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Proximate Composition of Three Head Organs (Brain, Eyes, Tongue), Three Visceral Organs (Liver, Heart, Gizzard), Skin and Muscle of Muscovy Duck- hen

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ABSTRACT

The proximate compositions of brain (A), eyes (B), tongue (E), liver (D), heart (F), gizzard (C), skin (H) and muscle (G) of Muscovy duck-hen were determined. The proximate composition values ranged as follows (values in g/100g on dry weight basis) ash (0.18 – 3.77 ± 1.40), moisture (0.50 – 4.78± 1.40), protein (3.24 – 79.9 ± 29.7), fat (0.23 – 5.60 ± 2.04), carbohydrate (6.19 – 95.8 ± 33.6), dry matter (95.22 – 99.5± 1.40) and organic matter (91.45 – 99.27± 2.63) with all the parameters being significantly different among the samples. Metabolizable energy contribution from protein, fat and carbohydrate in the samples ranged from (kJ/100g/kcal/100g): 740(180) – 7924(1864). Percentage energy contribution range was 5.53/5.70 – 59.2/59.1. Whereas the crude fat ranged from 0.23 – 5.60 g/100g, the total fatty acid (TFA) ranged from 0.217 – 5.08 g/100g or EPg/100g with corresponding energy of (kJ/100g versus kcal/100g): 8.51/2.07 – 207/50.4 and 8.03/1.95 – 188/45.7 respectively. UEDP% (assuming 60% energy utilization) range was 1.95/1.96 – 49.0/48.9. Approximate sample weight equivalents to the energy requirements of adults and infants had ranges of : for 2500kcal per day, sample range was 617 – 644g (adults) and at 3000kcal per day, requirement was 741 – 773g (adults); infant at 740kcal would require 183 – 191g. Water balance for protein metabolism had value range of 6.48 – 160ml. Correlational analyses of samples at $r_{=0.01}$ gave these results: A/B (0.3024), B/E (0.1794), A/E (0.9916), C/D (0.9994), D/F (0.9892), C/F (0.9923) and G/H (-0.2014). Hence, Muscovy duck-hens are good sources of protein, metabolizable energy and low fat.

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Introduction

The FAO has recommended a minimum requirement of 34g/head/day of animal protein for a healthy human being; this is against a value of 3.8g/head/day intake in Nigeria. Evidently, this is far below the average animal protein intake per head per day in developed countries. The following statistics had been given on stock of animals in Nigeria by Baruwa et al.: greater than 13 million cattle, 34 million goats, 24 million sheep, 3.4 million pigs, about 1.7 million domestic rabbits and 104.3 million local poultry with about 20 million exotic poultry, meat supply in Nigeria is said to remain critical. Therefore, one of the most serious nutritional problem in the developing countries (typified by Nigeria) is the shortage of high protein from animal sources. One of such potential source of animal protein, which is not popularly produced in Nigeria, is the duck. The demand for chemical-free meat has been increasing yearly because of the growing awareness of their safety, especially among health-conscious people. The prejudice against duck and duck consumption was informed by ignorance on the part of consumers [1-5].

The domestic ducks are water fowls. They are raised mainly in regions of high rainfall, deltas, riverine areas and coastal districts of the tropics. Ducks are mini-livestock. They are hardier and more resistant to environmental hazards, therefore, better as scavenger birds in developing countries like Nigeria [6]. In terms of meat quality, duck meat is comparable to chickens as depicted in Table 1. Duck varieties not popular in Nigeria are Pekin, Aylesbury and Indian Runner. Those varieties popular in Nigeria are Muscovy and the Campbell (Khaki Campbell duck) [6]. The Muscovy duck is the most popular in Nigeria. They are most commonly kept on free-range and at backyard level. Plumage could be black, white or a combination of both colours. Muscovy ducks are able to hatch and care for an average of 30 ducklings (young ducks) annually per bird. The egg weighs between 55-60g each. As scavengers, the adult female weighs 1.5kg while the male weighs 2.2kg. They are found numerous in the Southern States along the coastal part of Nigeria [6]. Many people in Nigeria see ducks as dirty animals because they can mesh in any water including dirty smelly stagnant water and eat from there as well [6, 7]. But now that duck can be confined in one place and be reared just like poultry it calls for necessary attention.

Table 1: Meat qualities of duck versus chicken

Meat quality	Duck	Local chicken	Broiler
Appearance	7.2	8.2	6.5
Juiciness	6.8	7.2	8.7
Tenderness	6.3	5.6	8.5
Flavour	8.2	8.8	6.9
Overall*	9.0	9.5	7.1

*Scoring is over 10 points using 10 tasters. Source [6]

The classification of ducks, geese and waterfowl come under similar category. Order: Anseriformes; Family: Anatidae. Anatidae includes the ducks and most duck-like waterfowl, such as geese and swans. These birds are adapted to an aquatic existence with webbed feet, flattened bills and feathers that are excellent at shedding water due to an oily coating [8]. Ducks are ranked close to chicken by many countries of the world in regards to meat and egg population. The following statistics would show the place of duck in Nigeria. In Nigeria, more emphasis is laid on domestic fowl to the neglect of other classes of poultry. As a result domestic fowl dominated the poultry industry. Of the 150 million poultry population, 120 million (80%) were indigenous. Domestic fowl constituted 91% of this while guinea fowl, duck, turkey and others were 4%, 3% and 2% respectively. The population of ducks in Nigeria had been put as 1.21 million as against 133.5 million local/exotic chicken. According to a report (Federal Government of Nigeria, 1988), 69% of total meat, and 12% of total eggs were supplied by domestic fowl in 1987. Despite abundant water, pasture land and the fact that 10% of Nigerian households keep duck, consumption of its meat and especially eggs, was still low. A survey by Adenowo et al. showed that ducks were neither raised for egg production nor for consumption. Thus duck eggs were seldom eaten or sold. The reason obtained by the survey, basically on taboo, partially explains why duck eggs have not found favour with consumers [8-11].

