



Evaluation of the Nutritional Composition of Selected Ruminant and Poultry Carcasses in Nigeria

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Abstract

This research was conducted in Jos, Plateau state to evaluate the nutritional composition of meat of selected local breeds of livestock in Nigeria, with the aim to provide basic data for their nutritional values. The breast portion or breast muscles of local broilers and thigh muscles (semi-tendinous) of cow (beef), sheep (mutton) and goats (chevon) were cut into equal sizes to determine Protein and amino acid profiles. Analyses were performed to determine the main directions of variations among the meats. Results indicated that Calorie is lower in chevon followed by broiler then mutton and beef. Chevon is also lower in fat, saturated fat, protein and cholesterol than the others. Percentage of proteins in broiler chicken meat, beef, mutton and chevon ranged from 18.37 to 25.13%. Glycine had higher concentration compared to other amino acids measured in all the meat types, although its concentration was not significantly ($p > 0.05$) different between meat types. The lowest content of amino acids was methionine in Broiler, Beef, Mutton and Chevron. Broiler meat had significantly richer contents of proline than beef, mutton and chevon. Additionally, animals with higher concentrations of alanine and glutamic acid in the meat studied were found to have lower histidine concentration. Amongst the meats studied, Chevron is recommended because of its taste and low cholesterol level.

Keywords: breeds, meat, nutritional composition, amino acid, correlations

slaughter until consumption (Lambert *et al.*, 1991).

Introduction

In many developing countries, especially in Nigeria meat is widely consumed as a source of protein; either cooked or processed into other forms to avoid associated spoilage (Olaoye *et al.*, 2010; Olaoye and Onilude, 2010). Meat is defined as 'the edible part of the skeletal muscle of an animal that was healthy at the time of slaughter (CFDAR, 1990). Chemically meat is composed of four major components including water, protein, lipid, carbohydrate and many other minor components such as vitamins, enzymes, pigments and flavour compounds (Lambert *et al.*, 1991). The relative proportions of all these constituents give meat its particular structure, texture, flavour, colour and nutritive value. However, because of its unique biological and chemical nature, meat undergoes progressive deterioration from the time of

Red meat contains high biological value protein and important micronutrients that are needed for good health throughout life. It also contains a range of fats, including essential omega-3 polyunsaturated fats. Recent analyses have shown that there has been a significant trend to leaner cuts of meat over the past two decades (Williams, 2007). While the nutritional composition will vary somewhat according to breed, feeding regimen, season and meat cut, in general, lean red meat has a low fat content, is moderate in cholesterol and rich in protein and many essential vitamins and minerals.

With the recent increase in the national income and the development of the food service industry, the rate of meat consumption has been steadily increasing in developed countries. In particular, the

individual consumption rate of chicken has increased from 6.0 kg/caput/day in 2000 to 12.8 kg/caput/day in 2014. In 2005, it became the second-most consumed type of meat after pork. This rapid increase in the consumption of chicken can be explained by the fact that it is lower in saturated fatty acid content than other livestock products and high in unsaturated fatty acid contents, while also being a source of protein, with over 40% of the total amino acids being essential ones (Chae *et al.*, 2002).

Raw red meat contains around 20 to 25g protein/100g. Cooked red meat contains 28-36g/100g. This is because the water content decreases and nutrients become more concentrated during cooking. The protein is highly digestible, around 94% compared to the digestibility of 78% in beans and 86% in whole wheat (Bhutta, 1999). Protein from meat provides all essential amino acids (lysine, threonine, methionine, phenylalanine, tryptophan, leucine, isoleucine, valine) and has no limiting amino acids. Protein Digestibility Corrected Amino Acid Score (PDCAAS) is a method of evaluating the protein quality, with a maximum possible score of 1.0. Animal meats like beef have a score of approximately 0.9, compared to values of 0.5-0.7 for most plant foods Schaafsma, (2000). The amino acid glutamic acid/glutamine is present in meat in the highest amounts (16.5%), followed by arginine, alanine, and aspartic acid.

