AMINO ACID COMPONENTS IMPORTANT FOR HEALTH FROM ANIMAL PROTEIN SOURCES

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Abstract

A study was conducted to investigate in to the concentrations of crude proteins and amino acids in six animal protein sources (goat meat, beef, chicken, guinea fowl, fish and pork) using standard analytical techniques. The results mealed that crude protein values ranged from 54.69 -74.54% while total amino add (TAA) content was 80.04 - 94.94g/100g crudeprotein. The total essential amino add (TEAA) content was 30.56-38.58 *g/lOOg crude protein or* 38.20-*41.30% with His but28.49-35.98g/100g crude protein or* 35.60- 38.70% *withoutHis. The predicted protein efficiency ratio (PPER) was 2.24 - 2.62 whereas the calculated isoelectric point was 4.10- 5.41. The results also Mowed that the values of total sulphur amino acids (TSAA) were low, ranged between 2.60 - 3.70 g/lOOg crude protein while the percentage ofCys in TSAA was 33.10- 37.60. In comparison with provisional amino add scoring pattern, Thr was the limiting AA in all the animal protein samples.*

Keywords: Animal protein sources, amino add, crude protein

INTRODUCTION

Protein is a large group of organic substances that is I essential to the structure and functioning of all living things. It is also the principal component of all living cells and is practically important in all aspects of cell structure and functions (Shakuntala rt «!., 1987). In addition to being components of foods, proteins are involved in greater variety of functions than any other type of molecules in life (Milner, 1981). Animal sources refer to the muscle tissue which is very high in protein, containing all the essential amino acid and in most cases is a good source of essential minerals and vitamins (Lawrie and Ledword, 2006). The proteins of meat and their high benefits to organism have an eminent biological value; from nutritional aspect, they are rightly regarded as the most invaluable component of meat (Ruan and Chaan, 1997). Since the proportion of meat derived foods that one consumes is related to the general affluence of the society in which he lives, meat consumption in the developed countries is more than in less developed countries (Ihekoronye and Ngoddy, 1985). Obtaining foods through animals tends to use up a much greater amount of the available calories, proteins and other nutrients which might be .available directly from plants (Kramlich *et al,* 1973). Meat such as beef, pork, goat, chicken containing many essential nutrient necessary for healthy growth and development in children. Most meat contains a full complement of amino acids required for human diet. Fruits and vegetables by contrast are usually lacking several essential amino acid contained in meat (Lawrie and Ledword, 2006).

In view of the nutritional important of protein from animal sources, the present study was therefore undertaken in an attempt to gain some information on the crude proteins and amino acids of meats from six different local animal sources; and to compare their values with the amino acid levels of the whole hen's egg. The selected animals were goat *(Copra aeggrus hircus),* cow *(Bovine),* chicken *(Callus gallus domesticus),* guinea fowl *(Numida meleagris),* cat fish *(Clarias lazera)* and pig *(Sus domesticus).*

MATERIALS AND METHODS

Preparation of Samples

The samples of animal were purchased from the Keffi market, Nasarawa State, Nigeria in their fresh form. The samples were conveyed into the laboratory in a black polyethylene bags. Due to the changes that occur frequently in fresh meat, the samples were carefully cleaned of blood with a stainless steel knife, washed with water," drained and thinly sliced with the stainless steel knife. The sliced samples were oven dry at about 45°C for duration of 30 to 48 h. Part of every sample was homogenized in Kenwood major blender, packed in labeled plastic container and stored the laboratory refrigerator for pending analysis. Analyses were carried out without further processing.

Crude Protein Determination and Fat Extraction

The micro Kjeldahl method as described by Pearson (1976) was followed to determine the fat free crude protein. The fat was extracted with a chloroform/ methanol (2:l^{v}/v) mixture using Soxhlet extraction apparatus (AOAC, 2005) .

Amino Acid Analysis

About 32 mg defatted samples was weighed into glass ampoule, 7 ml of 6M HC1 added and hydrolyzed 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 ionexchange chromatography (Spackman, 1958) using a Technicon Sequential Multisample Amino Acid Analyzer (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.

