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Cultural Practices, Nutritional and Anti-nutritional Composition of Anchote (*Coccinia abyssinica*)

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Abstract: Anchote [*Coccinia abyssinica* (Lam.) Cogn] is one of the indigenous annual trailing vines belonging to the cucurbitaceae family. It is cultivable in the south southwestern parts of Ethiopia. The crop is rich in nutritional, major and minor trace elements and comparatively less amount of anti-nutritional than other roots and tuber crops. However, the crop is neglected and there is less awareness and scientific information regarding the nutritional and anti-nutritional composition of the crop. Thus, this review paper is aimed to pinpoint highlight cultural utilization practices, nutritional contents *viz.* protein content, fat, fiber, ash, moisture, carbohydrate and energy, and anti-nutritional factors such as (phytate, oxalate, tannin and cyanide). Traditional practices to make anchote more palatable, digestible, to inactivate enzyme inhibitors, and other anti-nutritional factors to qualify it for human consumption were also mentioned. The crop has tremendous nutritional qualities and safe anti-nutritional components. Even though, anchote has such attractive nutritional and socio-economic importance less attention is given to maintain processing quality, reduction of anti-nutrition and standardizing the indigenous knowledge of processing. Thus, the review confirmed that as anchote is untapped food crop to fill foods gaps and feed alarmingly increasing population growth in Ethiopia.

Keywords: Anchote, Boiling, Calcium, Root Crops, Phytate

1. Introduction

Anchote [*Coccinia abysinica* (Lam.) Cogn.] is a trailing vine tuberous crops, belongs to Cucurbitaceous family and grown annually [1]. It is an indigenous root crop commonly produced and highly utilized in the socio-economics of Oromo nation around the South and South Western in Wollega, Ilubabor, Kafa and Sidamo in Ethiopia [2]. Its production also extended to the Southern Nations Nationalities Peoples (SNNP) Regional State, where it is contributing to food security in the region [3, 4]. It is a subsistence crop commonly produced to fill food security gaps during the hunger months (June to September) in Ethiopia.

The production of anchote has strong cultural ties with Oromo nation; it is used as cultural food during the finding of true cross locally called *Meskel Festival* [2, 5]. According to Negassa and Amenu [6], anchote tubers have useful nutrient content and great importance. Its protein content is also by far greater than other root crops, although, root crops are known for their low protein content. Comparable to other root crops, anchote tuber and leaf contains valuable nutrient and promoted for greater consumption for human use to improve nutrition [3]. Nutritionally, anchote is a good source of minerals and fibers. It is rich source of calcium, which is an important constituent of our bones and teeth. Traditionally, it is also believed that, anchote makes lactating mothers healthier and stronger [2]. This might be body's demand for calcium is greater during pregnancy and breastfeeding. The juice prepared from tubers of anchote has saponin as an active substance and uses to treat gonorrhea, tuberculosis, and tumor cancer [7]. Anchote is also an ample source of potassium and iron. So, it can contribute to the food security in the country [8].

Now a day's industrialization is growing at a much faster rate and food processing industries are also increasing. Therefore, utilization of different raw materials, which are locally available, including anchote, potato, carrot, beat root, sweet potato, yam, garlic, and others at a processing scale is

necessary. Among these different root crops cover lower parts in the food sector where, anchote plant is also categorized under this group [9]. However, anchote flour contains higher amount of minerals and crude fiber than wheat flour [8]. Biscuit produced from blend of anchote and wheat may have good potential for a number of reasons. It will increase the consumption of anchote and encourage farmers; the products will be a more acceptable healthy alternative since it enriches the products by dietary fiber and minerals. Generally, this paper is aimed to review on cultural utilization practices, nutritional and anti-nutritional composition of anchote *(Coccinia abyssinica*).

2. Cultural Practices, Nutritional and Anti-Nutritional Composition of Anchote (*Coccinia abyssinica*)

2.1. Cultural Practices of Anchote Utilization

Aerial parts and fibrous roots are removed from the tubers. After thorough washing, it boiled in a clay pot called '*xuwwee*' (Afan Oromo). To achieve rapid cooking, the pot is covered by leaves of enset, maize, sorghum, or pumpkin [2]. Final sealing may be by a lid or cow dung. This arrangement minimizes heat loss. The well-boiled tubers are then cooled, peeled and processed in different ways. Presumed purpose of such processing is to make anchote more palatable, digestible, to inactivate enzyme inhibitors, and other anti-nutritional factors to qualify it for human consumption [10].

