the AA; total acidic (TAAA) ranged from 24.4 -27.3 which were much lower than % TNAA, while the percentage range in total basic AA (TBAA) was 16.7-18.2 which made them the third largest group among the samples. The predicted protein efficiency ratio (P-PER) was 2.21-2.75. These results were highly comparable to the following literature values: 2.27 (skin) and 1. 93 (muscle) of turkey hen [1]; 1.58 (brain) and 2.08 (eyes) of African giant pouch rat[19]; 2.22 (*Clariasanguillaris*), 1.92 (*Oreochromisniloticus*) and 1.89 (*Cynoglossus senegalensis*)[23]but lower than in the values from various parts of fresh water female crab: 3.4 (whole body), 3.1 (flesh), 2.6 (exoskeleton)[24]; fresh water male crab: 2.9 (wholebody), 2.8 (flesh), 2.4 (exoskeleton)[25]; 2.56 (cattle brain), 3.04 (pig brain), 2.68 (sheep brain), 3.26 (pig heart), 3.24 (pig kidney), 3.22 (pig liver), 3.00 (sheep heart), 2.57 (sheep kidney), 2.88 (sheep liver), 2.45 (sheep tongue) but better than 1.15 (cattle heart), 0.99 (cattle kidney), 1.20 (cattle liver) and 1.14 (cattle tingue)[2]. It is interesting to note that the P-PER in heart was 2.21<2.40 in the gizzard. The bird stomach's second chamber is known as the gizzard. If you have ever eaten a chicken gizzard you know how tough and robbery it is. To accomplish what the gizzard does, it absolutely must be tough, for the gizzard's main function is to grind and digest tough food. Despite these characteristics P-PER in gizzard was still greater than P-PER in heart.

Table 2: Essential, non-essential, acidic, neutral, sulphur, aromatic, etc (g/100 g crude protein) of turkey-hen samples (dry weight)

Amino acid	Gizzard	Heart	Liver	Mean	SD	CV%
TAA	83.0	81.8	91.7	85.5	5.41	6.33
TNEAA	44.8	44.1	48.5	45.8	2.35	5.14
TEAA-with His	38.1	37.7	43.2	10.3	0.91	48.88
-no His	36.1	35.3	40.9	37.4	3.02	8.07
% TNEAA	54.0	54.0	52.9	53.6	0.635	1.18
% TEAA -with His	45.9	46.1	47.1	46.4	0.643	1.39
-no His	43.5	43.2	44.6	43.8	0.737	1.68
TNAA	45.5	45.4	54.1	48.3	4.98	10.3
% TNAA	54.8	55.5	59.0	56.4	2.25	3.99
TAAA	22.7	21.6	22.4	22.2	0.555	2.50
% TAAA	27.3	26.4	24.4	26.0	1.48	5.71
TBAA	14.8	14.9	15.3	15.0	0.273	1.82
% TBAA	17.8	18.2	16.7	17.6	0.777	4.41
TSAA	3.18	3.44	3.19	3.27	0.147	4.50
% TSAA	3.83	4.21	3.48	3.84	0.365	9.51
% Cys/TSAA	25.5	34.6	35.7	31.9	5.60	17.6
TArAA	9.76	9.88	11.4	10.3	0.914	8.88
% TArAA	11.8	12.1	12.4	12.1	0.300	2.48
P-PER[a]	2.40	2.21	2.75	2.45	0.274	11.2
Leu/Ile ratio	2.30	1.68	1.96	1.98	0.310	15.7
% Leu-Ile (difference)	56.6	40.4	48.9	48.6	8.10	16.7
pI[b]	4.80	4.74	5.33	4.96	0.325	6.55
EAAI[c]	1.21	1.16	1.31	1.23	0.076	6.21

[a]P-PER = predicted protein efficiency ratio, [b]pI = isoelectric point, [c]EAAI = essential amino acid index

The Leu/Ile ratio was low in the samples (1.68-2.30) with CV % of 15.7; hence no concentration antagonism might be experienced in the turkey-hen viscera when consumed as protein source in food. The essential AA index (EAAI) ranged from1.16-1.31. EAAI is useful as a rapid tool to evaluate food formulations for protein quality, although it does not account for difference in protein quality due to various processing methods or certain chemical reactions [26]. The EAAI of deffated soybean is 1.26 [26]; 1.10 (brain) and 1.10 (eyes) of African giant pouch rat[19]; the EAAI values much better than the cited literature values. In the results of the isoelectric points (pI), there were various values (4.74-5.33). This type of observation had been made in African giant pouch rat [19] in brain (4.28) and eyes (4.25); also in turkey meat: skin (4.41) and muscle (5.01)[1]. The calculation of pI from AA would assist in the quick production of protein isolate of an organic product without going through the protein solubility determination to get the pI. Most animal proteins are low in Cys, for example: 36.3 % in *M. bellicossus*[17]; 25.6 % in *Z. variegatus*[16]; 35.5 % in

