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Amino acid composition of three different types of land snails consumed in Nigeria

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Abstract

The amino acid concentration of three land snails, *Limicolaria* sp., *Archatina archatina* and *Archachatina marginata*, were evaluated. Amino acid results showed that the protein contained nutritionally useful quantities of most of the essential amino acids, including sulphur-containing amino acids. The total essential amino acids (TEAA) ranged from 361 to 45.0 mg/g crude protein (with histidine) while the TEAA without histidine ranged from 331 to 403 mg/g crude protein. Significant differences existed between essential amino acids and non-essential amino acids at $P<0.05$ in *A. archatina and A. marginata*. The amino acid scores were greater than 1.0 in Lys and Phe + Tyr in all the snail samples while threonine was the limiting amino acid in all the samples. Percentage total neutral amino acids ranged from 53.2–62.0 mg/g crude protein; for total acidic amino acids, the range was 12.0–25.4 and for total basic amino acids the range was 18.8–26.0.

1. Introduction

Snails are members of the phylum Mollusca, which contains at least 80,000 species and is the second largest phylum in the animal kingdom. Members of the group are found throughout the world; they are predominantly aquatic but some are terrestrial. The phylum includes snails and slugs (class *Gastropoda*—the univalves), mussels, oysters and cockles (Bivalvia) and the octopus, squid and cuttlefish (*Cephalopoda*) (Cooper & Knowler, 1991).

All the farmed snails are members of the class *Gastropoda*, suborder *Stylommatophora*, family Achatinidae and are land snails which are capable of breathing free air. The species farmed most frequently are *Helix aspersa,* the common garden snail, *Helix pomatia,* the Roman or edible snail, and *Archatina fulica* and *Archachatina marginata,* the giant African land snails (Nisbet, 1974; Pfleger & Chatfield, 1988; Plummer, 1975).

Molluscs are important for six main reasons. First, they occupy many different ecosystems, provide food for other species and are sensitive indicators of environmental change. A number of species are now threatened in the wild (Murray, 1987; Wells, Pyle, & Collins, 1983), largely through the destruction of their habitat; second, they are intermediate hosts for important diseases of human beings, domesticated animals and wildlife (Soulsby, 1982); third, they are important agricultural pests (British Crop Protection Council, 1989); fourth, the gastropods, cephalopods and bivalves are reared in captivity, or harvested for food in many parts of the world (Ajayi, Tewe, Moriarty, & Awesu, 1978; Invertebrates in agriculture, 1989; Mason, 1984); fifthly, they are maintained in large numbers in laboratories for research and as 'companion' animals (Murphy, 1980; Nisbet, 1974; Sanz Sampelayo, Fonolla, & Gil Extremera, 1990); last, they are of economic importance for pearl production and as tourist souvenirs (Wells et al., 1983).

Human consumption of the land snails has been practised since the very earliest times. The main users are at present the populations of West Africa and West Europe and their markets are supplied, mainly, with wild snails. In Nigeria, the edible land snails are fast becoming culinary delicacies and demand has been so great that snail farming is gaining importance (Odaibo, 1997). The snail represents food of high nutritive value with a shell mainly composed of calcium carbonate, and flesh consisting of water (at least 70%) and protein

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(about 60–70% on dry basis). The giant snails are rich in lysine and generally low in cholesterol. In West Africa, particularly in Nigeria, various species of *Archatina* and *Archachatina* are eaten to a great extent. In some cases they actually form the largest single item of animal protein in the diet of the common people in rural areas (Odaibo, 1997).

Few publications are available on the nutritional qualities of Nigeria land snails. Published works include: Odaibo (1997) on snail and snail farming; Cooper and Knowler (1991) on snails and snail farming (an introduction); Adeyeye (1996) on waste yield, proximate and mineral composition of three different types of land snails found in Nigeria; and Adeyeye (1998) on the mineral composition of the haemolymph of three different types of land snails consumed in Nigeria. The study in this paper is therefore, an attempt to assess the amino acid concentration from land snails consumed in the Southwest zone of Nigeria. These are the Nigeria garden snail (*Ipere*) *Limicolaria* sp.; (*Ilako*) *Archatina* (*archatina*) *archatina* (Linne) and the giant African land snail, *Archachatina* (*Calachatina*) *marginata* (Swaison).