All ingredients either preserve or lost nutrients during the cooking process. Also, since the type of tissue and moisture content differed for each ingredient, nutrient content may vary depending on the cooking method. It is difficult to know whether the nutrients were actually preserved or lost, by simply calculating the weight of the nutrient to the appointed weight of the sample. Therefore, it is necessary to study the actual reduction of nutrients through the nutrient retention rate.

Developed countries consumed a consistent level of 77 kg of meat per capita annually, while developing countries struggled to maintain a diet with only 25 kg of meat per capita annually. Nigeria remained slightly below the meat intake of all low-income countries and consuming 9 kg per capita annually (Abbey, 2004). Currently, little attention has been given to the awareness of meat and its consumption among many consumers of the product in many developing countries, such as Nigeria. Broadly, the composition of meat, after rigor mortis but before post-mortem degradative changes or fresh meat, can be approximated to 75% water, 19% protein, 3.5% soluble non-protein substances and 2.5% fat. The proteins in muscle can be broadly divided into those which are soluble in water or dilute salt solutions (the sarcoplasmic proteins). Those which are soluble in concentrated salt solutions (themyofibrillar proteins) and those which are insoluble in the latter, at least at low temperature. The proteins of connective tissue and other formed structures (Lawrie and Ledward, 2006).

There is little information on meat cut yields, quality and sensory characteristics of meat of local breeds of broiler chicken, cow (beef), sheep (mutton), goats (chevon) sold every day in Nigerian markets. However, due to lack of knowledge on composition, quality characteristics and amount of nutrients or trace elements in meat that our community are consuming. There is need to put the record clear for them to know. However, because the meat composition. Meat quality characteristics in Nigeria is constrained due to lack of awareness and understanding of the composition, quality and content of trace elements, as well as limited consumption of meat product.

The study was therefore designed to examine and compare the changes and the retention rates of the protein and essential amino acid components in cooked local broiler chicken breasts and in muscle longissimus thoracis lumborum (LL) of beef, mutton, chevon.

Materials and Methods

Description of the Study Area

The study area was Jos, Plateau State. Jos is a city in the Middle Belt of Nigeria. The city has a population of about 900,000 residents based on the 2006 census. Popularly called "J-Town", it is the administrative capital of Plateau State. It is about 1,238 metres or 4,062 feet above sea level. Coordinates: latitude 09°55'00"N, longitude 08°53'2" During British colonial rule, Jos was an important centre for tin mining and now it has become the trading hub in the state as commercial activities are steadily on the rise.

Sample Collection

Purposive and random sampling methods were used for the study. The study city has eight administrative sub-cities of which five sub-cities which had more butchers were purposively selected. From the selected sub-cities, 15 butchereries were selected randomly for each beef, chevon and mutton. Thus, a total of 45 butchers were selected. From these selected butchers, meat sample of beef, chevon and mutton were purchased from the *Longissimus dorsii* muscle. Forty animals (10 animals each for broilers, cattle/bovine, sheep, goats) were used for the experiment. The breast muscles of broilers, the thigh muscles (semi-tendinous) of cattle (beef), sheep (mutton) and goats (chevon) were obtained cut equally by four butchers (each for each animal) into equal sizes. The breast portion of broiler was cut into 3 cm cubes while beef, mutton and chevon were cut into 5 cm cubes. A total of 1,500 g of meat were prepared for each part.

Laboratory Analysis

The following parameters were determined: fat, protein, ash and moisture contents, pH level, water holding capacity as well as loss on cooking. The study was carried out at the Food Science laboratory Ahmadu Bello University, Zaria.

