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Full Length Research Paper

Effect of domestic processing on the amino acid profile of *Dioscorea rotundata* (White yam)

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Yam (*Dioscorea* species) is one of the most important food crops in West Africa. It is a major source of carbohydrates and nutrient energy for many people in tropical countries. Like many other foods, roots and tubers are rarely eaten raw. They normally undergo some forms of processing which makes them more palatable, digestible and safe for human consumption. Freshly harvested tubers of *Dioscorea rotundata* were peeled, washed and diced and subjected to different domestic processing techniques namely: Drying, roasting, boiling and frying. The flour was evaluated for proximate and amino acid composition. Glutamic acid was the most concentrated amino acid, with the drying process recording the highest value. Histidine, an essential amino acid showed a higher value than the FAO standard for the four techniques. The lysine contents were comparable with the reference egg protein. Total aromatic amino acid and total sulphur-containing amino acids gave values comparable with FAO/WHO/UNU standards. In general, the amino acid content was significantly higher (p<0.05) when the yam was subjected to drying process, suggesting that *D. rotundata* flour has potential as a high quality protein source, hence can be exploited to enhance protein quality of diet for adults and weaning/complimentary feeding for children.

Key words: White yam, *Dioscorea rotundata*, amino acid.

INTRODUCTION

Yam (Dioscorea species) is the most important food crop in West Africa except for cereals (Coursey, 1967; Onwueme, 1978). However, West Africa is the most important yam-producing region in the World with Nigeria being the highest producer, accounting for 71% of the world's total production (BBC, 2010). Yam is reported to be a major source of carbohydrates and nutrient energy for many people in tropical countries including East Africa, the Carribean, South Africa, India and South East Asia (Ayensu and Coursey, 1972; Muzac-Tucker et al., 1993; Yang et al., 2009). Yam also occupies an important place in the diet and economy of the people in Nigeria because of its ability to give high yield under rainfall condition. Most species of yam are important source of pharmaceutical compounds like saponins and sapogenins, which are precursors of cortisone and steroidal hormones. This aspect has generated considerable research (Coursey, 1983).

Yam plant is classified under the genus Dioscorea, family Dioscoreaceae, and order Dioscoreales (Ayensu and Coursey, 1972). Dioscoreaceae includes many other genera but Dioscorea is the largest and most important genus. Six common species and twelve cultivars were reportedly grown in Jaimaca (Muzac-Tucker et al., 1993) while Lape and Treche (1994) reported eight yam species grown in Cameroon. *D. rotundata*, widely consumed in Nigeria, has a large number of cultivars.

Like many other foods, roots and tubers are rarely eaten raw. They normally undergo some forms of processing and cooking before consumption. The methods of processing and cooking range from simple boiling to elaborate fermentation, drying and grinding, to

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make flour depending on the varieties of roots and tubers. Moreover, fresh yam can also be peeled, boiled and pounded until sticky elastic dough called pounded yam is produced. The basic purpose of these methods is to make roots and tubers and their products more palatable, digestible, and safe for human consumption. Processing also extend the storage life of roots and tubers which are often highly perishable in their fresh conditions. It also provides a variety of products which are more convenient to cook, prepare and consume than the original new materials. Women are known to play a very active role in all stages involved in the production and processing of root crops (FAO, 1990).

This study takes a cursory look at the effect of various processing methods commonly used before consumption on the amino acid profile of *D. rotundata* (white yam).

MATERIALS AND METHODS

Freshly harvested tubers of *D. rotundata* from a farmland located at Ifaki-Ekiti, Ekiti State, Nigeria were peeled and diced to get representative samples of the yam tubers. The yam samples were subjected to different domestic processing techniques namely: drying, roasting, boiling and frying.

Determination of amino acids

Two grams of each sample was defatted with chloroform-methanol (2:1) using soxhlet extraction apparatus as described by AOAC (1990). The extraction lasted for 5 to 6 h. About 30 to 35 mg of each defatted sample was weighed into glass ampoule. Seven mililiters of 6 M HCl was added and oxygen was expelled by passing nitrogen gas into the ampoules, to avoid possible oxidation of some amino acids during hydrolysis. Each glass ampoule was then sealed with Bunsen burner flame and put in an oven preset at 105 ± 5℃ for 22 h. Each ampoule was allowed to cool before breaking open at the top and the content was filtered to remove the humins. The filtrate was then evaporated to dryness at 40℃ under vacuum in a rotary evaporator. Each residue was dissolved with 5 ml acetate buffer (pH 2.0). The method of amino acid analysis was by ion-exchange chromatography (IEC) (Spackman et al, 1958) using the Technicon Sequential Multisample Amino acid Analyzer (TSM), Technicon Instruments Corporation, New York.

