Asian Journal of Biological and Life Sciences | Short Communication

Evaluation of selective nutritional and antinutritional components in underground storage organs

S.Chidambaram Pillai*, N.Suresh, M.Padmasree

P.G. & Research Department of Botany, V.O.Chidambaram College,Tuticorin- 628 008 (India).

E-mail : drcpbotvoc@yahoo.co.in

Submitted : 06.07.2012 Accepted :06.08.2012 Published : 31.12.2012

Abstract

A study on selected nutritional and antinutritional contents in the edible parts of ten domesticated underground storage organs was carried out. Their quantitative data obtained have been depicted and compared with other similar studies in the storage organs of wild nature. Among them, *Manihot esculenta*, a tuber was found to have highest amount of nutritional contents and is recommended as good dietary source.

INTRODUCTION

Root crop, a general term commonly used for a wide variety of food plants that have an underground storage organ known as a root, tuber (rhizome), corm, or bulb which are rich in starch, low protein, oil and are excellent sources of calories. They are the most important food crops of human kind after cereals and grain legumes and are generally processed into various forms before consumption. Processing makes them digestible and palatable, extends the shelf-life and reduces post harvest losses [1].The nutritional value of roots and tubers lies in their potential ability to provide one of the cheapest sources of dietary energy in the form of carbohydrates [2].

Nutritionally root crops are rich in carbohydrates especially the starches and sugars. Starches are made up of amylase, a straight chain glucose polymer which usually constitutes about 10 to 30 percent of the total, and amylopectin [3]. Most of the root crops contain appreciable amounts of vitamin C [2] and many antinutritional factors which interfere with the assimilation of nutrition contained in them [4].

Carbohydrates such as soluble sugars and starches are the main energy yielding substances of the diet. Starches are the main sources of nutritive energy. The principal constituent of edible carbohydrate is starch together with some sugars, the proportion depending on the root crops [2]. Starch is the principal constituent of edible carbohydrate and consequently the main source of energy in root and tuber crops. Starches are made up of amylase, a straight chain glucose polymer which usually constitutes about 10 to 30 percent of the total, and amylopectin [3]. Most of the root crops contain appreciable amounts of vitamin C when the diet is correctly prepared. Many foods, particularly those of plant origin, contain a wide range of anti-nutritional factors which interfere with the assimilation of nutrition contained in them [4]. The term antinutritional factor, which is not as restrictive as toxic and may be liberally interpreted to mean nothing more (or) less than an adverse physiological response, produced in humans (or) animals by a particular food (or) substance derived there from [5].

The present study was undertaken to quantify the amount of energy yielding substances like total soluble carbohydrates (sugars) and starch, an essential vitamin ascorbic acid (vitamin C) and anti-nutritional factors like free phenols and tannins which have been reported to have several health benefits including antioxidant activities.

MATERIALS AND METHODS

For the present study 10 underground storage organs were procured from the local market and the botanical names of the crops were confirmed by referring to the Flora of Presidency of Madras [6].

Ovendried underground storage organs were powdered in wiley mill 60 mesh size and stored in screw cap bottles at room temperature to quantify the amount of energy yielding substances like total soluble carbohydrates (sugars) and starch, an essential vitamin ascorbic acid (vitamin C) and anti-nutritional factors like total free phenols and tannins.

The contents of total soluble carbohydrates were determined by the method [7] starch, vitamin C and antinutrtional factors - total free phenolics [8] and tannins [9].

RESULTS AND DISCUSSION

The present study deals with the quantification of selective nutritional and anti-nutritional components in ten underground storage organs including 3 corms, 1 rhizome, 4 tubers and 2 modified storage tap roots distributed in 8 families were listed with botanical name, family name, and vernacular names are depicted in Table 1 and the Table 2 reveals the amount of selected nutritional and antinutritional contents contained in them.

