Biochemical Quantification of protein , Fat, Starch, Crude fibre, Ash and Dry matter content in different Collection of Greater Yam (*Dioscorea alata* L.) found in Orissa

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Abstract

A study was under taken to quantify the biochemical composition of protein, fat, starch, crude fiber, ash and dry matter in 22 different collections (C1 to C22) of *Dioscorea alata* fresh tubers. In the present study C-18 was found with highest dry matter (33.33%) where as lowest in C-3 (24.91%). The Average dry matter was highest in intermediate shape groups and collections with white flesh tubers. Starch percentage is highest in C-20 (82.51%) followed by C-1, C-7, C-3, C-22 and lowest is estimated in C-15 (78.36%). The highest protein content in dry matter of tuber was observed with C-1 (9.67%) and the lowest protein content was observed with C-13 (7.31%). The lowest fat content, however, was observed in C-11 (0.67%) and highest value was with C-2 (1.24%). C-1 had the lowest ash content of 1.89 % whereas C-15 had the highest value of 7.08 %. However, the ash content was towards the higher side in the intermediate group (5.85%). The crude fiber range was higher in the intermediate group i.e. out of five collections four were having more than 2% crude fiber. From the present investigation it is concluded that different collections of *D. alata* vary greatly for their dry matter, starch, protein, fat, ash and crude fiber content depending on different collection groups and the geographical regions. [Nature and Science. 2009; 7(7):24-32]. (ISSN: 1545-0740).

Keywords: Ash, Crude fiber, *Dioscorea alata*, Dry matter, Greater Yam

Introduction

Roots and tubers are the most important food crops since time immemorial in the tropics and subtropics. Theses crops are associated with the human existence, survival, and their socio-economic history. The Indo-Burma region is the centre of origin of taro and Asiatic edible yams. The two hot spots of global biodiversity viz. North Eastern Himalayas and Western Ghats are particularly rich in wild relatives of tropical root and tuber crops (Burkill, 1960). Root crops occupy nearly 50 million hectares of arable land and account for a global production of 560 million tones. Nigeria alone accounts for 70% of the total yam production. In terms of the productivity and gross return, yam ranks second among all the roots and grain producing food crops (FAO, 2004). It also ranks second in dry matter and energy production per hectare (IITA, 2004).Yams belong to the genus *Dioscorea* of family *Dioscoreaceae* an important members of the oldest monocot. More than 600 species have been reported under this genus (Coursey, 1976). Out of many species of *Dioscorea* only ten species have been domesticated and commercially cultivated. In India so far 26 species of *Dioscorea* have been reported (Panneerselvam , 2007). Among the *Dioscoreas*, *D.alata* is the leading species grown globally as well as all over Orissa. It is highly polymorphic in relation to shape and colour of the tuber. Basing on the shape of the tuber and colour of the cortex or flesh , some selections were made from the collections of *D.alata* on different parts of the state .Out of the collections only 22 cultivars were included in the present study. Detail information of these 22 cultivars of *D. alata* is presented in Table-1&2.

Yams are valuable source of carbohydrates, fibers, and low level fats, which makes them a good dietary source and could be eaten as boiled yam , fufu or fried in oil (Osman ,1990). Several species of Yams also have medicinal properties and the tuber is said to contain some pharmacologically active substances including dioscorine, saponin and sapogenin (Jaleel et al., 2007). The objective of the present study therefore, was to examine the biochemical composition of dry matter, starch, protein, ash, crude fiber and fat content of different collections of *D.alata* found in different parts of Orissa and the selection of the cultivated variety for higher crop production for the yam cultivars of the state (Niswass, 1985).

Materials and Methods

Highly polymorphic *D.alata* tubers were collected from different parts of Orissa during the year 2005-06. Basing on the shape of the tubers and colour of the cortex or flesh, some selections were made .Out of the collections only 22 cultivars were included in the present study. All the 22 collections were grouped under three shape types namely (1) Pyramidal (2) Cylindrical (3) Intermediate (those in between pyramidal and cylindrical types) and four flesh colours namely (1) White, (2) Cream, (3) Yellowish pink (4) Violet. Detail information of these 22 cultivars of *D.alata* are presented in Table-1&2.