Protein and Amino Acid Analyses

Part of breast of Local broiler chicken and the thigh muscles (semi-tendinous) of beef, mutton, chevon were obtained and cut by butcher into equal sizes. The breast portion of broiler was cut into 3 cm cubes while beef, mutton and chevon were cut into 5 cm cubes. The amino acid contents were determined according to the procedures described by the AOAC (2005). About 1.0 g of each sample was weighed into a protein digestion tube. 10 mL of 6 M HCl were added, and nitrogen gas was also added to displace the oxygen. The protein digestion tubes were sealed and hydrolysed at 115°C for 24 h. After completion of the hydrolysis, the solutions were opened, placed in a 50 mL constant volume flask, and adjusted with distilled water. The solutions were then filtered, and 1 mL of the filtrate was taken and adjusted to 10 mL. All the analysed samples were filtered through 0.2 µm membrane filters prior to the amino acid analysis. An auto-amino acid analyser (AAA L-8900, Hitachi, Japan) was used for the analysis. The column was an ion exchange column packed with Hitachi custom ion exchange resin (4.6 × 60 mm), and the mobile phase was a ninhydrin buffer solution from Mitsubishi (Japan). The AA analysis was used to determine the value for pure protein, expressed as the sum of AA (aspartic acid, glutamic acid, serine, histidine, glycine, threonine, arginine, alanine, tyrosine, cystine, valine, methionine, phenylalanine, Isoleucine, leucine, lysine and proline).

Processing Factor

The term "processing factor" refers to the increase or decrease that occurs during a process. It is calculated by measuring the weight of a sample before and after cooking

and inputting the measurements into the following equation.

$$\text{Processing factor (\%)} = \frac{WVc}{WVr} \times 100$$

WVc: Weight or volume of cooked food

WVr: Weight or volume of raw food

Retention Factor

Nutrition analyses analyse the nutrients contained in samples of a specific weight. As the weight changes before and after cooking, it cannot be assumed that the same amounts of nutrients are distributed equally before and after cooking. Therefore, the following equation was applied in consideration of the different weights before and after cooking. An over-100 retention factor is given as 100 (USDA, 2007).

$$\text{True retention (\%)} = \frac{Nc \times Gc}{Nr \times Gr} \times 100$$

Nc= nutrient content per g of cooked food

Gc= g of cooked food

Nr= nutrient content per g of raw food

Gr= g of food before cooking

Statistical Analysis

One-way analysis of variance was done using the General Linear Model (GLM), while principal component analysis (PCA) was performed using principal component analysis of Statistical Analysis System (SAS) computer package (SAS Institute Inc., 2005). Subsequently, the Duncan's New Multiple Range Test was used to separate means. Principal Component Analysis was performed to determine the main directions of variations among the meats.

Results and Discussion

The Composition of Nutrition in Cooked Meat of Local Broiler Chicken and Ruminants in Nigeria

The nutritional compositions of cooked meat of ruminant and local broilers chicken are shown in Table 1. The results showed that there was non-significant difference in calories and fats in beef and mutton but significant difference occurred between broiler chicken meat and chevon with

difference of 39.70 and 3.71 in calories and fats, respectively. The results further showed that in saturated fat, Protein and cholesterol significant different occurred except in local broiler chicken meat and chevon, local broiler chicken meat and beef, local broiler chicken meat and mutton that were non-significant for fat, protein and cholesterol, respectively. Chevon meat has been established as a lean meat with favourable nutritional qualities, and it's an ideal choice for the health-conscious consumer. Calories are lower in chevon followed by local broiler chicken than in mutton and beef. Chevon meat is also lower in fat, saturated fat, protein and cholesterol than in local broiler meat, beef and mutton. Less saturated fat and less cholesterol mean healthier meat for the health-conscious consumer.

Proximate composition of cooked meat is necessary for assessing nutritive value of meat. The nutrient value of cooked meat is more useful than raw as the cooked meat show actually consumed meat (Ono *et al.*, 1984). However, the raw value was used to evaluate the effect of husbandry practices, production and marketing on the nutrient composition of the muscles (Sainsbury, 2009).

