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MUSCLE AND SKIN AMINO ACID COMPOSITIONS OF THE GREATER CANE RAT (*THRYONOMYS SWINGERIANUS*)

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ABSTRACT

The Greater Cane Rat muscle and skin samples were evaluated for their amino acid profiles. The amino acid values were (in mg/g crude protein): highest concentrated amino acid was glutamic acid (150; muscle) and 140 (skin) with highest essential amino acid as leucine (72.2; muscle) and 69.0 (skin). Total essential amino acids (mg/g crude protein): 382(42.9 %) muscle and 350 (47.6 %) skin. The limiting amino acid on whole hen's egg score was threonine (0.39; muscle) and serine (0.39; skin); on provisional scoring pattern, it was threonine (0.50) muscle and 0.75 (skin); on pre-school child requirement, it was threonine (0.59) in muscle but lysine (0.69) in skin. Significant differences existed between the amino acid profiles at $r_{=0.05}$ and n-2; total amino acid levels being 891 mg/g crude protein (muscle) and 736 mg/g crude protein (skin).

KEYWORDS

Thryonomys swinderianus, muscle and skin, amino acid compositions.

INTRODUCTION

The Greater Cane Rat (*Thryonomys swinderianus*; Temminck, 1827) is one of two species of cane rats, a small family of African hystricognath rodents. It inhabits Africa, south of the Sahara Desert. The cane lives by reed beds and riverbanks. As humans move into such territories, the cane rats accepted plantations and cultivated areas. Cane rats can grow about 2 feet (61cm) long in the longest individuals and weighs a little less than 19 1b (8.6 kg). It has rounded ears, short nose, and coarse bristly hair. Its forefeet are smaller than its hind feet and support its weight on only three toes. Cane rats live in small groups led by a single male. They are nocturnal and make nests from grasses or burrow underground. The oldest cane rat lives more than four years. If frightened, they grunt and run towards water. They eat grasses and cane and since they have tastes for cultivated foods, they make serious agricultural pests. So far their conservation status is lower risk[1].

In the country of Ghana and other regions of West Africa, the Greater Cane Rat is usually called a grass cutter or cutting grass. In both West Africa and Southern Africa, it is considered a delicacy. As a consequence, "grass cutters" are beginning to be

raised in cages for sale, and so are sometimes referred to as micro livestock[1].

Works already reported on the grasscutter included: some aspects of marketing the grasscutter[2]; the report of Ajayi and Tewe on the nutritional value of the meat of grasscutter[3]; an important role in traditional African medicine [4, 5]; it had also been reported that the pancreas of the grass cutter contains high concentration of insulin which is used in local preparation for treatment of diabetes[6]. Other works included breeder's selection and gestation diagnosis in grasscutter[7] and the study of the reproductive indices and performance of captive reared grasscutters[8]. This study concerned the evaluation of the amino acid profiles of *Thryonomys swinderianus* muscle and skin in order to provide information on the nutritional attributes of this delicacy.

MATERIALS AND METHODS

T. swinderianus matured sample was caught in the wild by a local hunter commissioned for that purpose at Iworoko Ekiti, Nigeria; identified, immersed in hot water (10 min), hair removed and the animal dissected. The muscle and skin were then separately removed, washed with distill water and dried to constant weight; milled into flour and kept in a freezer, pending analysis.

The method of amino acid analysis was by ion-exchange chromatography (IEC) [9] using the Technicon Sequential Multisample Amino acid Analyzer (TSM) (Technicon Instruments Corporation, New York). The internal standard was norleucine. The period of analysis was 76 min, with gas flow rate of 0.50 ml/min at 60 ^{0}C and the reproducibility was ±3 %. Trypophan was not determined. The nitrogen was determined by the micro-Kjeldahl method[10] with crude protein taken as N x 6.25.

The essential amino acid scores were determined using the method of FAO/WHO[11]; also using the suggested pre-school child requirement[12] and comparison with whole hen's egg[13]. The predicted protein efficiency ratio was determined using the method of Alsmeyer et al.[14] while the essential amino acid index was determined by the method of Steinke et al[15].The isoelectric point was calculated by the method of Olaofe and Akintayo[16]. The linear correlation, regression, coefficient of determination, coefficient of alienation and index of forecasting efficiency were all calculated, testing the significance of the results at $r_{=0.05}$ and n-2 degrees of freedom[17]. The summary of the amino acid profiles into factors A and B was done using the method of Adeyeye et al[18].