Table.1. *D. alata* L., Collections based on shape of the tuber

Sl. No	Shape of tuber	Total collection	Code number of different *D.alata* collections
1	Pyramidal shape	9	C1, C7, C18, C19, C11, C12, C13, C3, C20
2	Intermediate shape	5	C5, C6, C2, C15, C21
3	Cylindrical shape	8	C4, C14, C8, C16, C17,C 9, C10, C22

Table.2 *D. alata* L., Collections based on colour of the tuber

Sl .No	Colour of flesh	Total collection	Code number of different *D. alata* collections
1	White	11	C1, C7, C18, C19, C5, C6, C4, C14, C8, C16, C17.
2	Cream	4	C11, C2, C9, C10
3	Yellowish pink	3	C12, C13, C15.
4	Violet or pink	4	C3, C20, C21, C22

These 22 collections (C1 to C22) were grown in the experimental garden, P.G. Deptt. of Botany, Utkal University as per the standard agronomic practices with stacking and non stacking system and harvesting of the tuber was done after all the vines dried and it was done around 300 days after planting. There were three replications and in each replication 22 treatments were randomly distributed. In each treatment 16 plants were grown besides border rows. Observations were recorded in four randomly selected plants as per Bradbury and Holloway (1988) methods.

Dry matter: Dry matter in tuber was calculated by taking 100 gm of freshly harvested tuber from a representative sample of tuber and drying the sample at 40^0C till a constant weight was obtained and the value was expressed in percentage (Cozzolino and Labandera, 2002; Egesi et al., 2003).

Starch: Starch was estimated by following the anthrone reagent method of Hodge and Hofreiter (1962) and the percent of starch was calculated by Thayumanavan and Sadasivam (1984) method.

Protein: Protein content of the yam tuber was estimated on the basis of nitrogen content of the tubers and on dry matter basis. The micro Kjeldhals distillation method as per Jackson (1967) was used for such estimation. The protein content was estimated by 'N' percent x 6.25 considering that the protein contains 16 percent nitrogen (Balogun and Fetuga**,** 1986; Bressani, 1994; Gary, 1986; Amoo 1998; Adeyeye, 1995).

Fat: Fat content was estimated as per the standard procedure indicated in methods of analysis of AOAC (1990) and the value was expressed in percentage (Vogel, 1980; Panneerselvam, 2007).

Crude fiber: Crude fiber was estimated as per standard procedure stated in methods of analysis AOAC (1990) and value was expressed in percentage.
Ash: Ash was calculated on dry matter basis of tuber as per the standard procedure specified in methods of analysis of AOAC (1990).The value was expressed in percentage.

Result and Discussion

Dry matter in tubers: During the studies significant difference was observed for the dry matter content in tubers of different collections of *D. alata* in both the years of observations and also in the pooled analysis. The dry matter was highest in the tubers of C-18 (33.33%) followed by C-13 (32.75%) and no significant difference was observed in these two cultivars. The lowest dry matter content was observed in C-3 (24.91%) which was significantly lowest as compared to the rest of the collections. The mean value was 29.19%, 30.43% and 28.09% respectively in pyramidal, intermediate and cylindrical types and 29.70%, 28.56%, 30.47% and 26.81% respectively in white, cream, yellowish pink and violet flesh colour group of tuber (Table-3).

Starch content of tubers: As regard to the starch content, significant differences were recorded. Analysis of angular transformed values revealed that starch content was highest in C-20 (82.51%) but this was at par with C-1, C-7, C-3 and C-22. The lowest starch content was however, observed with C-15 (78.36%). The mean was 81.44%, 79.55% and 80.20% respectively in the pyramidal, intermediate and cylindrical types and 80.52%, 79.77% 80.07% and 81.82% respectively in the white, cream, yellowish pink and violet coloured flesh groups (Table-4).

Protein (% in dry matter of tubers): Protein content in the tubers was significantly differed among the collections. The highest protein content in dry matter of tuber was observed with C-1 (9.67%) and it was however, at par with C-4, C-14, C-16, C-17 and C-9. The lowest protein content was observed in C-13 (7.31%). The mean was 8.55, 8.16% and 7.75% respectively in pyramidal intermediate and cylindrical types and 8.03%, 7.8 %, 8.34 % and 8.35% respectively in white, cream, yellowish pink and violet cololured flesh tuber groups (Table-5).

