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ORIGINAL ARTICLE **OPEN ACCESS**

Evaluation of Percent antioxidant and related secondary metabolite compositions of *Dioscorea alata and D. rotundata* cultivars

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ABSTRACT
Dioscorea alata and D. rotunda cultivars harvested from All India Coordinated Research Project on Tuber Crops (AICRPT), W.B. at full maturity are analyzed for its proximate compositions viz. phenol, vitamin C, β-carotene and antioxidant activity using standard methods. The species D. alata shows higher antioxidant activity than D. rotundata. The higher antioxidant percentage of D. alata correlates with the presence of their higher phenol, vitamin C and flavonoid (β-carotene) content. Within the species, the cultivars BCDA-5, BCDA-6 of D. alata, and I-146 of D. rotundata shows higher antioxidant percentage which also correlates with their higher phenol, vitamin C and β-carotene contents.
Key words: Dioscoreaceae; vitamin C; β-carotene; phenolic contents; proximate quantification

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INTRODUCTION

Yam constitutes a staple food crop for over 100 million people in Africa, Latin America, and Asia [1]. Yams are the members of the genus *Dioscorea,* representing the largest genus in the family Dioscoreaceae, containing 650 accepted species names with 728 synonyms [2]. According to "The Plant List" 40 species with one synonym from the family were reported from India viz.

1. *Dioscorea alata* L.,
2. *D. arachidna* Prain & Burkill,
3. *D. bellophylla* (Prain) Voigt & Haines,
4. *D. bulbifera* L. [synonym of *D. rogerrsei* Prain & Burkill],
5. *D. cumingii* Prain & Burkill,
6. *D. decipiens* Hook.f.,
7. *D. deltoidea* - vulnerable in Assam, Sikkim [3]
8. *D. wattii* Prain & Burkill, (endemic to Arunachal Pradesh[3]; Jammu & Kashmir [4]; rare & threatened in Himachal Pradesh [5]
9. *D. esculenta* (Lour.)Burkill,
10. *D. glabra* Roxb.,
11. *D. hamiltonii* Hook.f.,
12. *D. hispida* Dennst.,
13. *D. intermedia* Thwaites.,
14. *D. japonica* Thunb.,
15. *D. kalkapershadii* Prain & Burkill - endemic to Tamil Nadu [6],
16. *D. kamoonensis* Kunth,
17. *D. lepcharum* Prain & Burkill,
18. *D. listeri* Prain & Burkill,
19. *D. melanophyma* Prain & Burkill,

20. *D. nummularia* Lam.,
21. *D. oppositifolia* L.,
22. *D. pentaphylla* L.,
23. *D. prazeri* Prain & Burkill,
24. *D. pubera* Blume,
25. *D. pyrifolia* Kunth,
26. *D. rogerrsei* Prain & Burkill
27. *D. scortechinii* Prain & Burkill,
28. *D. spicata* Roth – rare and threaten to Chhattisgarh [7],
29. *D. tomentosa* J. Koenig. ex Spreng,
30. *D. trinervia* Roxb. Ex Prain & Burkill,
31. *D. vexans* Prain & Burkill,
32. *D. wallichii* Hook.f.,
33. *D. wightii* Prain & Burkill
34. *D. brandisii* Prain & Burkill,
35. *D. colletii* Hook.f.,
36. *D. daunea* Prain & Burkill,
37. *D. laurifolia* Wallich ex Hook.f.,
38. *D. orbiculata* Hook.f.,
39. *D. polystachya* Turcz.
40. *D. rotundata*

Species no. (1–32) were reported by Karthikeyan *et al.*8*,* Species no. 33 by Goswami *et al.* [9], Species no. 34 in the Flora of China [10] and Species no. (35-39) by Saikia *et al.* [11].

