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Nutrient Composition of Minor Tubers of Joida Taluk of Uttara Kannada, Karnataka

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ABSTRACT

Fourteen different types of tubers collected from Joida taluk of Uttara Kannda district exhibited significant differences in the nutrient composition. The protein (4.14-8.73 %), fat (0.07-1.10 %), dietary fibre (4.80-12.13 %), total sugar (1.31-11.16 %), reducing sugar (0.32-4.28 %), ascorbic acid (1.65-8.44 %), starch (33.97-69.18 %), and energy (349-368 kcal) values varied. The range of macro mineral- calcium (447.00-1041.50 mg), phosphorus (112.95-398.66 mg), magnesium (178.00-417.50 mg) and micro mineral- iron (0.45-3.31 mg), zinc (0.56-6.93 mg) per 100 g of sample varied and significant difference was found between the tubers. As the tubers were genetically not identical, these wide variations in the nutrient composition were naturally expected. The tubers being the good source of nutrients, it can be well replaced with other food ingredients in the regular diet.

Key words: *Minor tubers, Yams, Taro, Cassava, Arrowroot*

INTRODUCTION

India holds a rich genetic diversity of tropical root and tuber crops *viz.* cassava, sweet potato, aroids, yams and several minor tuber crops. 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. Taro plant is best planted in soil with pH around 5.5–5.6 and in an environment that is high in humidity with rainfall level of 1,000 mm each year and optimum temperature around 21–27 °C[4].

Tuber and root crops are carbohydrate-rich foods, produced and consumed worldwide as they represent an important source of energy[13]. In addition to the high starch content, these vegetables may further include other carbohydrates such as MALTOS, FOS and inulin[14,18]. Studies regarding oligosaccharides in tubers/roots are often conducted with raw vegetables, but humans consume cooked forms of these foods. It is important to stress that thermal treatment could lead to substantial changes in the compounds present in foods and in their concentrations[15].

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In addition, pre-processing of food prior to cooking can influence these changes.

Most of the root and tuber crops are rich in energy, minerals, vitamins, antioxidants and dietary fibre. They may play an important role in mitigating hidden hunger through diet diversification and have proved to be life sustaining crops in times of natural calamities and famine, when all crops fail; tubers sustain[5]. It contains vitamins, minerals, and energy and has medicinal and therapeutic value[9].

Mucilage extracted from various tubers and roots has been reported to possess angiotensin converting enzyme inhibitory[16], and antioxidative activities[20]. Also tubers and roots do not contain any gluten, which renders them right foods for celiac disease. Using tubers as a source of carbohydrate, may aid in reduction in the incidence of celiac disease or other allergic reactions[25].

Systematic studies on minor tubers of Joida taluk have not been undertaken. Hence present study was undertaken with the objective to screen the nutrient composition of fourteen types of minor tubers cultivated and consumed in Joida, Uttara Kannada.

MATERIAL AND METHODS

Collection of materials

Fourteen different types of minor tubers grown in red laterite soil, planted in the month of March-April and harvested in the month of September-October 2016 were collected from the farmers of Joida, Uttara Kannada District. The collected tubers were washed in running water to remove the adhered soil and other dirt particles. The cleaned tubers were peeled and sliced into 1.2 mm thickness and dried in hot air oven at 40^{o} C till constant weight was attained. The dried slices were powdered and stored under refrigerated condition for chemical analysis.

Chemical analysis

The composition of the minor tubers including protein (pelican kel-plus apparatus), fat (pelican socs-plus apparatus), ash, dietary fibre[6], sugars by Nelson-Somogyi's procedure, starch[18], calcium and magnesium[10], phosphorus and ascorbic acid[24], iron and zinc using Atomic absorption spectrophotometer was carried out in triplicates, using standard procedures. Analytical grade chemicals were used for analysis. Carbohydrate and energy was computed. All analysis were carried out in triplicates.