Anchote tubers are most of the time consumed boiled [2]; [11]; but it is consumed in various forms as following:

1) *Chufata* (boiled anchote) is cooked and peeled anchote tuber cut into smaller sizes and simply consumed with pepper '*kochkocha*' (chilies mixed with butter).
2) *Mooqa* (Soup) is prepared from anchote flour and different ingredients (oat flour, butter, and spices). It is a delicious and occasional dish. Here, uncooked tuber is peeled off, cut into smaller pieces with knife, dried in the sun and grounded into flour on local milling stone. Then the flour is kept in a clay pot and made to soup with ingredients added to 'wot' (like spices, butter and onion) in the same form from other pulses.
3) Defqi *(Lanqaxaa)/* Paste is type of anchote food in which cooked tubers are peeled and finely chopped made dry in the sun, and ground into flour; then again after the flour cooked enough butter and spices added to it and eaten alone or as a side food with enjera. This is the major form in which anchote is usually served in restaurants, important ritual ceremonies and marriage ties.

Like many other roots and tuber crops, anchote are rarely eaten raw. The survey result by Negassa and Amenu [6] revealed that, respondents' anchote utilization at home as boiled or cooked, in hotel as cooked, in supermarket boiled or raw and in market as raw were 70%, 6%, 2% and 22%, respectively. Traditionally it is consumed either boiled after peeling or boiled before peeling and/or further cooking is applied prior to consumption. According to Fekadu et al [10], 66% of consumers gave priority taste for anchote boiled before peeling. However, both methods of preparations were effective to reduce the levels of anti-nutritional factors, thereby improving the bioavailability of zinc and calcium [10]. They reported that boiled before peeling proved to have better nutrient minerals and higher gross energy yielders and minimizes the nutritional losses and unnecessary moisture gain. However, according to study by Shebabaw [9] among boiling, roasting and natural fermentation on anchote flour, it was founded that fermentation has significant reduction in proximate composition, anti-nutritional factors, physicochemical and functional properties. Indigenous knowledge of farmers' assumption to delay harvesting and/or in-situ storage reported to improves nutritive value of anchote (e.g. Ca and Fe concentration increased during later harvesting than early [3].

2.2. Nutritional Contents of Anchote

Nutritional value is the main concern when a crop is considered as a food source. Anchote is endemic tuber crop used as a food source in parts of Western Ethiopia. Anchote plant parts contain valuable nutrient i.e. tuber, leaf and fruit presented in Table 1 below.

Table 1. *Protein and minerals contents of anchote plant parts.*

Plant part	protein and minerals								
	Protein%	Ca(mg/100g)	K(mg/100g)	P(mg/100g)	Cu(mg/100g)	Fe(mg/100g)	Mg(mg/100g)	Zn(mg/100g)	DM%
root	4.6-16.4	9.65-93.0	0-1662	8-38	0.003-18.6	11-89	0-189.4	0.17-29	4-11
leaf	34.5-53	6.48-109.2	178-432	37-85	0.09-2.33	0.3-57	0.01-1.17	0.01-.62	9-13
fruit	10-36.4	5.95-124.4	240.4-6782	0.1-58	.001-5.04	0-39	3.57-118	0.5-45	7.5-11

Source: [12]

Nutrient concentrations in anchote tubers are by far higher than that found in equal weight of potato (S*olanium tuberosum L.*), yam (*Dioscorea abyssinica)* and cassava (*Manihot esculenta* Crantz) tubers, Swiss chard and cucumber [3]. The nutrient compositions of raw and processed anchote tubers are presented in Table 2.

