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The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; SP-10(10): 168-172

www.thepharmajournal.com
Received: 02-08-2021
Accepted: 04-09-2021

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Availability, Physical properties and starch content of the tuber crops

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Abstract
Tuber is a thickened underground part of stem. Technically a tuber is either a modified stem or modified root, for example sweet potato, potato, cassava and colocasia. In Karnataka, Western Ghats region including Sirsi, Joida and Yallapura talukas of Uttar Kannada district and Mysore district are a treasure trove for these tuber crops. The extraction of starch helps to provide employment to unemployed youths and women in both rural and urban areas. The study was conducted in Uttar Kannada district of Joida during 2019-20. For this study, thirty farmers who were cultivating tuber crops were randomly selected as samples. Survey was carried out with a help of self-structured interview schedule to elicit the required information from the respondents. For measuring the physical properties of tubers, the selected parameters were tuber size, colour, greening, tuber weight, length, width and circumference. The weight of wet starch, dry starch and yield of starch was calculated. For analysis of data, frequency, percentage, and ANOVA were used. The study shows that, around nineteen different tubers were growing by tuber growers in Joida. Appearance of the selected tubers depends on shape of the tubers. Cassava tuber was heavier in weight and length was also high, whereas, sweet potato width was more compared to cassava and Colocasia. Significant difference at 0.01 level was seen between the selected tubers and physical properties. Yield of extracted starch was more in cassava compared to other two tubers. Significant difference was observed at 0.01 level between the types of tubers and wet starch weight, dry starch weight, yield of starch. For analysis of data, frequency, percentage, and ANOVA were used.

Keywords: Cassava, colocasia, sweet potato, starch, physical properties

Introduction
Tuber is a thickened underground part of stem. Technically a tuber is either a modified stem or modified root, for example sweet potato, potato, cassava and colocasia. In the year 2013, the major roots and tuber crops occupied about 56.11 million hectares producing 835.55 million metric tons of tubers worldwide, 43 per cent of which was from Asia and 6.43 per cent from India. Globally, the major tubers grown are cassava, sweet potato, potato, yams, taro, aroids and tannia. The major tuber growing states in India are Tamil Nadu, Kerala, Meghalaya, Assam, Andhra Pradesh, Karnataka and Nagaland (Anon., 2015) [2].

In Karnataka, Western Ghats region including Sirsi, Joida and Yallapura talukas of Uttar Kannada district and Mysore district are a treasure trove for these tuber crops. More than twenty types of tubers are cultivated in Western Ghats region of Karnataka. The major tuber crops grown in Karnataka are potato, sweet potato cassava, taro, yam, elephant foot yam, arrow root and Chinese potato *etc.* The each tuber is differing with their appearance, colour and physical properties. Some tubers like, elephant foot yam, cassava and greater yam are large in shape and colocasia, arrowroot and lesser yam are small in size.

The tuber crops proved to be life sustaining crops in times of natural calamities and famine. When all other starch based crops fail, tuber sustains. Most of these tuber crops are flexible in nature and they adjust with climate change and they have the potential for good return under adverse soil and weather condition (Anon, 2013) [1].

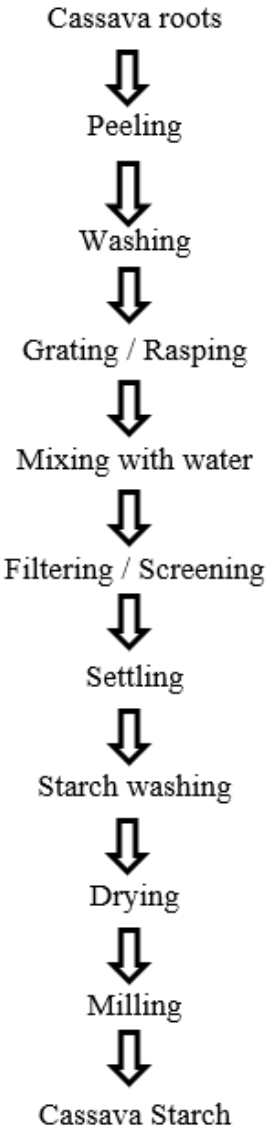
In recent days, the tuber starch is used as raw material for several industries, which become more important due to their versatility. Starch is a naturally occurring, biodegradable, inexpensive and abundantly available polysaccharide molecule (Kenji *et al,* 2002) [5]. Starch is soft, white in colour, tasteless powder that is insoluble in cold water. It is a major carbohydrate easily extracted from various native sources like sweet potato, cassava and taro *etc.* (Edison *et al.,* 2005) [4]. Demand of tuber starch is increasing day by day both in national and international market. The tuber starch marketing has grown rapidly as consumers become "Eco conscious" and they choose starch products as the biodegradable and environmental friendly.