In the present study, the amount of total soluble carbohydrates (total sugars) in the tubers of *Dioscorea esculenta* is found to be higher than that of a previous study in the wild yam tubers of *Dioscorea esculenta* [10]. The starch content in the tubers of *Dioscorea esculenta* is found to be lower than that of previous studies in the tubers of *Dioscorea esculenta* [11]. The starch content in the corms of *Colocasia esculenta* is found to be higher when compared with an earlier report in the corms of *Colocasia esculenta* [12].

Ascorbic acid (Vitamin C) is a natural antihistamine which prevents histamine release and increases the detoxification of histamine [13]. Vitamin C may also be useful in lowering serum uric acid levels resulting in a correspondingly lower incidence of gout [14] and an oxidized version that can cross the blood-brain barrier

Table 1

S.No	Botanical Name	Family	Vernacular Name	Storage Organ Used
1	*Amorphophallus campanulatus* (Roxb.) Blume ex Dene.	Araceae	Saenaikilangu	Corm
2	*Amorphophallus sylvaticus* (Roxb.) Kunth	Araceae	Karnunaikilangu	Corm
3	*Colocasia esculenta* (Linn.) Schott	Araceae	Saepankilangu	Corm
4	*Daucus carota* Linn.	Apiaceae	Carrot	Modified tap root
5	*Dioscorea esculenta* (Lour.) Burk	Discoreaceae	Sirukilangu	Tuber
6	*Ipomoea batatas* (Linn.) Lam.	Convolvulaceae	Sakaraivallikilangu	Tuber
7	*Manihot esculenta* Crantz.	Euphorbiaceae	Maravallikilangu	Tuber
8	*Raphanus sativus* Linn.	Brassicaceae	Mullangi	Modified tap root
9	*Solanum tuberosum* Linn.	Solanaceae	Urulaikilangu	Tuber
10	*Zingiber officinale Rosc.*	Zingiberaceae	Ingi *	Rhizome

* unpeeled

Table 2

S.No	Botanical Name	Total soluble carbohydrates /sugar g/100g	Starch g/100g	Ascorbic acid g/100g	Total free Phenols g/100g	Tannins g/100g
1	*Amorphophallus campanulatus* (Roxb.) Blume ex Dene.	3.57	23.15	0.0079	0.90	0.58
2	*Amorphophallus sylvaticus* (Roxb.) Kunth	4.68	26.21	0.0081	0.81	0.64
3	*Colocasia esculenta* (Linn.) Schott	4.32	25.22	0.0069	0.79	0.51
4	*Daucus carota* Linn.	11.04	20.23	0.0152	0.46	0.14
5	*Dioscorea esculenta* (Lour.) Burk	3.84	24.16	0.0138	0.93	0.69
6	*Ipomoea batatas* (Linn.) Lam.	8.84	27.89	0.0125	0.39	0.08
7	*Manihot esculenta* Crantz.	7.47	31.36	0.0088	0.98	0.91
8	*Raphanus sativus* Linn.	3.85	10.87	0.0486	0.39	0.09
9	*Solanum tuberosum* Linn	5.47	28.80	0.0089	0.34	0.08
10	*Zingiber officinale Rosc.*	1.27	5.32	0.0125	0.65	0.37

may reduce neurological deficits and mortality following a stroke [15]. The ascorbic acid level in the corms of *Colocasia esculenta* is found to be higher when compared with an earlier report in the corms of *Colocasia esculenta* [12]. The levels of ascorbic acid in the modified storage tap roots of *Daucus carota* and in the tubers of *Solanum tuberosum* are found to be higher than that of a previous report in the same organs [16]. The levels of ascorbic acid in the modified storage tap roots of *Daucus carota* and *Raphanus sativus;* in the tubers of *Ipomoea batatus* and in the rhizomes of *zingiber officinale* are found to be higher than that of a previous report in the same organs [17]. The ascorbic acid level in the tubers of *Solanum tuberosum* is found to be lower than that of previous reports in the tubers of *Solanum tuberosum* [17,18].

