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Biochemical Quantification of Diosgenin and Ascorbic Acid from the Tubers of Different *Dioscorea* Species Found in Orissa

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Abstract: A study was under taken to quantify and estimate the diosgenin and ascorbic acid content from fresh tubers of different species of *Dioscorea* found in different parts of Orissa. The biochemical analysis revealed that diosgenin content was the highest in *D. bulbifera* (1383 mg) followed by *D. hispida* (825 mg) and these two differed significantly. Similarly *D. tomentosa* and *D. oppositifolia* were at par. All the right twining species except *D. oppositifolia* were at par and the lowest quantity was found in *D. glabra* (95 mg) per 100 gm of fresh tuber. Similarly the ascorbic acid (Vitamin 'C') content was significantly the highest in *D. tomentosa* (19.96 mg) followed by *D. kalkapershadii* (17.41 mg) *D. glabra* and *D. tomentosa* which were at par with each other and the lowest quantity was found in *D. esculenta* (8.46 mg) which was significantly the lowest as compared to the rest of the species.

Key words: Dioscorea % Diosgenin % Ascorbic acid % Gravimetric method % Dry matter % Starch

INTRODUCTION

Out of six hundred species of *Dioscorea*, so far, reported in the world only ten species are in commercial cultivation [1]. However, some species which are edible, yet, have not been domesticated because of several reasons like inferior quality of tuber, low yield, inaccessible deepest tubers and transformable poisonous forms of tuber. In India so far twenty-six species of *Dioscorea* have been reported Burkill [2]. At present thirteen *Dioscorea* species are available in Orissa. Out of them two species are cultivated and rest eleven are wild. A study conducted by NISWASS [3] revealed that six *Dioscorea* species are edible in Tumudibandha area of Phulbani district. Sing and Arora [4] reported that several wild yams are used as food items in the Eastern Ghat region. All the thirteen *Dioscorea* species available in the state are used as food item as when required [5,6].

Out of thirteen *Dioscorea* species, *D. alata, D. oppositifolia, D. pubera, D. glabra, D. wallichii, D. hamiltonii, D. belophylla* twine to right so placed under section *Enantiophyllum.* Rest six species are left twiner. Among them, the compound leave *Dioscorea* i.e. *D. pentaphylla, D. hispida, D. kalkapershadii* are under the section Lasiophyton. The air yam, *D. bulbifera* is under section opsophyton and *D. esculenta*, the cultivated species is under the section cambilium which produces a cluster of small tuber

MATERIALS AND METHODS

Fresh tubers of thirteen *Dioscorea* species were collected from the experimental garden of P.G. Dept. of Botany Utkal University. The tubers were cleaned properly by removing their hairy root and washed 4-5 times through tap water and then through distilled water. After cleaning, 100 gm of edible portion of tuber from each species were taken as sample material for estimation of diosgenin and ascorbic acid content both in tubers stored for six months and fresh tubers.

Estimation of Diosgenin: Diosgenin was estimated by gravimetric method. Exactly 10 gms of powered dry matter was made into a slurry with 2.5 N, HC1 for 2 h [7-9]. The hydrolyzed material washed with distilled water and dried. Extraction was made for 8 h with petroleum ether at 40-60°C in a Soxhlet extractor. The solvent with diosgenin was concentrated, chilled in ice and filtered and dried in an oven at 100°C for 2 h and value was expressed in mgs present in 100 gms of edible matter. Crop of diosgenin, if

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any was added to the first crop and the pooled diosgenin was weighed after drying it in an oven at 60°C for 4 h [10].

Estimation of Vitamin 'C' Content: Vitamin 'C' content was analyzed by following iodine titration method by taking 0.88 mg ascorbic acid equivalent for each ml of iodine solution. The amount of ascorbic acid was calculated /100 gms edible portion. The vitamin C content was calculated in fresh tuber and also in adequately boiled tuber. The vitamin C was also calculated in tubers stored for six months [11].

Estimation of Starch: Starch was calculated from a representative 2.5 gms of powered dry tuber following the standard method and titrating with Fehling's solution A + B. The percent of starch was calculated by the following formula. [12-14].

$$\frac{.05 \times 250 \times 100 \times 0.9}{\text{Burate reading} \times 2.5}$$

(10 cc of Fehlings (A + B) = 0.05 gm glucose)

Estimation of Dry Matter: Dry matter in tuber was calculated by taking 100 gms of freshly harvested tuber from a representative sample of tuber and drying the sample at 40°C till a constant weight was obtained and the value was expressed in percentage [15].