This has been further confirmed by Baruwa et al [2]. that among the relative rankings of problem sources in duck production in Oyo State, Nigeria, consumption taboos had importance rating mean of 1.77, most important problem source of 20%, index (mean x percentage) of 35.4 and rank 2. However, ducks meat consumption is gaining popularity since it is equally nutritious and rich in nutrients as other well-known consumable birds [7]. A study carried out by Adeyeye reported the comparison of the amino acids profiles of whole eggs of duck, francolin and turkey consumed in Nigeria [9]. Results showed that all these eggs should be encouraged and taken (any of them) as choice eggs. The duck meat is generally becoming a delicacy in Nigeria; however, literature is not available on the proximate compositions of the heart, liver, gizzard, brain, eyes, tongue, muscle and skin. Among the offal meat, heart is unusual in that it consists almost entirely of muscle and which is in almost all instances an edible part of an animal. Hearts of poultry and game birds count as giblets. The gizzard is the bird stomach's second chamber. It is tough and robbery when eaten. To accomplish what the gizzard does in the bird, it absolutely must be tough, for the gizzard's major function is to grind and digest tough food consumed by the bird. Liver is a relatively large organ in many animals, birds and fish, usually edible and may be delicious. Livers are appreciated in many parts of the world, although consumption is low in N. America. Livers lend themselves well to the making of pastes, stuffings, sausages and the like. Chicken livers are the most widely eaten of poultry livers, but the famous are the specially flattened livers of goose or duck. Various game birds provide good livers, which may be served as special titbits on toast. Eyes of certain animals and fish are considered a delicacy in some culinary cultures. In Laos the eyes of the giant cat fish of the Mekong are among the most highly esteemed parts of this highly esteemed fish. However, the practice of eye-eating (even if cornea lens and iris are removed), as in an unusual French recipe for (*Yeux de veau farcis*) seems likely to contract rather than spread as the centuries roll by. Eyes are perfectly eaten in Nigeria particularly by the young children. Brains particularly those of calf and lamb, have been accounted a delicacy, valued mainly for their creamy texture. They can be poached in a court bouillon, or braised, or made into fritters. In the 1990s marketing and consumption of calf's (or cow's) brains, together with some other organs, ceased in W. Europe because of fear that human beings might be affected by BSE (bovine spongiform encephalitis). Generally, brains are a very rich food, of which a little goes a long way. In Nigeria, brains are eaten without any special inhibitions. Rabbits tongues, cooked, have been served in France as an *hors d'oeuvre* or as a garnish for dishes. In the world of seafood, various fish, such as cod, have tongues which are eaten with enthusiasm. The Pectoralis muscles of ducklings and broiler chickens are approximately the same size at market age and have the same function, as they are the predominant flight muscle, which is incapable of sustained flight at the early age at which these species are commercially processed. The integumentary system consists of the skin, the feathers and the appendages (claws and beak). The skin covers the majority of the body. The integumentary system is very important in providing protection to the bird from a number of potentially dangerous situations. The skin is usually covered by the feathers is therefore normally protected and hence is thinner. Over the wings and thighs, the skin is more closely joined to underlying tissue than over the rest of the body. The epidermis is about 12 cells thick with the horny outer layer being about 5 cells, the transitional layer being about two and the inner, germinative layer being about 4-6 cells [11-15]. This work was therefore set out to evaluate the proximate compositions and other related parameters in the various organs of the *Cairina moschata* bird. The information to be provided in the data and the discussion might improve the information on Food Composition Tables.

Materials and Method

The Treatment of Samples

The duck-hen used were three matured birds. Prior to slaughtering the birds were starved of feed for 24h. This was to ensure the digestive system was empty. The duck was slaughtered by severing the jugular vein and cutting it just below the hind brain at the throat. Cutting to kill was immediately and caused no excessive suffering to the fowl [12]. Feather removal (plucking) was done immediately after killing before the carcass got cold. The method of plucking was the method of dry plucking the wings and tail, then carcass was dipped into hot water (60°C) to penetrate through the body for about 6-10 minutes. The feathers were then removed by scalding [12]. After the removal of feathers, the duck-hen anus was rinsed for the removal of any residue, thereafter, a sharp knife was inserted just below the hip bone without puncturing any of the internal organs. The duck was removed, both skin and muscle sliced, rinsed and oven-dried. The heart, liver and gizzard were also saved for the analyses. The gizzard was sliced into half until the gravel inside grates against the knife, then sliced around and opened up, peeling away the inner layer and discarding the contents, then rinsed out with distilled water. Other parts analyzed were in the head: eyes, brain and tongue were plucked out of the head and dried. The dried samples ground, sieved and kept in the refrigerator (2.8°C), in McCartney bottles pending analysis.

Proximate Analysis

Representative aliquots of 2-4g were taken from each sample for analysis. Moisture, total ash, fibre and ether extract of the samples were determined by the methods of the AOAC. Nitrogen was determined by the micro-Kjeldahl method and the crude protein content was calculated as N (per gramme) x 6.25 [16, 17]. Carbohydrate was determined by differences. All the proximate results were reported in g/100g dry weight. The calorific values in kilojoules (kJ) were calculated by multiplying the crude fat, protein and carbohydrate by Atwater factor 37, 17 and 17 respectively. Determinations in kilocalories were calculated by multiplying the crude fat, protein and carbohydrate by Atwater factor of 9, 4, 4 respectively. Determinations were in duplicate.

Statistical Analyses and other Calculations

Statistical Analysis

The statistical analyses were in two major forms: descriptive statistics and inferential statistics. For descriptive model, the data obtained were subjected to calculation of mean, standard deviation (SD) and coefficient of variation percent (CV %). For the inferential statistics, two model types were involved: there was calculation on Chi-square (χ^2) model and correlational analysis. Both models were subjected to statistical table setting the critical level at $\alpha = 0.01$ to find out if statistical differences occurred within the samples as appropriate. The coefficient of correlation (r_{xy}) was further expanded to variance (coefficient of determination) (r_{xy}^2), regression coefficient (Rxy). Further on this, was the calculation for coefficient of alienation (C_A) and index of forecasting efficiency (IFE) [18, 19].

Other Calculations

(i) Energy contribution from protein, fat and carbohydrate in the proximate data.
(ii) The percentage contribution to the total energy due to protein (PEP), due to total fat (PEF) and due to carbohydrate (PEC) as PEP%, PEF% and PEC% respectively were calculated.
(iii) The percentage utilizable energy percent due to protein (UEDP %) assuming 60% protein energy utilization was also calculated.
(iv) Fat profiles from the proximate fat values were calculated using appropriate fat conversion factors to get total fatty acids (TFAs) and non-fatty acid lipids.
(v) Approximate sample weight equivalents to the energy requirements of adults and infants from the proximate values.
(vi) Water balance requirements for complete protein metabolism.

