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Research Article

Anti-Nutrient Composition of Milk Yam (*Ipomoea digitata* L.) Tuber

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Abstract

Milk yam (*Ipomoea digitata* L.) tubers are medicinal and contain an ideal nutrient composition favouring diabetic diet but its anti-nutrient composition remain unexploited. Anti-nutrients viz., oxalates, phytic acid, tannins and trypsin inhibitors in fresh milk yam tubers were analysed and was compared with milk yam tuber powder. Milk yam tuber powder with reduced tannins (3.90 mg/ 100g), phytic acid (36.20 µg/ 100 g), oxalates (18.20 mg/ 100g) and trypsin inhibitor (10.45 mg/ 100g) can be prepared when fresh milk yam tubers are dried by adopting standardized postharvest handling protocol. Milk yam tubers with reduced anti-nutrients can be effectively used as such in folkloric medicine or as an ingredient in dietary supplements.

Keywords: diabetic, dietary, phytic acid, oxalates, trypsin, tannins

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Introduction

Milk yam (*Ipomoea digitata* L.) is a tuberous climber commonly habituated near river banks, lakes, ponds etc. Its tubers are having cream, yellow, orange or brown skin colour, tuber length more than 30 cm, approximate 25 cm girth and more than two kilo gram weight. Mature tuber when cut horizontally shows annulations through which latex exudates [1]. The tubers are rich in therapeutically active phytochemicals and nutrients favouring its use as a dietary supplement for curing emaciation in children, diabetic patients and as a rasayana preparation in Ayurveda [2, 3].

Milk yam tubers raised using vine cuttings of the plant is ready for harvest by 21 months after transplanting [4]. Tubers at this stage reported superior physical quality total ash - 4.74 %, acid insoluble ash - 0.60 %, water soluble ash - 3.22 %, crude fiber - 7.3 % and pH value - 5.29 that could meet Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) standards [5]. After adopting thorough postharvest handling operations milk yam powder (100 g) with superior nutrient composition - carbohydrate (50.82 g), protein (12.44 g), fat (1.33 g), total ash (3.56 g), crude fiber (7.13 g), calcium (3.40 mg), iron (2.47 mg), sodium (2.53 mg), vitamin A (613.33 µg) and vitamin C (7.43 mg) can be developed. Its nutrient content is really confirming its addition in geriatric diet since it is rich in fiber, moderate carbohydrate, and protein as well as low in fat [6, 7]. But its anti-nutrient content is still remaining unexplored hence, the present study aimed on it.

Materials and Methods

Anti-nutrient composition in mature milk yam tubers harvested at 21 months after planting was done raising the crop in Instructional Farm, College of Agriculture, Vellayani under rainfed and organic management conditions. Milk yam tuber powder prepared by adopting different pre-treatments like peeling, shredding, washing three times-dewatered by keeping in bamboo basket and dried in hot-air oven at 60 ^{0}C [3, 6] and fresh milk yam tubers were analysed for anti-nutrient components viz., oxalates, phytic acid, tannins and trypsin inhibitors.

Oxalates (mg/ 100 g)

A mixture of milk yam tuber powder, hydrochloric acid, caprylic alcohol and water was boiled, cooled and re-dissolved in sulphuric acid to obtain total oxalates. Total oxalates were analysed using spectrophotometer at 340 nm following Nip *et al*. [8].

Phytic Acid (mg/ 100 g)

Phytic acid present in milk yam tuber powder was extracted by centrifugation with the addition of three per cent trichloroacetic acid, ferric chloride and sodium hydroxide. The precipitate was washed and dissolved using 3.20 N nitric acid followed by addition of 1.50 M potassium thiocyanate and read the absorbance read at 480 nm [9].

Tannins (mg/ 100 g)

Tannins present in milk yam tuber powder was extracted by centrifugation after addition of methanol. Tannins when reacted with vanillin-hydrochloric acid, a coloured complex of resourcinol was formed and the absorbance was read at 500 nm. A graph was plotted against standard gallic acid and amount of tannic acid was calculated [10].

