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Research Article

Quantitative Estimation of Anti-Nutritional Factors (ANF) of Taro (*Colocassia Esculenta*) and Development of ANF Minimization Method

Ketki Rode*, Dnyaneshwar Khodse, Ajay Shinde, Shweta Jadhav, Asiyanujahat Shaikh, Preeti Sharma, Priyanka Pingat, Sonia Sharma, Vaibhav Samudre

Department of Pharmacology, Dr. D. Y. Patil Pharmaceutical Sciences and Research, Pimpri, Pune-411018, India

ABSTRACT

The term Taro is used to refer *Colocasia esculenta* belonging to aroid family (Aracaceae). Nutritionally, Taro contains more than twice the carbohydrate content of potatoes, minerals like calcium, phosphorus, iron, potassium and magnesium, Vitamin C, thiamin, riboflavin and niacin. The reported activities of Taro include anti-diabetic, anti-oxidant, fungicide, anti-lipidemic, anti-cancer anti-anaemic, anti-inflammatory, anti-allergic, hepatoprotective and anti-viral properties. Also, it is used in nutritional deficiency and malnutrition. Taro not only provides nutritional values but also responsible to manage various conditions like diabetes and increased lipid profile. Inspite of possessing these good properties, Taro cannot be used for nutrition as it also possess Anti-Nutritional Factors (ANF) like mucilage, oxalic acid, tannis, cyanides, lectins, alpha-amylase inhibitors and protease inhibitors. Therefore, methods to reduce the level of ANF can be used and the ANFs can be quantitively estimated which gives a challenge to the researchers to serve a better nutritional supplement to the patients in need. If validated methods to remove ANFs are found, then Taro can serve as a marvelous herb to treat many abnormalities.

Keywords: *Colocassia esculenta*; Taro; Anti-nutritional factors; Mucilage; Oxalate

INTRODUCTION

Taro (*Colocassia esculenta*), an annual herbaceous plant belong to the Araceae family [1] and genus *colocassia. Colocassia* genus is edible with large leaves and food storing underground stems (corms). It is best planted in environment that is high in humidity and rainfall level of 1000 mm in soil with pH 5.5-5.6 and optimum temperature 21-27˚C (4). It is a well-known plant with long history of cultivation [2,3]. The main concern when a crop is being considered as a food source is its nutritional value [4]. Also root crops contain a wide variety of minerals and trace elements which includes relatively substantial quantities of iron and calcium, as well as potassium and magnesium [5,6]. It is low in vitamin C and deficient in vitamins A. It is a good source of minerals [7].

Taro contains a wide variety of minerals and trace elements which includes relatively substantial quantities of iron and calcium, as well as potassium and magnesium [5,6]. It is low in vitamin C and deficient in vitamins A. It is a good source of minerals [7]. It is a good source of energy, minerals, and vitamins and also contains phytochemicals and crude fibres. In spite of having nutritional value, Taro also contains Anti-Nutrional Value (ANF) which limits its use and reduces the nutritional value of a root crop. The main anti-nutrients that exist in taro are: mucilage, oxalic acid, tannins, cyanide, lectins, alpha–amylase inhibitors, protease (trypsin and chymotrypsin) and inhibitors [8].

Presence of anti-nutritional factors limits the use of taro and result in various toxic effects due to accumulation of ANF. Reduction in ANF will improve nutritional value of a vegetable and can promote various health effects. Therefore, researchers have studied various methods of reducing ANF in Taro which will give insight in reducing side effects and may help in further development of Taro as a nutritional supplement and may help researchers to formulate more effective treatment option for various diseases like mineral deficiency, diabetes, cardiovascular disorders, immunomodulatory properties [9].

Correspondence to: Ketki Rajesh Rode. Department of Pharmacology, Dr. D. Y. Patil Pharmaceutical Sciences and Research, Pimpri, Pune-411018, India, E-mail: ketki.rode11@gmail.com

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The main aim of the study is to develop and evaluate effect of various methods for reduction of anti-nutritional factors. Authors have investigated and compared the effect of various methods described here.

MATERIALS AND METHODS

Plant material

Fresh leaves of Taro (*colocassia escluenta*) were collected from local market of Pimpri, Pune, Maharashtra, India. The Leaves were plucked from the stalk and washed with potable water to remove adhering soil, dirt and contamination. The leaves were divided into 6 groups. One group did not receive any pretreatment while the other 5 groups received pretreatment [10-15]. After pre-treatment, leaves from all groups were air-dried for a period of 8 days and powdered.