Results

The proximate composition values of three head organs (brain, A; eye, B; tongue, E), three visceral organs (liver, D; gizzard, C; heart, F), muscle (G) and skin (H) were depicted in Table 2. Parameters reported on were ash, moisture, protein, fat, fibre, carbohydrate, dry matter and organic matter. Both descriptive and inferential statistics were used to analyse the data obtained from the analyzed samples. On the horizontal axis we have 13 columns whereas in the vertical axis we have 12 columns. All the data result values were reported in g/100g unit. In the ash column, values ranged from 0.18-3.77±1.40 g/100g; 0.18 g/100g was recorded for eye (B) whereas 3.77 g/100g was recorded for the muscle being lowest and highest value respectively. These ash values were all generally low. The total all samples ash content was 13.2 g/100g with a mean of 1.66 g/100g and high level of coefficient of variation (CV %) of 84.7; this showed an evidence of high variation in the ash values within the samples. The percentage value of ash for each sample ranged from 1.36-28.5%.

Table 2: Proximate compositions of three head organs, three visceral organs, muscle and skin of domestic female duck from Nigeria

Bird part	Proximate constituents (g/100g), percentage values in parenthesis											
	Ash	Moisture	Protein	Fat	Fibre	Carbohydrate	Dry matter	Organic matter	χ^2	Mean	SD	CV%
Brain (A)	0.25 (1.89)	3.25 (14.1)	70.7 (15.2)	1.31 (6.55)	ND	24.5 (8.81)	96.75 (12.5)	96.5 (12.6)	285*	41.9	44.7	107
Eye (B)	0.18 (1.36)	1.04 (4.51)	18.2 (3.91)	0.33 (1.65	ND	80.2 (28.9)	98.96 (12.7)	98.78 (12.9)	312*	42.5	47.7	112
Gizzard (C)	2.95 (22.3)	3.35 (14.5)	71.7 (15.4)	2.54 (12.7)	ND	19.5 (7.02)	96.65 (12.4)	93.7 (12.3)	280*	41.5	44.0	106
Liver (D)	1.08 (8.16)	3.49 (15.1)	72.2 (15.5)	2.35 (11.8)	ND	20.9 (7.52)	96.51 (12.4)	95. 43 (12.5)	286*	41.7	44.6	107
Tongue (E)	2.38 (18.0)	3.25 (14.1)	74.6 (16.0)	2.25 (11.3)	ND	17.6 (6.23)	96.75 (12.5)	94.37 (12.4)	290*	41.6	44.8	108
Heart (F)	2.40 (18.1)	3.41 (14.8)	75.6 (16.2)	5.60 (28.0)	ND	13.0 (4.68)	96.59 (12.4)	94.19 (12.3)	290*	41.5	44.8	108
Muscle (G)	3.77 (28.5)	4.78 (20.7)	79.9 (17.1)	5.38 (26.9)	ND	6.19 (2.23)	95.22 (12.3)	91.45 (12.0)	297*	41.0	45.0	110
Skin (H)	0.23 (1.74)	0.50 (2.17)	3.24 (0.695)	0.23 (1.15)	ND	95.8 (34.5)	99.5 (12.8)	99.27 (13.0)	346*	42.7	51.9	122
Total	13.2	23.1	466	20.0	-	278	776.93	763.69	-	-	-	-
Mean	1.66	2.88	58.3	2.50	-	34.7	97.12	95.46	-	-	-	-
SD	1.40	1.40	29.7	2.04	-	33.6	1.40	2.63	-	-	-	-
CV%	84.7	48.7	51.1	81.8	-	96.8	1.45	2.76	-	-	-	-
χ2	8.30	4.79	106*	11.7	-	228*	0.1422	0.5091	-	-	-	-

χ^2 = chi-square; ND = not detected; SD = standard deviation; CV% = coefficient of variation; - = not determined; df_1 ($n - 1 = 8 - 1 = 7$ in proximate value across column); df_2 ($n - 1 = 7 - 1 = 6$ in animal proximate value vertical column); critical level at $\chi^2_{0.01}$ for df(7) = 18.48 and for df (6) = 16.81; * value is significant, that is $\chi^2_{calculated} > \chi^2_{Table}$

The moisture content values were generally low and ranged from 0.50-4.78 ± 1.40 g/100g. As in the ash lowest/highest moisture values came from skin (H)/muscle (G) respectively. The total moisture content was 23.1g/100g with a mean of 2.88 g/100g and CV% of 48.7 which was much lower to that of ash of CV% of 84.7. Percentage moisture values ranged from 2.17-20.7%. Protein ranged from very low (3.24g/100g, skin) to very high (79.9g/100g, muscle) ± 29.7 g/100g. Duck samples of protein values of 70.0 g/100g and above were: sample (protein value and percentage position): brain (A) (70.0, 15.2%), gizzard (C) (71.7, 15.4%), liver (D) (72.2, 15.5%), tongue (E) (74.6, 16.0%), heart (F) (75.6, 16.2%) and muscle (G) (79.9, 17.1%); both eyes (B) and skin (H) were much lower than the other samples with respective information values of 18.2 (3.91%) and 3.24 (0.695%). The total protein value was 466 g/100g, mean of 58.3 g/100g and CV% of 51.1. The fat values were also low generally as observed in ash and moisture contents. Fat content varied between 0.23 g/100g (skin, H) and 5.60 g/100g (heart, F) ± 2.04 g/100g. The total fat value in the eight samples was 20.0 g/100g with a mean of 2.50 g/100g but high CV% of 81.8. The highest fat value was observed in the heart; this was expected because the food of the heart is fat which is used by the heart during the period of stress. The percentage fat values ranged from 1.15-28.0. Crude fibre was not detected in all the eight samples. The carbohydrate values also ranged from very low to very high values. Values range were 6.19 (muscle, G) – 95.8 (skin, H) ± 33.6 g/100g; it would appear as if the carbohydrate contents were the reflection of the fat contents. The total carbohydrate value was 278 g/100g with a mean of 34.7 g/100g and CV% of 96.8. The percentage range was 2.23-34.5. Many characteristics were unusual concerning dry matter (DM) values: all high DM values (95.22-99.5 g/100g), very high total value of 776.93 g/100g; high mean value of 97.12 g/100g; very low standard deviation (1.40) and CV% (1.45); percentage values were low and virtually similar (12.3-12.8). Some characteristics of the DM were also exhibited by the organic matter (OM): high sample values (91.45-99.27 g/100g); total OM of 763.69 g/100g; high mean (95.46 g/100g); low SD (2.63) and CV% (2.76); again the percentage values were low, close, and virtually similar (12.0 – 13.0). Hence, on the vertical axis for the proximate parameters, the level of variation among parameter values followed this trend: carbohydrate (96.8) > ash (84.7) > fat (81.8) > protein (51.1) > moisture (48.7) > OM (2.76) > DM (1.45). Among the proximate parameters, the chi-square ($\chi 2$) values at $\chi 20.01$ showed that protein values and carbohydrate values were significantly different among the sample results since their $\chi^2_{calculated} >> \chi^2_{Table}$ because χ^2 critical was 18.48 (df = 7) whereas $\chi^2_{protein}$ was 106 and $\chi^2_{carbohydrate}$ was 228.