Estimation of Isoelectric Point (pi)

The theoretical estimation of isoelectric point (pi) was determined using the equation of Olaofe and Akintayo(2000).

Where: pirn is the isoelectric point of the mixture of amino acids, pli is the isoelectric point of the i* amino acids in the mixture, and Xi is the mass or mole fraction of the amino acids in the mixture.

Estimation of Dietary Protein Quality The quality of dietary protein was measured by finding the ratio of available amino acids in the protein compared with needs expressed as a ratio (FAO, 1970). Amino acid score (AAS) was then estimated by applying the FAO/WHO (1991) formula:

A AC; *ngoj ii* mino *acid in\goj test protein*|00 *mg oj*
a nvntf *acid in Ig of reference protein* 1

Estimation of predicted protein efficiency ratio (PPER)

The predicted protein efficiency ratio (PPER) was estimated by using the equation of the form (Alsmeyer,1974):

PPER = 0.468 + 0.454 (Leu) 0.105 (Tyr)

Leucine/Isoleucine Ratio

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

RESULTS AND DISCUSSION

Amino acid (AA) composition for each sample is presented in Table 1. The range of glutamic and aspartic acids were 11.06-13.58g/100g crude protein (cp) and 10.10-11.50 g/lOOg cp, respectively and they were the highest concentrations among their groups. Arginine and leucine constituted the highest essential AA (EAA) in all the samples with values ranged from 6.30 - 7.83 g/lOOg cp and 6.59-7.58 g/lOOg cp, respectively. Arginine is essential for children and reasonable levels were present in this report. The lysine contents of the samples (4.99-6.90 g/lOOg cp) are very dose to the content of the reference egg protein (6.3 g/lOOg), and they will therefore serve as good sources for fortification of cereal weaning foods. The protein values (54.69-74.54%) are close to the value 74.50% reported for *Gymnarchus niloticus* by Adeyeye *et al.* (2003); some sea foods: *Parapenacopsis atlanta* (74.95%), *Penacus duorarum* (71.89%) and *Penanus kerathurus* (79.13%) (Ogunlade *et al.* (2005), *Clarias lazera* (73.1%) (Aremu and Ekunode, 2008), guinea hen organs' (60.7- 4%) (Adeyeye and Aremu, 2010) and *Tilajnn quineensis* (Aremu *etal*, 2007).

The FAO/WHO/UNU (1985) standards for preschool children (2 - 5 years) were (g/lOOg protein): Leu (6.6), Phe + Tyr (6.3), Thr (3.4), Try (1.1), Val (3.5), lie (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, all the meat samples in this report would provide enough or even more of all the essential amino acids except beef and pork samples that may require supplementation in Thr. Tryptophan was not determined. Histidine is a semiessential 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 (Bingham, 1977). The values of He were (4.17-5.59g/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 He and two other EAA, Leu and Val. These three EAA were high in the current report. Methionine is an EAA with value range of 1.67 - 2.40 g/lOOg cp or 2,6 3.7 g/lOOg cp with Cys (Table 1). 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

Table I: Amino acid concentration (g/lOOg crude protein) from six animal protein sources