The present studied indicated that chevon meat has been established as a lean meat with favourable nutritional qualities, and it's an ideal choice for the health-conscious consumer. This is similar to findings of (USDA, 2002). Calories are lower in chevon followed by local broiler chicken than in mutton and beef. Chevon meat is also lower in fat, saturated fat, protein and cholesterol than in local broiler meat, beef and mutton, as stated in many similar studies (Cammack, *et al.*, 2006; Casey 1992; Lawandowski, 2003 and Pinkerton 1994). Less saturated fat and less

cholesterol mean healthier meat for the health-conscious consumer.

For crude protein, the average value in beef was comparable to those observed by Fernanda *et al.* (2003), Williams (2007), Fakolade and Omojola (2008) and Nikmaram *et al.* (2011). Similarly, the average value for protein in chevon and mutton as observed in this study were similar to the values reported by Schonfeldt (1989) and Williams (2007). The values were also similar to the results observed by Ghita *et al.* (2009) and Maiti and Ahlawat (2011).

Breast meat contains less than 3 g fat/100 g and corresponding average value for dark meat (skin off) is 5–7 g/100 g. Unlike beef and dairy fat, chicken meat contains no trans-fat (Greger 2014) which contributes to coronary heart disease and about half of the fat is made up of the desirable monounsaturated fats, and only one-third of the less healthy saturated fats. The World Cancer Research Fund and others (Bingham 2006) have suggested that the consumption of large amounts (more than 500 g/week) of red meat, particularly processed meat, but not chicken meat, may be unhealthy. Poultry meat, particularly from scavenging birds due to their varied diet, is an important provider of the essential polyunsaturated fatty acids (PUFAs), especially the ω -3 fatty acids (Farrell 2013). The amounts of these important fatty acids, particularly long-chain polyunsaturated fatty acids (LC-PUFA), can be increased more easily in chicken meat than in other livestock meats, although negative effects on the oxidative stability may erupt.

Nutritive values in terms fat content in Thai native chicken tended to be lower (0.12%) than local broiler meat chicken (Jaturasitha, *et al.*, 2002). In contrary, crude fat content was significantly ($P < 0.05$) lower in breast

and thigh muscles of native chicken and higher amount of crude fat content was noted in breast and thigh muscles of broiler. This result is consistent with the report of Young and Choi (2003), in that the fat contents of traditional Korean chickens were lower than those of the general broilers.

Highly significant ($P < 0.05$) amount of ash content was noticed in breast and thigh muscles of native chicken than broiler meat samples. The present result of the study is not in agreement with reports of Choe *et al.* (2010) who stated that crude ash contents measured in the Korean native chicken (0.96%) were higher than those of commercial (0.47%) broilers. Fuzhu and Zhuye, (2008) found that ash components of both breast muscle and thigh muscle were higher for native quality chicken white Lueyang (W) L than Arbor Acres (AA). Higher level of calcium and phosphorus was recorded in breast and thigh muscles of broiler than native chicken. There exist no significant different was found in gross energy of breast and thigh muscles of broiler than native chicken.

The Percentage Protein in Cooked Broiler, Beef, Mutton, Chevon Meat

The percentage of protein in the local broiler chicken breast, beef, mutton and chevon ranged from 18.37 – 25.13% as indicated in Table 2. These results indicated that the percentage of protein in the thigh of fresh veal and beef were 19.80 and 18.76%, respectively. This work showed that chevon meat was more preferred and attributed it to its low fat content chevon contains higher amounts of polyunsaturated fatty acids compared with mutton. The present study also showed that the protein content in local broiler chicken was (19.14%).

Percentage of protein in the local broiler chicken breast, beef, mutton and chevon ranged from 18.37 – 25.13% are

concomitant with the one obtained by Aegina (2001) which indicated that the percentage of protein in the thigh of fresh veal and beef were 19.80 and 18.76%, respectively. It is higher than the results of Rahim (2003); Moreria (2003); Al-Ani (2004); USDA, (2004), when they studied the chemical composition of the thigh muscle of cattle and reported that the percentage of protein was 18.80, 21.8,

19.67, 18 and 18.7%, respectively. Tamimy and Abu Maaly (2011) stated that the percentage of protein in beef taken from markets, were 20.58, 20.97 and 21.18% which corresponds to the value in the current study. Hoffman, and Falvo (2004) explained that the percentage of protein in meat products obtained from cattle and goats were 21.3 and 22%, respectively.