Along the horizontal columns the sample proximate values could be compared. The total sample values were generally close at mean values of 41.0-42.7 g/100g; the SD values were close at 44.0-51.9; CV% values were above 100 but close at values of 106-122. The $\chi^2_{0.01}$ for the sample showed that the proximate parameters were all positively high and significant different since all $\chi^2_{calculated} > \chi^2_{Table}$ (critical value = 16.81, calculated values ranged from 280-340) at df (6).

Table 3 contained energy contribution from protein, fat and carbohydrate in the proximate compositions of the samples. Total energy values were recorded at both vertical (along proximate parameters) and along horizontal (along sample types). Energies from protein contribution ran thus (kJ/100g/kcal/100g): 55.1/13.0 and total of 7924/1864; the percentage sample contribution to the protein energy values ranged from (kJ/100g/kcal/100g): 0.6951/0.6951-17.1/17.1. For fat contribution, the energy values were generally low; values ranged from kJ/100g/kcal/100g: 8.51/2.07-207/50.4; total fat energy contribution was 740/180 and the percentage energy range was 1.15/1.15-28.0/28.0. The carbohydrate energy contribution when compared to that of the protein was 1.00: 1.68. Energy contribution from carbohydrate to the total energy of the proximate energy contributors had range values of (kJ/100g/kcal/100g): 105/24.8-1629/383 with total contributed carbohydrate energy values of 4719/1110; percentage energy range was 2.23/2.23-34.5/34.5. The total energy contribution per sample (values across the horizontal columns) ranged from (kJ/100g/kcal/100g): 1644/388-1713/404 and total contribution of 13384/3156. This showed that the samples were good sources of energy as they were generally energy dense. The proportion of total energy due to protein (PEP %), fat (PEF %) and carbohydrate (PEC %) from protein, fat and carbohydrate in the proximate composition values were shown in Table 4. Vertical columns 2 and 3 showed the total energy contribution (kJ/100g/kcal/100g): 1644/388-1713/404 and total energy of 7924/1864. The PEP% values ranged from low to high values, and were (kJ/100g/kcal/100g): 3.25/3.27-81.7/81.4 and total of 59.2/59.1. For PEF%, the values were all low (kJ/100g/kcal/100g): 0.5027/0.5201-12.0/12.3 and total of 5.53/5.70. The PEC% values closely rivaled the PEP% but still generally lower. PEC% values were of the range (kJ/100g/kcal/100g): 6.32/6.31-96.2/96.2 and total of 35.3/35.2. The trend summary of the percentage energy values was: PEP% (59.2/59.1) > PEC% (35.3/35.2) > PEF% (5.53/5.70).

Table 3: Energy contribution from protein, fat and carbohydrate in the proximate compositions of three head organs, three visceral organs, muscle and skin of domestic female duck from Nigeria

Bird part	Energy contribution										
	Protein			Fat			Carbohydrate			Total	
	kJ/100g	kcal/100g	%value	kJ/100g	kcal/100g	%value	kJ/100g	kcal/100g	%value	kJ/100g	%value
A	1202	283	15.2	48.5	11.8	6.55	416	97.8	8.81	1667	393
B	310	72.9	3.91	12.2	2.97	1.65	1364	321	28.9	1686	397
C	1218	287	15.4	94.0	22.9	12.7	332	78.0	7.02	1644	388
D	1227	289	15.5	87.0	21.2	11.8	355	83.5	7.52	1669	394
E	1268	298	16.0	83.3	20.3	11.3	299	70.2	6.33	1650	389
F	1285	302	16.2	207	50.4	28.0	221	51.9	4.68	1713	404
G	1358	320	17.1	199	48.4	26.9	105	24.8	2.23	1662	393
H	55.1	13.0	0.6951	8.51	2.07	1.15	1629	383	34.5	1693	398
Total	7924	1864	-	740	1.80	-	4719	1110	-	13384	3156

A (Brain); B (Eyes); C (Gizzard); D (Liver); E (Tongue); F (Heart); G (Muscle); H (Skin)

Table 4: Proportion of total energy due to protein (PEP%), fat (PEF%) and carbohydrate (PEC%) from protein, fat and carbohydrate in the proximate compositions of three head organs, three visceral organs, muscle and skin of domestic female duck from Nigeria

Bird part	Total contributed energy		PEP%		PEF%		PEC%	
	kJ/100g	kcal/100g	kJ/100g	kcal/100g	kJ/100g	kcal/100g	kJ/100g	kcal/100g
Brain (A)	1667	393	72.1	72.0	2.91	3.00	25.0	24.9
Eye (B)	1686	397	18.4	18.4	0.7236	0.7481	80.9	80.9
Gizzard (C)	1644	388	74.1	74.0	5.72	5.90	20.2	20.1
Liver (D)	1669	394	73.5	73.4	5.21	5.38	21.3	21.2
Tongue (E)	1650	389	76.8	76.6	5.05	5.22	18.1	18.0
Heart (F)	1713	404	75.0	74.8	12.1	12.5	12.9	12.8
Muscle (G)	1662	393	81.7	81.4	12.0	12.3	6.32	6.31
Skin (H)	1693	398	3.25	3.27	0.5027	0.5201	96.2	96.2
Total	7924	1864	59.2	59.1	5.53	5.70	35.3	35.2

In Table 5, the utilizable energy due to protein (UEDP %) from protein assuming 60% utilization had been depicted. Columns shown were total energy in kJ/100g/kcal/100g, energy due to protein in kJ/kcal/100g UEDP% (assuming 60% utilization reported as $UEDP_{kJ}$ and $UEDP_{kcal}$. The $UEDP_{kJ}/UEDP_{kcal}$ ranged between 1.95/1.96-49.0/48.9. The $UEDP_{kJ}/UEDP_{kcal}$ for the samples were: muscle (G), 49.0/48.9 > tongue (E), 46.1/46.0 > heart (F), 45.0/44.7 > gizzard (C), 44.5/44.4 > liver (D), 44.1/44.1 >brain (A), 43.3/43.2 > eyes (B), 11.0/11.0 > skin (H), 1.95/1.96. The UEDP% was generally high except in skin and eye and therefore samples would prevent protein energy malnutrition among the duck-hen consumers.