Amino acid	Groat meat	Beef	Chicken	Guinea fowl	Fish	Pork
JUtsine (Lys)*	6.80	5.58	6.77	6.12	6,90	4.99
Histidine (His)*	2.38	2.32	2.51	2.29	2.60	2.07
. Arginine (Arg)'	7.40	7.66	7.57	6.89	7.83	6.30
Aspartic acid (Asp)	10.31	11.22	11.50	10.59	10.16	10.10
Threonine (Thr)*	3.38	2.89	3.61	3.00	3.50	2.89
Senine (Set)	4.69	4.51	4.91	3.89	4.80	3.29
Olutamic acid (Glu)	12.01	13.13	12.29	11.06	12.57	13.58
Praline (Pro)	4.14	4.46	4.99	4.03	5.20	3.82
Glycine (Gly)	5.13	5.20	5.59	5.01	5.54	4.13
Alanine (Ala)	4.90	4.48	5.29	5.02	5.40	4.59
Cystine (Cys)	1.19	1.06	1.32	1.13	1.32	0.93
VallneCVal)*	4.88	4.76	5.14	4.47	5.23	4.04
Methionine (Met)"	2.40	2.08	2.19	1.90	2.37	1.67
Isoleucine (He)"	5.59	5.05	5.15	4.58	5.33	4.17
Leucine (Leu)"	7.19	7.03	7.38.	7.03	7.41	6.59
Tyrosine:(Tyr)	3.54	3.38	3.38	3.06	3.54	2.74
Phenylalantne (Phe)'	4.90	4.73	5.07	4.65	:5.24	4.14;
Crude protein :(%)	71.67	74.54	72.01	7O.85	67.17	54.69

"Essential amino acid

Table 2: Concentrations of essential, noivessential, acidic, neutral, aromatic, etc. (g/lOOg

crude protein) of six animal protein sources

Amino acid	Groat meat	Beef	Chicken	Guinea Fowl	Fish	Pork ;
Total amino acid (TAA)	90.83	89.54	94.86	84.72	94.94	80.04
Total essential amino acid (TBAA)	-					
•With Ilia	37.52	34.44	38.02	34.O4	38.58	30^56
Without His	35.14	32.12	35.51	31.75	35.98	28.49
% TEAA (With His)	41.3O	38^50	40.1	40.18	40.60	38.20
% TEAA (Without His)	38.70	35.9O	37.40	37.50	37.90	35.60
Total non-essential AA (TNAA)	55.69	57.42	59.35	52.97	58.96	51.55
Total wuential alphatie AA(TEAAA)	21.04	19.73	21.4	19.O8	21.47	17.69
Total enendal aromatic AA (TEArAA)	4.90 :	4.73	5.07	4.65	5.24	4.14
Total neutral AA (TNAA)	54.31	52.00	56.7	50.1O	57.50	45.1O
%TNAA	*59.80*	58.1O	59.8	59.10	6O.6O	56.30
Total acid AA (TAAA)	22.32	24.35	23.79	21.65	22.73	23.68
%TAAA	24.60	27.20	25.	25.6	23.9O	29.60
Total basic AA (TBAA)	16.58	15.56	16.85	15.30	17.33	13.36
%TBAA	18.30	17.40	17.80	18.10	18.50	16.7O
Total sulphur AA (TSAA)	3.6O	3:14	3.51	3.03	3.70	2.60
%CystnTSAA	33.1O	33.80	37.0	37.3	35.7O	35.80

Table 3: Other calculated parameters from the amino acid profiles of six animal protein sources

Parameter		Groatmeat	Beef	Chicken	Guinea fowl	Fish	Pork
(P-PER)"		2.42	2.37	2.62	2.40	2.52	2.24
(P 0^s•	-	5.16	4.1	5.4	4.81	5.41	4.41
Leu/He ratio		1.29	1.39	1.47	1.53	1.39	1.58
Leu/He (difference)		1.60	1.98	2.43	2.45	2.08	' 2.42
% Leu - lie (difference)		22.25	28.17	32.06	34.85	28.07	36.72