The data was tabulated and analyzed using one-way analysis of variance. The results were presented as Mean ± SD. Critical difference was used to test the significance between the samples. The probability fixed for the test of significance was $p < 0.01$. The statistical analysis was done using SPSS software (version 16.0).

RESULTS AND DISCUSSION

Table 1 presents the proximate composition of minor tubers. All the proximate principles differed significantly among the tubers. The moisture content was significantly higher in tannia bulbs (85.52 %), followed by Alocasia (77.92 %) and Greater yam- bunch type (75.50 %), whereas, finger type of Greater yam possessed significantly lower amount of moisture (61.31 %). Protein content ranged from 4.14 (Colocasia banda type)-8.73 per cent (Greater yam- wild edible type). However, the protein content of Alocasia (4.92 %), Greater yam- slender type (5.11 %), Greater yam- bunch type (6.05 %) and Tannia bulbs (4.43 %) was lower and statistically on par with each other, while that of Greater yam- arial bulbs (6.88 %), Chinese potato (7.99 %), Colocasia dwarf type (7.77 %), Elephant foot yam (6.99 %), Greater yam- lion foot type (7.03 %), Greater yam- wild edible type (6.96 %), Lesser yam (7.06 %), Greater yam- fingers type (8.08 %) and Greater yam- hairy type (8.73 %) was higher and on par with each other. Fat content of the tuber varied significantly with Chinese potato having higher value of 1.10 per cent, followed by Elephant foot yam (0.67 %) and Greater yam- hairy type (0.60 %). The tuber Alocasia was found to have significantly lower fat content of 0.07 per cent.

Ash content was significantly higher in Colocasia dwarf type (6.37 %), followed by

Alocasia (6.27 %) and these differences were statistically not significant. Significant difference was seen in the carbohydrate and energy values of the tubers. Total carbohydrate content of Greater yam- slender type (85.56 %), Greater yam- bunch type (84.64 %), Colocasia banda type (83.53 %), Elephant foot yam (83.39 %) and Greater yam- lion foot type (83.44 %) did not differ significantly as indicated by F-value and was higher. The tuber colocasia dwarf type contained significantly lower total carbohydrate of 81.26 percent. Elephant foot yam (368 kcal), followed by Greater yam- bunch type (366 kcal) and Greater yam- lion foot type (365 kcal) possessed significantly higher energy with tannia bulbs and Colocasia dwarf type having lower energy. As the tubers were genetically different, the variations among the tubers were expected. Shanthakumari *et al.*[27], on wild yam of Tamil Nadu, Akin-Idowu *et al.*[2]. on yellow yams of Nigeria, Udensi *et al.*[28], on water yam of Nigeria, Alinnor and Akalezi[3], on white yam of Nigeria, Abara[1], on aerial yam of Nigeria, Ezeocha and Ojimelukwe[12], on water yam of Nigeria, Ezeocha *et al*.[12], on trifoliate yam of Nigeria reported the similar values for the nutrient composition of tubers.

Carbohydrate profile includes total sugar, reducing sugar, non reducing sugar, starch and dietary fiber. Carbohydrate profile of the tubers varied significantly and it is given in Tables 2 and 3 and is depicted in Fig. 1 and 2. Total sugar was significantly higher in banda type of Colocasia (11.16 %) and it was on par with Alocasia (10.28 %), Significantly lower total sugars was recorded in Greater yam- lion foot type (1.31 %) and was on par with Greater yam- arial bulbs, Chinese potato, Greater yam- lion foot type, Greater yam- bunch type, Lesser yam and Greater yam- hairy type. Reducing sugar was significantly higher in Alocasia (4.28 %), followed by Colocasia- banda type (3.27 %) and Elephant foot yam (2.56 %). Non reducing sugar was significantly higher in banda type of Colocasia (7.50 %), followed by Alocasia (5.70 %).