Protein content

The protein content of raw and processed anchote flour samples collected from Nekemte regions were in the range of 6.78% and 10.68 [9]. Whereas, the crude protein content in leaves were ranged between 30.38 ± 0.01% ("240407-1") and 35.42 ± 0.05% ("223109-1") [13] and anchote tubers ranged from 10.70% ± 0.26% to 13.72% ± 0.10% for accession from Debrezeit Agricultural Research Center. In average crude

protein content of anchote tuber found to be 10.5% [12]. Compared with equal weight of beet root 1.35% [14], cassava 3.01% [15], enset bulla 36 % [16] and okra 18.21% [17] anchote tuber contains valuable nutrient. It is obvious that anchote leaf protein content exceeds tubers as well comparable with enset bulla; hence, should be promoted for greater consumption. However, others anti-nutritional factors of leaves as well processing methods should be tested for human use to safe level of palatable quality.

Crude Fat

Anchote is low crude fat content; whereas raw anchote tuber contains 19%, boiled after peeling (BAP) and boiled before peeling (BBP) contains 13% and 14% per 100g fresh weight of tubers, respectively [18]. Compared to raw tubers, crude fat content was decreased in boiled after peeling by 31.58% and in boiled before peeling by 26.32% [18]. It also indicated difference in processing method (boiling, fermentation and roasting) change the fat content [9] where, in fermentation fat content is high due to the possibility of fermenter organisms could secrete microbial oil [19] cited in [20]. Compared with raw beetroots and cassava gari which is 0.3% and 1.48% [14, 15] respectively, anchote has great fat content, but it is lesser than enset 30% [16].

Carbohydrate

Relative to other nutritional factors anchote mainly contains high carbohydrate. Whenever, compared with different processing methods boiled after and before peeling 10.42 and 15.23 [10, 18], roasting (82.27%) and fermentation (74.69) anchote tubers had [9] respective carbohydrate. These two results disagreed as reported by author [9] decrease of carbohydrate by fermentation and increase of carbohydrate by boiling contributes proportionally to the increase and decrease of protein by fermentation and boiling respectively as the values of all proximate analysis was computed out of hundred percent; because of boiled tuber by far less carbohydrate content in fermented.

Table 2. *Proximate nutrient content of root and tuber crops compared with anchote.*

Nutrient content (g/100g)	Root and tuber crop (%)				
	Potato [a]	Beet root [b]	Cassava [c]	Anchote [d]	Enset (bulla) [e]
Carbohydrate	21.47	6.99	86.25	16.86	97.71
Gross energy (Kcal/100g)	96.78	42	364.6	82.12	394.24
Moisture	75.17	87.4	7.28	74.93	54.1
Fiber	0.43	2.56	1.53	2.58	1.04
Ash	0.83	1.4	1.89	2.19	1.05

Source(s): [a] [21]; [b] [14]; [c] [15]; [d] [18] and [e] [16]. * Superscripts letter shows where to quote.

Gross energy

Boiling before peeling is the most desirable acceptance taste by many consumers [10]. However, gross energy is by far lower than that of boiling after peeling. As indicated on the Table 2 above the gross energy content of anchote tuber is valuable, which is by far exceeding beet root and close to Irish potato. Gemede [18] reported that raw anchote tuber yields 82.12 Kcal/100g, but result from Shebabaw [9] was 348.71 and 340.40 Kcal/100g energy values for samples collected from Nekemte and Dembidollo respectively. The author's finding is also not agreed with [10] gross energy contents were 82.12, 53.48 and 75.26 raw, boiled after peeling and boiled before peeling anchote tubers had respective contents of (g/100g). Even though anchote tubers accessions and time of analysis vary this value does not indicate growth stage of the crops to which accurate estimate of calories is possible.

Moisture

George [22] reported that high moisture content is important in maintaining the protoplasmic content of the cells, but it makes the vegetables perishable and susceptible to spoilage by microorganisms during storage. It was reported by [10, 18] moisture content of raw Anchote tubers was 74.93%, but [9] reported that 6.48%. The report looks like contradictory, but carbohydrate, gross energy and dry matter content reported by the author was also too high; and this may indicate that the crops may be under different growth stage [3] delaying harvest increased fresh and dry tuber yield by an average of 450% in which succulent plant parts may have high moisture content and low dry matter composition.

Fiber

Dietary fiber is structural part of plants, some can dissolve in water (soluble fiber) are easily digested by bacteria in the colon and often associated with protecting against heart disease and by lowering blood cholesterol and glucose level, respectively whereas insoluble fiber is less readily fermented thus promote bowel movement and alleviate constipation [23]. Thus anchote was reported to have high 2.58% [18] compared to 0.43%, 2.56, 1.53 and 1.04% potato, beet root, cassava and enset bulla [14-16, 21], respectively.