Fat content: Fat content was assessed from the dried material of the tuber of different collections of *D. alata* in both the years. There were significant differences among the collections. In the first year, the range was 0.64% to 1.30 % and in the second year it was from 0.73 to 1.20 % whereas in the pooled data it was 0.67% to 1.24%. The lowest fat content, however, was observed in C-11 (0.67%) and highest value was with C-2 (1.24%). The white fleshed types including the cylindrical types had less than 1% fat as indicated from the observations. The means value was 0.88 %, 0.92 % and 0.81% respectively in pyramidal, intermediate and cylindrical types. However, the white, cream, yellowish pink and violet flesh colour tuber groups were found to be 0.84, 0.91, 0.75 and 0.92 per cent respectively (Table-5).

Ash content: (Dry matter basis): Significant differences were observed for the ash content in the tubers. C-1 had the lowest ash content of 1.89 % whereas C-15 had the highest value of 7.08 %. However, the ash content was towards the higher side in the intermediate group (5.85%). The mean value was 3.82 %, 5.85 % and 4.37 % respectively for pyramidal, intermediate and cylindrical group, whereas, it was 4.25%, 5.1 %, 5.16 % and 3.48 % respectively in white, cream, yellowish pink and violet coloured tuber groups (Table-6).

Crude fiber: The crude fiber content of the tuber was in a range of 1.39 to 2.60 % in the first year of the study while, it was 1.46 to 2.53% in the second year. There were significant differences among the collections of *D. alata* as regard to crude fiber content. The range was higher in the intermediate group i.e. out of five collections four were having more than 2% crude fiber. The mean was 1.95 %, 2.27 % and 1.96 % respectively in the pyramidal, intermediate and cylindrical groups whereas it was 1.94 %, 2.25 %, 2.32 % and 1.81 % respectively in the white, cream, yellowish pink and violet colour flesh tuber groups (Table-6).

Table .3. Drymatter content (%) in different collections of *D. alata* L.

Collection	Dry matter content in tuber (%)		
	I	II	Pooled
Pyramidal			
C-1	32.48 (28.83)	31.82 (27.80)	32.15 (28.31)
C-7	34.03 (31.33)	34.30 (31.76)	34.17 (31.54)
C-18	35.71 (34.06)	34.00 (32.60)	35.26 (33.33)
C-19	31.04 (26.60)	30.70 (26.08)	30.82 (26.34)
C-11	32.43 (28.76)	32.26 (28.50)	32.35 (28.63)
C-12	31.94 (28.00)	32.47 (28.83)	32.21 (28.41)
C-13	34.69 (32.41)	35.12 (33.10)	34.90 (32.75)
C-3	29.66 (24.5)	30.22 (25.33)	29.94 (24.91)
C-20	32.24 (28.66)	32.22 (28.43)	32.23 (28.54)
Intermediate			
C-5	33.82 (31.00)	34.03 (32.41)	33.92 (31.71)
C-6	34.69 (32.33)	34.75 (32.50)	34.67 (32.41)
C-2	33.67 (30.73)	33.56 (30.58)	33.61 (30.65)
C-15	33.33 (20.20)	33.62 (30.33)	33.47 (30.26)
C-21	31.52 (27.33)	31.30 (27.00)	31.41 (27.16)
Cylindrical			
C-4	32.41 (28.75)	32.37 (28.66)	32.39 (28.70)
C-14	32.62 (29.08)	32.58 (29.00)	32.60 (29.04)
C-8	32.41 (28.73)	32.26 (28.50)	32.34 (28.61)
C-16	31.73 (27.66)	32.16 (28.33)	31.94 (27.99)
C-17	32.79 (29.33)	32.15 (28.33)	32.47 (28.80)
C-9	31.16 (26.76)	31.09 (26.66)	31.12 (26.71)
C-10	31.89 (26.16)	33.43 (30.38)	32.66 (28.27)
C-22	31.11 (26.70)	31.17 (26.58)	31.14 (26.64)
'F' test	Sig.**	Sig.**	Sig.**
S.E (m) ±	0.485	0.413	0.326
C.D (0.05)	0.980	0.835	0.640
Data in parenthesis are actual value and analyzed data are angular value			

Table .4. Starch content (in dry matter) in different collections of *D. alata* L.