Starch content as seen from Table 2 and Fig. 1 was significantly higher in Greater yam- bunch type (69.18 %) and was on par with Greater yam- fingers type (63.32 %), Greater yam- lion foot type (62.73 %), Greater yam- wild edible type (60.38 %) and Lesser yam (60.36 %). Starch is the storage form of energy for the future growth of the plant. It serves as reserve energy. In the present study, starch varied from 33.97-69.18 percent. Great genetic variation in starch yield of the tubers has been observed[8]. It was interesting to note that elephant foot yam having thicker peel possess lesser starch. Obviously, higher the dry matter better is the starch content. Pérez *et al.*[23]. also reported that high dry matter content and thinness of peel are related to starch content.

Table 3 and Fig. 2 infer the dietary fiber profile of the minor tubers and it ranged from 4.80-12.13 per cent. Lesser yam and Greater yam- lion foot type possessed equal quantity of soluble fibre (3.00 %) and was significantly higher than other tubers. Dietary fiber acts as bioactive compound with soluble fiber having the capacity to regulate blood glucose and reducing cholesterol level, where as insoluble fiber is capable of relieving constipation. The soluble, insoluble and total dietary fiber varied significantly in the tubers tested. The total dietary fiber content of tubers varied from 4.80 to 12.13 g/100 g, indicating that the consumption of 100 g of tuber provides half to 1/3rd the suggested fiber intake.

Soluble fiber which is viscous and fermentable is made up of gums, pectin, β-glucan and mucilage. Most of the tubers are mucilaginous in nature, a fact for beneficial effect in controlling blood sugar and reducing the cholesterol level. On the contrary, insoluble dietary fiber comprising of cellulose, lignin, hemicelluloses, *etc* ranged from 3.80 to 10.93 per cent. Having water holding capacity, it behaves like a sponge, adds bulk to the diet, and increases the transit time in the gut, thus relieving constipation and diverticulitis. The results of the present study are in concurrence with those of Mcanuff *et al.*[17], and Baah *et al.*[7], for soluble fibre content of tubers.

Mineral composition (Table 4) is a major component of the tubers as they are grown under soil and cultivated organically. The range of macro mineral- calcium (447.00-1041.50 mg), phosphorus (112.95-398.66 mg), magnesium (178.00-417.50 mg) and micro mineral- iron (0.45-3.31 mg), zinc (0.56-6.93 mg) per 100 g of sample varied and significant difference was found between the tubers. Calcium, phosphorus, magnesium and zinc content of the tubers were higher compared to potato. This shows the capacity of the tubers to act as remedy to mitigate micronutrient deficiencies. For the cultivation of tuber crops, farm yard manure (humus) is the source of fertigation but not inorganic fertilizer. Humus being a package of macro and micro nutrients, based on the capacity of the tubers to draw minerals from the soil, the mineral content varied. Colocasia bunda type and Greater yam hairy type having calcium of more than 1000mg/100 g meets the RDA of pregnant and lactating women, if 100g is consumed. Colocasia banda type having noticeably higher amount of zinc (6.93mg) is beneficial for the pregnant women.

The changes in the proximate composition, carbohydrate profile, and mineral composition of different tubers was may be due to the differences in species, geographical sources, maturity of the tuber at harvest, composition of soil, soil fertility, time of planting, cultural practices, agro-climatic conditions and other environmental factors. The results of the present study are in agreement with those of Ogbuagu[21], on yam of Nigeria, Sanful *et al.*[26]. on aerial yam of Ghana, and Owuamanam[22], on trifoliate yam.

Wide variation in the ascorbic acid content was observed and is depicted in Fig. 3. It ranged from 1.65-8.44mg and was significantly higher in lesser yam (8.44 mg), followed by Greater yam- lion foot type (4.78 mg) and Greater yam- hairy type (4.45 mg). However, since tubers cannot be consumed raw and are subjected to thermal processing, the loss of ascorbic acid is inevitable. Hence, tubers cannot be considered as a source of ascorbic acid.