Ash

Ash content represents the total mineral content in food. It refers to the inorganic reside remaining after either ignition or complete oxidation of organic matter in a food stuff [24]. Ash content of anchote reported by [18] 2.19%, 1.33%, and 1.99% (g/100g) for raw, boiled after peeling and boiled before peeling, respectively. Anchote tuber and leaf produced, on average 94 and 84% dry matter, respectively. This indicates that there is higher translocation of dry matter to the tuber of anchote. Accordingly, ash contents of 6 and 16%, respectively for tuber root and leaf of anchote were recorded [3]. This report confirmed anchote tuber ash content reported by [9], which is 3.96%. When overall analysis observed ash content and dry matter goes parallel.

2.3. Anti-Nutritional Contents of Anchote

Some anti-nutritional factors (phytate, oxalate, tannin and cyanide) content of the raw and processed Anchote tuber were determined [10]. According to [25], Anchote tubers were found to contain low anti-nutritional factors, and except phytate.

Table 3. *Mean (± SE) anti-nutritional factors content of raw and processed Anchote.*

Treatment	Phytate (mg/100g)	Oxalate (mg/100g)	Tannin (mg/100g)	Cyanide g/100g)
RW	389.30±0.39[a]	8.23±0.09[a]	173.55±0.35[a]	12.67±0.22[a]
BAP	333.63±0.29[c]	4.23±0.02[c]	102.36±0.46[c]	8.16±0.07[c]
BBP	334.74±0.42[b]	4.66±0.17[b]	121.21±0.11[b]	11.14±0.17[b]

Means not followed by the same superscript letters in the same column are significantly different (P<0.05). NB. RW stands for Raw Anchote, BAP: for Boiled after peeling and BBP: for Boiled before peeling.
Source: [10]

Phytate

According to [10] anchote tubers were found to have low anti-nutritional factors and except phytate; where the raw anchote tuber contained 389.30 mg/100g phytate. The phytate content of anchote boiled after peeling and before peeling had 333.63 mg/100g and 334.74 mg/100g, respectively. The mean phytate content was reduced in boiled after peeling by 14.30% and in boiled before peeling by 14.01% compared to raw tubers [25]. The evident reduction in phytate during cooking may be caused by leaching into the cooking medium, degeneration by heat or the formation of insoluble complexes between phytate and other components, such as phytate-protein and phytate-protein mineral complexes [26]. Phytic acids markedly decrease Ca bioavailability and the Ca: Phy molar ratio has been proposed as an indicator of Ca bioavailability. The Ca: Phy molar ratios >6, indicative of poor calcium bioavailability [27] cited in [25].

Oxalate

Oxalates can have a harmful effect on human nutrition and health, especially by reducing calcium absorption and aiding the formation of kidney stones [28]. However, traditionally processed anchote tubers analyzed in this study are low compared to the recommendations for patients with calcium oxalate kidney stones. Therefore, the reduced oxalate content resulting from processed anchote tubers could have a positive impact on the health of consumers to enhance the bioavailability of essential dietary minerals of the tubers, as well as reduce the risk of kidney stones occurring among consumers. Hence, boiling the tuber would reduce the nutritional problems that the high levels of oxalates could cause [25]. The importance of oxalate contents of an individual plant product in limiting total dietary Ca availability is of significance only when the ratio of Oxalate: Ca is greater than one [29].

Tannin

The tannin content of anchote boiled after peeling was significantly (P<0.05) lower than both boiled before peeling and raw anchote tubers. Similarly, the mean tannin content of anchote boiled before peeling was significantly (P<0.05) lower than raw anchote tubers. The mean tannin content was reduced in boiled after peeling by 41.87% and in boiled before peeling by 30.12% compared to raw tubers [25]. However, it is, tannin content of raw anchote tuber is very low compared to its critical toxicity effect and further reduced during traditional processing, its anti-nutritional effect may be insignificant in both raw and processed tuber.