Trypsin Inhibitor (mg/ 100 g)

Trypsin inhibitor activity was determined by enzymatic assay developed by Kakade *et al*. [11]. Reaction mixture containing milk yam tuber powder and enzymes was treated with glacial acetic acid to stop the reaction. Absorbance was recorded at 410 nm against a blank. Trypsin inhibitor activity (Inhibition per cent) is defined in terms of number of trypsin units inhibited.

$$\text{Inhibition per cent} = \frac{(\text{Absorbance of control–Absorbance of sample}) \times 100}{\text{Absorbance of control}}$$

Results and Discussion

Anti-nutritional factors are compounds of plant origin which reduce the nutrient utilization and/or food intake humans or animals and they play a vital role in determining the use of plants as a food source [12]. These are secondary metabolites of plants and it include alkaloids, cyanogenic glycosides, cardiac glycosides, flavonoids, saponins, phytosterols, resins, tannins, trypsin (protease) inhibitors, oxalates, phytates, haemagluttinins (lectins), coumarins etc. [13]. Some of these may cause harmful biological responses, so we have to properly address the issue by adopting adequate processing methods [4].

Anti-nutritional factors viz., tannin, phytic acid, oxalate and trypsin inhibitor of milk yam tuber powder was lower than the fresh milk yam tubers (**Table 1**). Fresh milk yam tuber contained 3.15, 46.30, 83.20 and 19.28 mg 100/ g tannin, phytic acid, oxalate and trypsin inhibitor respectively and that of the dried milk yam powder were 3.90, 33.30, 12.20 and 9.28 mg 100/ g respectively.

Table 1 Anti-nutritional composition of fresh tuber vs milk yam (*Ipomoea digitata* L.) tuber powder

Parameters	Fresh Tuber	Milk Yam tuber powder
Tannin (mg /100 g)	3.15	3.90
Phytic acid (µg/ 100 g)	46.30	36.20
Oxalates (mg/ 100 g)	83.20	18.20
Trypsin inhibitor (mg/ 100 g)	19.28	10.45

Fresh milk yam tubers (100 g) when processed to milk yam tuber powder by adopting standardized protocol [3, 6] could reduce 69.84 per cent tannins, 81.02 per cent phytic acid, 94.69 per cent oxalates and 86.83 per cent trypsin inhibitors (**Figure 1**). Tannin rich foods exert negative effect on bio-availability of proteins, inhibits digestive enzymes, affects the utilization of vitamins and minerals and affects iron absorption [15]. Reduction in tannin content might be due to thermal degradation, denaturation as well as formation of insoluble complexes [16] or by leaching while washing [17]. Similar report existed for raw and powdered taro 32.24 mg/ 100 g too how beit, it is not a significant value in view of the total acceptable tannic acid intake for an adult man (560 mg) [18].

Akaninwor and Okechukwu [19] reported a similar reduction in tannin content of weaning mixes produced using sweet potato-cray fish-soyabean/ Bambara ground nut mixtures by adopting processing techniques like soaking and drying besides, in Polynesian arrow root (*Tacca leontopetaloides* L.) by steeping in water for sometimes [20]. Cooking, boiling, auto-claving etc. can further reduce the tannin content as reported in taro (6.69 per cent reduction), lablab seeds (60-70 per cent reduction), Anchote tubers (30.16 per cent). Hopefully the effect of tannins can be further reduced on cooking the milk yam flour.

Phytates in food lowers the availability of several dietary minerals like iron, zinc, phosphorous etc. [21]. Phytate concentration recorded in 100 g fresh milk yam tubers (46.30 µg) as well as dried milk yam tuber powder (36.20 µg), were far below the values prescribed by FAO and hence was expected to enhance the bio-availability of proteins and dietary minerals [22]. A higher reduction of phytates (81.02 per cent) was obtained through pre-treatments and drying operations of milk yam tubers, which might be due to the leaching of phytic acid by the action of endogenous phytases, degeneration due to heat on drying or due to the formation of insoluble complexes between phytate and protein and protein-mineral complexes [23]. A similar reduction in phytates by soaking in tap water before drying were reported on Bambara ground nut (45.92 per cent) and soya bean flours (74.78 per cent) by Akaninwor and

Okechukwu [19] and in Faba beans (*Vicia faba* L., nine per cent to 24 per cent reduction) by Luo *et al*. [24]. A further reduction of phytates can be ensured through cooking since several studies on taro [18, 25], peanut, soyabean, sun flower, pigeon pea and rice [14, 26] have been reported so. Thus, we can ensure that the dietary supplement developed from milk yam tuber powder will be a consumable product with little phytate.