Collection	Starch content in tuber (%)		
	I	II	Pooled
Pyramidal			
C-1	64.95 (82.06)	65.14 (82.33)	65.04 (82.19)
C-7	65.49 (82.80)	64.68 (81.80)	65.08 (82.30)
C-18	64.15 (81.00)	64.40 (81.33)	64.28 (81.17)
C-19	63.79 (80.50)	63.91 (80.66)	63.85 (80.58)
C-11	63.60 (80.23)	63.56 (80.16)	63.58 (80.20)
C-12	64.64 (81.66)	64.23 (81.40)	64.43 (81.53)
C-13	63.67 (80.33)	64.13 (81.30)	63.90 (80.32)
C-3	64.89 (82.00)	65.14 (82.33)	65.02 (82.16)
C-20	65.75 (83.13)	64.82 (81.90)	65.28 (82.51)
Intermediate			
C-5	63.48 (80.06)	63.60(80.23)	63.54 (80.14)
C-6	63.24 (79.73)	63.26 (79.73)	63.24 (79.73)
C-2	62.84 (79.16)	62.49 (78.66)	62.66 (78.91)
C-15	62.60 (78.83)	61.96 (77.90)	62.28 (78.36)
C-21	64.20 (81.06)	63.55 (80.16)	63.88 (80.61)

Cylindrical			
C-4	63.93 (80.70)	63.96 (80.73)	63.95 (80.71)
C-14	63.41 (79.96)	62.84 (79.16)	63.12 (79.56)
C-8	63.79 (80.50)	63.08 (79.50)	63.43 (80.00)
C-16	62.02 (81.00)	62.24 (78.30)	63.30 (79.65)
C-17	63.43 (80.00)	63.05 (79.46)	63.24 (79.73)
C-9	63.01 (79.40)	63.79 (80.50)	63.40 (79.95)
C-10	63.41 (79.96)	63.53 (80.13)	63.47 (80.04)
C-22	65.65 (88.00)	64.22 (81.03)	64.93 (82.01)
'F' test	Sig.**	Sig.**	Sig.**
S.E (m) ±	0.285	0.479	0.301
C.D (0.05)	0.575	0.967	0.591
Data in parenthesis are actual value and analyzed data are angular value			

Table .5. Protein and fat percent in dry matter basis in different collections of *D. alata* L.