Cyanide

According to Fekadu et al [25], cyanide in raw, boiled after peeling and boiled before peeling anchote tubers were 12.67 mg/100g, 8.16 mg/100g, and 11.14 mg/100g, respectively. The cyanide content of anchote boiled after peeling was significantly (P<0.05) lower than both boiled before peeling and raw anchote tubers. The mean cyanide content of anchote boiled before peeling was also significantly (P<0.05) lower compared to mean raw anchote tuber. The mean cyanide content was reduced in boiled after peeling by 35.59% and in boiled before peeling by 12.08% compared to raw tubers. The results obtained showed that the processed tuber could be considered safe with regard to cyanide poisoning due to the fact that the cyanide levels were far below the detrimental levels of 50 to 200 mg/100g [30]. However, the amount remaining cyanide content might be slightly toxic to people who consume high quantities of anchote tubers and need to be further study.

2.4. Major, Minor and Trace Metals in Anchote

It was reported that thirteen elements (K, Ca, Fe, Zn, Mn, Mg, Co, Ni, Cu, Na, Cd, Pb and Cr) were identified in anchote tuber and leaf by the aid of Flame Atomic Absorption Spectrometry (FAAS/FAES) [31]. The concentration of N and K found to be 2-3 times; Calcium contents were 5-8 times, Fe nutrient 3.5 times higher in leaf tissue than anchote tuber [3], while equivalent P nutrient contents exhibited in both leaf and tuber tissues. Except phosphorus, vine + leaf petiole contains more nutrients than leaf, tuber and root. The most predominant metal among the macro and micro elements were Ca, Mg and Fe in order of richness [31, 25]. The following Table 4 describes the tested macro and micro nutrients metals found in root and tuber crops compared with anchote.

Table 4. *Proximate mineral contents of root and tuber crops compared with anchote.*

Mineral contents (g/100g)	Root and tuber crop (mg/g and/or mgkg-^{1})			
	[a]Potato raw	[b]Beet root raw	[c]Cassava (Gari)	[d]Anchote raw
Na	24.67	73.60	0.22	0.891
K	433.00	31.20	0.28	3.83
Ca	16.67	13.82	1.02	2.04
Mg	34.67	18.60	1.30	2.49
Zn	-	0.29	-	169.22mgkg-^{1}
Mn	-	0.86	-	1.11
Fe	1.76	0.76	0.17	21.67
Cu	-	0.08	-	43.56 mgkg-^{1}
Co	-	-	-	28.41 mgkg-^{1}
Cr	-	-	-	18.84mgkg-^{1}
Ni	-	-	-	26.31mgkg-^{1}
Pb	-	-	-	ND
P	48.97	-	1.20	34.61
Cd	-	-	-	ND

Note: Superscripts letter show where to quote; ND-note detected and for; - data is not presented
Source(s): [a] [21]; [d][30]; [b][14]; [c][15]; [d][25].

3. Summary and Conclusion

Anchote (*Coccinia abyssinica*) is an indigenous root crop that is commonly produced by Oromo Nation around the South and South Western part of Ethiopia. It has strong cultural ties with Oromo Nation, since it is used as cultural food during the finding of true cross locally called "Meskel Festival and offered for special guests as respected food in Wollega regions. It is highly nutritious food crops where even leaf parts are found to contain highly valuable nutritional composition. Traditionally it is used as boiled boiling after peeling or before peeling as chufata (boiled), soup, paste and etc. The proteins, fats, carbohydrate, ash, fiber, macro and micro nutrient contents of anchote are very attractive as compared with other roots and tuber crops. Anti-nutritional factors like phytate, oxalate, cyanide and tannin contents are very low compared to its critical toxicity effect and easily reduced below safe level by simple processing. Even though, anchote has such attractive nutritional and socio-economic importance attention given to improve yield and yield quality, maintaining quality through post-harvest management, processing technology are very low. Therefore, emphasis should be given to the crops in order to fill foods gaps and to feed alarmingly increasing population growth.

4. Future Directions

1) Identifying the potential area and enhancing technological based production, harvesting and post-harvest management.
2) Developing processing technologies' that enables availability of essential nutrients, macro and micro elements for human consumption.
3) Identifying the possible maximum and minimum elemental nutrients found in anchote leafs, roots and whole parts with determined stage of growth time and accessions/cultivars.

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