Table 1: Nutrition Composition of Cooked Meat of Local Broiler Chicken and Ruminants in Nigeria

Nutrient	Broiler chicken meat	Beef	Mutton	Chevron
	(Mean ±SE)	(Mean ±SE)	(Mean ±SE)	(Mean ±SE)
Calories	162.11±0.12 ^b	179.13±0.01 ^a	175.31±0.03 ^a	122.41±0.02 ^c
Fats(g)	6.33±0.02 ^b	7.92±0.23 ^a	8.21±0.21 ^a	2.62±0.05 ^c
Saturated fat(g)	1.71±0.11 ^c	3.02±0.04 ^a	2.93±0.33 ^b	1.79±0.09 ^c
Protein(g)	25.23±0.31 ^a	25.13±0.11 ^a	24.12±0.06 ^b	23.23±0.13 ^c
Cholesterol (mg)	77.21±0.18 ^a	73.14±0.02 ^b	78.22±0.04 ^a	63.18±0.22 ^c

^{abc}- Mean in the same row and column with different superscripts are significantly different (P < 0.05)

The values pertaining to the average fat% of beef as observed are similar to those of Fakolade and Omojola (2008) from dried beef (in Nigeria); Williams (2007) from red beef. However, the results of mutton and chevon fat (%) are lower than Maiti and Ahlawat (2011) who found 21.63% of chevon fat values of cooked while Ghita *et al.* (2009) found 35.07% from Carabash lamb. On the other hand, the results of average mutton and chevon fat value are higher than that of the findings of Schonfeldt (1989) of lamb (4.7%), angora (4.7%) and boar goat chevon (4.4%) from the semi membranous muscle. The discrepancy might be due to the age and breed of the animals in the various studies. However, the relatively higher mean carcass fat in some Ethiopian goat breeds would be useful in reducing chilling losses and improving quality (Amha, 2007). For ash content, the present result in beef meat is similar to the results published by Fernanda *et al.* (2003) and Nikmaram *et al.* (2011). Also, the results for ash % of chevon and

mutton were similar to those obtained by Schonfeldt (1989) for lamb (1.06%), angora (1.07%) and boar goat chevon (1.08%) from M Longissimus Thoracis and lumborum. For moisture content, the results in beef were almost in similar range to those reported by Nikmaram *et al.* (2011) who found that 73.45% for raw, 34.8% microwave, 42.55% roasting and 38.19% braising beef and Williams (2007) reported as 35.09 and 73.17% from dried and lean red beef, respectively. The results for chevon and mutton as assessed in this study finds consonance with the observations of Adam *et al.* (2010) from Nilotic male kid (fresh meat) on feed lot trial sorghum and molasses-based diets and Maiti and Ahlawat (2011).

Aaslyng *et al.* (2003) stated that indicate raw meat samples (beef, chevon and mutton) had higher moisture (%) when compared to the cooked meat (beef, chevon and mutton) while protein, fat and ash nutrient components (%) showed an increase after cooking. This may be because

that there is coagulation of meat protein thereby hardening of the muscle fibers which leads to expulsion of water from the muscles which resulted in lower moisture content of the cooked meat. The result is in accordance with the observations of Jamora and Rhee (1998) and Sainsbury (2009).

From the protein obtained in this study, mutton is lower than that in lamb meat which contains protein level of about 26.37%, but lower than the 17% cited by Al-Marazany and Abdul K.M. (2007) when they studied meat of sheep. In similar studies; Hoffman and Falvo, (2004) reported the percentage of protein in lamb's meat and small lamb's meat as 20.4 and 15.7%, respectively. Williams, (2007) noted that the percentage of protein in the lamb's meat was 21.12 %, and Al-Marazany and Abdul K.M, (2007) reported that the percentage of crude protein in the lamb's meat was 16.30% while Al-Asadi, (2009) found the percentage of protein in the Najdy and Oraby lamb's meat aged two weeks were 22.8 and 18.7%, respectively.