Predicted protein efficiency ratio; "Isoelectric point

Table 8: Amino acid scores of six different anunal proteins

		Goat meat		Beef		Chicken		Guinea		Fish	,	Pork	
		EAAC	AAS	EAA	AA	EAA	AA	EAA	AA	EAA	AAS	EAA	AAS
He	4.0	5.59	1.40	5.05	1.26	5.15	129	4.58	1.15	533	1.33	4.17	1.04
Leu	7.0	7.19	1.03	7.03	1.00	7.58	1.08	7.03	1.00	7.41	1.06	6.59	0.94
Lys	5.5	6.80	1.24	5.58	1.01	6.77	123	6.12	1.11	6.90	1.25	4.99	0.91
Met + Cys,	3.5	3.59	1.03	3.14	0.90	3.51	1.00	3.03	0.87	3.7	1.06	2.6	0.74
(TSAA)	6.0	8.44	1.41	8.11	1.35	8.5	1.42	7.71	1.29	8.8	1.47	6.9	1.15
Thr	4.0	3.38	0.85	2.89	0.72	3.61	0.90	3.00	0.75!	| 3.50	0.88	2.89	0.72
Try	1.0	nd	na	nd	na	nd	na	nd	na	nd	Na	nd	na
Val	5.0	4.88	0.98	4.76	0.95	5.14	1.03	4.47	0.89	5.23	1.05	4.04	0.81
Total	36.0	39.87	7.94	36.56	7.19	41.26	7.95	35.94	7.06	40.87	8.10	32.18	631

EAA = Es^ntial amino acid; PAAESP = Provisional amino acid (egg) scoring pattern; "Source: Belschant *et al.* (1975); EAAC = Essential amino acid composition (Table 1); AAS = Amino acid score; nd = Not determined; na = Not applicable

'(Bingham, 1977). Phenylalanine values ranged between 4.14 g/lOOg cp in pork sample to 5.24 g/lOOg cp in fish. 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 cf phenylalanirie and the brain is irreversibly damaged unless a diet low in phenylalanine is given in the first few weeks of life (Bingham, 1977). Tyrosine value range was 2.74-3.54 g/lOOg cp.

Tyrosine is the precursor of some hormones (like the thyroid hormones) and the brown pigment j: melanin formed in hair, eyes and tanned skin. It ; reduces the requirement of Phe. Permanent deficiency of the enzymehypertyrosinaemia, a rare inborn error of metabolism can cause liver and kidney failure unless treated with a synthetic diet low in Phe and Tyr (Bingham, 1977).

Parameters on the quality of the protein of the samples are presented in Tables 2 and 3. The EAA (with His) ranged between 30.56 g/lOOg cp in pork sample to 38.58 g/lOOg cp in fish. These values were more than half the average of 56.6 g/lOOg cp of the egg reference protein (Paul *et al*, 1980). The aromatic AA (ArAA) range suggested for infant protein (6.8 - 11.8 g/lOOg cp) (FAO/WHO/UNU, 1985) is a little above the content report of 4.14 5.24 g/lOOg cp. The percentage ratio of EAA to the total AA (TAA) in the samples ranged between 38.20% in pork sample to 41.30% in goat meat. These values are very favourably comparable with 39% considered adequate for ideal protein food for infants, 26% for children and 11% for adults (FAO/WHO/UNU, 1985). The EAA/TAA (%) for the samples could also be favourably compared with other animal protein sources: 43.7% in *Macrotermes bellicosus* (Adeyeye, 2005b), 47.10% in Claras *lazera* (Aremu and Ekunode, 2008), 46.2% in *Zonocerus variegatus* (Adeyeye, 2005a), 47.5% in *Tilapia quineensis* (Aremu *et al*., 2007) and 47.5% in *Numida meleagris* brain (Adeyeye & Aremu, 2010) whereas it is 50% for egg (FAO/ WHO, 1990). The TEAA in this report are higher than the TEAA of some underutilized legumes (28.1-32.7 g/lOOg cp) (Aremu *et al*, 20D6) but close to the value of 44.4 g/lOOg cp in soybean (Kuri *et al*, 1991). The percentage of total neutral AA (TNAA) ranged from 56,3 in pork to 60.6 in fish, indicating that these formed the bulk of the AA; total acid AA (TAAA) ranged from 23.9 -29.60 which are far lower than % TNAA, while the percentage range in total basic AA (TBAA) is 17.70 18.50 which made them the third largest group among the samples. Most animal proteins are low in cystine (Cys) and hence Cys in TSAA. For examples (Cys/TSAA) % are 36.3 in M. *bellicosuls* (Adeyeye, 2005b), 35.7 in Cn'cetomys *gambianus* liver (Adeyeye & Aremu, 2011) and 34.6 in *Numida meleagris* brain (Adeyeye &t Aremu, 2010). In contrast, many vegetable proteins contain substantially more Cys than Met, for examples, 62.9% in coconut endosperm (Adeyeye, 2004); it is 48.1% in *Prosopis africana* (Aremu *et al*, 2007) and 51.1% in *Phaseolus cocrineus* concentrate (Arerrtu ef *al*., 2008). Thus; for animal protein^ Cys is unlikely to contribute up to 50% of the TSAA (FAO/WHO, 1991). The % Cys/TSAA had been set at 50% in rat, chick and pig diets (FAO/WHO, 1991) but not in men. Cys can spare with Met in improving the protein quality and has positive effects on mineral absorption, particularly zinc (Mendoza, 2002). The % Cys in TSAA obtained in this study are very comparable to the literature values of the animal proteins.