Archachatinamarginata, 38.8 % in *Archatinaarchatina*and 21.0 % in *Limicolaria*sp., respectively [27]; 27.3 %–32.8 % in female fresh water crab body parts [24]; 23.8–30.1 % in three different Nigeria fishes [23]; 13.3 %–15.9 % in male fresh water crab body parts [25]; 26.0–26.5 % in turkey hen meat[1]; 20.8 –28.2 % in skin and muscle of African giant pouch rat [19] in their (Cys/TSAA) % values. The present results corroborated these literature observations with values of 25.5–35. 7 %. This type of results had also been observed in guinea fowl egg (14.0 %), 44 % in domestic fowl [28]; 26.2 % (muscle) and 30.2 % (skin) in guinea fowl [29]. In contrast, many vegetable proteins contain substantially more Cys than Met, examples (Cys/TSAA) %: 62.9 % in coconut endersperm[30] and in *Anacardiumoccidentale*it is 50.5 % [31]; 58.9–72.0 % (raw, steeped, germinated sorghum) [15]; 51.2–53.1 (raw, steeped, germinated millet) [32]. Thus, for animal protein diets or mixed diets containing animal protein, Cys is unlikely to contribute up to 50 % of the TSAA [33]. The percentage of Cys in TSAA had been set at 50 % in rat, chick and pig diets [33]. Cys can spare with Met in improving protein quality and also has positive effects on mineral absorption, particularly zinc [34].

Table 3 shows the AA scores (AAS) of the samples based on whole hen's egg profile [9]. The scores had values greater than 1.0 in Lys, Arg, Glu, Pro and Gly (gizzard); Lys, Glu and Gly (heart) and Lys, Arg, Glu, Pro, Gly and Phe (liver). Only Lys, Glu and Gly were greater than 1.0 in all the samples. Gly had the highest score (1.38–2.50) in all the samples; the least score was Ser in gizzard (0.470) and liver (0.481) whereas Val was lowest in heart (0.407). The AAS values in these results followed the pattern observed in the African giant pouch rat skin and muscle [19]. The organ meats of the turkey–hen generally showed good comparisons with AA profile of the whole hen's egg. The CV % of the AAS ranged between 2.45– 34.6. Table 4 contains the EAA scores (EAAS) based on provisional amino acid scoring pattern [10]. The EAAS greater than 1.0 in the gizzard were Lys, Thr, Leu, Phe + Tyr and total; in heart they were Lys, Phe + Tyr and total; for liver we had Lys, Thr, Met + Cys (TSAA), Val, Ile, Leu, Phe + Tyr and total. Lys, Phe + Tyr and total were consistently greater than 1.0 in all the samples. The limiting AA (LAA) in the gizzard was Ile (0.765), it was Val (0.610) in heart but none in the liver. Although these would have been described as the LAA, however, the EAA most often acting in a limiting capacity are Met (and Cys), Lys, Thr and Try [11]. Since Try was not determined, the Val and Ile would be taken as LAA for the basis of corrections. To make corrections for the LAA in the samples if they serve as sole sources of protein food therefore, it would be 100/76.5 (or 1.31) x protein of gizzard and 100/61.0 (or1.64) x protein of heart [14]. The highest EAAS in gizzard was Phe +Tyr (1.28),it was Phe +Tyr (1.26) in heart and Met + Cys (1.94) in liver. The Table 5 shows the EAAS based on suggested requirement of the EAA of a preschool child [11]. In the liver all the EAAS were greater than 1.0 and the same observation applied to gizzard and heart. The following values would show the position of the quality of the turkey–hen organ meats protein: the EAA requirements across board are (values with His) (g/100 g protein): infant (46.0), preschool (2–5 years) (33.9), school child (10–12 years) (24.1) and adult (12.7) and without His: infant (43.4) preschool (32.0), school child (22.2) and adult (11.1)[11]; from the present results based on these standards, we have: 38.1g protein (with His) and 36.1 (no His) in gizzard; 37.7 g protein (with His) and 35.3 g protein (no His) in heart and 43.2 g protein (with His) and 40.9 g protein (no His) in liver. While the present results would satisfy a high percentage of infant needs, they will satisfy the requirements of preschool children and above.