Extraction of starch from tubers is easy process and not required any equipment. The extraction of starch helps to provide employment to unemployed youths and women in both rural and urban areas. This tuber starch gives more important contribution to national economies and act as a stable base for several industries and small scale entrepreneurship. The main aim of the study was providing information about availability of tubers, physical properties of tubers, starch extraction process and starch content in different tubers.

Materials and Methods

The present investigation was done in Department of Family Resource Management, CCSc, UAS, Dharwad during 2019-20. For this study, thirty farmers who were cultivating tuber crops were randomly selected as samples. Survey was carried out with a help of self-structured interview schedule to elicit the required information from the respondents. Based on survey three tubers such as Cassava, Colocasia and Sweet potato were selected for the experimental study. The criteria for selection of tubers were, easy availability and not suitable for consumption. For measuring the physical properties of tubers, the selected parameters were tuber size, colour, greening, tuber weight, length, width and circumference. The starch was extracted from these three different selected tubers namely sweet potato, Collocasia and Cassava by the method given by Buba and Aliyu, 2014 [3], with some modifications. The weight of wet starch, dry starch and yield of starch was calculated. For analysis of data, frequency, percentage, and ANOVA were used.

Starch Extraction Process



Result and Discussion:

A close perusal of Table 1 shows the tubers grown by the tuber growers. In study area, around 19 different types of tubers were growing. Among these tubers, sweet potato (70.00%), Colocasia (dwarf type) (60.00%), elephant foot yam (53.33%), cassava (30.33%), arrowroot (33.33%), potato (30.00%), dhavikon greater yam (26.66%), lesser yam (26.66%) and dukar kon yam (23.33%) were growing in higher quantity. The results are in line with the results of Prakash *et al.* (2018) [10], The important tubers grown in Kerala were cassava, sweet potato, yam, Colocasia and elephant foot yam. And Mesta and Pushabharati (2017) [7], reported that, in Western ghats of Karnataka, the farmers growing more than 20 types of tuber crops.

Table 1: Different types of tubers grown by the farmers in selected area N=30

Tubers	Frequency	Percentage (%)
Cassava	09	30.33
Chinese Potato	05	16.66
Sweet potato	21	70.00
Elephant foot yam	16	53.33
Greater Yam		
Dhavi Kon (lion foot type)	08	26.66
Yam (Dukar Kon)	07	23.33
Yam (nagar kon)	06	20.00
Yam (arial bulbs)	04	13.33
Yam (aale kon, hairy type)	04	13.33
Arrowroot	10	33.33
Shatavari	04	13.33
Taro		
Colocasia (banda type)	11	36.66
Colocasia (dwarf type)	18	60.00
Alocasia	03	10.00
Red taro (tambade aalu)	01	3.33
Bili suli gedde	05	16.66
Potato	09	30.00
Lessar yam	08	26.66
Tannia bulbs (kaasar aalu)	01	3.33

Note: Multiple Responses

From tubers survey it was concluded that mainly three tubers such as sweet potato, colocasia and cassava tubers available easily in study area and also available with low cost. Hence, for further experimental study these three tubers were selected.

Table 2: Appearance and Colour of the tubers

Types of Tubers	Appearance	Greening	Skin Colour	Flesh Colour
Sweet potato		Light (2-4cm)	Pale rose	Light Cream
Colocasia		Trace (>2cm)	Light Brown	Pinkish White
Cassava		Trace (>2cm)	Natural Oak Brown	Milky white

Table 2 examined that appearance, greening, flesh and skin colour of the selected tubers. Appearance of the selected tubers depends on shape of the tubers. Sweet potato was oval in shape followed by Colocasia was dwarf shape and cassava tuber were cylindrical in shape. The greening and colour varied between the different tubers. Greening surface of the tubers varying from light to trace, sweet potato possessed light green surface followed by both colocasia and cassava possessed trace green surface. Skin colour of the sweet potato was pale rose followed by colocasia contains light brown and cassava skin colour was natural oak brown. Whereas, flesh colour of the sweet potato was light cream followed by colocasia possessed pinkish white flesh and cassava flesh colour was milky white. The wild variations were observed in appearance, greening, skin and flesh colour of the selected tubers; it may be due to intrinsic physiological attributes, variant compositions and genetic differences.

Physical properties of the selected tubers such as sweet potato, colocasia and cassava were depicted in Table 3. Cassava tuber was heavier with mean weight 1066.12 gm followed by sweet potato (1038.66 gm) and colocasia was light in weight with mean score 14.16 gm.