About 28 species and 25 varieties has been reported from NE region mainly in the Garo hills [12]. The most popular cultivated yam in the world are *D. rotundata* (white guinea yam), *D. alata* (yellow yam), *D. bulbifera* (aerial yam), *D. esculent* (Chinese yam) and *D. dumetorum* (trifoliate yam). However, only a few species are cultivated as food crops such as *D. rotundata* (white yam) and *D. alata* (water yam) as the most common cultivated species. Yam is an excellent source of starch [13], protein [14], carbohydrate, energy, vitamins (especially vitamin C), minerals and protein (much higher than the popular tuber cassava [15]. Apart from food, yams are also sources of pharmaceutical compounds [16]. Many bioactive compounds, individually or combined, possess high antioxidant capacity. Antioxidants are the substances that can scavenge free radicals. These radicals have an unpaired electron in the outer orbit that results in their instability and reactiveness. The human body possesses defense mechanisms against free radical-induced damage, such as "oxidative stress", but cumulative oxidative damage leads to various diseases. Additionally, some dietary antioxidants may help to decrease the incidence of oxidative stress-induced damage. It is supposed that there is an association between antioxidant-rich diets and the reduction of oxidative damage to DNA. Therefore, antioxidants could be a prevention of some crucial points in carcinoma genesis [17-19]. There is a relationship between the antioxidant activity levels and the total phenolic and flavonoid contents of plant extracts (20-22). Ascorbic acid is an essential water-soluble vitamin with excellent reducing properties, well known for its high antioxidant activity due to the neutralization of free radicals and other reactive oxygen species, formed via cell metabolism, which is associated with several forms of tissue damage and diseases. It is also considered as the nutrient quality indicator during processing and storage as it is known that if ascorbic acid is well-retained, the other nutrients could stay in foods with minimum changes and losses, too. The loss in ascorbic acid content is also cultivar-dependent 23. However, this vitamin is a great reducing agent with high antioxidant activity 24; in many studies, it was evaluated to contribute only a small amount (up to 10%) to the total antioxidant capacity of the fruits (25-28). The objective of this study is to evaluate the antioxidant percentage and the phytochemical compositions like phenol, vitamin C, and flavonoids that help in contributing the bioactive compounds and the antioxidant activity.

MATERIALS AND METHODS

Tubers of *Dioscorea alata and D. rotunda* cultivars harvested at full maturity i.e. nine months after planting, from AICRPT, Mondouri field, Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal, India were collected for the study. Samples consisted of 12 cultivars, 3 [I-212, I-146 and T3(1)] from *D. rotundata* and 9 (BCDA-1, BCDA-2, BCDA-3, BCDA-4, BCDA-5, BCDA-6, BCDA-7, BCDA-8 and BCDA-9) from *D. alata* (Fig. 1). Proximate quantification of samples for phenol using Folin-Ciocalteau reagent at 650 nm; vitamin C by titration method using 2, 6 dichlorophenol indophenol solution; β-

carotene at 452 nm 29 and antioxidant activity by DPPH (1, 1-diphenyl-2-picrylhydrazyl radical) method 30 were carried out. Statistical analysis was done completely randomized design (CRD) and by excel.

RESULTS AND DISSCUTION

Phenol

It was observed that the phenol content of the cultivar BCDA-5 recorded the highest (77.2 mg/ 100 g) while BCDA-9 the least (52.3 mg/ 100 g) and falls within the range of the findings of Ezeocha and Ojimelukwe [31] i.e.191 mg/100g and 68 mg/100g for *D. alata* as in the method of Shajeela *et al*.[32] The phenolic contents of yam are the substrate responsible for the browning reaction, which occurs when the tubers are cut or damaged. So, high level of phenolics showed fast and strong browning.

Vitamin C

The cultivars vary significantly in Vitamin C content, expressed in mg/ 100 g and was highest in cultivars BCDA-4 (9.4) and the least in T3(1) (6.5) which fall within the range of 4 – 18 mg/ 100 g as reported by Osagie [33] but lower than the range of vitamin C content in yam tubers as reported by Udensi *et al.* [34] which is 16.7-28.4 mg/ 100 g, on fresh weight basis. Natural vitamin C levels of most yam varieties are between 6.5 and 11 mg/ 100 g of the tuber, but some are found to contain as small as 4.5 mg and as much as 21.5 mg/ 100 g.

