

Short Communication

Nutritional Composition of Anchote (*Coccoloba abyssinica* (Lam.) Cogn.) and its Products: A tip for Future Research and Development

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Abstract

Anchote is one of the tuber crops which belongs to the cucurbitaceae family and genus *coccoloba* with over 30 species. This review was conducted with the objective to assess the knowledge gap and recommend further studies for generating and documentation of information related to anchote. It is an underutilized tuber crop with high nutritional compositions especially protein [tuber (3.33-17.8%), leaves(34.5-53%)] and calcium contents [tuber (416.50, leaves 313.50)]. The methodology used were literature review and case studies. Although anchote is rich in nutrients and has special place in the social value of the society, it has been less addressed by research and development to enhance its contribution to food and nutrition security in Ethiopia. For instance, the available literature indicates wide variation in its protein (3.33 -17.8 %) and Calcium (0.47-416.50 mg/100g) contents. The basis for this high variation needs to be explored through controlled studies for further improvement of the plant. There are more than seven food products that are traditionally prepared from anchote but detailed information on their preparation methods, ingredients used, consumption and nutritional significance are lacking. The protein content of anchote leaf is very high which makes it very important to use it as a food ingredient which is also another potential area of research. Therefore, it is necessary to conduct detailed assesment on the production, processing and utilization of anchote in the community for further optimization and exploitation of the plant as a potential source of food in Ethiopia.

Keywords: Anchote, root and tuber, protein content, nutritional compositions, Calcium content

Introduction

Anchote (*Coccoloba abyssinica* (Lam.) Cogn.) is one of tuber crops and it belongs to the cucurbitaceae family and *coccoloba* genus with more than 30 species where eight of them are believed to be indigenous to Ethiopia?? (Yassin *et al.*, 2013). Anchote is highly utilized in the socio-economic life of Oromo community in western Oromia (Abera, 1995). Its production is also known in western?? part of the country where it is used as food security crop (Girma and Dereje, 2015). Anchote is an important root crop with high protein and Ca contents in relative to

other tuber crops which makes it more feasible for further research (Adugna *et al.*, 2019).

Anchote is a potentially productive tuber crop that can grow in a wide range of agro-ecological conditions (Adugna *et al.*, 2021). Anchote favorably grows in soils with pH of 4.5 - 7.5, temperature of 12 -28°C, and rainfall ranges of 800 - 1200 mm/year (Wandimu *et al.*, 2013). Another survey report revealed that farmers allocate 0.16ha for Anchote production (12.70% total landholding). The production of anchote remains continuous in all seasons and under irrigated conditions due to its high demand from restaurants and individual consumers (Parmar *et al.*, 2017). The total yield of the tuber was reported to be about 15– 18 tons/ hectare which is relatively similar with yields of sweet potatoes and Irish potatoes (Habtamu, 2014).

Anchote is a drought resistant tuber crop and it can withstand problematic soil conditions (Wandimu *et al.*, 2013). The nutritional compositions of its tubers and leaves were studied by different scholars and found to be higher in protein than other common root and tuber crops (Ayalew *et al.*, 2016). It is regarded as a leading tuber crop with high protein and calcium (Ca) contents (Aga and Badada, 1997). According to Ayalew *et al.* (2016), anchote leaves contain more protein (33.12%) than its roots (12.6 %). In contrast, its tubers contain more Ca (9.69 - 93mg/100g) than the leaves (6.48 - 109.2mg/100g). Several reports revealed huge variations in protein contents of anchote tuber that ranged from 2.77 (Parmar *et al.*, 2017) to 17.8 % (Girma and Dereje, 2015). These authors reported variations of 4.65 to 33.12 % for anchote leaves. The highest percentage of 17.8% protein in anchote tuber was obtained at 10 months of age of maturity level and the authors revealed that the protein content decreased after 10 months of maturity level. The difference in Ca content of anchote tuber ranged from 0.47 mg/100 g (Girma and Dereje, 2015) to 416.15 mg/100 g (Desta *et al.*, 2021) and 33.12 mg/100 g to 100.68 for its leaves. Variation in zinc (Zn) content is from 0.58 to 5.74 mg/100g in anchote tuber. In the community, it is believed that its high Ca contents is associated to its traditional use in bone fracture treatment. The difference in Zn contents is very high and could be toxic to humans.