2. Materials and methods

2.1. Materials

Snail samples were purchased at Oba market (Ado-Ekiti, Ekiti State, Nigeria). The samples were purchased between the months of April and May 2002. Samples were then identified.

Samples were washed with water and then wrapped separately in aluminium foil and frozen at −4 °C for 5 days before samples were prepared for analysis.

The shells were carefully removed to recover the edible parts. The edible parts were cut into small pieces and oven-dried at 95–105 °C until dried and ground into fine powder.

2.2. Determination of amino acids

2.2.1. Defatting

About 2.0 g of each sample was weighed into the extraction thimble and the fat extracted with chloroform/methanol mixture using a soxhlet extraction apparatus (AOAC, 1990). The extraction lasted for 5–6 h.

2.2.2. Hydrolysis of samples

From 30 to 35 mg of the defatted samples were weighed into glass ampoules. Seven millilitres of 6 MHCl were added and oxygen was expelled by passing nitrogen gas into the ampoule (to avoid possible oxidation of some amino acids during hydrolysis). Each glass ampoule was then sealed with a bunsen flame and put into an oven at 105 °C ± 5 °C for 22 h. The ampoule was allowed to cool before breaking open at the tip and the content was filtered to remove the humins.

The filtrate was then evaporated to dryness at 40 °C under vacuum in a rotary evaporator. Each residue was dissolved with 5 ml of acetate buffer and stored in a plastic specimen bottle, and kept in the deep freezer.

2.2.3. Sample analysis

Our method of analysis was by ion-exchange chromatography (IEC) (FAO/WHO, 1991). The amounts loaded, for both samples, were 5–10 μl each. These were dispensed into the cartridge of the analyser. The Technicon Sequential Multisample Amino Acid Analyser (TSM) (Technicon Instruments Corporation, New York) was used for the analysis. The TSM analyser is designed to separate and analyse free acidic, neutral and basic acids of the hydrolysate. The period of an analysis lasted for 76 min for each sample. The column flow rate was 0.50 ml/min at 60 °C with reproducibility consistent within ±3%. The net height of each peak produced by the chart record of the TSM (each representing an amino acid) was measured and calculated. The values reported were averages of two determinations.

2.3. Statistical analyses

All results were subjected to statistical analyses. Mean, standard deviation (S.D.) and coefficients of variation percent (CV%) were calculated (Steel & Torrie, 1960). Also calculated were the amino acid scores (Bender, 1992; FAO, 1970; Orr & Watt, 1957) and the F test values at $P<0.05$ for essential amino acids versus non-essential amino acids, essential amino acids versus essential amino acids per sample and amino acid scores for each sample.

3. Results and discussion

The amino acid compositions of the three land snail samples are shown in Table 1. The total weights of the various snail samples have earlier been estimated as *A. marginata* (302.0 g), *A. archatina* (14.31 g) and *Limicolaria* sp. (5.41 g) while their percentage edible portions (flesh + haemolymph) were as follows: *A. marginata* (49.21%), *A. archatina* (60.17%) and *Limicolaria* sp. (55.45%) (Adeyeye, 1996). Despite the small size of *Limicolaria* sp., its amino acid concentrations were much higher, in some cases than in the other two land snails. Such amino acids included: Lys, Asp, Arg, Ser, Ile. *Limicolaria* sp. are usually found in large numbers. They are generally not favoured for consumption (Odaibo, 1997). However, they have become a delicacy to the local population because of their large population and easy access for collection in the early rains of each year.

