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SHORT COMMUNICATION

Amino acid composition of wild yam (*Dioscorea* spp.)

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Abstract

Tubers of wild yam (*Dioscorea alata, D. bulbifera* var. *vera, D. esculenta, D. oppositifolia* var. *oppositifolia, D. oppositifolia var. dukhumensis, D. pentaphylla var. pentaphylla, D. spicata, D. tomentosa* and *D. wallichi*) were analyzed for its amino acids composition. Asparatic acid and glutamic acid were found to be predominant among all the investigated *Dioscorea* species which ranged from 5.21 to 9.36 and 3.20 to 8.12 g/100 g protein respectively. The essential amino acids such as isoleucine, phenylalanine tyrosine, histidine, isoleucine and valine were found to be more or less higher than FAO/WHO (1991) requirement pattern. Thus, the present investigation demonstrated that the *Dioscorea* spp. can act as a good source of amino acid.

1. Introduction

Since time immemorial in the tropics and subtropics, roots and tubers are the most important food crops (Behera *et al*., 2009). In developing countries, the nutritional value of roots and tubers lie in their potential ability to provide one of the cheapest sources of dietary energy in the form of carbohydrates (Ugwu, 2009). The genus *Dioscorea* (Yam) belongs to the family *Dioscoreaceae*. It comprises 35-400 species (Caddick *et al*., 2002) and is distributed throughout the tropic and subtropic regions especially in West Africa, parts of Central America and the Caribbean, the Pacific islands and Southern Asia. *Dioscorea* has been suggested to have nutritional superiority when compared within the tropical root crops. They are reported as good sources of essential dietary nutrients (Bhandari *et al*., 2003; Shanthakumari *et al*., 2008; Maneenoon *et al*., 2008; Arinathan *et al*., 2009; Shajeela *et al*., 2011).

These wild yams make an important contribution to the diets of the tribal people of India. The tubers are found with a high amount of protein, good properties of essential amino acids and appeared as a fairly good source of many dietary minerals. However, their wide utilization is limited due to the presence of some toxic and anti-nutritional factors. In India, the cooked wild tubers are known to be consumed by the Palliyar and Kanikkar tribe (Arinathan *et al*., 2007; Shanthakumari *et al*., 2008; Shajeela *et al*., 2011) living in South-Eastern slope of Western Ghats, Tamilnadu. The information on the subject of the chemical and nutritional content of wild edible tuber is not enough (Babu *et al*., 1990; Nair and Nair, 1992; Rajyalakshmi and Geervani, 1994; Shanthakumari *et al*., 2008; Alozie *et al*., 2009; Anatharaman *et al*., 2009; Mohan and Kalidass, 2010; Shajeela *et al*., 2011). In spite of their importance as a food source, to the best of our knowledge, there are no published studies on the amino acid composition of wild yam tubers consumed by Palliyars and Kanikkars tribes, South-Eastern slopes of Western Ghats, Tamilnadu and also information on the amino acid composition of wild yam is scarce. The present study was therefore initiated to evaluate the amino acid profile of *Dioscorea* spp. for the first time.

2. Materials and methods

Plant sample: Nine samples of wild yam tubers (*D. alata, D. bulbifera* var. *vera, D. esculanta, D. oppositifolia, var. oppositifolia, D. oppositifolia var. dukhumensis, D. pentaphylla var. pentaphylla, D. spicata, D. tomentosa* and *D. wallichi*) grown in sandy loam soil consumed by the tribals Kanikkars/Palliyars were collected using multistage sampling technique in three consecutive rainy seasons during August and January 2016 from the South Eastern slopes of Western Ghats, Virudhunagar district, Madurai District, Kanyakumari district, Tirunelveli district in Tamilnadu. The plant specimens were identified with the help of local flora and authenticated by Botanical Survey of India (Southern Circle), Coimbatore.

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2.1 Amino acid analysis

The total protein was extracted by a method of Basha *et al*. (1976). By precipitation with cold 20% trichloroacetic acid (TCA) the extracted proteins were purified. In an evacuated sealed tube a protein sample of 30 mg was hydrolysed by 6N HCl (5mL), which was kept in a hot air oven at 100°C for 24 hrs. The sealed tube was broken. After the addition of de-ionized water, the acid was removed completely by repeated flash evaporation. Dilution was effected by means of citrate buffer pH 2.2 to such an extent that the solution contained 0.5 mg protein ml. The solution was passed through a Millipore filter (0.45iM) and by using an automated pre-column (OPA) the solution was derivatized with O-phthaldialdehyde. Amino acids were analysed by a reverse- phase HPLC (method L 7400, HITACHI, Japan) fitted with a Denali Cig 5 micron column (4.6 X 150 mm). The flow rate was 1 ml min with fluorescence detector. Using the Liddelle and Saville (1959) method, the cystine content of protein sample was obtained separately. For the determination of tryptophan content of proteins, aliquots containing known amounts of proteins were dispersed into glass ampoules together 1 ml 5M NaOH. The ampoules were flame sealed and incubated at 110°C for the 18 hrs. Using the method of Spies and Chambers, (1949) as modified by Rama Rao *et al*. (1974) the tryptophan contents of the alkaline hydrolysates were determined colorimetrically. The contents of the different amino acids were expressed as 100 g proteins and were compared with FAO / WHO (1991) reference pattern. The essential amino acid score was estimated as follows:

Essential amino acid score = grams amino acid in l00 g of total protein/ grams of essential amino acid in 100g of FAO, WHO (1991) reference pattern x 100.

3. Results and discussion

The amino acid composition of the *Dioscorea* species is summarized in Table 1. Glutamic and aspartic acid was the most abundant amino acid with values ranging from 5.21 to 9.36 and 3.20 to 8.12 g/100 g protein respectively. Among the species identified *D. oppositifolia* var. *dukhumensis* contain a higher amount of glutamic acid and similarly, *D. alata* contain a higher amount of aspartic acid. These values were comparable with *D. bulbifera, D. deltoidea, D. versicolor, D. triphylla* (Bhandari *et al*., 2003), *D. rotundata* (Ogunlade *et al*., 2011) and *D. dumenforum* (Alozie *et al*., 2009).

Aspartic and glutamic acids are dispensable amino acids since most of the dispensable amino acids derive their alpha-amino groups from glutamic acid which, in turn, has alpha ketoglutamic acid and ammonia as its precursors. Equally, aspartic acid is a precursor of such essential amino acid as asparagine, methionine, threonine and lysine (Berg *et al.,* 1992). In the presenting investigation of *Dioscorea* species the sulphur containing amino acid (cystine and methionine) was the most lining amino acid followed by tryptophan and lysine which

Table 1. Amino acid profile of *Dioscorea* species

Amino acid	*D. alata*	*D. bulbifera*	*D. esculenta*	*D.oppositifolia var. oppositifolia*	*D.oppositifolia var. dukhumensis*	*D. pentaphylla var. pentaphylla*	*D. spicosa*	*D. tomentosa*	*D.wallichi*
Glutamic acid	6.29	5.21	7.36	6.66	9.36	6.38	5.36	8.39	6.39
Asparatic acid	8.12	3.2	5.24	4.34	6.36	5.46	4.24	5.31	7.24
Serine	2.42	1.1	2.32	1.94	3.21	2.31	1.48	2.3	1.94
Therionine	2.63	2.41	1.96	2.74	3.04	2.38	2.76	3.21	2.14
Proline	2.14	3.1	3.33	2.66	3.66	3.36	3.04	3.16	1.74
Alanine	3.12	3.54	3.26	3.1	3.14	3.54	3.32	3.37	2.84
Glycine	3.65	2.3	2.84	2.56	2.36	2.94	2.76	2.58	2.04
Valine	2.65	2.49	3.3	3.08	2.98	3.2	2.96	3.56	2.94
Cystine	0.52	0.49	0.62	0.26	0.34	0.48	0.36	0.74	0.42
Methionine	1.02	0.84	0.76	0.94	0.76	1.14	0.92	0.84	0.92
Isoleucine	3.59	3.53	4.56	3.36	3.33	4.26	3.37	4.26	2.38
Leucine	3.62	2.04	2.36	2.78	2.56	3.02	3.21	2.94	3.14
Tyrosine	1.91	3.56	3.36	3.26	3.56	3.34	2.94	3.24	2.14
Phenylalanine	3.21	1.96	3.31	2.66	2.16	2.68	2.58	2.76	2.43
Lysine	2.12	1.34	2.34	2.24	2.94	2.14	2.38	2.36	1.24
Histidine	1.78	0.76	1.96	2.1	2.36	1.76	1.84	2.14	1.26
Tryptophan	0.82	0.96	1.01	1.04	0.84	0.98	1.02	0.96	1.12
Arginine	3.68	2.76	4.78	3.64	3.26	4.28	4.36	3.28	3.56

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agreed with the report of Osagie (1992).