There are about 27 food products from anchote tuber that are categorized into boiled, dehydrated, and soup (Parmar *et al.* 2017). Another study showed that 'defeki' (paste), 'moqa' (soup), and 'chufata' (boiled and peeled anchote tuber is sliced and eaten with kochkocha) are traditional ways of anchote recipe preparation in western Oromia (Desta *et al.*, 2021). Different types of traditional foods prepared from anchote tubers and leaves need to be clearly studied and documented by including their preparation methods, ingredients, and the reasons for consuming anchote food products. Therefore, the objective of this review is to

compile information related to nutrient composition of anchote and its traditional place in the community in order to recommend future studies and identify the gaps on traditional anchote food products.

Glossary

Table 1: The definition of some words and phrases

Terms	Definition of terms
Anchote	A tuber type used for traditional food preparation mainly in wellega
Anchote gubo (ancootee guboo)	The type of anchote stayed in soil for one year or above
Humbawo (Humbaawoo)	The type of wild anchote used to treat abdominal cramb. It is used for both human and animals. It is also used for treatment of wound (both animal and huma).
Ilalcha	The kind of social life where individuals/households go to relatives' house in a year to visit each other. For this purpose, different food and beverages are prepared and taken with them.
Dafaqqii/lanqaxaa (Defeki or lenketa)	The sliced anchote is ground to fine paste with red pepper flour, garlic, ginger, butter, salt, and mixed spices (korerima and tikur azmude, fenugreek, linseed)
Qocqocaa (Kochkocha)	The paste of finely ground green paper with different ingredients like garlic, genger, butter, salt, green basil and coriander.
Meskel	The meskel is the first big festival of the Ethiopian religious year and marks the finding of the cross that Jesus was crucified on, according to Orthodox Christian tradition.
Murmuraa (murmura)	Sliced anchote added with butter, pepper, salt and other spices
Ittoo ancootee (Ito Anchote)	The type of stew prepared from sliced anchote, split pulse, salt, pepper, onion, garlic, and other spices. Split pulse is not added in some areas.
Qorii ancootee (Kori anchote)	The type of anchote product prepared from sliced anchote (in rectangular form), red pepper flour, salt and melt butter flavored with mixed spices (korerima and tikur azmude, fenugreek, linseed)
Kori Garbu	The roasted barley mixed with salt, and butter flavored with spices
Cuffannaa (chufana)	The boiled anchote is sliced in its length wise and consumed with 'Kochkocha'
Raafuu ancootee (Rafu Anchote)	The food type made from chopped anchote leaves (bud), butter, salt, pepper, and other spices. The leaf of pumkin (bud) and other cabbage may be included into it. -for 'meskel' celebration, its leaf is chopped with the leaves of onion and cucumber.
Moqa	A type of food prepared from anchote flour, oat flour, salt, butter, sometimes with bone marrow
Hido (Hiddoo)	Fibrous anchote that is difficult to be boiled (takes long time)

Food products from anchote and consumption

Some of the above products listed in the glossary (Table 1) are served at special occasions while the left are used as staple food. Chufana and murmura are consumed on meskel holiday and any time for family consumption as staple food. Defeki/lenketa is common mostly on holidays celebration especially for 'meskel' and also used as a regular dishes. It is also given to a person suffering of malaria and bone related problems. Kori anchote is commonly prepared during 'meskel' holiday. It is consumed with a loaf of bread. As 'kocho' (product of false banana) and 'kitfo' (raw meat paste) cannot be separated in Gurage traditions, 'korii anchote' and a loaf of bread cannot be separated on 'meskel' holiday in Oromo people of wellega. However, it can be consumed with 'injera' (a flat bread) for normal family consumption at any time. In addition to these, it is also a must food for wedding celebration and during 'Ilalcha'. 'kori anchote' and 'Kori Garbu' are unseparated and considered as a great gift during marriage celebration. 'Ittoo

ancootee' is consumed as a regular food and also common food at grievance time. Rafu anchote' is consumed any time when the leaf are immature. Moka (soup) served for women who gave birth, for a person whose bone is fractured.