Pre-treatment groups

- Group I: No treatment (leaves were washed, dried and powdered).
- Group II: Soaking method
- Group III: Pressure cooker method
- Group IV: Boiling method
- Group V: Fermentation
- Group VI: Pre-curding

Methods for pre-treatment

Soaking method: 8-9 fresh taro leaves were soaked in a beaker full of water for 18 hours. After 18 hours of soaking leaves were dried for a period of 7-8 days and powdered to perform test for determination of ANF.

Pressure cooker method: 8-9 fresh taro leaves were added to pressure cooker and pressure cooked for 15 minutes. The leaves were then dried for a period of 7-8 days to form powder and to find the levels of ANF.

Boiling Method: 1500 ml water was added to 8-9 fresh taro leaves. It was then boiled at 92° C for 45 minutes. It was then dried at 50 degree overnight. The leaves were then powdered and tests were performed accordingly.

Fermentation: 8-9 fresh taro leaves were added to a beaker with 500 ml distilled water. It was kept at room temperature for 72 hours. The supernatant was discarded leaves were then dried for a period of 7-8 days to form powder and to find the levels of ANF.

Pre-curding: 8-9 fresh taro leaves were cut into small pieces using knife. It was then heated at 60 °C in water for 12 minutes. Upper portion of boiled leaves was discarded. The extract was pressed to produce a green curd. Green curd were dried and powdered to check the levels of ANF [16-20].

Determination of ANF

Oxalate determination: 1 mg/ml stock solutions of various pre-treatment groups were prepared. To it, one drop of an aqueous solution of 5% (w/v) MnSO4 added and heated to between 70 and 80°C, and titrate rapidly with 0.01 N KMnO4. A 'control' sample of powdered calcium oxalate (20 mg) when treated in the same manner should give a recovery of 99 to 100% after allowing for titration blanks (1 ml of O.O1N KMnO4 is equivalent to 0.45 mg of oxalic acid) [21].

Tannins: Stock solution of 1 mg/ml of tannin acid was prepared by dissolving 100 mg of accurately weighed tannic acid in water. About 1-10 ml aliquots were taken in clear test tube and 0.5 ml of Folin-Denis reagent, 1 ml of sodium carbonate solution were added to each test tube. Each tube was made upto 10 ml with distilled water. All the reagents in each tube were mixed well and kept undisturbed for about 30 min and read at 760 nm against blank reagent [22].

Mucilage: Briefly, 2 g of dry samples mixed with 10 ml of acidified distilled water (pH=3.7). Then, 200 ml of distilled water (the same pH as above) was added and blended for 20 minutes. After separating the waste products using a Buchner funnel, the remaining solution was centrifuged and ethanol 96% was added (4 times the solution volume). The final solution kept at 4°C for 24 hours to mucilage precipitation. The precipitate was separated by vacuum filtration using a Buchner funnel and then weighted after drying [23,24].

RESULTS

Oxalate Determination

Accumulation of oxalate results in formation of calcium oxalate stones in the body. Group-III (Pressure cooker method) significantly reduced the levels of oxalates as compared to the Group-I (Not receiving any pre-treatment) (Figure 1) [25-27].

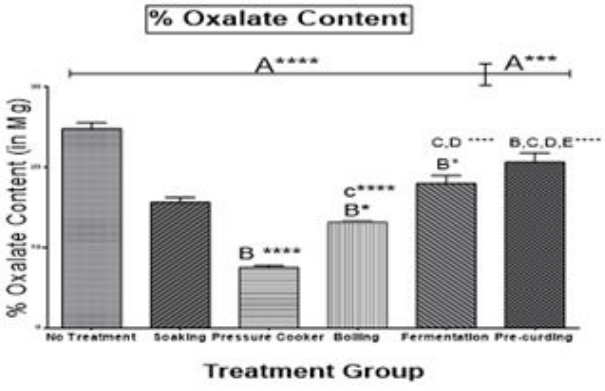

Figure 1: Representation of comparison of % oxalates content in various treatment methods. All values are expressed as mean ± SEM, n=3 by using One Way ANOVA followed by Sidak's multiple comparison test. (a) No treatment is compared with all treated groups; (b) Soaking (B) is compared with all treated groups; (c) Pressure Cooker (C) is compared with all treated groups; (d) Boiling (D) is compared with all treated groups; (e)Fermentation (E) is compared with all treated groups; *p<0.05, **p<0.01, ***p<0.001, ****p<0.0001, NS: Non-Significant.

Tannins determination

The level of tannins in various pre-treatment groups were compared and Group-III was found to be most effective in reducing the level of tannins compared to the Group-I (Figure 2) [18-35].