RESULTS AND DISCUSSION

Amino acid compositions (mg/g crude protein, cp) for the different samples are shown in Table 1. Glutamic acid was the most concentrated amino acid (AA) in the samples with values of 150 (muscle)-140 mg/g cp (skin). This was the exact trend in the AA profiles of ostrich, beef and chicken[19].While our lysine levels were lower than in ostrich, beef and chicken[19], our levels of Lys and Leu were favorably comparable to the levels in the muscle and skin of turkey-hen[20]. Our His levels (20.6-22.5 mg/g cp) were close to the levels in ostrich (20.3), beef (32.0), chicken (30.4)[19]; turkey-hen: muscle (26.0) and skin (24.7)[20]. Phenylalanine levels (40.5-48.0 mg/g cp) were close to these literature values (mg/g cp): ostrich (48.4), beef (44.8), chicken (44.8)[19]; turkey-hen: muscle (47.9) and skin (38.0)[20]. Our values in Ile, Val and Met were close with regard to corresponding values in ostrich, beef, chicken and turkey-hen. The remaining non- essential AA was very close to the corresponding levels in ostrich, beef, chicken and turkey-hen. On comparison with pork[21] and mutton[21], the following AA were better concentrated in pork and mutton than *T. swinderianus* muscle: Leu, Ile, Lys, Cys, Tyr, Thr and His and total essential amino acids; however it was a reverse case in Met, Phe and Val; whereas in skin the reverse was in Met, Cys, Phe and Val. The protein levels are also shown in Table 1. The value in the muscle (80.8 g/100 g) was close to the value of 84.2 g/100 g in turkey-hen muscle whereas the skin protein (90.8 g/100 g, fat free) was much greater than the value in the skin of turkey-hen (79.3 g/100 g) [20] and the muscle of the present sample suggesting that lipids in the skin of the sample would be much greater than in the muscle and skin of turkey-hen and muscle of *T. swinderianus*. While the sample muscle would produce an energy density of 1373

kJ/100 g in the muscle, it would produce 1544 kJ/100 g in the skin.

Histidine is a semi-essential AA 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 nestle rash. The value of Ile was 31.8-39.5 mg/g cp in the samples. It is an EAA for both old and young. Male Syrup Urine Disease is an Inborn Error of metabolism in which brain damage and early death can be avoided by a diet low in Ile and two other EAA, Leu and Val. These EAA's are slightly higher than what obtains in plant sources[23]. Methionine is an EAA which 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[22]. Phenylalanine was high in the samples. It is the precursor of some hormones and the pigment melanin in hair, eyes and tanned skin. Phenylketonuria is the commonest inborn error of metabolism successfully treated by diet. The absence of an enzyme in the liver blocks the normal metabolism of phenylalanine and the brain is irreversibly damaged unless a diet low in Phe is given in the few weeks of life. Tyrosine was 23-30 mg/g cp in the samples. It is the precursor of some hormones (like the thyroid hormones) and the brown pigment melanin formed in hair, eyes and tanned skin. It reduces the requirement of Phe. Permanent deficiency of the enzyme-hypertyrosinaemia, a rare inborn error of metabolism-can cause liver and kidney failure unless treated with a synthetic diet low in Phe and Tyr[22]. Valine, an EAA is restricted in the treatment of Maple Syrup Urine Disease.

Table 1

Muscle and skin amino acid compositions of the Greater Cane Rat (mg/g crude protein, dry weight)