Collection	Protein % content			Fat % content		
	I	II	Pooled	I	II	Pooled
Pyramidal						
C-1	3.20(10.25)	3.01(9.10)	3.10(9.67)	0.92(086)	0.90(0.82)	0.84
C-7	2.89(8.50)	2.89(8.37)	2.89(8.43)	0.92(0.86)	0.92(0.96)	0.86
C-18	2.75(7.60)	2.69(7.26)	2.72(7.43)	1.00(1.00)	1.06(1.13)	1.06
C-19	2.91(8.65)	2.89(8.39)	2.90(8.52)	0.92(0.85)	0.89(0.79)	0.82
C-11	2.78(8.20)	2.73(7.55)	2.75(8.40)	0.80(0.64)	0.84(0.70)	0.67
C-12	2.56(8.27)	2.58(8.27)	2.56(8.72)	0.86(0.75)	0.85(0.73)	0.74
C-13	2.57(7.22)	2.59(7.40)	2.58(7.31)	0.86(0.74)	0.86(0.74)	0.74
C-3	2.95(7.74)	2.92(7.80)	2.93(7.77)	1.11(1.24)	1.09(1.20)	1.22
C-20	2.72(9.41)	2.78(9.38)	2.75(9.36)	0.95(0.92)	1.01(1.02)	0.97
Intermediate						
C-5	2.87(6.63)	2.74(6.73)	2.80(6.68)	0.97(0.95)	0.90(0.82)	0.88
C-6	287(6.60)	2.93(6.54)	2.90(6.57)	0.92(0.85)	0.89(0.80)	0.82
C-2	2.54(8.72)	2.58(8.54)	2.56(8.63)	1.13(1.30)	1.08(1.18)	1.24
C-15	2.68(9.59)	2.72(9.39)	2.70(9.46)	0.96(0.93)	0.93(0.86)	0.89
C-21	2.68(9.38)	2.79(9.60)	2.74(9.94)	0.85(0.73)	0.90(0.81)	0.77
Cylindrical						
C-4	3.09(8.38)	3.06(8.37)	3.08(8.37)	0.87(0.77)	0.89(0.80)	0.78
C-14	3.06(7.21)	3.09(7.83)	3.08(7.53)	0.90(0.82)	0.93(0.88)	0.85
C-8	2.68(7.60)	2.93(7.26)	2.91(7.43)	0.95(0.91)	0.98(0.84)	0.87
C-16	3.06(9.12)	3.06(9.50)	3.06(9.31)	0.90(0.82)	0.87(0.75)	0.79
C-17	30.02(8.30)	3.08(6.81)	3.05(8.45)	0.84)0.72)	0.86(0.74)	0.73
C-9	3.08(7.45)	3.06(7.73)	3.07(7.59)	0.96(0.94)	0.94(0.89)	0.91
C-10	2.94(6.49)	2.89(6.67)	2.91(6.58)	0.91(0.85)	0.91(0.83)	0.84
C-22	2.58(6.69)	2.62(6.87)	2.60(6.78)	0.85(0.72)	0.87(0.75)	0.74
'F' test	Sig.**	Sig.**	Sig.**	Sig.**	Sig.**	-
C.D (0.05)	0.052	0.052	0.050	0.025	0.045	-
Data in parenthesis are actual value and analyzed data are ⌐ value						

Table. 6. Ash and crude fiber content in the dry matter of tuber in different collections of *D. alata* L.

Collection	Ash (%)			Crude fiber (%)		
	I	II	Pooled	I	II	Pooled
Pyramidal						
C-1	(1.74)1.31	(2.05)1.43	(1.89)	(1.42)1.19	(1.46)1.21	(1.44)
C-7	(2.34)1.52	(2.94)1.71	(2.64)	(1.80)1.34	(1.90)1.38	(1.55)
C-18	(4.90)2.20	(4.62)2.14	(4.76)	(1.31)1.34	(1.36)1.36	(1.35)
C-19	(3.92)1.97	(4.34)2.03	(4.13)	(2.14)1.46	(2.23)1.49	(2.23)
C-11	(4.93)2.22	(5.37)2.31	(5.15)	(2.46)1.66	(2.40)1.54	(2.43)
C-12	(4.67)2.15	(4.66)2.15	(4.66)	(2.28)1.50	(2.41)1.55	(2.34)
C-13	(5.59)2.36	(6.09)2.46	(5.34)	(2.10)1.44	(2.14)1.46	(2.12)
C-3	(2.20)1.43	(2.40)1.55	(2.34)	(1.60)1.26	(1.51)1.22	(1.55)
C-20	(2.74)1.63	(3.30)1.31	(3.02)	(1.69)1.30	(1.66)1.29	(1.57)
Intermediate						
C-5	(5.45)2.33	(5.72)2.39	(5.53)	(1.90)1.37	(2.00)1.41	(1.95)
C-6	(5.00)2.23	(4.78)2.18	(4.89)	(2.21)1.48	(2.26)1.50	(2.23)
C-2	(6.72)2.59	(6.76)2.60	(6.74)	(2.26)1.56	(2.44)1.55	(2.35)
C-15	(5.89)2.62	(7.27)2.69	(7.06)	(2.50)1.53	(2.41)1.55	(2.45)
C-21	(4.58)2.13	(5.36)2.31	(4.97)	(2.08)1.44	(2.26)1.50	(2.17)
Cylindrical						
C-4	(3.60)1.89	(3.70)1.92	(3.65)	(1.39)1.17	(1.50)1.22	(1.44)
C-14	(4.58)2.14	(4.65)2.15	(4.61)	(1.71)1.30	(1.78)1.33	(1.74)
C-8	(3.95)1.98	(4.46)2.11	(4.20)	(2.60)1.61	(2.53)1.59	(2.56)
C-16	(5.98)2.44	(5.60)2.36	(5.79)	(2.24)1.49	(2.23)1.49	(2.23)
C-17	(4.66)2.15	(4.60)2.14	(4.63)	(1.64)1.27	(1.63)1.27	(1.63)
C-9	(3.56)1.38	(3.77)1.94	(3.66)	(2.10)1.44	(2.10)1.44	(2.10)
C-10	(4.98)2.23	(4.73)2.17	(4.85)	(2.15)1.46	(2.09)1.44	(2.12)
C-22	(3.53)1.87	(3.76)1.94	(3.64)	(1.33)1.35	(1.83)1.35	(1.33)
'F' test	Sig.**	Sig.**	-	Sig.**	Sig.**	-
C.D (0.05)	0.109	0.148	-	0.057	0.057	-
Data in parenthesis are actual value and analyzed data are ⌐ value						