Table 1: Proximate composition of minor tubers

Sl.No.	Tuber	Proximate principles (g/100 g dwb)							
		Moisture		Protein	Fat	Ash	CHO		Energy (Kcal)
		(fwb)	(dwb)				Total	Available	
1.	Alocasia	77.92 ± 1.01	6.10±0.12	4.92 ± 1.26	0.07 ± 0.03	6.27 ± 0.06	82.63 ± 1.39	73.86 ± 1.01	351 ± 0.83
2.	G.Y. (arial bulbs)	70.07 ± 1.01	7.21±0.05	6.88 ± 0.35	0.42 ± 0.03	4.24 ± 0.03	81.26 ± 0.31	71.66 ± 1.14	356 ± 0.32
3.	Chinese potato	67.50 ± 1.07	7.31±0.19	7.99 ± 1.70	0.55 ± 0.00	4.17 ± 0.10	79.98 ± 1.86	68.05 ± 1.94	357 ± 0.66
4.	Colocasia (dwarf type)	69.58 ± 1.04	7.84±0.10	7.77 ± 1.48	1.10 ± 0.05	6.37 ± 0.15	76.92 ± 1.53	72.12 ± 1.53	349 ± 0.22
5.	Elephant foot yam	69.58 ± 1.28	5.66±0.07	6.99 ± 0.23	0.67 ± 0.18	3.29 ± 0.02	83.39 ± 0.17	75.79 ± 0.17	368 ± 1.16
6.	G.Y. (lion foot type)	65.58 ± 1.24	5.85±0.09	7.03 ± 0.96	0.32 ± 0.03	3.36 ± 0.01	83.44 ± 1.04	75.64 ± 1.20	365 ± 0.35
7.	G.Y.(wild edible type)	70.50 ± 1.18	6.32±0.03	6.96 ± 0.16	0.25 ± 0.00	3.55 ± 0.04	82.93 ± 0.10	73.53 ± 0.92	362 ± 0.28
8.	G.Y. (slender type)	64.75 ± 1.15	6.48±0.23	5.11 ± 0.46	0.20 ± 0.00	2.66 ± 0.03	85.56 ± 0.47	74.76 ± 1.20	364 ± 0.10
9.	G.Y. (fingers type)	61.31 ± 0.87	5.65±0.10	8.08 ± 0.79	0.35 ± 0.00	4.59 ± 0.04	81.33 ± 0.83	70.76 ± 1.62	361 ± 0.50
10.	G.Y. (bunch type)	75.50 ± 1.01	5.73±0.13	6.05 ± 0.75	0.35 ± 0.00	3.23 ± 0.10	84.64 ± 0.64	76.24 ± 0.79	366 ± 0.50
11.	Lesser yam	68.42 ± 0.94	6.13±0.19	7.06 ± 0.19	0.22 ± 0.03	3.53 ± 0.06	83.06 ± 0.33	72.86 ± 0.36	362 ± 0.57
12.	Colocasia (banda type)	68.29 ± 1.05	5.83±0.21	4.14 ± 0.22	0.40 ± 0.10	6.10 ± 0.13	83.53 ± 0.06	71.93 ± 0.87	354 ± 0.87
13.	Tannia bulbs	85.52 ± 1.20	7.24±0.13	4.43 ± 1.35	0.32 ± 0.13	5.95 ± 0.08	82.06 ± 1.28	70.66 ± 1.22	349 ± 0.58
14.	G.Y. (hairy type)	71.73 ± 1.15	7.70±0.08	8.73 ± 0.99	0.60 ± 0.15	3.45 ± 0.03	79.52 ± 0.99	67.39 ± 0.46	358 ± 0.97
Mean±SD		70.45±5.93		6.58 ± 1.60	0.42 ± 0.26	4.34 ± 1.27	82.16 ± 2.32	72.52 ± 2.82	359 ± 6.18
F-value		90.93		7.21	32.23	945.92	16.20	17.27	250.39
S. Em. ±		0.63		0.54	0.04	0.04	0.56	0.65	0.40
C. D. @ 1 %		2.46**		2.09**	0.18**	0.16**	2.17**	2.56**	1.56**