Yield t/ha: Yield in tones per hectare was calculated on the basis of plot yield.

RESULTS AND DISCUSSION

From the experimental analysis it is found that diosgenin content was same both in fresh tuber and tuber stored for six months in different *Dioscorea* species. Among different species diosgenin content was the highest in *D. bulbifera* (1383 mg) followed by *D. hispida* (825 mg) and these two differed significantly [16]. Similarly *D. tomentosa* and *D. oppositifolia* were at par. All the right twining species except *D. oppositifolia* were at par and the lowest quantity was found in *D. glabra* (95 mg).

Similarly Vitamin 'C' was significantly the highest in *D. tomentosa* (19.96 mg) followed by *D. kalkapershadii* (17.41 mg). *D. glabra* and *D. tomentosa* which were at par with each other and the lowest quantity was found in *D. esculenta* (8.46 mg) which was significantly the lowest as compared to the rest of the species [17,18]. After boiling, the extent of vitamin 'C' loss was not very high and it was the highest in *D. tomentosa* (15.41 mg). The lesser quantity was found in *D. esculenta* (4.46 mg) followed by *D. hispida* (5.58 mg) (Table 1).

Data on loss of vitamin 'C' during storage revealed that the highest amount of vitamin 'C' was available with *D. bulbifera* (8.27 mg) which was significantly high from all others followed by *D. glabra* (7.48 mg). However, significant difference was also observed between

Table 1: Vitamin 'C' content in tubers stored for six months and diosgenin content in tubers of different *Dioscorea* species

		Vitamin 'C' after six months storage (mg/100 mg)			Diosgenin content (mg/100 gm)		
Sl. No.	Species	I	II	Pooled	I	II	Pooled
1	*D.oppositifllia*	4.733	4.900	4.817	750.000	566.667	958.333
2	*D. hamiltonii*	3.967	4.300	4.133	138.333	139.333	138.833
3	*D.pubera*	7.200	7.167	7.183	168.333	186.667	177.500
4	*D.glabra*	7.133	7.833	7.483	85.00	105.000	95.000
5	*D.belophlla*	7.367	7.233	7.300	115.000	126.667	120.833
6	*D.wallichii*	6.100	6.067	6.083	133.333	125.000	129.167
7	*D.tomentosa*	6.467	6.600	6.533	575.000	616.667	595.833
8	*D.pentaphylla*	5.400	5.433	5.417	761.667	875.000	818.333
9	*D.kalkapershadii*	4.100	4.700	4.400	650.000	666.667	658.333
10	*D. hispida*	7.500	7.367	7.433	866.667	783.333	825.000
11	*D.bulbifera*	8.233	8.200	8.217	1350.000	1416.667	1383.333
12	*D. esculenta*	4.333	4.000	4.167	516.667	550.000	533.333
'F' test		Sig. **	Sig. **	Sig. **	Sig.**	Sig. **	Sig. **
C.D. (0.05)		0.630	1.009	0.568	166.46	171.158	117.55

Table 3:Yield/ ha, total dry matter/ ha, anticipated starch yield (t/ha) and diosgenin yield (kg/ha) (DM-Dry matter)

Sl. No.	Name of the species	Inclination of leaf (degree)	Yield (t/ha)	Total DM (t/ha)	Starch yield (t/ha)	Diosgenin (Kg/ha)
1	*D. oppositifolia*	30	9.20	2.081	1.33	13.62
2	*D. hamiltonii*	15	6.91	2.351	1.93	32.65
3	*D.pubera*	25	6.82	1.896	1.41	33.65
4	*D.glabra*	10	10.06	2.575	1.88	24.46
5	*D.belophylla*	20	6.90	1.933	1.51	28.35
6	*D.wallichi*	20	9.44	2.881	2.23	37.27
7	*D.tomentosa*	35	10.13	2.898	2.05	172.00
8	*D.kalkapershadii*	30	10.17	3.134	2.19	256.00
9	*D.pentaphylla*	35	9.51	2.862	2.08	1.88
10	*D. hispida*	40	9.76	2.851	2.32	2.35
11	*D.bulbifera*	35	15.66	4.823	3.60	6.67
12	*D.esculenta*	20	9.76	2.449	17.38	1.31

these two (Table 1 and 2). The lowest quantity was available in *D. hamiltonii* (4.13 mg) followed by *D. esculenta* and *D. kalkapershadii* and *D. oppositifolia*. These three species were at par with each other [19].