Tannins have shown potential antiviral [19], antibacterial [20] and antiparasitic effects [21]. Tannins have also been reported to exert other physiological effects, such as to accelerate blood clotting, reduce blood pressure, decrease the serum lipid level, produce

liver necrosis and modulate immune responses [22]. It has been reported that tannins are known to inhibit the activities of digestive enzymes [23] and hence the presence of even a low level of tannin is not desirable from nutritional point of view. The corms of *Colocasia esculenta* are found to contain more tannin compared to an earlier report in the corms of *Colocasia esculenta* [12]. The tannin content in the rhizomes of *Zingiber officinale* is found to be higher when compared with a previous study in the rhizomes of *Zingiber officinale* [24]. The contents of total free phenols and tannins in the tubers of *Dioscorea esculenta* are found to be higher when compared with an earlier report in the tubers of other *Dioscorea sp*. [10]. Phenolic compounds inhibit the activity of digestive as well as hydrolytic enzymes such as amylase, trypsin, chymotrypsin and lipase [25]. But the tubers of *Dioscorea esculenta* are found to contain lower phenolic contents when compared with an earlier report in the tubers of other *Dioscorea sp*. [26]. Although tannins and phenols are considered earlier as anti-nutritional compounds, under the present nomenclature phenols fall under the category of nutraceuticals, offering many nutritional advantages to man [10].

Studies have indicated that suitable processing techniques can reduce (or) eliminate the acidity, cyanide content, phenols, tannins, trypsin and amylase inhibitors [27] It has been found that the tubers are denatured on cooking and hence do not seem to pose digestive problems [28]. Processing of tubers, corms and rhizomes tend to increase the palatability and improve the digestibility by reducing or eliminating the anti-nutritional contents.

CONCLUSION

Nutritive evaluation of this study reveals that the tubers of *Manihot esculenta* are one of the good sources of starch and ascorbic acid. Tubers of *Manihot esculenta* are found to contain more free phenols and tannins. If needed, by autoclaving (a processing method), free phenols and tannins in the tubers of *Manihot esculenta* can be reduced/ inactivated before consumption.

Based on the nutritive evaluation studies in the selected underground storage organs it can be concluded that the nutritional value of root crops that have an underground storage organ depends not only on their ability to provide dietary energy in the form of carbohydrates and considerably higher amount of vitamin C than cereals and leguminous seeds, but also cultural practices and storage conditions.

REFERENCES

1. Egwu FC Ugwu FM. (2000). Processing and preservation of food crops in reading in general Agric. Published by Research and Development Group, Ebonyl State University, Abakaliki, pp: 220-235.

2. Ugwu FM. The potentials of roots and tubers as weaning foods. Pakistan Journal of Nutrition. 2009: 8: 1701-1705.

3. Treche S. Tropical root and tuber crops as humans staple food. Conference presentee au I Congresso Latino Americano de Raizes Tropicais 1996.4.

4. Narasinga Rao BS, Deosthale YG Plant KC. (1989). Nutritive value of Indian foods. National institute of nutrition, Indian council of medical research, Hyderabad, India.

5. Liener IE 1994. Implications of antinutritional components in soybean foods. CRC Crit. Rev. Food Sci. Nutr.1989: 34: 31-67.

6. Gamble JS. Flora of the Presidency of Madras Vol. I-III Publ: Bishensingh Mahendra Pal Singh.1986 P. 1-2017.

7. Yemm EW Willis AJ. The estimation of carbohydrates in plant extracts by anthrone. J. Biochem.1954: 57: 508 514.

8. Sadasivam S Manickam A (Eds.).Biochemical methods. New Age International (P) Limited Publishers, New Delhi, India. 1996. pp. 1-250.

9. Burns RR. Methods for estimation of tannin in grain, Sorghum. Agron. J.1971: 63: 511-512.

10. Shanthakumari S Mohan VR Britto JD. Nutritional evaluation and elimination of toxic principles in wild yam (Dioscorea spp.). Tropical and Subtropical Agroecosystems. 2008: 8: 319-325.