As per the FAO/WHO (1991) requirement pattern the following eleven amino acid threonine, valine, cystine, methionine, isoleucine, leucine, tyrosine, phenylalanine, lysine, histidine and tryptophan have been registered as essential amino acids. Generally, in most of the present investigation, *Dioscorea* species deficiency of the essential amino acids via, threonine, valine, sulphur containing amino acids leucine, lysine and tryptophan are noted when compared with FAO/WHO (1991) requirement pattern (Table 2). In the presently investigated *Dioscorea* species the essential amino acids threonine, valine, methionine, isoleucine, leucine, phenylalanine, lysine and histidine are found to be lower when compared with early reports, the tubers of *Manihot utilissima* and *Dioscorea alata* (Ciacco and D' Appolonia, 1978) and *Dioscorea dermentrum* varieties (Alozie *et al*., 2009).

Table 3 shows the essential amino acid (EAA) score of *Dioscorea* species herbs studied. The results show that among the *Dioscorea* species tribes studied, *D. wallichi* was lowest the EAA score. The sulphur contain amino acids (Met + Cys) and lysine turned out to be the most limiting in all species with EAA score ranging between 44.0-63.2 and 21.37 to 50.69 respectively. Sulphur containing amino acids were the limiting one in all analysed wild yam tubers. These results agree well with the study results reported by Splittstoesser *et al*. (1973) and Bhandani *et al.* (2003). In general, the essential amino acids such as phenylalanine, tyrosine, histidine, isoleucine and valine in *Dioscorea* species tuber have a high essential amino acid score, which implies that essential amino acids present in these tubers have high biological value.

Amino acids are precursors for the synthesis of secondary metabolites such as alkaloids, which provide chemical defence for plants that confer beneficial

Table 2. Essential amino acid (EEA) composition of *Dioscorea* species compared to the FAO/WHO reference pattern

EAA[a]	FAO/WHO[b]	*D. alata*	*D. bulbifera*	*D. esculenta*	*D. oppositifolia var. oppositifolia*	*D. oppositifolia var. dukhumensis*	*D. pentaphylla var. pentaphylla*	*D. spicosa*	*D. tomentosa*	*D. wallichi*
Therionine	3.4	2.63	2.41	1.96	2.74	3.04	2.38	2.76	3.21	2.14
Valine	3.5	2.65	2.49	3.3	3.08	2.98	3.2	2.96	3.56	2.94
Methionine + Cystine	2.5	1.54	1.33	1.38	1.2	1.1	1.62	1.28	1.58	1.34
Phenyl alanine + Tyrosine	6.3	5.12	5.52	6.67	5.92	5.72	6.02	5.52	6	4.57
Leucine	6.6	3.62	2.04	2.36	2.78	2.56	3.02	3.21	2.94	3.14
Isoleucine	2.8	3.52	3.53	4.56	3.36	3.33	4.26	3.37	4.26	2.38
Lysine	5.8	2.12	1.34	2.34	2.24	2.94	2.14	2.38	2.36	1.24
Histidine	1.9	1.78	0.76	1.96	2.1	2.36	1.76	1.84	2.14	1.26
Tryptophan	1.1	0.82	0.96	1.01	1.04	0.84	0.98	1.02	0.96	1.12

a- Essential Amino Acids only are given; b – FAO/WHO 1991 reference pattern

Table 3. Essential amino acid (EEA) score of Dioscorea species

EAA[a]	*D. alata*	*D. bulbifera*	*D. esculenta*	*D. oppositifolia var. oppositifolia*	*D. oppositifolia var. dukhumensis*	*D. pentaphylla var. pentaphylla*	*D. spicosa*	*D. tomentosa*	*D. wallichi*
Therionine	77.35	70.88	57.65	80.58	89.41	70	81.2	94.41	62.94
Valine	75.71	71.14	94.29	88	85.14	91.42	84.6	101.7	84
Methionine + Cystine	61.6	53.2	55.2	48	44	64.6	51.2	63.2	53.6
Phenyl alanine + Lysine	81.26	87.61	105.87	93.96	90.79	95.55	87.6	95.23	72.53
Leucine	54.84	30.9	35.75	42.12	38.79	45.75	48.6	44.54	47.57
Isoleucine	128. 71	126.07	162.86	120	118.9	152.1	120	152.1	85
Lysine	36.55	23.1	40.38	38.62	50.69	36.89	41	40.68	21.37
Histidine	93.68	40	103.16	110.53	124.2	92.63	96.8	112.6	66.31
Tryptophan	74.54	87.27	91.81	94.54	76.36	89.09	92.7	87.27	101.8

a- FAO/WHO 1991 reference pattern

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physiological effects in consumers. Alkaloids give protection to plants from a variety of herbivores and some of them possess important pharmacological activity such as analgesic, antibacterial and antibiotic. In conclusion, the findings of this study suggest that the wild *Dioscorea* species are rich certain amino acid and non-essential amino acids. However, these *Dioscorea* species could be used as alternatives to cereals in human and animal nutrition or in livestock industries since they compare favourably in their amino acids compositions.

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