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Comparison of nutrient composition of wild *Dioscorea* species consumed by ethnic groups of Odisha in India with commercially cultivated roots and tubers

Charupriya T S[a], Geethanjali K[a], Kauser S[a], Ann Raeboline Lincy Eliazer Nelson[a], Kavitha Ravichandran[a,*], C Manjula[b] & Usha Antony[a]

[a]Centre for Food Technology, Department of Biotechnology, A. C. Tech. Campus, Anna University, Chennai 600 025, Tamil Nadu, India
[b]M. S. Swaminathan Research Foundation, Taramani, Chennai 600 113, Tamil Nadu, India

E-mail: kavisri9@gmail.com

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This study was carried out to analyze the nutrient composition of wild tubers belonging to *Dioscorea* genus of the Dioscoreaceae family consumed by the ethnic groups in the Jeypore District of Koraput region in Odisha, India. The collected tubers are significant storehouses of energy and nutrition and also, they are known to produce large quantities of energy in relatively less time than the other crops. We have selected six wild species of *Dioscorea* collected from Odisha among the twenty-six reported species of India, along with five locally available cultivated tuber varieties of different genera from Tamil Nadu markets for comparison. The objective of this study is to understand the major source of nutrition of the ethnic groups, who consume local plant varieties collected from the wild and also to compare them with that of commercially available cultivated varieties in the view of the prevailing biodiversity and the varied agro-climatic conditions in India.

Keywords: Cultivated varieties, *Dioscorea*, Ethnic groups, Nutrition profile, Tubers, Total dietary fiber

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India has a rich diverse gene pool of root and tuber crops. The world-wide area under the cultivation of roots and tubers is estimated to be 51 million hectares, of which one third is occupied by the Asia- Pacific[1]. The wild edible tuber species are an important source of food among the ethnic groups in India and rank third among the crops consumed after cereals and legumes[2]. The wild tuber species play a vital role as a dietary supplement, even in times of drought and famine[3]. These ethnic groups possess knowledge about the local flora and are well versed in the medicinal and food usages of those species. They consume a wide variety of roots and tubers, including *Dioscorea spp*. Though, more than six hundred species of *Dioscorea* exist[4], only ten species are widely cultivated and used commercially[5]. Very few wild species are edible and many have not been domesticated because of several reasons such as inferior quality of tuber, low yield, inaccessible deep-set tubers and transformable poisonous forms of the tuber. In India, twenty-six species of *Dioscorea* have been reported so far[6]. Thirteen *Dioscorea* species are found in Odisha alone[7], which are abundant in the regions of Similipal Biosphere Reserve (SBR) forest, Karlapat Sanctuary (Kalahandi), Gajpati, Ganjam, etc. Although the use of these species for the treatment of diseases by ethnic populations has been reported earlier[8], there is little information about their nutrient profile. Further, the difference, if any, in composition between cultivated and wild varieties of tubers is not well documented. Upon considering, the role of these species in providing health benefits and food security of the nation, it is important to study the composition of these foods.

Materials and Methods

Plant materials

The field scientists working with M S Swaminathan Research Foundation at Jeypore, Odisha between July and December 2013 collected six species of *Dioscorea* from Jeypore District as seen in Figure 1. These are wild varieties and were collected from dry uplands mainly during the rainy season, as they are highly seasonal. The cultivated tuber varieties were purchased from local markets in

*Corresponding author

Chennai during the months of December 2013 and January 2014.

Preparation of plant material for chemical analyses

The samples were taken to the Food Technology laboratory at Anna University, Chennai, cleaned of surface dirt, weighed and photographed. They were then peeled, sliced and dried using a tray dryer (Hotkings Instruments Company) at 60°C to obtain a moisture level below 10% for extended shelf life. The dried tubers were ground using an electric grinder to obtain powdered samples for easy handling and stored in the cold room (5°C) for further experimental analysis.