Table 2. Percentage Protein in Cooked Broiler, Beef, Mutton, Chevron Meat

Sample	Percentage of protein (%)
Local Broiler	19.14 ^c
Beef	18.37 ^c
Mutton	20.13 ^b
Chevon	25.28 ^a

Amino Acids in Local Breeds of Animals in Nigeria

Table 3 shows the composition of amino acids measured from different meat types studied. The results indicated that glycine has the highest concentration compared to other amino acids measured in all the meat types, although its concentration was not significantly $p > 0.05$ different from the different meat types. Glycine had the highest amount in local broiler meat chicken, Beef, Mutton and Chevron compared to other amino acids. The lowest

This work showed that chevon meat was more preferred and attributed it to its low fat content chevon contains higher amounts of polyunsaturated fatty acids compared with mutton. The present study also showed that the protein content in local broiler chicken was lower (19.14%) than that reported by Sahasrabudhe *et al.* (1985) who stated that the percentage of protein in chicken meat amounted to 24%, while is the same with what Azizia, (1996) found, which he stated that the protein of local broiler chicken meat increased to 21.4%. Al-Ani, (1999) reported that the percentage of protein in the thigh and breast of chicken meat were 23.32 and 24.9% respectively, which is less than what Van Laack, (2000) (20.50 %) found when determined be percentage of protein in chest muscle of chicken meat. The results (20 %) and this indicated similar in chicken meat which was similarly with Hashem, and Al—Musawy (2008) and Al-Shatty (1994) found that the percentage of protein in poultry meat was 15-24%.

amino acid was methionine in Broiler chicken meat, Beef, Mutton and Chevron. Interestingly, the amount of valine was found to be significantly high quantity of valine in mutton and chevon. Two amino acids glutamic and histidine were shown to be significantly different between chevon and broiler chicken meat. The quantity of arginine was found to be significantly ($p < 0.05$) different between local broiler chicken meat, mutton and those found in chevon and beef. Broiler meat appeared to

be poor in alanine and Serine compared to other meat types.

The results in this study further indicated that glycine has the highest concentration compared to other amino acids measured in all the meat types, although its concentration was not significantly $p > 0.05$ different from the different meat types. Aristoy and Toldra (1991) similarly reported that glycine had the highest amount in broiler meat, beef, mutton and chevron compared to other amino acids. The lowest amino acid was methionine in Broiler chicken meat, beef, mutton and chevron. Similar results were reported by Eng *et al.* (1986), Hoffman *et al.* (2005) and Zyl and Ferreira (2003). Interestingly, the amount of valine was found to be significantly high as stated by Gilka *et al.* (1989) and Webb *et al.* (2005) excessive high quantity of valine in mutton and chevon. Two amino acids; glutamic and histidine were shown to be significantly different between chevon and broiler chicken meat. The quantity of arginine was found to be significantly ($p < 0.05$) different between local broiler chicken meat, mutton and those found in chevon and beef. This is in agreement with Gilka *et al.* (1989) who reported similarly the same results. Broiler meat appeared to be poor in alanine and Serine compared to other meat types.

The cooking of meat results in a number of quality changes viz. flavor and taste enhancement, inhibition of microorganism, increase of shelf life and digestibility (Broncano *et al.* 2009). However, cooking also mainly contributes to the deterioration of the cooked meat giving undesirable odours, rancidity, texture modification, nutritional losses and toxic compound production. Each cooking method has its own advantages and disadvantages depending upon the product processed