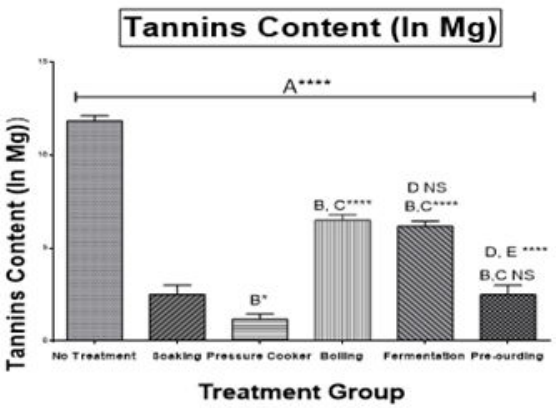

Figure 2: Representation of comparison of Tannins content in various treatment methods. All values are expressed as mean ± SEM, n=3 by using One Way ANOVA followed by Sidak's multiple comparison test. (a) No treatment is compared with all treated groups; (b) Soaking (B) is compared with all treated groups; (c) Pressure Cooker (C) is compared with all treated groups; (d) Boiling (D) is compared with all treated groups;(e)Fermentation (E) is compared with all treated groups;*p<0.05, **p<0.01, ***p<0.001, ****p<0.0001, NS: Non-Significant.

Mucilage content

The mucilage contents in various pre-treatment groups were compared and Group-III was found to be most effective in reducing the level of tannins compared to the Group-I [Figure 3].

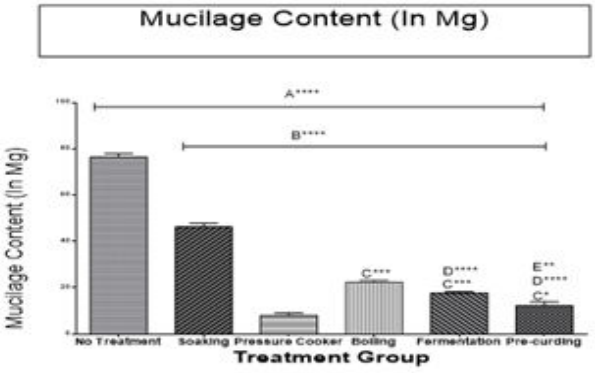

Figure 3: Representation of comparison of Mucilage content in various treatment methods. All values are expressed as mean ± SEM, n=3 by using One Way ANOVA followed by Sidak's multiple comparison test. (a)No treatment is compared with all treated groups; (b) Soaking (B) is compared with all treated groups; (c) Pressure Cooker (C) is compared with all treated groups; (d) Boiling (D) is compared with all treated groups; (e) Fermentation (E) is compared with all treated groups; *p<0.05, **p<0.01, ***p<0.001, ****p<0.0001, NS: Non-Significant.

DISCUSSION

Taro, one of the best food supplements for farmers and poor peoples, unnoticed fact which can be a great food supplements if ANF can be reduced. Reduction in ANF like oxalate, Phytates, tannins and mucilage requires attention and give insights to the researchers. Development in the effective method to reduce ANF can be used for treatment of various disorders like cardiovascular disorder, immunomodulatory property, anti-diabetic activity, anti-oxidant property. After extensive literature survey, authors compared the levels of ANF in various treatment groups and all pretreatments methods showed significantly decreased levels of ANF as compared to no treatment group (Group-I). Multiple comparisons were carried out by using One-way ANOVA method and Pressure Cooker Method (Group-III) was found to be most effective in reducing the levels of ANF [36-46].

CONCLUSION

From various multiple comparisons, it has been observed that pressure cooker method is most effective in reducing the levels of ANF which was the main of the present study. It may give researchers further insights to study qualitative and quantitative measurements of nutritional as well as anti-nutritional factors to develop Taro as a best nutritional supplement.

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REFERENCES

1. Monte-Neshich DC, Rocha TL, Guimarães RL, Santana EF, Loureiro ME, Valle M, et al. Characterization and spatial localization of the major globulin families of taro (*Colocasia esculenta* L. Schott) tubers. Plant Sci. 1995; 112(2):149-59.
2. Taiwo AA, Agbotoba MO, Oyedepo JA, Shobo AA, Oluwadara I, Olawuro MO. Effect of processing on proximate composition and mineral contents of selected indigenous soup-vegetable of Akwa Ibom State. AJFAND. 2007; 7:1-8.
3. Odedeji JO, Akande EA, Oladele AK, Adebayo-Oyetaro AO. Chemical Attributes and Consumer Acceptability of Blends of Fruit Juices from African Star Apple (Chrysophywum albidum) and Mango (Mangifera indica). J Applied Sci 2007; 10(4): 7353-63.
4. Oyeleke, G.O. (2007). Proximate Analysis of Common Vegetables in South-Western Tropics of Nigeria. A Journal of Contemporary Issues in Business and Technology. Vol. (2) No. 4. (2007): 72 – 79.
5. Huang JA, Zhang YL, Zhao Y, Zhang XL, Sun ML, Zhang W. Superhydrophobic SERS chip based on a Ag coated natural taro-leaf. Nanoscale. 2016; 8(22):11487-93.