Proximate analysis

Moisture analysis was done using a hot air oven (SWASTIK) maintained at 105°C for 3 h. Total carbohydrates were determined by the difference. The total mineral content was the result of inorganic residues after ashing[9]. Crude protein was quantified by analysis of the nitrogen content in the sample by Kjeldahl method[10]. The total crude fat content was determined using a Soxhlet extractor[11].

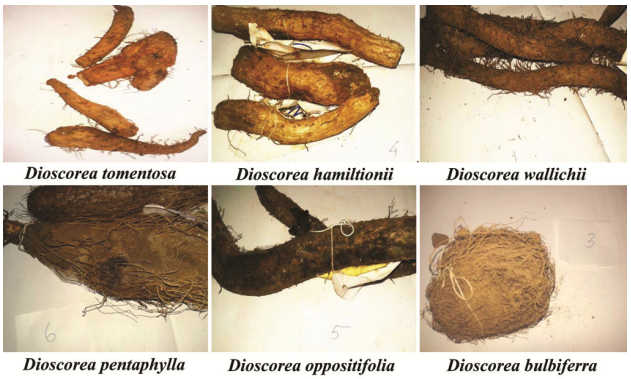

Fig. 1 — *Dioscorea* species consumed by ethnic groups of Odisha

Total dietary fiber

The enzymatic method was adopted to determine the soluble and insoluble fiber present in the samples as described by Asp *et al*., (1983). The summation of soluble and insoluble fiber gave the total dietary fiber present[12].

Results and Discussion

A comparative study was performed between the commercial and the wild tuber species, so as to clearly understand the difference in their nutrient composition (Table 1). The protein content of *Dioscorea oppositifolia* (9.13%) was found to be the highest among the wild varieties. This is appreciably high, quite uncommon in most of the tuber varieties. *D. hamiltonii* had the highest carbohydrates content accounting, 83.52%. The lowest recorded carbohydrate content value was 65.18% found in *D. wallichi*, which also had the least fat content (0.19%). Four out of the five tubers had less than 2% fat. *D. pentaphylla* had the highest ash / inorganic matter.

Both the wild and cultivated varieties analyzed were rich in insoluble fiber and had low levels of soluble fiber. However, the wild varieties were rich in total dietary fiber than the cultivated ones (Table 2). The highest amount of insoluble fiber was present in *D. bulbifera* (50.8%) which shows the fibrous nature of the sample. *D. oppositifolia* had 7.5% of soluble fiber, the highest amount among the wild varieties

Table 1 — Proximate composition of wild *Dioscorea* varieties and cultivated tuber varieties (g/100 g of the powdered sample)

Botanical Name	Moisture (%)	Carbohydrate (%)	Crude Protein (%)	Crude Fat (%)	Ash (%)
		Wild tubers			
D. wallichii Hook. f.	26.58 ± 0.27	65.18 ± 0.32	4.83 ± 0.02	0.19 ± 0.01	3.22 ± 0.02
D. oppositifolia L.	7.52 ± 0.23	79.64 ± 0.34	9.08 ± 0.07	0.54 ± 0.02	3.56 ± 0.09
D. bulbifera L.	11.84 ± 0.12	79.18 ± 0.33	5.69 ± 0.14	0.19 ± 0.01	3.1 ± 0.08
D. hamiltonii Hook. f.	9.25 ± 0.01	83.52 ± 0.15	3.20 ± 0.09	1.9 ± 0.02	2.13 ± 0.07
D. pentaphylla L.	7.07 ± 0.12	79.07 ± 0.159	8.39 ± 0.07	0.34 ± 0.04	5.13 ± 0.01
D. tomentosa J. Koenig ex Spreng.	11.59 ± 1.99	72.39 ± 2.05	7.49 ± 0.04	3.98 ± 0.05	4.55 ± 0.06
D. alata L.	10.30 ± 0.02	79.12 ± 0.49	6.31 ± 0.24	0.44 ± 0.02	3.83 ± 0.21
		Cultivated tubers			
Amorphophallus campanulatus Decene.	7.49 ± 0.07	77.05 ± 0.33	10.07 ± 0.08	1.77 ± 0.01	3.62 ± 0.33
Colocasia antiquorum Schott	9.89 ± 0.61	71.86 ± 0.34	9.94 ± 0.09	4.45 ± 0.05	3.86 ± 0.23
Typhonium trilobatum (L.) Schott	9.90 ± 0.38	74.37 ± 0.3	7.56 ± 0.18	3.46 ± 0.06	4.71 ± 0.04
Plectranthus rotundifolius (Poir.) Spreng.	6.05 ± 0.02	75.85 ± 0.49	13.18 ± 0.64	1.2 ± 0.04	3.72 ± 0.09