(Cholan *et al.* 2011). Among all the processing methods heat is the most destructive one. Lysine and threonine and thiamine are most affected amino acids and vitamin, respectively, depending on time of exposure and the degree of heat. In oven heating Hall and Lin (1981) found significantly ($P < 0.01$) higher thiamine retention in breast meat at high temperature short cooking time (204 °C, 46 min) than low temperature long cooking time (121 °C, 131 min) and probably due to a lower end temperature of the breast meat (82 °C) significantly ($P < 0.05$) higher thiamine content was also retained in breast meat compared to the thigh meat because of thicker and larger size of breast meat. Thus time of exposure to heat has more impact than temperature on nutritional quality of “further processed” meat product. Generally, riboflavin and niacin are less susceptible to heat than thiamine. Though, niacin is stable to air and light at all pH levels, riboflavin can be destroyed under alkaline conditions (Bender 1978). The effects of heating on protein appear to be minimal and there occurs minor losses of all amino acids except tryptophan. No significant effect was found on fatty acids upon heat treatment of meat samples (Myers and Harris 1975). Thomas and Calloway (1961) reported no changes in riboflavin, niacin and total amino acid levels due to canning. However, in vitro pepsin digestion revealed the availability of lysine, cystine, methionine, and tryptophan reduced to less than 50% after canning. Ascorbic acid and thiamine, both present in only minimal quantities in poultry meat, are susceptible to loss during prolonged storage of conventionally canned foods. Significant losses in thiamine and niacin of cured, smoked, and cured canned chicken versus canned chicken were observed by Millares and Fellers (1949). Higher pH (6.1 vs 5.6) and longer heat exposure increased the

losses. Microwave cooking can alleviate two major destructive components of conventional heating: external heat and time of heating.

Table 3: Mean Values of Amino Acids Measured from Different Local Breed of Animals in Nigeria

Meat type	ASP	GLU	SER	HIS	GLY	THR	ARG	ALA	TYR	CYS	VAL	MET	PHE	ILE	LEU
Broiler (Local)	1.95 ^c	6.02 ^c	3.30 ^c	6.19 ^a	16.09 ^c	2.81 ^a	8.63 ^a	4.12 ^c	1.40 ^a	1.90 ^b	4.77 ^a	1.77 ^b	2.11 ^b	2.40 ^a	5.94 ^a
Beef	1.99 ^c	6.90 ^a	3.89 ^b	4.70 ^c	18.08 ^a	2.33 ^b	7.20 ^c	5.53 ^a	1.03 ^c	1.32 ^c	3.43 ^c	1.00 ^a	2.04 ^c	2.31 ^b	6.08 ^a
Mutton	2.12 ^b	6.51 ^b	4.05 ^a	5.24 ^b	16.01 ^c	1.88 ^c	7.80 ^{bc}	5.40 ^c	1.32 ^b	1.33 ^c	4.67 ^a	1.03 ^a	2.03 ^c	2.09 ^c	4.88 ^a
Chevron	2.38 ^a	7.22 ^a	4.09 ^a	5.20 ^b	16.17 ^b	2.42 ^b	8.28 ^b	5.57 ^a	1.44 ^a	2.11 ^a	3.60 ^b	1.17 ^c	2.15 ^a	2.32 ^b	6.13 ^a

^{abc}- Mean in the same column with different superscripts are significantly different ($P < 0.05$), ASP= Aspartic acid, GLU=Glutamic acid, SER= Serine, HIS= Histidine, GLY= Glycine, THR= Threonine, ARG= Arginine, ALA= Alanine, TYR= Tyrosine, CYS= Cystine, VAL= Valine, MET= Methionine, PHE= Phenylalanine, ILE= Isoleucine, LEU= Leucine, LYS= Lysine and PRO= Proline

Correlation Coefficient among the Amino Acids Measured

The results of the correlation coefficients among the amino acids measured in local broiler chicken meat, beef, mutton and chevron are presented in Table 4. Valine was found to be highly correlated ($p \leq 0.01$) with Aspartic acid, Serine, Histidine, Threonine and Alanine with correlation coefficients of -0.66, - 0.72, 0.62, 0.62 and -0.70, respectively. The direction of the correlation coefficients showed negative relationships between Alanine and Aspartic acid, Serine and Alanine. This indicates that Alanine concentration in the meats studied increased when concentration of Aspartic acid, Serine and Alanine decreased, and vice versa.