Table 5: Utilizable energy due to protein percent (UEDP%) from protein in the proximate compositions of three head organs, three visceral organs, muscle and skin of domestic female duck from Nigeria

Sample	Total energy		Energy due to protein		UEDP% (assuming 60% utilization)	
	kJ/100g	kcal/100g	kJ/100g	kcal/100g	UEDPKj	UEDPkcal
Brain (A)	1667	393	1202	283	43.3	43.2
Eye (B)	1686	397	310	72.9	11.0	11.0
Gizzard (C)	1644	388	1218	287	44.5	44.4
Liver (D)	1669	393	1227	289	44.1	44.1
Tongue (E)	1649	389	1268	298	46.1	46.0
Heart (F)	1713	405	1285	302	45.0	44.7
Muscle (G)	1662	393	1358	320	49.0	48.9
Skin (H)	1692	398	55.1	13.0	1.95	1.96

Fat profiles from the proximate values of the samples had been shown in Table 6. The crude fat or total lipid in the samples ranged from 0.23-5.60 g/100g with a mean values of 2.50 g/100g, SD of 2.04, CV% of 81.8 and total lipid for all samples of 20.0 g/100g. Conversion factors were used to convert the total lipids to total fatty acids (TFAs) or EP g/100g (edible portion). The conversion factors as used were crude fat x conversion factor to TFA: A (x 0.561); B (x 0.945); C (x 0.945); D (x 0.741); E (x 0.945); F (x 0.789); G (0.945); H (x 0.945) [20]. Results of conversion gave the TFAs values that ranged from 0.217-5.08 EPg/100g; mean was 2.13±1.82 and CV% of 85.3 and total of 17.0 EPg/100g. Other dietary fat from the crude fat ranged from 0.013-1.18 g/100g, mean of 0.369± 0.401 g/100g, CV% of 109 and total of 2.96 g/100g. Percentage differences between the total lipid and the other dietary fats had values that ranged between 5.50-43.9; it should be noted that these percentage values were reflections of the conversion factor of each sample. For examples: B = C = E = G = H = 5.50 (common conversion factor = 0.945); A, D and F had different conversion factors and hence, different percentage difference values. Whereas the total lipid energy range was (kJ/100g/kcal/100g): 8.51/2.07-207/50.4; TFAs energy range was: 8.03/1.95-188/45.7 with respective total values of 630/153. Other dietary fat energy ranged from 0.481/0.117-43.7/10.6 and total of 109/26.6. Let us note special characteristics of the CV% values: all readings that concerned the crude fat and their corresponding energy values had CV% of 81.8 in each case; for TFA and its energy the CV% was constantly at 85.3 and other dietary lipids and their energy, all had CV% of 109 at each parameter. %TFA/crude fat had values of 56.1-94.6 and % of other dietary fat/crude fat had values of 5.50-43.9. The low EPg/100g would be good for people advised to do away with high TFA in their diets.

Table 6: Fat profiles from the proximate values of three head organs, three visceral organs, muscle and skin of domestic female duck from Nigeria

Fat profile	Sample							H	Mean	SD	CV%	Total
	A	B	C	D	E	F	G					
Crude fat (g/100g)	1.31	0.33	2.54	2.35	2.25	5.60	5.38	0.23	2.50	2.04	81.8	20.0
Total fatty acid (TFA) (g/100g)	0.735	0.312	2.40	1.74	2.13	4.42	5.08	0.217	2.13	1.82	85.3	17.0
Other dietary fats (g/100g)	0.575	0.018	0.140	0.609	0.124	1.18	0.296	0.013	0.369	0.401	109	2.96
Percentage difference	43.9	5.50	5.50	25.9	5.50	21.1	5.50	5.50	14.8	14.4	97.0	-
Crude fat energy:												
kJ/100	48.5	12.2	94.0	87.0	83.3	207	199	8.51	92.5	75.7	81.8	740
kcal/100g	11.8	2.97	22.9	21.2	20.3	50.4	48.4	2.07	22.5	18.4	81.8	180
TFA energy:												
kJ/100g	27.2	11.5	88.8	64.4	78.8	164	188	8.03	78.8	67.2	85.3	630
kcal/100g	6.62	2.81	21.6	15.7	19.2	39.8	45.7	1.95	19.2	16.3	85.3	153
Other dietary fat energy:												
kJ/100g	21.3	0.666	5.18	22.5	4.59	43.7	11.0	0.481	13.7	14.8	109	109
kcal/100g	5.18	0.162	1.26	5.48	1.12	10.6	2.66	0.117	3.33	3.61	109	26.6
%TFA/Crude fat	56.1	94.6	94.5	74.0	94.7	78.9	94.4	94.4	85.2	14.4	16.9	-
% other dietary fat/ Crude fat	43.9	5.45	5.51	25.9	5.51	21.1	5.50	5.65	14.8	14.3	96.8	-

For A, B, C, D, E, F, G, H (see Table 1); crude fat conversion factor to TFA : A (x 0.561); B (x 0.945); C (x 0.945); D (x 0.741); E (x 0.945); F (x 0.789); G (x 0.945); H (x 0.945)

In Table 7 the calculated approximate sample weight equivalents to the energy requirements for both adults and infants had been shown. Adult energy requirements are 2500kcal per day at lower level and 3000kcal per day at higher level whereas for infants it is 740kcal per day. At the 2500kcal per day bracket, the sample equivalent ranged from 617-644g and for 3000kcal bracket the equivalent sample weight range was 741-773g. The infants required weight range was 183-191g. It should be noted that the weights required were reflections of the total energy (kcal/100g) density of each sample.