Mean ± S.D values of three independent estimations.

Table 2 — Total dietary fiber content of wild *Dioscorea* varieties and cultivated tuber varieties (g/ 100g of powdered sample)

Botanical name	Insoluble fiber	Soluble fiber	Total dietary fiber
	Wild tubers		
D. wallichii Hook.f.	42.58	0.5	43.08
D. oppositifolia L.	28.5	7.5	36
D. bulbifera L.	49.7	1.1	50.8
D. hamiltonii Hook.f.	33.3	3.9	37.2
D. pentaphylla L.	51.4	0.6	52
D. tomentosa J. Koenig ex Spreng.	49.2	0.3	49.5
D. alata L.	24.8	1.9	26.7
	Cultivated tubers		
Amorphophallus campanulatus Decene.	8.9	1.5	10.4
Colocasia antiquorum Schott	17.1	12.4	29.5
Typhonium trilobatum (L.) Schott	37.2	7.8	45
Plectranthus rotundifolius (Poir.) Spreng.	16.5	0.8	17.3

*Mean of two independent estimations.

while *C. antiquorum*, a cultivated variety, had 12.4% which was the highest among all the samples analyzed for dietary fiber. Also, four out of six wild varieties had more than 50% total dietary fiber while; the amount did not exceed 30% in the cultivated varieties except in *Typhonium trilobatum*. It is important to consume a good amount of insoluble fiber as it facilitates the formation of bulk, in turn, makes defecation easy avoiding constipation, gas formation and abdominal pain. The soluble fiber attenuates the absorption of sugar, reduces sugar response after eating, normalizes blood lipid levels and produces short-chain fatty acids as by-products with wide-ranging physiological activities on fermentation[14].

The nutrient analysis of the wild tubers collected from Jeypore region, Odisha, India revealed that they are an extremely valuable source of nutrients almost in the right proportions to satisfy the requirements of the people. A high amount of carbohydrates in the wild tubers in the range of 53 to 75 g/100 g of the powdered sample shows that they could be an invaluable source of energy. Two of the wild tubers *D. pentaphylla* and *D. oppositifolia* are significant sources of protein (8.39±0.07 and 9.08±0.07%). The values are comparable with the commonly consumed cereals, which is also an added advantage. The quality of protein in terms of amino acid composition needs to be estimated further. The fat content of most of the wild tuber samples was less than 2% except for *D. tomentosa.* It is apparent that the consumption of the wild varieties of tubers provides ethnic groups an access to nutrient-rich food, as this study shows that the wild tubers relatively have better nutrient content when compared with the cultivated varieties.

Conclusion

From this research, it is evident that the consumption of wild *Dioscorea* sp. plays a vital role in the diet of the ethnic groups and so such species need to be preserved, to avoid them becoming extinct. This nutritional profile of both wild and cultivated tubers proves that they can be recommended for health-conscious people.

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Conflict of interest

Author(s) declare that they have no conflict of interest.

Authors' contributions

CTS, GK and KS– Investigation; Writing - Original Draft; ARLEN– Writing - Review & Editing; KR – Conceptualization; Methodology; Validation; Supervision; Writing - Review & Editing; CM– Conceptualization; Validation; Resources; and UA– Conceptualization; Methodology; Validation; Resources; Supervision; Writing - Review & Editing

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