Estimation of quality of dietary protein

The quality of dietary protein was measured by the method described in FAO/WHO (1990). The formula used to calculate the essential amino acid scores is shown as:

$$Amino\ acid\ score = \frac{mg\ of\ amino\ acid\ per\ g\ of\ test\ protein\ mg/g}{mg\ of\ amino\ acid\ per\ protein\ in\ reference\ pattern\ mg/g} X100$$

Determinations of the ratio of total essential amino acids (TEAA) to the total amino acids (TEAA/TAA); total sulphur amino acid (TSAA); percentage cystine in TSAA (%Cys TSAA); total aromatic amino acid (TArAA); total neutral amino acid (TNAA); total acidic amino acid (TAAA); total basic amino acid (TBAA) were estimated from the amino acid profile. The predicted protein efficiency ratio (P-PER) was determined using one of the equations developed by Alsmeyer et al. (1974), that is:

P-PER = -0.464 + 0.454(Leu) – 0.105(Tyr)

The leucine/isoleucine ratio and Leu–Ile difference were also calculated.

Statistical analysis

All data were analyzed statistically; the mean, standard deviation and coefficient of variation (Christain, 1977). The calculations were meant to determine the level of variation among the data for the four different processing techniques of the *D. rotundata*.

RESULTS AND DISCUSSION

Amino acid composition (g/100 g crude protein) for the *D. rotundata* subjected to four different processing techniques is shown in Table 1. Glutamic acid was the most abundant amino acid, with values ranging from 3.13 to 7.15 g/100 g crude protein. However, the drying process recorded the highest value. This followed similar trend in amino acid profile of some animal and plant sources especially in *D. dumetorum*, a closely related species (Ogunlade et al., 2006). The amino acid composition of *D. rotundata* was relatively higher when compared with other Dioscorea species (Alozie et al., 2009). Leucine levels ranged from 2.20 to 7.50 g/100 g crude protein. The values were however lower than the FAO standard for preschool children (2 to 5 years) (FAO/WHO/UNU, 1985) and that for Jamaican yams (Muzac-Tucker et al., 1993) when subjected to frying, roasting and boiling.

Essential amino acids such as histidine (His) ranged from 1.19 to 5.20 g/100 g crude protein, isoleucine (Ile) (1.47 to 6.22 g/100 g crude protein); these values are higher when compared to the FAO standards of His (1.9) and Ile (2.8) (FAO/WHO/UNU, 1985) for the four techniques. The lysine (Lys) content, of between 3.00 and 7.10 g/100 g crude protein was comparable with that of the reference egg protein (6.3 g/100 g crude protein) (Adeyeye, 2008) (Tables 2 and 3). The phenylalanine and tyrosine (Phe + Tyr) levels ranged from 1.99 to 9.40 g/100 g crude protein, showing that the boiling and drying techniques gave values that were comparable with 6.3 FAO/WHO/UNU standards suggesting that *D. rotundata* can be exploited to enhance protein quality of weaning/complimentary feeding, especially in dry form. Another amino acid found to be lower than FAO standards for preschool children is valine (Val) 2.26 to 3.33 g/100 g crude protein. The total amino acid (TAA) ranged between 28.27 to 91.47 g/100 g crude protein. The values were higher than the value of 56.6 g/100 g crude protein of the reference egg protein (Paul et al., 1980) and 21.48 to 30.70 g/100 g crude protein for guinea corn (Adeyeye, 2008).

In general, the amino acid content was significantly higher ($p<0.05$) when the yam was subjected to drying process, suggesting that *D. rotundata* flour has potential

Table 1. Amino acid composition (g/100 g crude protein) of four methods of domestic processing of *D. rotundata* (white yam).

Amino acid	Fried	Roasted	Boiled	Dried	Mean	SD	C.V (%)
Lys	3.00	3.10	4.10	7.10	4.33	1.92	44.29
His	1.19	1.20	2.20	5.20	2.45	1.90	77.43
Arg	3.06	3.06	4.06	6.66	4.21	1.70	40.38
Asp	2.93	2.94	3.94	5.94	3.94	1.42	35.98
Thr	1.22	1.23	2.34	4.43	2.31	1.51	65.55
Ser	0.81	0.82	2.84	4.82	2.32	1.92	82.64
Glu	3.13	3.15	5.15	7.15	4.65	1.92	41.34
Pro	0.63	0.65	1.16	3.65	1.52	1.44	94.54
Gly	2.24	2.25	3.25	5.25	3.25	1.42	43.62
Ala	0.77	0.78	1.78	4.07	1.85	1.55	84.00
Cys	1.06	1.07	2.07	5.27	2.37	1.99	84.15
Val	2.26	2.27	3.27	3.33	2.78	0.60	21.49
Met	0.31	0.33	1.33	5.48	1.86	2.46	131.99
Ile	1.47	1.48	3.48	6.22	3.16	2.25	71.05
Leu	2.20	2.22	4.22	7.50	4.04	2.50	61.88
Tyr	0.81	0.83	2.10	4.10	1.96	1.55	79.03
Phe	1.18	1.19	4.20	5.30	2.97	2.11	70.99
TAA	28.27	28.57	51.49	91.47	49.95	29.74	59.54