Note: G.Y. - Greater yam dwb- dry weight basis fwb- fresh weight basis
**Significant @ 0.01 level, NS-Non-significant

Table 2: Carbohydrate profile of minor tubers

Sl. No.	Tuber	Carbohydrate profile (g/100 g)			
		Reducing sugar	Non reducing sugar	Total sugar	Starch
1.	Alocasia	4.28 ± 0.28	5.70 ± 0.83	10.28 ± 0.59	41.00 ± 3.00
2.	G.Y. (arial bulbs)	1.26 ± 0.14	0.27 ± 0.24	1.54 ± 0.11	51.55 ± 4.05
3.	Chinese potato	0.52 ± 0.11	1.05 ± 0.30	1.62 ± 0.20	42.10 ± 4.10
4.	Colocasia (dwarf type)	1.06 ± 0.20	1.63 ± 0.03	2.78 ± 0.17	40.17 ± 5.34
5.	Elephant foot yam	2.56 ± 0.03	2.94 ± 0.07	5.65 ± 0.04	33.97 ± 5.14
6.	G.Y. (lion foot type)	0.48 ± 0.20	0.79 ± 0.28	1.31 ± 0.10	62.73 ± 3.16
7.	G.Y.(wild edible type)	1.95 ± 0.04	0.92 ± 0.20	2.92 ± 0.17	60.38 ± 1.31
8.	G.Y. (slender type)	1.96 ± 0.11	0.87 ± 0.21	2.88 ± 0.11	50.03 ± 1.86
9.	G.Y. (fingers type)	1.37 ± 0.07	4.02 ± 0.77	5.60 ± 0.88	63.32 ± 8.10
10.	G.Y. (bunch type)	0.32 ± 0.06	1.20 ± 0.03	1.58 ± 0.03	69.18 ± 3.76
11.	Lesser yam	0.51 ± 0.07	1.07 ± 0.04	1.64 ± 0.11	60.36 ± 4.80
12.	Colocasia (banda type)	3.27 ± 0.04	7.50 ± 0.55	11.16 ± 0.62	52.55 ± 0.05
13.	Tannia bulbs	0.63 ± 0.07	1.62 ± 0.36	2.34 ± 0.31	51.65 ± 6.33
14.	G.Y. (hairy type)	2.62 ± 0.20	0.96 ± 0.28	3.63 ± 0.099	37.25 ± 3.25
Mean ± SD		1.63 ± 1.18	2.18 ± 2.11	10.28 ± 3.15	51.16 ± 11.32
F-value		152.53	60.15	162.59	19.15
S. Em. ±		0.10	0.27	0.25	2.52
C. D. @ 1 %		0.41**	1.16**	1.06**	9.83**

Note: G.Y. - Greater yam
**Significant @ 0.01 level, NS-Non-significant

Table 3: Dietary fiber of minor tubers

Sl. No.	Tuber	Dietary fiber profile (%)		
		Soluble fiber	Insoluble fiber	Total fiber
1.	Alocasia	1.60 ± 0.20	10.00 ± 0.80	11.60 ± 0.92
2.	G.Y. (arial bulbs)	0.60 ± 0.20	10.80 ± 0.00	11.40 ± 0.20
3.	Chinese potato	1.40 ± 0.20	8.80 ± 0.40	10.20 ± 0.60
4.	Colocasia (dwarf type)	1.20 ± 0.20	10.93 ± 1.21	12.13 ± 1.30
5.	Elephant foot yam	0.80 ± 0.00	7.60 ± 0.40	8.40 ± 0.40
6.	G.Y. (lion foot type)	3.00 ± 0.60	4.80 ± 0.00	7.80 ± 0.60
7.	G.Y.(wild edible type)	1.40 ± 0.60	8.00 ± 0.40	9.40 ± 1.00
8.	G.Y. (slender type)	2.33 ± 0.12	9.60 ± 0.80	11.93 ± 0.70
9.	G.Y. (fingers type)	2.00 ± 0.80	8.80 ± 0.00	10.80 ± 0.80
10.	G.Y. (bunch type)	1.00 ± 0.20	3.80 ± 0.20	4.80 ± 0.00
11.	Lesser yam	3.00 ± 0.60	4.60 ± 0.60	7.60 ± 0.00
12.	Colocasia (banda type)	1.80 ± 0.20	7.80 ± 1.00	9.60 ± 1.20
13.	Tannia bulbs	2.97 ± 0.21	5.80 ± 0.20	8.77 ± 0.40
14.	G.Y. (hairy type)	1.20 ± 0.40	9.37 ± 1.20	10.57 ± 2.10
Mean ± SD		1.74 ± 0.86	7.91 ± 2.36	9.64 ± 2.13
F-value		12.87	26.87	15.10
S. Em. ±		0.23	0.45	0.53
C. D. @ 1 %		0.89**	1.76**	2.05**