Table 6 gives a brief summary of the AA profile in the three samples. Column under Factor B means showed that the values there were close with a range of 39.7–45.8. However the mean of Factor A means and Factor B means gave a value of 42.8 g/100 g as a total summary.

The chi square (X^2) test results were all low for all the parameters determined and the values were not significantly different at $\alpha = 0.05$ among the samples.

CONCLUSIONS

The present study has presented the amino acids data of organ meats of turkey–hen (*Meleagrisgallopavo*). It was found that the samples were good sources of high quality protein of almost adequate or more than adequate essential amino acids, low Leu/Ile ratio and high protein efficiency ratio values thereby providing a probable premium quality meat. The samples were also very highly comparable to the red viscera of cattle, pig and sheep. The analytical results would also improve the information in the Food Composition Table.

Table 3: Amino acid scores of the samples based on whole hen's egg

Amino acid	Gizzard	Heart	Liver	Mean	SD	CV%
Lys	1.05	1.09	1.10	1.08	0.026	2.45
His	0.867	0.967	0.958	0.931	0.055	5.94
Arg	1.02	0.949	1.01	0.993	0.038	3.87
Asp	0.805	0.710	0.910	0.805	0.096	11.9
Thr	0.822	0.757	0.784	0.788	0.033	4.14
Ser	0.470	0.524	0.481	0.492	0.029	5.80
Glu	1.17	1.17	1.06	1.13	0.064	5.62
Pro	1.06	0.866	1.17	1.03	0.154	14.9
Gly	1.48	1.38	2.50	1.79	0.620	34.6
Ala	0.702	0.959	0.785	0.815	0.131	16.1
Cys	0.450	0.661	0.633	0.581	0.115	19.7
Val	0.584	0.407	0.779	0.590	0.186	31.5
Met	0.741	0.703	0.641	0.695	0.050	7.26
Ile	0.546	0.713	0.721	0.660	0.099	15.0
Leu	0.849	0.806	0.953	0.869	0.076	8.70
Tyr	0.793	0.853	0.878	0.841	0.044	5.19
Phe	0.844	0.814	1.10	0.933	0.149	16.0
Try	–	–	–	–	–	–
Total	0.846	0.834	0.935	0.872	0.055	6.33

Table 4: Essential amino acid scores of the samples based on provisional amino acid scoringPattern

Amino acid	Gizzard	Heart	Liver	Mean	SD	CV%
Lys	1.18	1.23	1.24	1.22	0.032	2.63
Thr	1.05	0.965	1.00	1.01	0.043	4.25
Met + Cys (TSAA)	0.909	0.983	1.94	1.28	0.575	44.9
Val	0.876	0.610	1.18	0.885	0.280	31.7
Ile	0.765	0.998	1.01	0.924	0.138	14.9
Leu	1.01	0.956	1.13	1.03	0.089	8.63
Phe + Tyr	1.28	1.26	1.52	1.35	0.145	10.7
Try	–	–	–	–	–	–
Total	1.09	1.08	1.23	1.13	0.084	7.42

Table 5: Essential amino acid scores of the samples based on suggested requirements for pre-school children (2-5 years)

Amino acid	Gizzard	Heart	Liver	Mean	SD	CV%
Lys	1.12	1.16	1.17	1.15	0.026	2.30
Thr	1.23	1.14	1.18	1.18	0.045	3.82
Met + Cys (TSAA)	1.27	1.38	1.28	1.31	0.061	4.64
Val	1.25	0.871	1.67	1.26	0.400	31.7
Ile	1.09	1.43	1.44	1.32	0.199	15.1
His	1.09	1.22	1.21	1.17	0.072	6.18
Leu	1.07	1.01	1.20	1.09	0.097	8.91
Phe + Tyr	1.22	1.20	1.44	1.29	0.133	10.3
Try	–	–	–	–	–	–
Total	1.16	1.15	1.32	1.21	0.095	7.88

Table 6: Summary of the amino acid profile of the samples

	Turkey-hen (Factor A) Gizzard	Heart	Liver	Factor B Means
Amino acid composition (Factor B)				
	38.1	37.7	43.2	39.7
Total non-essential amino acid	44.8	44.1	48.5	45.8
Factor A Means	41.5	40.9	45.9	42.8

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