Table 2 shows different types of foods made from anchote tubers and leaves (with their processing methods). About seven types of anchote products are known where six of them are food types made from its tubers. A survey report by Parmar *et al* (2017) showed that about 27 types of dishes can be prepared from anchote roots and leaves. This report also categorized products made from anchote into four group namely soups, boiled roots, flour, and other main anchote dishes. Among these, there are some well known type of traditional dishes made from anchote.

Table 2: Different types of food products prepared from anchote

No	Food Types	Preparation method
1	'Chufana' (Cuffannaa)	Washed, boiled, peeled, sliced on length side (long-thin size)
2	'Murmura' (Murmuraa)	Boiled, peeled, cut in to pieces and is larger than defeki in size, rectangle/square in shape, exactly similar size with kori anchote
3	'Defeki' (Dafaqqii)	Boiled, peeled, sliced to small size, made paste with sliced ginger and garlic together using stone (traditional) or machine, mixed with melt butter and other ingredients on slight heating
4	'Kori anchote' (Qorii Ancootee)	Boiled, peeled, sliced to small size (rectangle/square) and mixed with ingredients while on heat
5	'Ittoo ancootee' (Anchote stew)	Boiled, peeled, sliced to small size, mixed with stew of split pea/mung bean or other pulses
6	'Rafu anchote' (Rafu anchote)	Immature (bud) of anchote collected, washed, chopped, boiled and other ingredients added. Sometimes mixed with bud of cucumber or other cabbages.
7	'Moqa' (Soup)	Washed, sliced, dried, milled, and mixed with other flour for making soup

Some authors have tried to define anchote dishes as 'kitifo', 'lankata' (finely grounded tuber), 'wot', soup, and 'murmura' (boiled tuber cut in pieces) (Tilahun wendimu, 2012). Other authors have also stated that anchote stew (locally called "Ittoo ancootee" is one of anchote products (Aga and Badada, 1997; Paramar *et al.*, 2017). According to Wubeshet and Nesru (2021), anchote stew locally called 'anchote Ittoo' is prepared on festive occasions solely from sliced anchote with sufficient butter. These reports do not give any details about preparation method, ingredients, and the occasions of their preparation. What they reported as 'anchote itto' may be the product called 'Itto anchote' (Ittoo ancootee). But, their explanation seems 'kori anchote' (qorii ancootee) which is prepared from sliced anchote dipped into melted butter with different spices. This type of anchote food is known for 'meskel' celebration.

Boiled anchote is served usually with 'kochkocha' a fermented side-dish prepared from ground green pepper (Wubeshet and Nesru, 2021). Amazingly the

preparation of 'Kochkocha' doesn't need any fermentation process. Also, this report has not identified which cooked anchote food type it is. Every anchote product is prepared by boiling. The soups from the anchote flour are more commonly prepared from red anchote due to their believed higher medicinal properties. In local traditional medicines, well as pregnant women and lactating mothers (Parmar *et al.*, 2017).

Economic, social, nutritional and health benefits of 'anchote'

Economic and social importance of anchote

In Ethiopia, root and tuber crops including 'anchote' have diversified contribution for the traditional food system and income generation (Fantaw *et al.*, 2014). Different benefits of anchote includes nutritional, economic, medicinal and social values (Fikadu 2011, Guma *et al.*, 2015). Detailed understanding about 'anchote' production, consumption and its economic importance makes it a far-reaching crop in research and development perspectives (Gudeta *et al.*, 2022). The food potential of root and tuber crops such as 'anchote' is not yet been fully exploited, documented and utilized despite their significant contributions towards food and nutrition security, income generation, provision of resource base conservation (Abadura *et al.*, 2021).