6. Njintang YN, Mbofung CM. Effect of precooking time and drying temperature on the physico-chemical characteristics and in-vitro carbohydrate digestibility of taro flour. LWT LWT-FOOD SCI TECHNOL. 2006; 39(6):684-91.
7. Phillippy BQ, Lin M, Rasco B. Analysis of phytate in raw and cooked potatoes. J Food Compos. Anal. 2004; 17(2):217-26.
8. Lewu MN, Adebola PO, Afolayan AJ. Effect of cooking on the mineral contents and anti-nutritional factors in seven accessions of *Colocasia esculenta* (L.) Schott growing in South Africa. J Food Compos Anal 2010; 23(5):389-93.
9. Hodgkinson A. A combined qualitative and quantitative procedure for the chemical analysis of urinary calculi. J Clin Pathol1971; 24(2):147-51.
10. Elgailani IE, Ishak CY. Determination of tannins of three common Acacia species of Sudan. Adv Chem. 2014; 2014:1-5.
11. Andrade LA, Nunes CA, Pereira J. Relationship between the chemical components of taro rhizome mucilage and its emulsifying property. Food Chem. 2015; 178:331-8.
12. Fu YC, Ferng LH, Huang PY. Quantitative analysis of allantoin and allantoic acid in yam tuber, mucilage, skin and bulbil of the Dioscorea species. Food chem. 2006; 94(4):541-9.
13. Duangmal K, Apenten RK. A comparative study of polyphenoloxidases from taro (*Colocasia esculenta*) and potato (Solanum tuberosum var. Romano). Food Chem.1999; 64(3):351-9.
14. Lebot V, Aradhya KM. Isozyme variation in taro (*Colocasia esculenta* (L.) Schott) from Asia and Oceania. Euphytica. 1991; 56(1):55-66.
15. Aletor V.A and Adeogun, O.A., Nutrient and Antinutrients in Fluted Pumpkin (*Telfaira occidentalis*) J Food Chem 70(1995): 235 – 240.
16. Doll R. An overview of the epidemiological evidence linking diet and cancer. Proc Nutr Soc 1990; 49(2):119-31.
17. Oyenuga VA, Fetuga BL. First national seminar on fruits and vegetables. process and Recombination by NIHORT, Ibadan, Nigeria. 1975 :13-7.
18. Loy TH, Spriggs M, Wickler S. Direct evidence for human use of plants 28,000 years ago: starch residues on stone artefacts from the northern Solomon Islands. Antiquity. 1992; 66(253):898-912.
19. Ranjhan, S.R and Krishna, G., In Laboratory Manual of Nutritive Research eds. S.R Ranjhan and G. Krishna Vikas Publishing Company. (1980), New Delhi, India.
20. Larmond E. Laboratory methods for sensory evaluation of food. Research Branch, Canada Dept. of Agriculture; 1977.
21. Oboh G. Tropical green leafy vegetables prevent garlic-induced hepatotoxicity in the rat. J Med Food 2006; 9(4):545-51.
22. Odedeji JO, Oyeleke GO, Ayinde LA, Azeez LA. Nutritional, antinutritional compositions and organoleptic analyses of raw and blanched cocoyam (*Colocasia esculenta*) leaves. IOSR j. environ. sci., toxicol. food technol.. 2014;8(2):45-8.
23. Burns RE. Method for estimation of tannin in grain sorghum 1. Agronomy Journal. 1971; 63(3):511-2.
24. Alcantara RM, Hurtada WA, Dizon EI. The nutritional value and phytochemical components of taro [*Colocasia esculenta* (L.) Schott] powder and its selected processed foods. J Nutr Food Sci. 2013; 3(207):2.
25. Gemede HF, Fekadu H. Nutritional composition, antinutritional factors and effect of boiling on nutritional composition of Anchote (*Coccinia abyssinica*) tubers. Journal of Scientific and Innovative Research. 2014; 3(2):177-88.
26. Massey LK, Palmer RG, Horner HT. Oxalate content of soybean seeds (Glycine max: *Leguminosae*), soyfoods, and other edible legumes. J. Agric. Food Chem. 2001; 49(9):4262-6.
27. Khare SK. Application of immobilized enzymes in soybean processing. InThe Third International Soybean Processing and Utilization Conference (ISPCRC III) 2000 Oct 15 (pp. 15-20).