The amino acid concentrations were variously concentrated among the various samples, as shown in the coefficient of variation percent (CV%). Glu was lowest (10.1 mg/g protein) in *Limicolaria* sp. but highest (111 mg/g protein) in *A. archatina* and 144 mg/g protein in *A. marginata* with CV% of 78.9. Many other amino acid values were not as varied and had low CV%, such as 6.17 (Arg), 4.61 (Asp), 6.41 (Gly) and 8.86 (Tyr). While Lys (82.8 mg/g protein) was the most concentrated amino acid in *Limicolaria* sp., Glu was the most concentrated in *A. archatina*(111 mg/g protein) and *A. marginata* (144 mg/g protein). The present results contrast with the results in oilseeds where Asp and Glu are the major abundant amino acids (Olaofe, Adeyemi, & Adediran, 1994). The present essential amino acid values are favourably comparable with the published reports in milk and beef (FAO, 1970) and egg (FAO/WHO/UNU, 1985).

The total amino acids (TAA) ranged between 713 mg/g protein (*A. archatina*) and 874 mg/g protein (*A. marginata*) with a CV% of 12.0. These values are lower than the reported values in dehulled African yam bean (AYB) (703–918 mg/g crude protein) (Adeyeye, 1997). The total non-essential amino acids (TNEAA) of 288–424 mg/g protein are favourably comparable to those in AYB of 327–454 mg/g protein. The total essential amino acids (TEAA) were high in all the samples; the values ranged from 361 to 450 mg/g protein (with histidine) and 331 to 403 mg/g protein (without histidine). Tryptophan was not determined in our samples. These results are favourably comparable to the TEAA values in cow's milk, 490 (with histidine but no Try) and 463 (no histidine, no Try); beef, 467 (with histidine but no Try) and 433 (no His, no Try); and egg, 495 (with His but no Try) and 473 (no His, no Try) (FAO/WHO/UNU, 1985). Percent TNEAA ranged from 40.2 to 49.4 while the percent TEAA ranged from 50.6 to 59.8 (with histidine) and 46.1–54.9 (without histidine) showing that the samples were better concentrated in TEAA (with histidine) than TNEAA, making them good sources of animal protein for children. The TEAA (with histidine) values in the land snails were either higher or lower than that of soya bean, i.e. 444 mg/g (Altschul, 1958), depending on the particular snail under consideration. The percentages of total neutral amino acids (TNAA) ranged from 53.2 to 62.0, indicating that these formed the bulk of the amino acids; total acidic amino acid (TAAA) ranged from 12.0 to 25.4 which was lower than the% TNAA, while the percent range in total basic amino acids (TBAA) was 18.8–26.0, which made them the second largest group among the samples.

Comparison between the amino acid content and the FAO/WHO (1985) amino acid reference values showed that most of the amino acids would meet the recommended range of amino acid requirement for infants and significantly higher than the values recommended for pre-school children and school children. Clearly all would meet the amino acid requirements of adults (DHSS, 1977; FAO, 1970). The biological availability of amino acids of these samples is supported by lack of fibre content (Adeyeye, 1996) and the absence of anti-nutritional properties (Liener, 1983). Maize food

Table 1
Amino acid composition of the flesh of the land snails (mg/g crude protein) dry weight

Animo acid	*Limicolaria*sp.	*Archatina archatina*	*Archachatina marginata*	Mean	S.D.	CV%
Lysine (Lys)[a]	82.8	60.6	57.4	66.9	13.8	20.7
Histidine (His)[a]	35.6	29.6	47.0	37.4	8.84	23.6
Arginine (Arg)[a]	67.4	63.1	59.6	63.4	3.91	6.17
Aspartic acid (Asp)	76.1	69.4	72.7	72.7	3.35	4.61
Threonine (Thr)[a]	18.0	22.4	27.6	22.7	4.81	21.2
Serine (Ser)	40.5	31.7	33.3	35.2	4.69	13.3
Glutamic acid (Glu)	10.1	111	144	88.5	69.9	78.92
Proline (Pro)	39.9	30.1	36.1	35.4	4.94	14.0
Glycine (Gly)	50.6	51.6	45.7	49.3	3.16	6.41
Alanine (Ala)	39.8	24.2	51.9	38.6	13.9	36.0
Cystine (Cys)	4.8	8.7	10.9	8.13	3.09	38.0
Valine (Val)[a]	41.2	32.8	71.1	48.4	20.1	41.6
Methionine (Met)[a]	18.1	13.7	20.0	17.3	3.23	18.7
Isoleucine (Ile)[a]	52.4	44.6	38.7	45.2	6.87	15.2
Leucine (Leu)[a]	69.0	55.8	81.1	68.6	12.7	18.4
Tyrosine (Tyr)	25.8	24.8	29.3	26.6	2.36	8.86
Phenylalanine (Phe)[a]	43.7	38.4	47.3	43.1	4.48	10.4
Total amino acid (TAA)	716	713	874	768	92.1	12.0
Total essential amino acid (TEAA)						
with histidine	428	361	450	413	46.3	11.2
no histidine	393	331	403	376	38.6	10.3