The productivity of anchote can be different based on genotypes, soil fertility, and agricultural practices. With farmer practices anchote can give yield of 20 to 30 tons/hectares (Habtamu, 2014). Another recent study has shown that an average productivity of anchote was 16.12 tons/hectare (Wubshet and Nesru, 2021). However, under research condition it yielded about 73 - 76.45 tons/hectare (Daba *et al.*, 2012). The Oromia region is the leading producer of anchote although some areas of the country have adapted anchote production (Bekele *et al.*, 2014). Annual total production has been estimated to be 25,000 tons in the whole country (Bekele *et al.*, 2013).

In addition to home consumption, 'anchote' is also cultivated for market purposes. Its retail price was 4 to 5 times greater than other common root and tuber crops (Parmar *et al.*, 2017). The same report has also shown that 'anchote' seeds and seedlings are also marketed and fetch high price for smallholder farmers. This indicated that 'anchote' has a significant importance in improving the income of the farm households and retailers.

Traditional dishes are usually served on special occasions like 'mesqal', weddings and thanks giving days (Hora, 1995). During 'meskel' celebration, foods from different crop types are prepared and presented at a time which is traditionally believed as being blessed by God and in response to that blessings the community gives thanks to God. Anchote' is one of these very important crops and cannot be

left out (Girma and Dereje, 2015). For this purpose, it is a must to include into the meal even if it is not fully mutured. Also, the type of ‘anchote’ tradional dish called ‘kori anchote’ is prepared and taken to relatives home during visiting on the occasion known as ‘Ilaalchaa’. This may show that anchote is not only food for society but also used as enhancer.a social relation.

It was reported that ‘anchote’ has useful nutrient content (Hailu *et al.*, 2024; Habtamu *et al.*, 2021). It is a good source of protein, carbohydrate, calcium and iron where its high calcium content (Hailu *et al.*, 2024). It has higher amount of protein and Ca content than other root and tuber crops. Both ‘anchote’ tubers and leaves contain adequate nutrients and are recommended for wider human consumption to improve nutrition status (Girma and Dereje, 2015). Different reports revealed that anchote tuber could be used as a food ingredient due to its relatively higher calcium and protein levels than other common root and tuber crops (Ayalew *et al.*, 2016). A significant difference was observed in protein and amino acid profile among different accessions and plant parts (anchote leaves had higher protein contents (Ayalew *et al.*, 2016). The same report indicated that crude protein content of anchote is 10.70 to 13.72% for its tuber and 30.38 to 35.42% for its leaves.

Health benefits of ‘anchote’

‘Anchote’ has the advantage of social relation enhancement in addition to its food value and it is also consumed for health purposes. The community also use ‘anchote’ based foods for complementary feeding of lactating mothers. ‘Anchote’ is also used to treat bone fractures and backaches. This is said to be because of its high Ca content (Parmar *et al.*, 2017). Different studies indicated that ‘anchote’ has adequate Ca content and concluded that it might be the reason for healing fractured bones and backaches.

There are some myths that indicate that some parts of anchote plant are used to treat different type of diseases such as tuberculosis, asthma, gonorrhoea, diabetes, and cholesterol (Abera, 1995). In addition, according to (Hora, 1995), juice of anchote root is used to treat cancers, tuberculosis, skin eruptions and gonorrhoea. But, the variety of anchote used for disease treatment might not be the one used for human consumption. There are different types of wild anchote varieties used as traditional medicines. Anchote cultivars used to trat disease are are very bitter in their tastes which might be due to presence of high contents of phenolic compounds. The types of wild anchote locally known as ‘Humbaawoo’) is very common still now for treatment of human and animals stomach crumps. There are *Conccinia* genus with more than 30 species from which about eight are said to be found in Ethiopia (Yassin *et al.*, 2013). Another report indicated that roots, leaves, vine and fruits of other *Coccinia* groups such as *C. grandis* and *C. indica* are

widely used to treat gonorrhoea, asthma, skin eruptions, and diabetes and eye diseases (Koller, 2008).