Serine was found to have highly significant correlation (at $p \leq 0.01$) with Aspartic acid,

glutamic, threonine, valine, Lysine and proline with correlation coefficients of 0.53, 0.58, -0.42, 0.72, 0.68 and 0.64, respectively. There was a Positive and significant correlation ($p \leq 0.05$) just like that obtained between Serine and valine ($r = 0.65$). It was found that reduction in concentration of threonine in the meats evaluated result to significant increase in Serine concentration. Additionally, increase in concentrations of valine and glutamic in the meat studied were found to reduce histidine concentration ($r = -0.54$ and -0.50 , respectively). Since there was a positive relationship between histidine and valine, increasing alanine and glutamic indirectly decreased alanine concentration. this is similar to the results of other studies (Gilka *et al.*, 1989).

Table 4: Sample Correlation Coefficient among the Amino Acids Measured on Different Local Breed of Animals in Nigeria

Amino acid	ASP	GLU	SER	HIS	GLY	THR	ARG	ALA	TYR	CYS	VAL	MET
GLU	0.36											
SER	0.53**	0.58**										
HIS	-0.16	-0.47*	-0.31									
GLY	-0.42	-0.13	-0.32	-0.21								
THR	-0.49	0.01	-0.42	0.16	0.15							
AGR	-0.40	-0.31	-0.10	0.02	0.01	0.07						
ALA	0.12	0.42*	0.42*	0.50	0.22	-0.53	-0.10					
TYR	0.78**	-0.20	-0.32	0.02	-0.53*	-0.50	-0.27	-0.04				
CYS	0.37	-0.33	-0.03	-0.06	-0.17	0.01	-0.11	-0.33*	0.60**			
VAL	-0.66**	-0.37	0.72**	0.62**	0.02	0.62**	0.30*	-0.70**	-0.33	-0.09		
MET	-0.07	0.21	0.04	0.33	-0.29	0.07	-0.02	-0.01	-0.20	0.50*	0.17	
PHE	0.62**	-0.20	0.27	-0.09	-0.43	-0.60	-0.02	0.05	0.74**	0.53*	-0.37	-0.38
ILE	0.67**	0.05	0.41	-0.21	-0.41	-0.43	0.30	0.18	0.66**	0.52**	-0.58*	-0.53*
LEU	0.12	-0.16	-0.13	0.01	-0.08	-0.09	-0.40	0.02	0.15	0.06	-0.20	-0.12
LYS	0.74**	0.32	0.68**	-0.03	-0.60**	-0.50*	-0.17	0.16	0.63**	0.20	-0.50*	0.02
PRO	0.39	0.52**	0.64**	-0.31	-0.35	-0.41	0.09	0.43	0.10	-0.21	-0.50*	0.19

Significant at $P \leq 0.05$ and Significant at $P \leq 0.01$ ASP= Aspartic acid, GLU=Glutamic acid, SER= Serine, HIS= Histidine, GLY= Glycine, THR= Threonine, ARG= Arginine, ALA= Alanine, TYR= Tyrosine, CYS= Cystine, VAL= Valine, MET=

Conclusion

Calories, fat, saturated fat, protein and cholesterol are lower in chevon than local broiler chicken meat, mutton and beef. The percentage of protein in the local broiler chicken breast, beef, mutton and chevon ranged from 18.37 – 25.13%. Glycine has the highest concentration compared to other amino acids measured in all the meat types. The quantity of arginine was found to be significantly $p < 0.05$ different between local broiler chicken meat, mutton and those found in chevon and beef. Valine was highly correlated ($p \leq 0.01$) with Aspartic acid, Serine, histidine, threonine and alanine.

Recommendation

Chevon meat should be the more preferred than local broiler chicken meat, mutton and beef because of its low fat content and higher amounts of polyunsaturated fatty acids which means it's an ideal choice for the health-conscious consumer.

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