β-carotene

β-carotene was found to be low in all the yam cultivars, though low it varies significantly and showed highest in BCDA- 5 (0.52 mg/ 100 g) and the least in BCDA-4 (0.22 mg/ 100 g). β-carotene in yam ranges from 0.0-10.0 mg/ 100 g. as reported by Osagie [33].

Antioxidant Activity

Antioxidant activity was observed very high in all the yam cultivars under study. BCDA-5 recorded the highest (85.7%) followed by BCDA-6 (84.1%) and BCDA-8 (83.2%) while BCDA-9 records the least (78.6%). These values recorded were almost similar to the findings of Yi *et al*. [35] who worked on Taiwan yam variety. The high antioxidant activity of yam (*Dioscorea* sp.) extracts has been reported by Kaur and Kapoor [36], who states that yam has more than 70% antioxidant activity and are placed in the vegetable group with a high antioxidant activity. The importance of antioxidant constituents of plant materials in maintaining health and in protecting against coronary heart diseases and cancer is raising interest among scientist, food manufacturers and consumers as the trend of the future are moving towards functional food with specific health effects [37]. So, the presence of a high antioxidant in yam tubers is desirable. Among the cultivars, the cultivars with the highest and lowest antioxidant percentages show correspondingly higher and lower phenol and β-carotene contents viz. [cultivar (antioxidant%): phenol: β-carotene (mg/100) = BCDA-5 (85.7): 77.2: 0.52, BCDA-6 (84.1): 72.5: 0.42, BCDA-8: (83.2): 66.8: 0.35), BCDA-9 (78.6): 52.3: 0.33]. The amount of vitamin C content was higher in the cultivars having higher antioxidant percentages such as BCDA-6 antioxidant (84.1%) showing vitamin C 9.2 mg/100g while cultivar (I-212) having lower vitamin C (7.4 mg/100g) shows lower antioxidant activity (78.9%). However, cultivar (I-146) having lower vitamin C content (6.8 mg/100g) shows a higher antioxidant activity of 80.4%, than cultivar I-212. Therefore, the antioxidant percentage of the cultivars seems to more correlated to the phenol and β-carotene content and less dependent on the ascorbic acid content of the cultivars.

Table 1: Antioxidant activity in percentage of the 12 cultivars and quantities of the related metab

Cultivars	Phenol (mg/100g)	Vit C (mg/100g)	β-Caro. (mg/100g)	Antioxidant (%)
I-212	53.2	7.4	0.32	78.9
I-146	58.3	6.8	0.41	80.4
T-3(1)	55.5	6.5	0.51	79.1
BCDA-1	64.6	8.9	0.23	81.8
BCDA-2	66.3	9.3	0.24	82.6
BCDA-3	54.7	8.6	0.31	78.8
BCDA-4	56.5	9.4	0.22	79.3
BCDA-5	77.2	8.5	0.52	85.7
BCDA-6	72.5	9.2	0.42	84.1
BCDA-7	57.4	8.8	0.24	79.8
BCDA-8	66.8	7.6	0.35	83.2
BCDA-9	52.3	8.4	0.35	78.6
SEm (±)	0.981	0.125	0.006	1.233
CD (5%)	2.864	0.366	0.016	3.598

CONCLUSION

The statistics of the obtained data shows that all the secondary metabolites show positive correlation with the antioxidant production. The highest correlation of antioxidant production was shown by phenol content with a value of $r = 0.99$, $p < .0001$ and by β-carotene shows a weak correlation of $r = 0.33$ and weakest by vit. C with a $r = 0.28$. Proximate quantification of samples for phenol, vitamin C, β-carotene and antioxidant shows a complete randomized design with a significant difference lesser than 0.05 between the means of the proximate compositions within the cultivars. Antioxidant activities were higher in *D. alata* cultivars viz. BCDA-5 (85.7%), BCDA-6 (84.1%), BCDA-8 (83.2%), BCDA-2 (82.6%), BCDA-1 (81.8%) followed by *D. rotundata* cultivar I-146 (80.4%). Therefore, *D. alata* BCDA-5, BCDA-6 cultivars could be commercially exploited and used as a health benefited food.

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