Table 2. P-PER, essential, non-essential, acidic, neutral, sulphur-containing, aromatic amino acids (g/100g crude protein) of four methods of domestic processing of *D. rotundata* (white yam).

Amino acid	Fried	Roasted	Boiled	Dried	Mean	SD	C.V (%)
P-PER	0.446	0.453	1.227	2.507	1.158	0.503	19.326
TNEAA	14.63	14.72	24.25	42.81	24.10	13.26	55.03
TEAA	13.64	13.85	27.24	48.66	25.85	16.49	63.78
TEAA(- His)	12.45	12.65	25.04	43.46	23.40	14.61	62.45
% TEAA (with His)	48.25	48.48	52.90	53.20	50.71	2.71	5.35
% TNEAA	51.75	51.52	47.10	46.80	49.29	2.71	5.50
TNAA	14.96	15.12	32.04	59.42	30.39	20.95	68.95
% TNAA	52.92	52.92	62.23	64.96	58.26	6.26	10.75
TAAA	6.06	6.09	9.09	13.09	8.58	3.32	38.73
% TAAA	21.44	21.32	17.65	14.31	18.68	3.40	18.20
TBAA	7.25	7.36	10.36	18.96	10.98	5.51	50.17
% TBAA	25.65	25.70	20.12	20.73	23.06	3.06	13.26
TSAA (cys+met)	1.37	1.40	3.40	10.75	4.23	4.45	105.18
% cys in TSAA	77.37	76.43	60.88	49.00	65.93	13.57	20.58
TArAA (phe+tyr)	1.99	2.02	6.30	9.40	4.93	3.60	73.14
% TArAA	7.04	7.07	12.24	10.28	9.16	2.55	27.90
Leu/Ile ratio	1.50	1.50	1.21	1.21	1.35	0.17	12.33
Leu-Ile difference	0.73	0.74	0.74	1.28	0.87	0.27	31.14
% Leu-Ile (difference)	19.89	20.00	9.61	9.33	14.71	6.05	41.13

TAA: Total amino acid, P-PER, TNEAA: Total non-essential amino acid, TEAA: Total essential amino acid, TEAA(- His): Total essential amino acid without histidine, % TEAA (with His): Percentage total essential amino acid with histidine, % TNEAA: Percentage total non-essential amino acid, TNAA: Total neutral amino acid, % TNAA: Percentage neutral amino acid, TAAA: Total acidic amino acid, % TAAA: Percentage total acidic amino acid, TBAA: Total basic amino acid, % TBAA: Percentage total basic amino acid, TSAA (cys+met): Total sulphur-containing amino acid, % cys in TSAA: Percentage cysteine in total sulphur-containing amino acid, TArAA (phe+tyr): Total aromatic amino acid, % TArAA: Percentage total aromatic amino acid, Leu/Ile ratio: Leucine-isoleucine ratio: Leu-Ile difference: Leucine-isoleucine difference.

Table 3. Amino acid scores of *D. rotundata* (white yam) subjected to different processing techniques

Amino acid	Provisional amino acid scoring pattern (g/100 g)	Amino acid scores			
		Fried	Roasted	Boiled	Dried
Ile	4.0	0.37	0.37	0.87	1.56
Leu	7.0	0.31	0.32	0.60	1.07
Lys	5.5	0.55	0.56	0.75	1.29
Met+Cys	3.5	0.39	0.40	0.97	3.07
Phe+Tyr	6.0	0.33	0.34	1.05	1.57
Thr	4.0	0.31	0.31	0.59	1.11
Trp	1.0				
Val	5.0	0.45	0.45	0.65	0.67
Total	36.0	2.71	2.75	5.48	10.34

as a high quality protein source and can be exploited to enhance protein quality of diet for adults and weaning/ complimentary feeding for children. The frying method was the most limiting in terms of values of the amino acid present after processing.

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