[a] Essential amino acids.

products are highly deficient in Lys and they are the most common weaning foods for children in most African countries (Akinrele & Edward, 1971), the land snails, particularly *Limicolaria* sp. flour, would therefore be very suitable for the fortification of such maize food products. Oshodi, Olaofe, and Hall (1993) found Phe to be the most predominant anti-sickling agent in pigeon pea seed exract (Ekeke & Shode, 1990); the snail sample extracts would likely be able to perform this function since they contained a reasonable amount of Phe; it is in the third position in abundance among EAA in *A. marginata* but fourth position in both *A. archatina* and *Limicolaria* sp., coming after Lys, Leu and Ile (Table 1).

Both His and Arg are particularly essential for children (FAO/WHO/UNU, 1985; Harper, 1984; Muller & Tobin, 1980) and the current results (Table 1) showed that the snail samples were good sources of both amino acids. While it is known that cystine can spare part of the requirement for methionine, FAO/WHO/UNU (1985) does not give any indication of the proportion of total sulphur amino acids which can be met by cystine. For the rat, chick and pig, the proportion is about 50% (FAO/WHO, 1991). Most animal proteins are low in cystine; in contrast, many vegetable proteins, especially the legumes, contain substantially more cystine than methionine. Thus, for animal protein diets, or mixed diets containing animal protein, cystine is unlikely to contribute more than 50% of the total sulphur amino acids (FAO/WHO, 1991). This point is amplified by our results with the following values: *A. marginata* (35.3%); *A. archatina* (38.8%) and *Limicolaria* sp. (21.0%) respectively.

The data obtained for the total non-essential amino acids (TNEAA), total essential amino acids (TEAA) and essential amino acid scores (EAAS) were all subjected to the F test as follows: TEAA/TNEAA, TEAA/TEAA and EAAS/EAAS. The following results were obtained: in *A. archatina* TEAA/TNEAA value was Fc (3.64) > Ft (3.50) at $P<0.05$; the result was significant, but in both TEAA/TEAA and EAAS/EAAS (Fc < Ft), results were not significant; for *Limicolaria* sp., all the calculations for TEAA/TNEAA, TEAA/TEAA and EAAS/EAAS had values of Fc < Ft (not significant); in *A. marginata,*TEAA/TNEAA value was Fc (4.33) > Ft (3.50) at $P<0.05$, which was significant but, in both TEAA/TEAA and EAAS/EAAS, Fc < Ft (not significant at $P<0.05$).

The World Health Organisation recommended Val and Ile requirements for school children aged 10–12 years, of 33 and 30 mg amino acid/kg body weight/day (FAO/WHO, 1985; WHO, 1973). For example, a 30 kg child will require 990 and 900 mg of Val and Ile per day, respectively. The protein values for the land snails were 20.8/100 g (*A. marginata*), 14.5 g/100 g (*A. archatina*) and 17.5 g/100 g (*Limicolaria* sp.), all on a wet weight basis (Adeyeye, 1996). E.g., with *A. marginata,* 100 g of it would provide about 1476 and 803 mg of Val and Ile, respectively. If a 30 kg child therefore consumes 100 g of *A. marginata* per day, his WHO daily requirements of Val and Ile would be met by 149 and 89.3%, respectively. The same type of calculation holds for the other samples.

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