Table 3: Physical Properties of the selected tubers

Types of Tubers	Physical properties			
	Weight	Length	Width	Circumference
Sweet Potato	1038.66 ± 43.77	39.90 ± 12.99	11.83 ± 2.14	28.11 ± 1.26
Colocasia	14.16 ± 1.60	7.93 ± 2.11	9.97 ± 1.50	19.59 ± 6.04
Cassava	2179.66 ± 180.77	89.70 ± 1.41	9.15 ± 2.15	24.25 ± 1.34
Mean ± SD	1066.12 ± 926.16	45.79 ± 35.79	10.20 ± 1.31	22.14 ± 5.31
F-Value	4.76	6.00	65.01	2.40
S. Em. ±	30.98	0.33	0.36	0.25
C.D. @ 1%	53.61**	0.58**	0.63**	0.43**

Note: ** significant at 0.01 level

The length of the cassava was significantly higher with mean score 89.70 cm, followed by sweet potato length was 39.90 cm, where it was low in colocasia with mean score 7.93 cm. The width of the sweet potato was higher with a mean score 11.83 cm followed by colocasia (9.97 cm) and cassava was low in width with a mean score 9.15 cm. The circumference of sweet potato was significantly lower with a mean score 18.11 cm followed by cassava (19.25 cm) and colocasia was higher with a mean score 29.59 cm.

Irrespective of type of selected tubers the mean weight, length, width and circumference were 1066.12, 45.79, 10.20 and 22.14 respectively. Significant difference at 0.01 level was seen between the selected tubers *i.e.*, sweet potato, colocasia and cassava and physical properties such as size, weight, length, width and circumference. Similarly, Reddy *et al.* (2018) [9] stated that, variations in weight and length of the fifteen cultivars of sweet potato. And also, these results in line with Medhi and Parasarathy (1999) [6], noted that extensive variations in the length of the nineteen verities of corm taro. Oriole and Raji (2014) [8] reported that, physical properties of the tubers vary with harvesting period.

Yield of extracted starch includes wet starch weight, dry starch weight, and yield of starch is given in Table 4. For extraction of starch 1000 gm of each tuber was taken. The selected tuber for starch extraction was peeled and after peeling the tuber weight was recorded. After peeling the sweet potato weight was 898 gm followed by Colocasia (787 gm) and cassava weight after peeling was 800 gm. Wet starch weight of the cassava was more with a mean score 135.30 gm followed by colocasia (114.10 gm) and sweet potato wet starch weight was low with mean score 106.50 gm. Dry starch weight of the sweet potato was less with mean score 95.80 gm followed by colocasia (99.97 gm) and high dry starch weight was observed in cassava with mean score 119.00 gm. Yield of starch was more in cassava (11.90%) followed by colocasia (9.97%) and sweet potato contains 9.58 per cent starch.

Irrespective of type of tubers the mean wet starch weight, dry starch weight and yield of starch were 117.68 gm, 104.00 gm and 10.29 per cent respectively. Significant difference was observed at 0.01 level between the types of tubers and wet starch weight, dry starch weight, yield of starch. The wet and dry weight of the starch differed with tubers it may be due to water content of the starch and linear polymer amylose and amylopectin form. The yield of starch differs due to weight of the isolated starch differ with tubers.

Table 4: Yield of commercial grade starch from different types of tubers

Types of Tubers	Tuber weight after peeling (gm)	Wet Starch Weight (gm)	Dry Starch Weight (gm)	Yield of starch (%)
Sweet Potato	898	106.50	95.80	9.58
Colocasia	787	114.10	99.97	9.97
Cassava	800	135.30	119.00	11.90
Mean ± SD	828.33 ± 19.84	117.68 ± 13.66	104.00 ± 9.66	10.29 ± 0.87
F-Value	576.13	237.80	140.42	44.66
S. Em. ±	3.01	2.03	1.86	0.28
C.D. @ 1%	3.67**	3.51**	3.22**	0.48**

Note: Each tuber weight before peeling: 1000gm
** Significant at 0.01 level

Conclusion

Tubers are the most important crops after cereals. The Uttara Kannada district of Karnataka is a store house for several tubers because in this area around 19 types of tubers were growing. Studies related to physical properties of tuber crops helps to understand the nature and morphology of the tuber crops. Tuber starch can be a good alternate raw material for several industries. Therefore, it is suggested to provide knowledge about availability of various tubers and process of starch extraction from tubers. Demand of tuber starch is increasing day by day both in national and international market. The tuber starch marketing has grown rapidly as consumers become "Eco conscious" and they choose starch products as the biodegradable and environmental friendly.

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