Note: G.Y. - Greater yam
**Significant @ 0.01 level, NS-Non-significant

Table 4: Mineral composition of minor tubers

Sl. No.	Tuber	Mineral composition (mg/100 g)				
		Macro mineral			Micro mineral	
		Calcium	Phosphorus	Magnesium	Iron	Zinc
1.	Alocasia	898.50 ± 2.12	193.04 ± 1.42	417.50 ± 3.54	1.67 ± 0.03	3.36 ± 0.17
2.	G.Y. (arial bulbs)	697.00 ± 4.24	237.12 ± 1.44	268.00 ± 2.83	1.75 ± 0.01	1.23 ± 0.16
3.	Chinese potato	597.50 ± 3.54	263.56 ± 2.86	329.00 ± 1.41	2.20 ± 0.14	2.25 ± 0.06
4.	Colocasia (dwarf type)	995.00 ± 7.07	310.50 ± 1.62	328.50 ± 2.12	2.56 ± 0.16	4.28 ± 0.09
5.	Elephant foot yam	797.50 ± 3.54	157.53 ± 3.13	178.00 ± 2.83	0.47 ± 0.03	2.38 ± 0.07
6.	G.Y. (lion foot type)	599.00 ± 1.41	147.64 ± 1.87	417.00 ± 4.24	0.78 ± 0.01	1.06 ± 0.04
7.	G.Y.(wild edible type)	646.50 ± 4.95	162.44 ± 1.73	268.50 ± 2.12	1.05 ± 0.07	1.03 ± 0.02
8.	G.Y. (slender type)	546.50 ± 4.95	112.95 ± 2.42	387.50 ± 3.54	0.45 ± 0.00	0.56 ± 0.05
9.	G.Y. (fingers type)	597.00 ± 4.24	191.70 ± 1.92	358.00 ± 2.83	2.08 ± 0.04	2.26 ± 0.07
10.	G.Y. (bunch type)	695.50 ± 6.36	157.00 ± 2.49	237.50 ± 3.54	0.95 ± 0.00	1.16 ± 0.02
11.	Lesser yam	447.00 ± 4.24	199.13 ± 2.50	388.50 ± 2.12	1.50 ± 0.00	2.11 ± 0.02
12.	Colocasia (banda type)	1035.00 ± 21.21	398.66 ± 1.67	208.50 ± 2.12	2.83 ± 0.04	6.93 ± 0.04
13.	Tannia bulbs	694.50 ± 7.78	156.07 ± 2.42	327.00 ± 4.24	3.31 ± 0.08	1.20 ± 0.07
14.	G.Y. (hairy type)	1041.50 ± 12.02	247.45 ± 2.08	207.50 ± 3.54	2.29 ± 0.04	1.22 ± 0.05
Mean ± SD		734.86 ± 186.59	209.63 ± 74.79	308.64 ± 79.57	1.71 ± 0.87	2.22 ± 1.67
F-value		1149.32	2460.14	1415.23	340.66	911.28
S. Em. ±		5.61	1.54	2.15	0.05	0.06
C. D. @ 1 %		23.60**	6.47**	9.07**	0.20**	0.24**