Table 7: Approximate sample weight equivalents to the energy requirements of adults and infants from the proximate compositions of three head organs, three visceral organs, muscle and skin of domestic female duck from Nigeria|

Bird sample part	Total energy from samples (kcal/100g)	Adult energy requirement per day		Infant energy requirement per day 740kcal
		2500kcal	3000kcal	
		Sample equivalent (g)	Sample equivalent (g)	Sample equivalent (g)
Brain (A)	393	636	763	188
Eye (B)	397	630	756	186
Gizzard (C)	388	644	773	191
Liver (D)	393	636	763	188
Tongue (E)	389	643	771	190
Heart (F)	405	617	741	183
Muscle (G)	393	636	763	188
Skin (H)	398	628	754	186

The calculated water requirements for complete protein metabolism from proximate composition were shown in Table 8. The protein sample range was 3.24-79.9 g/100g and corresponding energy due to the protein content ranged from 13.0-320 kcal/100g. Water required for metabolism ranged from 38.9-959ml; total water deficit had range of 45.4-1118ml. To balance the water deficit of protein metabolism of the samples, water values required ranged from 6.48 -160ml; this would assist the body to eliminate the waste products due to protein metabolism. The inferential statistics using the correlation coefficient mode were depicted in Table 9. It was the inferential statistics of proximate compositions of three head organs [brain (A), eye (B) and tongue (E)]; three visceral organs [gizzard (C), liver (D) and heart (F)]; muscle (G) and skin (H). For the head organs there were comparisons of A/B, B/E and A/E. The correlation coefficient (r_{xy}) had low to high values of A/B (0.3024), B/E (0.1794) and A/E (0.9916) with corresponding variance (r_{xy}^2) levels of 0.0915, 0.0322 and 0.9834. Regression coefficient values ranged from 0.3474 – 1.03; that is for each unit (1.00 g/100g) increase in sample A there was a corresponding increase of 1.03 in sample B. Mean value of 20.0 g/100g was uniform for A, B and E. For standard deviation (SD), values were high as 30.1 (A), 34.5 (B), 31.2 (E) and high values for CV% too: 150 (A), 173 (B) and 156 (E). The coefficient of alienation (C_A) values were high to low as 0.9532 (A/B), 0.9838 (B/E) and 0.1290 (A/E). C_A values for A/B and B/E pairs showed that very little relationship existed between A/B, B/E but high relationship existed in A/E. On the other hand index of forecasting efficiency (IFE) values were low in A/B (0.0468), low in B/E (0.0162) but high in A/E (0.8710). The opposite of CA is IFE; whilst CA is the magnitude of the error of prediction of relationship, IFE gives a value of the reduction in the error of prediction of relationship between two entities. CA + IFE = 1.0 or 100%. For the visceral organs, we have the comparisons of C/D, D/F and C/F. The C/D, D/F and C/F had their inferential statistics scenario close or even similar to the observation in A/E (under head organs). The characteristics follow: all r_{xy} values were positively high and significant: C/D (0.9994), D/F (0.9892) and C/F (0.9923); their r_{xy}^2 were all high: C/D (0.9987), D/F (0.9786) and C/F (0.9847). It should be noted that both r_{xy} and r_{xy}^2 reduced from C/D to C/F that is for both rxy and r_{xy}^2: C/D > D/F > C/F. The Rxy was high as follows: C/D = D/F = 1.02 and C/F was 1.05; this further showed that C < D, D < F and C < F. As in the brain organs, the mean values of the compared pairs in the visceral were equivalent to each other, that is, mean value of C = D = F = 20 g/100g. The SD values for C. D, F ranged from 29.8 – 31.4 with CV% range of 149 – 157. The C_A values were low (0.0359-0.1462) with corresponding high IFE (0.85538 – 0.9641). Since IFE >>> C_A, it meant that the forecasting efficiency of relationship between each of the pairs: C/D, D/F and C/F would be easy because the error in the forecast of relationship would just be 3.59-14.62%. The last pair of comparison was between muscle (G) and skin (H), that is G/H. Again this pair was identified with a complete behaviour outside the other pairs earlier considered. The rxy was negative and low (-0.2014) with low r_{xy}^2 (0.0406) and low but negative R_{xy} (-0.2550). This meant a positive increase in the proximate value of G would lead to reduction of value in H. Both mean remain as in the earlier considered samples of 20.0 g/100g. The range of SD was 33.5-42.4 and corresponding CV% of 167-212. Whereas the CA was high (0.9795), the IFE was very low at 0.0205; making relationship unpredictable.

Table 8: Water requirements for complete protein metabolism from proximate compositions of three head organs, three visceral organs, muscle and skin of domestic female duck from Nigeria

Sample	Protein (g/100g)	Energy due to protein (kcal/100g)	Water required for metabolism (ml)	Water deficit (ml)	Water balance required (ml)
Brain (A)	70.7	283	849	990	141
Eye (B)	18.2	72.9	219	255	36.5
Gizzard (C)	71.7	287	860	1003	143
Liver (D)	72.2	289	866	1011	144
Tongue (E)	74.6	298	895	1044	149
Heart (F)	75.6	302	907	1059	151
Muscle (G)	79.9	320	959	1118	160
Skin (H)	3.24	13.0	38.9	45.4	6.48

Table 9: Inferential statistics of proximate compositions of three head organs, three visceral organs, muscle and skin of domestic female duck from Nigeria

Parameter	Head organs			Visceral organs			Muscle (G)	Skin (H)
	Brain (A)	Eye (B)	Tongue (E)	Gizzard (C)	Liver (D)	Heart (F)		
Ash	0.25	0.18	2.38	2.95	1.08	2.40	3.77	0.23
Moisture	3.25	1.04	3.25	3.35	3.49	3.41	4.78	0.50
Protein	70.7	18.2	74.6	71.7	72.2	75.6	79.9	3.24
Fat	1.31	0.33	2.25	2.54	2.35	5.60	5.38	0.23
Carbohydrate	24.5	80.2	17.6	19.5	20.9	13.0	6.19	95.8
Statistics	A/B	B/E	A/E	C/D	D/F	C/F	G/H	
r_{xy}	0.3024	0.1794	0.9916	0.9994	0.9892	0.9923	- 0.2014	
r_{xy}^2	0.0915	0.0322	0.9834	0.9987	0.9786	0.9847	0.0406	
R_{xy}	0.3474	0.1620	1.03	1.02	1.02	1.05	- 0.2550	
$Mean_1$	20	20	20	20	20	20	20	
SD_1	30.1	34.5	30.1	29.8	30.3	29.8	33.5	
$CV\%_1$	150	173	150	149	151	149	167	
$Mean_2$	20	20	20	20	20	20	20	
SD_2	34.5	31.2	31.2	30.3	31.4	31.4	42.4	
$CV\%_2$	173	156	156	151	157	157	212	