11. Paneerselvam R Abdul Jaleel C. Starch and sugar conversion in *Dioscorea esculenta* tubers and Curcuma longa rhizomes during storage. Caspian J. Env. Sci. 2008: 2:151-160.

12. Mohan VRM Kalidass C. Nutritional and anti-nutritional evaluation of some unconventional wild edible plants. Tropical and Subtropical Agroecosystems. 2010:12: 495-506.

13. Johnston CS Martin LJ Cai X. Antihistamine effect of supplemental ascorbic acid and neutrophil chemotaxis. *Am Coll. Nutr. 1992:* 11: 172176.

14. Choi H.K Gao X Curhan G Xiang Gao Curhan G. "Vitamin C intake and the risk of gout in men". *Archives of Internal Medicine.* 2009: 169: 502507.

15. Huang J Agus DB Winfree CJ Kiss S Mack WJ McTaggart RA Choudhri TF Kim LJ Mocco J Pinsky DJ Fox WD Israel RJ Boyd TA Gold DW Connolly ESJr. "Dehydroascorbic acid, a blood-brain barrier transportable form of vitamin C, mediates potent cerebroprotection in experimental stroke". *Proceedings of the National Academy of Sciences. 2001:* 98: 1172011724.

16. Melo EDA Lima VLAG Machel MIS.. Polyphenol, ascorbic acid and total carotenoid contents in common fruits and vegetables. Braz. J. Food. Technol. 2006: 2: 89-94.

17. Ogunlesi M Okiei W Azeez L Obakachi V Osunsanmi M Nkenchor G. Vitamin C contents of tropical vegetables and foods determined by voltametric and titrimetric methods and their relevance to the medicinal uses of the plants. Int. J. Electrochem. Sci. 2010: 5: 105-115.

18. Lee SK Kader AA Pre harvest and post harvest factor influencing vitamin C contents of horticultural crops. Post harvest Biology and Technology. 2000: 20: 207 220.

19. Akiyama H Fujii K Yamasaki O Oono T Iwatsuki K.. "Antibacterial action of several tannins against Staphylococcus aureus". *J. Antimicrob. Chemother. 2001:* 48 (4): 487491.

20. Kolodziej H Kiderlen AF. Antileishmanial activity and immune modulatory effects of tannins and related compounds on Leishmania parasitised RAW 264.7 cells. *Phytochemistry. 2005:* 66: 205671.

21. Junior N Helio V. "Neuroprotective actions of tannins from Myracrodruon urundeuva on 6-hydroxydopamine-induced neuronal cell death". *Journal of Herbs, Spices & Medicinal Plants* (Haworth Press) 2007: 13 (2).

22. Archana A Bele Varsha M Jadhav Kadam VJ 2010. Potential of Tannins: A Review. Asian Journal of Plant Sci. 2010:

9: 209-214.

23. Jumbunathan R Singh U. (1981). Grain quality of pigeon pea. IN: Proceeding of the International workshop on pigeon pea. Vol I. ICRISAT, Hyderabad, Andhrapradesh, India. pp 351-356.

24. Nwinuka NM Ibeh GO Ekeka GI. Proximate composition and levels of some toxicants in four commonly consumed species. J. Appl. Sci. Environ. Manag. 2005: 9: 150-155.

25. Salunkhe DK Sathe SK Reddy NR. (1982). Legume lipids. In: Chemistry and Biochemistry of Legumes. (Ed.) Arora, S.K. Oxford & IBH Publishing Co., New Delhi, India. pp. 51-107.

26. Arinathan V Mohan VR Maruthupandian A. Nutritional and anti-nutritional attributes of some under-utilized tubers. Tropical and Subtropical Agroecosystems. 2009: 10: 273-278.

27. Balagopalan, C (Ed.). (2000). Integrated technologies for value addition and post harvest management in tropical tuber crops. Central Tuber Crops Ressearch Institute, Kerala, India.

28. Hammer BC Shaw DC Bradbury JH. 1989. Trypsin inhibitor from Colocasia esculenta, Alocasia macrorrhiza and