The predicted protein efficiency ratio (PPER) ranged between 2.24 to 2.62 (Table 3). These results are highly comparable to the following literature values: 2.33 (eyes) and 1.82 (brain) of *Numida meleagris* (Adeyeye & Aremu, 2010), 2.62 (liver) and 2.32 (heart) of *Cricetomys gambianus* (Adeyeye & Aremu, 2011) and 2.6 of *Clarias lazera* (Aremu and Ekunode, 2008) but lower in values than 4.06 (corn ogi) and reference casein with PER of 2.50 (Oyarekua & Eleyinmi, 2004); 2.56 (cattle brain), 3.04 (pig brain) and 2.68 (sheep brain) (Fprnias, 19%). The Leu/ fle ratio are low in all the samples (1.29 -1.58) hence no concentration antagonism might be experienced in the meat products when used as protein source in food. The calculation of isoelectric point (pi) from amino acids would assist in the production of the protein isolate of organic product. The pi values in this study ranged from 4.10 in beef to 5.41 in fish. The difference in Leu and lie values ranged between 1.60 in goat meat to 2.45 in guinea fowl meat. It has been shown that high jLeu in the diet impairs the metabolism for Try and niacin and is responsible for niacin deficiency in sorghum eaters (Ghafoorunissa & Narasinga Rao, 1973). High Leu is also a factor contributing to the pellagragenic properties of maize (Belavady & Gopalan, 1969). Further studies have shown that the biochemical and clinical manifestations of dietary excess of Leu could ^counteracted not only by increasing the intake of niacin or tryptophari but also by supplementation with isbleucine (Belavady & Gopalan, 1969). H ^

The essential AA scores (EAAS) based on the provisional amino acid scoring; pattern (FAO/WHO, 1973) are shbwri in Table 4. The number of EAA that are higher in values than the FAO/WHO (1991) recommendation for goat meat, beef, chicken, guinea fowl, fish and pork is 5,4,6,4, 6 and 2, respectively. Thus, for a healthy diet, supplementation with essential amino acids will be required for all the samples such as Thr and Val (goat meat), TSAA, Thr and Val (beef and guinea fowl), Thr (chicken and fish) and Leu, Lys, TSAA, Thr and Val (pork). Try was not determined. It has been reported that the essential amino acids most often acting in a limiting capacity are Met (and Cys), Lys and Try (Bingham, *1977).* However, the first limiting A A (L AA) for all the six samples in this study was Thr (Table 4).

CONCLUSIONS

This study has presented crude protein contents and amino acid profiles of six animal protein sources (goat meat, beef, chicken, guinea fowl, fish and pork). It was found that the samples were good sources of high quality protein of almost adequate or more than adequate of essential amino acids, high protein efficiency ratio values and low Leu/Ile ratios thereby providing a probable premium quality meat. It was observed that pork has the highest number of essential amino acids that may require supplementation based on FAO/WHO (1991) provisional amino acid scoring pattern while the least in number which proved to be the best was chicken.

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