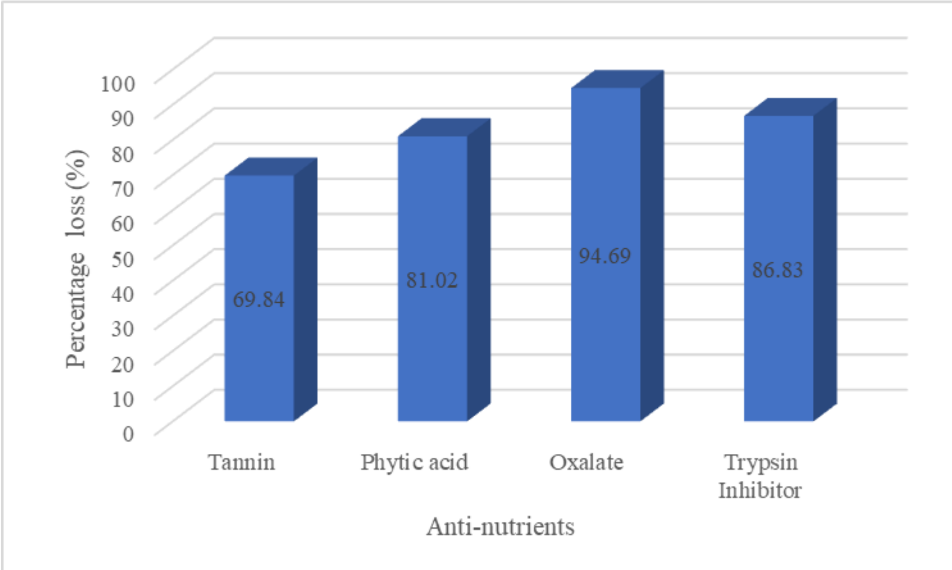

Figure 1 Anti-nutrient reduction (per cent) in milk yam (*Ipomoea digitata* L.) tuber powder

The threshold safe level of calcium oxalate in food is 71 mg/ 100 g [27]. Higher levels of oxalates are deleterious to calcium absorption and cause kidney disfunction [28]. The raw milk yam tubers contained 83.20 mg/ 100 g which underwent pre-treatments like peeling, shredding, washing for three times and dried in hot air oven at 60 ^{0}C to obtain milk yam tuber powder (24.30 g) containing only 4.42 mg of oxalates. A higher reduction of oxalates (94.69 per cent) was made possible which might be due to the pre-treatments adopted in the preparation of the tuber powder since, oxalates are water soluble [29]. Huang *et al*. [30] proved that washing could reduce 9.20 per cent of oxalates, Akpan and Umoh [31] reported peeling could also reduce oxalate and Buntha *et al*. [32] reported dicing the taro tubers could enhance leaching of oxalates. Alcantara *et al*. [18] surmised that pre-treatments combined with drying operations might have resulted in a high reduction of oxalate content of 77.18 per cent, when producing taro powder. As like tannins and phytic acid, several studies reported that boiling or cooking the tubers could cause a further reduction of oxalates in food [25, 33, 34]. Hence, milk yam tuber powder can be cooked for reducing oxalates to an insignificant value and rendering them more nutritive.

Trypsin inhibitor (protease inhibitor) reduces the biological activity of trypsin and can have an anti-nutritional effect. Trypsin inhibitors are present in many tropical root crops like sweet potatoes, giant taro, taro, potatoes etc. and several studies had reported the inactivation of trypsin inhibitors in them by suitable postharvest handling operations [35, 36]. In this study, only 13.17 per cent of trypsin was retained in the flour prepared using milk yam tuber shreds washed three times, dewatered using a bamboo basket and oven dried at 60 ^{0}C for 12.33 hours. Reduction of trypsin inhibitors (86.83 per cent) might have happened during drying process too due to its heat labile nature. Kiran and Padmaja [37] had obtained 10-20 per cent reduction of trypsin inhibitor activity (TIA) on oven drying sweet potato slices at 70 ^{0}C just for two hours. Those dried sweet potato slices when powdered to flour TIA further reduced to 88-95 per cent. Pre-treatments including washing followed by cooking the milk yam flour before consumption may further reduce the TIA as proved by Osman [38] on beans. Caddick *et al*. [39] had documented the effectiveness of soaking, washing and repeated rinsing in clean water for removing the toxic components in Dioscoreaceae and Dioscoreales. In short, the toxic effects of tannins, phytates, oxalates and trypsin inhibitor in milk yam will be negligible when it is dried by adopting the developed pre-treatments and cooked before consumption.

Conclusion

Anti-nutrients present in the milk yam tubers can be reduced to tolerable levels by adopting standardized postharvest handling protocol so that it will be safe for consumption for both folkloric and standardized drug preparations and also favours its utilization for developing dietary supplement.

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