CONCLUSION

Tubers of many *Dioscorea* are considered as good source of Vitamin 'C' [20]. Coursey and Aidoo [21] studied the ascorbic acid content in three species of *Dioscorea* and reported that the Vitamin 'C' content is 6.5-11 mg/100 gm edible portion of the tuber. In the present study Vitamin 'C' content is in-between 9.4 mg to 19.96 mg/100 gm of the fresh tuber.The highest amount of vitamin 'C' is present in fresh tubers of *D. tomentosa* (19.96 mg) and the lowest in *D. hamiltonii* (9.43 mg). Nearly 25 to 50% of vitamin 'C' is lost due to peeling and boiling of the tuber. Loss was the highest in *D. hispida* and *D. esculenta* and minimum in *D. tomentosa* and *D. kalkapershadii*. A good quantity of vitamin 'C' is lost from tuber during storage for six months. The loss was up to 70% in *D. tomentosa*, 50% in *D. esculenta* and nearly 25% in *D. bulbifera*. The loss was more in thin or slender tubers because maximum vitamin 'C' is present beneath the skin [21,22]. As compared to other tuber crops *Dioscorea* evaluated here contain appreciable amount of Vitamin 'C' to help in human nutrition. Some of the *Dioscorea* are important source of diosgenin [23]. Yams with high diosgenin content are grown for steroid preparation. Out of twenty six Dioscorea available in India *D. prazeri* and *D.deltoidea* are used to manufacture diosgenin [24]. Edible yams do not contribute for steroid production and the present study revealed that diosgenin content is very low in right twining species as compared to left twining species.The highest amount of diosgenin was observed in *D. bulbifera* (1.383 %) followed by *D. hispida* (0.825%) and *D. pentaphylla* (0.818%). Among right twining species *D. oppositifolia* contains the highest amount of diosgenin i.e. 0.658% and among others *D. alata* has the lowest amount of diogenin i.e. 0.095% ascended by *D. belophylla* (0.12%), *D. wallichii* (0.129%). All compound leaved *Dioscorea* contain higher amount of diosgenin. Except *D. glabra* other surface spreading species have higher amount of diosgenin. It is observed that *Dioscorea* species with higher diosgenin are less tastier. However, diosgenin content varies from species to species. Kunjithapadm [25] reported that diosgenin occurs as the rhamnorhamno-glucoside, dioscin in the rhizomes of several species of *Dioscorea* such as *D. deltoidea*, *D. floribunda*, *D. composita* and *D. orazeri*. Some of them contain up to 5% diosgenin in the dry matter. However, non of the species tried in this experiment is commercially viable for diogsgenin production (Table 1 and 2). The minimum per cent diosgenin in dry matter should be above 3% to use them as a source of diosgenin [26-28].

Evaluation of all wild *Dioscorea* species of Orissa revealed that productivity is highest in *D.bulbifera* 15.66t/ha (Table 3). Dry matter (4.8 t/ha) and starch (3.60 t/ha), production are also the highest in this species. However, anticipated diosgenin production is the highest in D. pentaphylla(256 kg/ha) followed by *D. tomentosa* (172 kg/ha). But the edible quality and market acceptability are high in *D. oppositifolia*. Presently, in some parts of the state tubers of *D. oppositifolia* are collected from jungles for marketing (Table 3). This species can be cultivated in field scale [29-31]. The quality of *D. hamiltonnii* is excellent. But search may be made to locate shallow seated types and effort may be made to grow bulbils. Among other wild species *D. hispida* possesses good plant characters like limited vegetative growth, quick bulking, early maturing, shallow seated tuber, good colour and easy harvesting for an ideal yam cultivation. But the species is highly poisonous, *D.dumetorum*, an African counter part of *D. hispida* has several nonpoisonous forms. Hence extensive collection

and evaluation may be made to locate nontoxic forms for the agronomic quality and commercial viability of the concerned species [32,33].

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