CA	0.9532	0.9838	0.1290	0.0359	0.1462	0.1239	0.9795
IFE	0.0468	0.0162	0.8710	0.9641	0.8538	0.8761	0.0205

Discussion

The proximate constituents (g/100g) of the samples were shown in Table 2. The samples ash levels were generally low but comparable with the organs of *Numidia meleagris* [21]; total mean ash in duck was 1.66 ± 1.40 g/100g but it was 2.34 ± 2.80 g/100g in *N. meleagris* whereas in African giant pouch rat, such organs mean ash value was 1.65±1.67 g/100g [13]. The moisture of the samples were generally low and again compared favourably with literature. In the duck organs, moisture mean was 2.88±1.40 g/100g; in *N. meleagris*, mean was 2.99±1.75 and in the pouch rat, moisture mean was 3.23±2.02 g/100g. The low moisture content would ensure a long shelf life for the samples against microbial attack/spoilage; this is because most Nigerians do not enjoy stable electricity energy supply that could have assisted in the preservation of the samples. Also, the ash content of any sample is a reflection of the mineral content of such a sample. Since the ash content of the samples was low then the minerals might not have been highly enhanced leading to low level of mineral content of the samples. The protein value was low in both eyes (18.2 g/100g) and skin (3.24 g/100g); this was also the case in *N. meleagris* as we have skin (1.08 g/100g) and eyes (17.7 g/100g) [21]; 2.70 g/100g in pouch rat skin and 7.11 g/100g in pouch rat eyes [13]. Other organs in the duck-hen had high levels of protein (70.7-79.9 g/100g); *N. meleagris*, other organs gave protein values of 71.6-81.5 g/100g whereas in the pouch rat other protein value range was 54.0-85.8 g/100g. In all the organisms, muscle protein was highest but the skin protein was the least concentrated. Both duck samples, guinea fowl samples and pouch rat samples had no detectable level of fibre. The crude fat levels ranged from 0.23-5.60 g/100g in the duck-hen, in the pouch rat, fat range was 0.210-4.62 g/100g and the range was 0.120-3.55 g/100g in guinea-fowl [13, 21]. The low level of fat samples made these present samples and those compared with in literature as good for fat diet conscious consumers. It is interesting to note that highest carbohydrate levels were observed in the eyes (80.2g/100g) and skin (95.8 g/100g) but lowest in the muscle (6.19g/100g) in the duck-hen. Other carbohydrate levels in duck-hen ranged from 13.0-24.5 g/100g. From literature, skin was highest in carbohydrate content (98.3g/100g) and followed also by the eyes (80.6g/100g) in guinea fowl with the muscle recording the lowest (5.46 g/100g). Also in the pouch rat, these observations were made in the organs carbohydrate contents: skin (94.6g/100g), eyes (88.7 g/100g) and muscle (6.82g/100g). For skin, eyes, muscle and other organs, both duck-hen, guinea-fowl and pouch rat share common and very highly comparable characteristics (concentration-wise). When the dry matter (DM) was considered, a buyer of the duck-hen samples would be getting good reward for the purchase since the DM were all high (95.22-95.5 g/100g). Also high DM indicated low moisture which will enhance the shelf life of the samples. It is noted that CV% of the DM was just 1.45% showing the values to be very close. The organic matter (OM) values were all high (91.45-99.27 g/100g) in the duck-hen samples. The high OM would lead to low mineral contents of the duck-hen samples. As observed in the DM, the CV% was low at 2.76%. In comparison, the OM values of 94.9-99.8 g/100g were reported in the organs of pouch rat, these values were highly comparable with those in duck-hen [13]. From literature, OM values were: ostrich muscle (98.97g/100g) [22], trunk fish (91.07 g/100g) and the values reported for four fresh water fishes of *Mormyrops delicious* (86.4 g/100g), *Bagrus bayad* (75.0 g/100g), *Synodontis budgetti* (84.0 g/100g) and *Hemichronis fasciatus* (76.0 g/100g) [23, 24]. The issue of the crude fat levels needs a further probe from the literature From literature the value of fat in the muscle of turkey was 2.12 g/100g and the skin of turkey was 12.1 g/100g this being opposite to the duck-hen muscle/skin fat; ostrich muscle (with skin) was 12.6 g/100g and beef (22.3 g/100g) [25-27]; kilishi (a beef product) (14.2 g/100g) [28].

The total energy contributions by each sample had been depicted in the Table 3. Highest total energy came from the heart [1713kJ/100g (1.713 MJ) or 404kcal/100g] whereas gizzard had the least energy [1644kJ/100g (1.644MJ) or 388kcal/100g]. Total energy from all the samples was 13384kJ/100g (13.384 MJ/100g or 3156 kcal/100g). These energy levels of 1.64-1.71 MJ/100g were better than 1.61-1.71 MJ in eight organs of guinea fowl but much better than in turkey muscle and skin (1.33-1.37 MJ), close to the levels in sheep lean meat (2.06 MJ), lean pork (2.29 MJ) and kilishi meat (1.66 MJ) [21, 25, 29 & 28]. The lower fat levels in the duck-hen samples could have been responsible for lower levels of energy than those reported from the literature results. The energy levels of 1.64-1.71 MJ/100g were better than 1.3-1.6 MJ/100g from cereals showing the samples to be energy dense [30]. Energy levels in 10 organs of African giant pouch rat had values of 1.63-1.70 MJ/100g which were still lower than in the duck-hen sample energy values. In the two birds available for comparison, both of them had the heart as the highest source of energy: duck-hen (1.71 MJ/100g) and guinea –fowl (1.71 MJ/100g), however in the pouch rat skin (1.70 MJ/100g) had the highest energy.

The PEP%, PEF% and PEC% values had been depicted in Table 4. The PEP% values were high with exception of eye (18.4) and skin (3.25) whereas other samples PEP% values ranged from 72.1-81.7 showing majorly that PEP% values would generally prevent protein energy malnutrition. PEF% was low in all the samples with PEF% range of 0.5027-12.1; these were far below the recommended level of 30% and 35% for total fat intake, this is useful for people wishing to adopt the guidelines for a healthy diet. PEC% is important because carbohydrate is the primary source of metabolizable energy. Its adequacy would enhance the metabolizable activity of both protein and particularly fat [31, 32].