Amino acid	Concentration		Mean	SD	CV %
	Muscle	Skin			
Lysine (Lys)*	51.9	40.1	46.0	8.34	18.1
Histidine (His)*	20.6	22.5	21.6	1.34	6.22
Arginine (Arg)*	70.2	49.5	59.9	14.6	24.4
Aspartic (Asp)	81.1	71.7	76.4	6.65	8.70
Threonine (Thr) *	20.0	30.0	25.0	7.07	28.3
Serine (Ser)	32.0	31.1	31.6	0.64	2.01
Glutamic acid (Glu)	150	140	145	7.07	4.88
Proline (Pro)	30.2	22.0	26.1	5.80	22.2
Glycine (Gly)	122	30.5	76.3	64.7	84.6
Alanine (Ala)	23.9	40.8	32.4	12.0	36.9
Valine (Val)*	62.0	46.1	54.1	11.2	20.8
Cystine (Cys)	10.5	11.6	11.1	0.78	7.04
Methionine (Met)*	42.5	20.5	31.5	15.6	49.4
Isoleucine (Ile)*	31.8	39.5	35.7	5.44	15.3
Leucine (Leu)*	72.2	69.0	70.6	2.26	3.21
Tyrosine (Tyr)	30.0	23.0	26.5	4.95	18.7
Phenylalanine (Phe)*	40.5	48.0	44.3	5.30	12.0
Total	891	736	814	110	13.5
Protein (g/100g), fat free	80.8	90.8	85.8	7.07	8.24

SD = standard deviation; CV = coefficient of variation.

The various categories of the AA are shown in Table 2. The current total EAA (TEAA) is comparable to some literature values (mg/g cp): 361-450 in three different snails consumed in Nigeria[24]; 351 in variegated grasshopper[25] and 350[26] in the white ants. The P-PER values 2.49-2.42 were better than in turkey hen (1.93-2.27)[20] but close to the reference casein with PER of 2.50[27]. The Leu/Ile ratio was low hence no concentration antagonism might be experienced in the grass cutter meat. In the results of isoelectric points, there was a shift from 4.13 in the skin to 5.14 in the muscle just as observed in turkey-hen 4.41 (skin) to 5.01 (muscle) [20]. The calculation of pI from AA would assist in the production of the protein isolate of an organic product. Most animal proteins are low in Cys, examples of some literature values of % Cys/TSAA are: 36.3 in white ants[26], 25.6 in variegated grasshopper[25] and 21.0-38.8 in three different snails[24]; our present results of 19.8-36.1 corroborated these earlier observations. In plants, the % Cys/TSAA in most cases was equal or greater than 50 %, like in the endosperm of coconut with a value of 62.9 % [23]. The percentage of Cys in TSAA had been set at 50 % in rat, chick and pig diets. Cys has positive effects on mineral absorption particularly zinc[29, 30].

Table 3 contains the various amino acid scores (AAS). Scores based on whole hen's egg showed that Thr (0.39) was limiting in the muscle whereas Ser (0.39) was limiting in the skin. Under the provisional EAA scoring pattern, Thr (0.50) was limiting in the muscle and Lys (0.73) was limiting in the skin; in the pre-school (2-5 years) child suggested requirements, Thr (0.59) was limiting in muscle and Lys (0.69) was limiting in the skin. To correct the limiting AA, we use the lowest value for correction which is 100/39 or 2.56 times as much of muscle/ skin grass cutter protein would have to be eaten when any of them serves as the sole protein source in the diet. The high score for Gly (1.02-4.05) could be interesting; this AA could have enhanced the delicacy of grasshopper meat. Monosodium glutamate is made from glutamic acid extracted from sugar beet and wheat gluten[22].

Table 4 shows the statistical summary of the results in Tables 1, 2 (pI only) and 3. The Table showed that the linear correlation coefficient (r_{xy}) was positively and significantly high at $r_{=0.05}$ and n-2 degrees of freedom for amino acids (from Table 1). The coefficient of determination (r_{xy}^2) was also high. The regression coefficient (R_{xy}) showed that for every one unit increase in the muscle AA (X) there was a corresponding increase of 11 units in the skin (Y). The coefficient of alienation was high at 0.63 whereas the index of forecasting efficiency (IFE) was low at 0.37.

Table 2

Summary of some essential parameters of Greater Cane Rat muscle and skin amino acid composition (mg/g crude protein)