28. Reddy NR. Occurrence, distribution, content, and dietary intake of phytate. InFood phytates 2001 (pp. 41-68). CRC Press.
29. Anonymous (1973) Tannic acid gain, Food Cosmetol Toxicol. In: Toxicants naturally occurring in foods. Natl Acad Sci p: 112.
30. Arnaud-Vinas MD, Lorenz K. pasta products containing taro (*Colocasia esculenta* L. Schott) and chaya (*Cnidoscolus chayamansa* L. McVaugh). J. Food Process. Preserv.1999.
31. Jane JL, Chen JF. Effect of amylose molecular size and amylopectin branch chain length on paste properties of starch. Cereal Chemistry. 1992;69(1):60-5.
32. Wang JK, Higa S. Taro, a review of *Colocasia esculenta* and its potentials.
33. Emmanuel-Ikpeme CA, Eneji CA, Essiet U. Storage stability and sensory evaluation of taro chips fried in palm oil, palm olein oil, groundnut oil, soybean oil and their blends. Pak J Nutr. 2007;6(6): 570-5.
34. World Health Organization, Joint FAO/NACA/WHO Study Group on Food Safety Issues Associated with Products from Aquaculture. Food safety issues associated with products from aquaculture: report of a joint FAO/NACA/WHO study group. World Health Organization; 1999.
35. Lucy M, Reed E, Glick BR. Applications of free living plant growth-promoting rhizobacteria. Antonie van leeuwenhoek. 2004 ;86(1): 1-25.
36. Tegelaar EW, De Leeuw JW, Largeau C, Derenne S, Schulten HR, Müller R, et al. Scope and limitations of several pyrolysis methods in the structural elucidation of a macromolecular plant constituent in the leaf cuticle of Agave americana L. J Anal Appl Pyrolysis 1989 ; 15:29-54.
37. Njoku PC, Ohia CC. Spectrophometric estimation studies of mineral nutrient in three cocoyam cultivars. Pak J Nutr. 2007;6(6): 616-9.
38. Mbofung CM, Aboubakar NY, Njintang YN, Abdou B, Balaam F. Physicochemical and functional properties of six varieties of taro (*Colocasia esculenta* L. Schott) flour. J Food Sci Technol. 2006;4(2):135-42.
39. Englberger L, Aalbersberg W, Ravi P, Bonnin E, Marks GC, Fitzgerald MH, et al. Further analyses on Micronesian banana, taro, breadfruit and other foods for provitamin A carotenoids and minerals. J. Food Compos. Anal. 2003; 16(2):219-36.
40. Mergedus A, Kristl J, Ivancic A, Sober A, Sustar V, Krizan T, et al. Variation of mineral composition in different parts of taro (*Colocasia esculenta*) corms. Food Chem. 2015; 170:37-46.
41. Foley S, Navaratnam S, McGarvey DJ, Land EJ, Truscott TG, Rice-Evans CA. Singlet oxygen quenching and the redox properties of hydroxycinnamic acids. Free Radic Biol Med. 1999; 26(9-10): 1202-8.
42. Hollyer JR, Sullivan JL, Josephson M. Taro Mauka to Makai, a Production and Business Manual for Growers of Taro in Hawai'i. College of Tropical Agriculture and Human Resources, University of Hawai'i. 1997.
43. Bradbury JH, Nixon RW. The acridity of raphides from the edible aroids. J. Sci. Food Agric.1998; 76(4):608-16.
44. Catherwood DJ, Savage GP, Mason SM, Scheffer JJ, Douglas JA. Oxalate content of cormels of Japanese taro (*Colocasia esculenta* (L.) Schott) and the effect of cooking. J. Food Compos. Anal. 2007; 20(3-4):147-51.
45. Standal BR. Nutritive value [Taro, *Colocasia esculenta*, leaves and stems for green vegetables in Hawaii, Pacific Countries, Southeast

Asia, India, West Indies, Africa; Pacific Islands; South East Asia; West Indies Associated States].

46. Ayele E, Urga K, Chandravanshi BS. Effect of cooking temperature on mineral content and anti-nutritional factors of yam and taro grown in southern Ethiopia. Int. J. Food Eng. 2015; 11(3):371-82.