The utilizable energy due to protein (UEDP %) for the samples (assuming 60% utilization) ranged from 1.95-49.0. Only the values of 1.95 (from skin) was much less than the recommended safe level of 8% for an adult man who requires about 55g protein per day with 60% utilization. The UEDP% in the muscle of turkey was 56.4% and 40% in the skin whereas the values were 12.1-28.8% (female and male exoskeleton) 12.5-23.8% (female and male flesh) and 13.8-17.9% (female and male whole body) of West African fresh water crab (*Sudananautes africanus africanus*) [25, 33]. In guinea-fowl, UEDP% ranged from 0.650-51.6 [21]. in the pouch rat range was 1.62-51.9% [13]. The UEDP% in kilishi was high at 39.2-39.6 [28]. The high UEDP% from many of the samples showed that the greater part of the samples have protein concentration in terms of energy that would be more than enough to prevent protein energy malnutrition in children and adult fed solely on the samples as the main source of protein. Table 6 showed the samples to be poor sources of fat. None of the fat levels would meet the daily recommended needs of both adults and infants. In the total lipids, the conversion of the lipids to total fatty acids (TFAs) showed that the total lipids contained more TFAs than other forms of lipids like phospholipids, sterols, etc. Whereas %TFA/total lipids ranged from 56.1-94.6, those of other dietary fat/total lipids % had value range of 5.50-43.9.

The daily energy requirement for an adult is between 2500 – 3000kcal (10455-12548 kJ) depending on ones physiological state whilst that of infants is 740 kcal (3094.68 kJ). In Table 7, the various weight equivalents for the energy requirements had been depicted. Equivalent weight levels were high: for 2500 kcal per day, weight range of 617-644g would be required; for 3000 kcal per day, weight would range from 741-773g and for 740 kcal per day, sample weight equivalent requirement would be 183-191g. It should be noted that the weight of sample required would always be a function of its energy density. In the guinea-fowl weight requirements ranged from 649-735g (adults) and 192g (infants); these values were highly comparable to the duck-hen values. Also, in the African giant pouch rat, weight values were 641-769.8g (adults) and 189.9g (infants) [13]. in kilishi, weight values were 634-760g (adults) and 188g (infants) [28]; in turkey we have 786 – 944g (muscle) and 761-913 (skin) to meet adult requirements but 233g (muscle) and 325 (skin) in infants [25].

As changes occur in dietary, nutritional status and age of an animal, appreciable shifts occur in the tissue compartments, water and protein levels. For the efficient utilization and conservation of food within the human body, water is indispensable, it is because the water content of the body changes with the type of diet. This important connection of water with other food substances is the fact that the biochemical basis for the relationship arises from the fact that the water deficit created by protein metabolism is about seven times that for equivalent calorie of carbohydrates or fat. Therefore, in young children an increase in calories from carbohydrates causes hydration; whereas an increase in calories from proteins causes dehydration [34-39]. The increased output of ketones and acids that accompanies a shift to high-fat diets is associated with increased water loss that can be offset by increase in carbohydrate intake. Protein quality as well influences the degree of tissue hydration. Albanese had estimated grammes of water needed for complete metabolism of 100 calories of some food substances. Food materials (protein, starch and fat) all have performed water of 0.00 in each case; water gained by oxidation: 10.3 (protein), 13.9 (starch) and 11.9 (fat); water lost in excreting end products (1 calorie of protein requires 3.0ml of water for the excretion of the urea and sulphate formed from it, 1g of ash requires 65ml of water for its excretion): 300 (protein), both 0.00 in starch and fat; deficit: 350 (protein), 46 (starch) and 48 (fat). The calculated water required to balance the deficit created by the protein consumption of the duck-hen samples had been depicted in Table 8. Water balance requirement ranged from 6.48-160ml. This water would provide enough good environment for the elimination of protein metabolism by-products.

The inferential statistics in Table 9 had the divisions of the samples as head organs [brain (A), eye (B), tongue (E)]; this led to the correlation pairs of A/B, B/E and A/E. The next group was the visceral organs [gizzard (C), liver (D), heart (F)]; this led to the correlation pairs of C/D, D/F and C/F. The remaining two samples were muscle (G) and skin (H) leading to just one pair G/H for the group. Group members that were significantly different in the $r_{=0.01}$ values were A/E, C/D, D/F and C/F. High R_{xy} values were observed in A/E, C/D, D/F and C/F. The C_A values that were high meant such pairs were highly alienated and therefore having high level of error of prediction of relationship between such pairs. Where we have high levels of IFE (index of forecasting efficiency) then prediction of relationship would be easy. Such would be the situation in pairs of A/E, C/D, D/F and C/F. In such pairs any of the member of a pair could carry out the physiological/biochemical functions of the other and vice-versa.

Conclusion

Muscovy duck-hen water fowls reared in Nigeria have high nutritional qualities as revealed by the proximate analyses data of the organs. To certify the quality of duck-hen, it's comparison with literature reports would confirm this point of view. Comparisons go thus as duck/guinea-fowl/African giant pouch rat (g/100g) mean: ash: 1.66±1.40/2.34±2.80/ 1.65±1.67 (leading to likely low mineral contents); moisture: 2.88±1.40/2.99±1.75/3.23±2.02 (will enhance long shelf life); protein: 58.3±29.7/50.0±35.8/61.6±31.1 (good as protein supplement in cereal flours); fat: 2.50±2.04/1.82±1.53/2.42±1.72 (its diet will be good for fat guidance); fibre: not detected for all; carbohydrate: 34.7±33.6/42.4±37.3/31.2±33.7 (serves as good energy source). Other quality parameter comparisons were: energy range (MJ/100g): 1.644-1.713/1.610-1.707/1.630-1.704; (a dense energy source); PEP%: 3.25-81.7/1.08-86.1/2.69-86.5 (will prevent protein energy malnutrition); PEF%: 0.5027-12.1/0.260-9.75/0.459-11.0 (good for diet guidance); PEC%: 6.32-96.2/5.77-98.6/7.11-94.4 (good as simple energy source) UEDP%: 1.95-49.0/ 0.650-51.56/ 1.62-51.9 (will prevent protein energy malnutrition). Some mention should be made of some samples with special characteristics: eye was low in protein (18.2g/100g), hence low in PEP% and UEDP% but high in carbohydrate (80.2g/100g), and high in PEC%; skin was low in protein (3.24g/100g), hence low in PEP% and UEDP% but high in carbohydrate (95.8g/100g) and therefore high in PEC%; muscle was low in carbohydrate (6.19g/100g) hence low in PEC% but highest in protein (79.9g/100g) and therefore highest PEP% and highest UEDP%.

Recommendations

Data results and literature comparisons had established the good nutritional content of the duck-hen as reared in Nigeria. It is therefore suggested that duck-hen meat should be one of the meat of first choice in Nigeria. Duck-hen eyes, brain and tongue are normally discarded as irritant meat sources, however these analytical results had shown that they all have quality nutrients, hence consideration should be given to their consumption. Duck-hen compared highly and favourably with the other birds compared and hence it is suggested that duck-hen should be given equal status with other birds.

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