DISCUSSION

D. alata cultivars are used as staple food in many communities of tropical world. As per Egbe and Treche (1984). *D. alata* cultivars in average contain 24.47% dry matter and 72.6% starch, 8.24% protein and 0.24% fat in dry matter. Similarly Lebot et al. (2005) studied the Physico-chemical characteristics of 48 *D. alata* accessions from Vanuatu regions. The result revealed that the dry matter, starch, protein and fat percentage were varies from 31.42% - 14.81%, 78.6%-63.6%, 17.0% 8. 8% and 0.5% -0.2% respectively among these accessions. In the present study C-18 had the highest dry matter (33.33%) and lowest was in C-3 (24.91%). Average dry matter was highest in intermediate shape and collections with white flesh. Starch percentage is highest in C-20 (82.51%) followed by C-1, C-7, C-3 and C-22 and lowest is estimated in C-15 (78.36%). The highest protein content in dry matter of tuber was observed with C-1 (9.67%) and the lowest protein content was observed with C-13 (7.31%). The lowest fat content, however, was observed in C-11 and (0.67%) highest value was with C-2 (1.24%). C-1 had the lowest ash content of 1.89 % whereas C-15 had the highest value of 7.08 %. However, the ash content was towards the higher side in the intermediate group (5.85). The crude fiber range was higher in the intermediate group i.e. out of five collections four were having more than 2% crude fiber (Vogel, 1980).

Rajyalakshmi and Geervai (1994) studied the nutritional assessment of different wild yam viz. *D. oppositifolia*, *D. bulbifera, D. pentaphylla* and *D. hispida*. The Proximate composition of protein, carbohydrate, fat and fiber of these *Dioscorea* tubers (gm per100 gm fresh weight) varies from 1.80gm - 5.20gm, 27gm 15gm, 0.67gm -1.10gm and 0.5gm – 2.0 gm respectively among these *Dioscorea*. Similarly Bhandari et al.,(2003) observed the protein, carbohydrate, fat, ash and fiber composition of *D. bulbifera, D. deltoidea, D. versicolor* and *D. triphylla*. The range were varies from 1.60gm – 3.10 gm, 17.50gm 25.90gm,0.20gm-0.30gm, 0.50gm-1.20gm and 0.50-1.5gm respectively gm per100 gm fresh tuber. Katesarin et al.,(2008) studied the nutritional assessment of yam viz. *D. calcicola*, *D. daunea*, *D. wallichii*, *D. stemonoides* and *D. glabra*. Based on fresh weight, the ranges of percentages of protein, carbohydrate, fat, crude fiber, moisture and ash in the study samples were 0.94% – 2.83%, 21.98% – 34.35%, 0.0 – 0.22% , 0.38% – 1.12%, 61.79 % – 75.57 %, and 0.73% – 1.02 % respectively.

Conclusion:-From the present investigation it is concluded that different collections of *D. alata* vary greatly for their dry matter, starch protein, fat, ash, and crude fiber content with respect to their agro climatic and wild genetic stock (Brown, 1995). Further the generated data in the experiment could be use full as a ready reference for selection of *D. alata* variety in commercial scale of yam farming to maintain the nutritional security.

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