The type of anchote tuber that is used for bone fracture treatment is that is kept aside for long time for more than one year in the soil before harvesting. Such types of anchote is known as 'Gubo anchote'. The time it stays in the soil and its relationship with its nutrient contents requires further study to identify the reason why 'gubo anchote' is preferred for treatment of bone fracture and backache. The type of anchote dish called 'anchote dafaqqii' is also used widely for treatment of malaria. This might be due to inclusion of high amount of different spices such as garlic which has a potential to treat many illnesses.

Nutrient compositions of 'anchote'

The known plant parts of anchote that are consumed by the community are only its roots or tubers and leaves. The consumption of anchote leaves is not well known in many areas although it is a very delicious and nutritious food. The nutritional compositions of both the tuber and leaves were reported by different scholars in which huge variations were observed (Table 1 and 2). According to Desta (2011), anchote leaves contain more protein (34.5 - 53 %) than the tubers (4.6 - 16.4 %) while the tuber contains more calcium (9.69 - 93mg/100g) than the leaves (6.48 - 109.2mg/100g).

According to (Hora 1995; Bekele 2007) 'anchote' is used for fattening of animals. However, the variety of anchote that is used for this purpose might be the wild type or the vine part of anchote could also be used for such purposes. The wild type of anchote called 'anchote gara' is a well-known type which is used for fattening of oxen. The edible type of anchote is not used for feed purpose. The edible type of 'anchote' is not yet produced in adequate amount for human consumption eventhough there is very high demand by restaurants and hotels to prepare traditional 'anchote' based foods. As a result, the price of anchote tubers is 4-5 times greater than other common root and tuber crops such as Iris potatoes and sweet potatoes (Parmar *et al.*, 2017).

Different studies have been conducted on 'anchote' tubers and leaves and their proximate compositions were reported with large variations (Table 3). There are variations of about 2.77 to 17.8 % of proteins for 'anchote' tubers (Girma and Dereje, 2015; Parmar *et al.*, 2017) whereas, for the leaves it was reported to be 14.65 to 33.12 % (Girma and Dereje, 2015; Ayalew *et al.*, 2016).

Table 3: Proximate compositions of 'anchote' tuber and leaves (in g/100g)

Tuber	Mc	CP	Ash	Co	CF	CHD	TE	Author/s
Peeled	70.31	10.16	2.38	0.89	3.37	12.96	100.60	Abadura <i>et al.</i> , 2021
Peeled		12.06	-	-	-	-	-	Ayalew <i>et al.</i> , 2016
Peeled	9.04	3.33	4.79	0.91	3.84	82.37	-	Desalegn and Kabir, 2022
Peeled	11.52	11.81	3.82	0.59	3.55	72.13		Desta <i>et al.</i> , 2021
peeled	74.93	3.25	2.19	0.19	2.58	16.86	82.12	Habtamu, 2014
At 10 months	-	17.8	6.20	-	-	-	-	Girma and Dereje, 2015
Peeled	6.91	12.20	3.87	1.93	7.39	67.69		Habtamu <i>et al.</i> , 2021
White, peeled	71.47	2.77	1.10	0.41	1.26	24.25	111.77	Parmar <i>et al.</i> , 217
Peeled	9.06	0.34	0.30	0.20	-	-	-	Getnet <i>et al.</i> , 2019
Leaves								
	-	33.12	-	-	-	-	-	Ayalew <i>et al.</i> , 2016
	79.65	21.60	13.46	3.19	10.46	41.42	280.76	Habtamu <i>et al.</i> , 2021
At 10 months		14.65	16	-	-	-	-	Girma and Dereje, 2015