Note: G.Y. - Greater yam
**Significant @ 0.01 level, NS-Non-significant

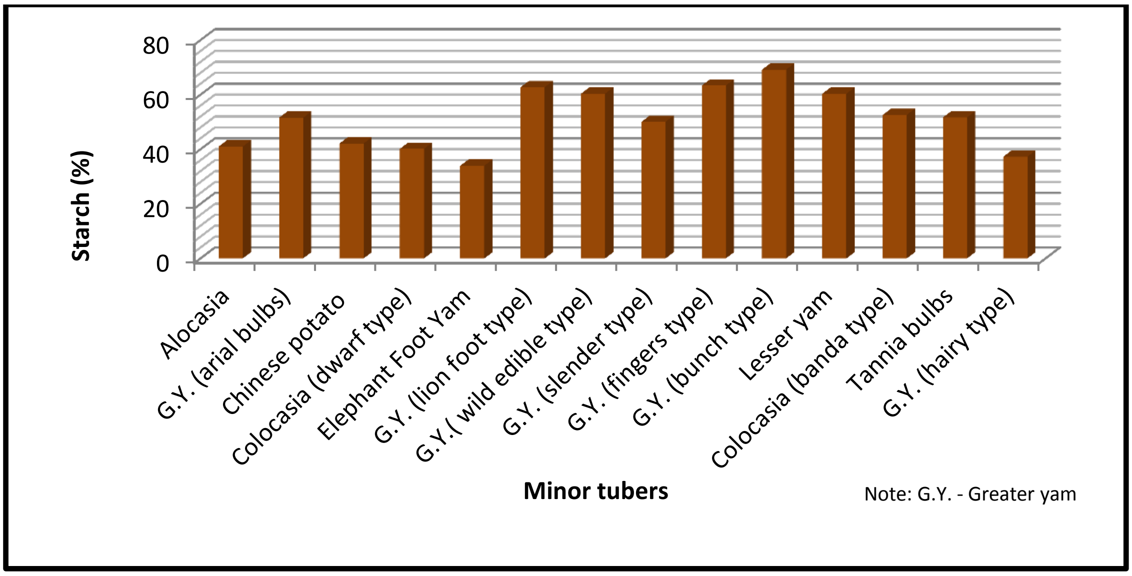

Fig. 1: Starch content of minor tubers

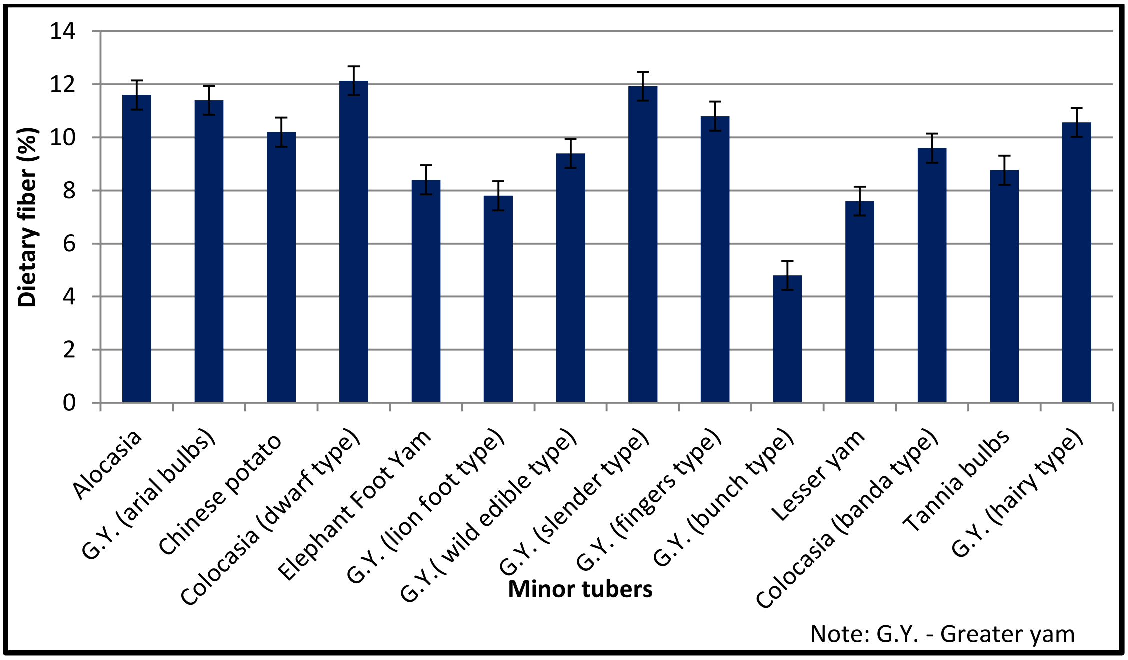

Fig. 2: Dietary fiber content of the tubers

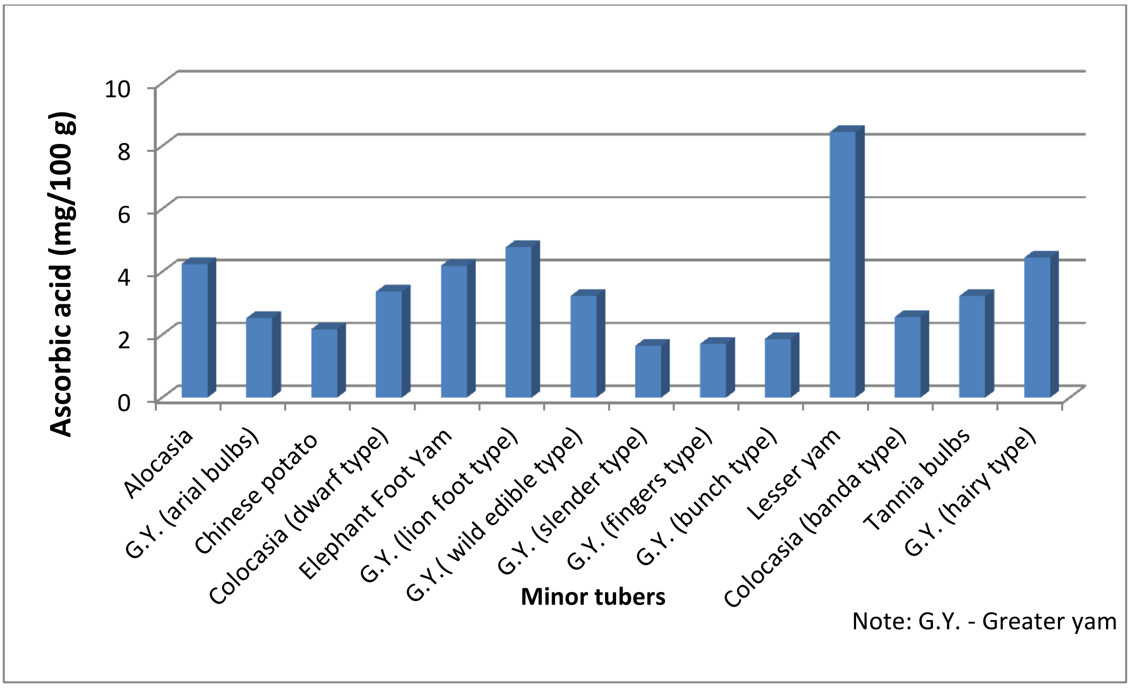

Fig. 3: Ascorbic acid content of the tubers

CONCLUSION

The difference in the values of all proximate, carbohydrate and mineral composition of the minor tubers indicates a wide variation among the tubers. Mineral content was found to be more in these tubers. Chemical analysis indicated that the tubers are good source of carbohydrates, dietary fibre and starch, thus can be used in regular diet and also for managing the non communicable disorders including celiac disease, wheat intolerance.

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