Parameter	Muscle	Skin	CV %
Predicted protein efficiency ratio (P-PER)	2.49	2.42	2.01
Leu/Ile ratio	2.27	1.75	18.3
Leu-Ile %	56.0	42.8	18.9
Isoelectric point (pI)	5.14	4.13	15.4
Essential amino acid index (EAAI)	1.15	1.09	3.79
Total acidic amino acid (TAAA)	231	212	6.07
% TAAA	25.9	28.8	7.48
Total basic amino acid (TBAA)	143	112	17.2
% TBAA	16.0	15.2	3.63
Total aromatic amino acid (TArAA)	91.1	93.5	1.84
% TArAA	10.2	12.7	15.4
Total neutral amino acid (TNAA)	517	412	16.0
% TNAA	58.0	56.0	2.48
Total sulphur amino acid (TSAA)	53.0	32.1	34.7
% TSAA	5.95	4.36	21.8
% Cys/TSAA	19.8	36.1	41.2
Total amino acid (TAA)	891	736	13.5
Total essential amino acid (TEAA)			
-with His	382	350	6.18
-without His	361	328	6.77
% TEAA			
-with His	42.9	47.6	7.34
-without His	40.6	44.5	6.48
Total non-essential amino acid (TNEAA)	509	386	19.4
% TNEAA	57.1	52.4	6.07

Table 3

Greater Cane Rat muscle and skin amino acid compositions (mg/g crude protein) scores based on hen's egg, provisional score and pre-school child suggested requirement

Amino acid	Hen's egg		Provisional scores		Pre-school child requirement	
	Muscle	Skin	Muscle	Skin	Muscle	Skin
Lys	0.84	0.65	0.94	0.73	0.89	0.69
His	0.86	0.94			1.08	1.18
Arg	1.15	0.81				
Asp	0.76	0.67				
Thr	0.39	0.59	0.50	0.75	0.59	0.88
Ser	0.41	0.39				
Glu	1.25	1.67				
Pro	0.79	0.58				
Gly	4.05	1.02				
Ala	0.44	0.76				
Val	0.83	0.61	1.24	0.92	1.77	1.32
Cys	0.58	0.64				
Met	1.33	0.64	1.51	0.92	2.12	1.28
Ile	0.57	0.71	0.80	0.99	1.14	1.41
Leu	0.87	0.83	1.03	0.99	1.09	1.05
Tyr	0.75	0.58				
Phe	0.79	0.94	1.18	1.18	1.12	1.13
Total	0.91	0.75	1.03	0.94	1.16	1.07

Table 4

Statistical summary of the results in Tables 1, 2 (pI only) and 3

Parameter	r_{xy}	r_{xy}^2	R_{xy}	Slope	X	Y	C_A	IFE	Remark
1. Amino acid	0.7764	0.60	11.0	0.62	52.4	43.3	0.63	0.37	*
2. pI	0.7109	0.51	10.9	0.44	30.3	24.3	0.70	0.30	*
3.(a)Score(Hen's egg)	0.3871	0.15	0.64	0.13	0.98	0.77	0.92	0.08	NS
(b)Score(Provisional)	0.4319	0.19	0.72	0.20	1.03	0.93	0.90	0.10	NS
(c)Score(Pre-school)	0.6400	0.41	0.73	0.31	1.23	1.12	0.77	0.23	NS

r_{xy} = linear correlation coefficient;
r_{xy}^2 = coefficient of determination;
R_{xy} = linear regression coefficient;
X = mean due to muscle;
Y = mean due to skin;
C_A = coefficient of alienation;
IFE = index of forecasting efficiency;
* = result significant at $r_{=0.05}$ and n-2 degrees of freedom;
NS =result not significant at $r_{=0.05}$ and n-2 degrees of freedom.

The IFE is actually the reduction in the error of prediction of relationship; meaning that relationship would be a bit difficult to predict between the AA of muscle and the AA of skin. This type of explanation goes for all the members of Table 4.

Table 5 is a summary of all the results of the AA compositions of the muscle and skin in the categories of essential and non-essential AA into factors A and B. The details are in the Table 5.

Table 5

Summary of the amino acid profiles into factors A and B

	Samples		
	Muscle	Skin	Factor B means
Amino acid composition (Factor B)			
Total essential amino acid	382	350	366
Total non-essential amino acid	509	386	448
Factor A means	446	368	407

CONCLUSION

The greater Cane Rat (*Thryonomys swinderianus*) has high levels of most of the essential amino acids and non-essential amino acids particularly Glu and Gly; has pI value close to hen's egg (5.64), has essential amino acid index (EAAI) close to the hen's egg (1.54); P-PER close to egg (2.88) and % Cys/TSAA close to egg (36.0). Both the muscle and the skin would individually supply more than 100 % of 6/8 (75 %) of the EAA determined meaning that the skin of the sample would serve similar physiological functions as much as the muscle would do.

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