Mc-Moisture content, CP-crude protein, Co –crude oil, CF – crude fiber, CHD - carbohydrate, TE– total energy

In similar condition with reported protein content, large variation is also observed in minerals when relating different reports. The difference ranged from 0.47 to 416.15 mg/100g for Anchote tuber and 33.12 to 100.68 mg/100g for its leaf. The difference in reported Fe content is from 0.98 to 15.33mg/100g while that of Zn content varied from 0.58 to 5.74 mg/100g (Table 4). In case where such type of variations exist, it might be difficult to know the real Ca content of the Anchote tuber although most of the studies have recommended anchote consumption for its high Ca content.

Table 4: Mineral contents of anchote tubers and leaves (in mg/100g)

Tuber	Ca	Fe	Zn	Mg	Author/s
Peeled	327	4.6	1.8	124	Aga and Badada, 1997
Whole	344	5.5	1.8	80	Aga and Badada, 1997
Peeled	107	0.31	0.29	27.20	Hailu <i>et al.</i> , 2024
Peeled	12.06	-	-	-	Ayalew <i>et al.</i> , 2016
Peeled	416.15	15.33	5.74	191.36	Desta <i>et al.</i> , 2021
Whole	119.50	5.49	2.23	79.73	Habtamu, 2014
Peeled	0.47	4.40	-	-	Girma and Dereje, 2015
White, peeled	81.16	0.98	0.58	50.30 – 50.33	Parmar <i>et al.</i> , 2017
Leaves					
	33.12	-	-	-	Ayalew <i>et al.</i> , 2016
	79.66-100.68	3.68-11.51	1.02-3.11	31.18 - 68.47	Habtamu <i>et al.</i> , 2021

Limitations in 'anchote' food preparation

'Anchote' tuber takes longer time during boiling because of its hardness. It is said that the aged anchote is takes long time to be boiled. The presence of large amount of fibers in anchote tubers might also, affect the boiling time. Significant amount of fuel wood is required to boil anchotem tuber that might take about three hours. Significant amount of fuel wood is required However, when anchote tubers are

boiled in a pressure cooker it takes only about 45 minutes. But, the white anchote is preferred over the orange one due to its ease of boiling. However, the local community indicated that red anchote has higher medicinal values compared to the white variety (Parmar *et al.*, 2017). Anchote tuber that is hard to boil is called ‘hiddoo’ (fibrous anchote). This type of anchote’ is usually selected and discarded by consumers since it cannot be easily boiled. Even if it is boiled it is difficult during consumption because of its fibrous nature. In general, the hardness of anchote might be affected by climate, soil type and agricultural practices. ‘anchote ‘ varieties that are grown on fertile and well aerated soils that get ample rainfall is not as such hard to boil.

Conclusion and Recommendations

‘Anchote’ is an endemic root and tuber crop commonly produced in the western part of Ethiopia (mainly in Wellega). The diversified advantages of anchote are nutritional, economic, medicinal, and social values for Oromo community especially in west Wellega. This review was conducted to assess the nutritional compositions of anchote and its various food products. Large variations were reported on different literatures on its nutritional contents and different types of anchote based food products. The protein content was reported to vary from 2.77 to 17.8 %, and 14.65 to 33.12 % in anchote tuber and leaves, respectively. In addition, the tuber Ca content was reported vary widely from 0.47 to 416.15 mg/100g. However, most of the reports did not provide adequate justifications for such large variations which may be a subject for further investigations. The traditional food products made from anchote were also described. But, adequate information on preparation methods, ingredients used, and occasions of consumption and associated benefits are still not documented well. Hence, there is a crucial need for further research to properly understand particulars associated with anchote in-terms of production environment, productivity, diversity, and its nutritional, socio-economic and health benefits in order to devise suitable development strategies to exploit the potential of the plant.

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