

A review of the role of the Cucurbitaceae family in food security in West Africa



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Background: Food and nutritional security are main development goals in several countries of Africa. In West Africa, the use of African indigenous vegetables caters for the food and nutritional needs of a high proportion of the people, most particularly amongst the poor and rural dwellers. The family Cucurbitaceae is one of the most important and widely grown vegetables in the tropical and subtropical climates.

Aim and objective: This review discusses the culinary relevance of several species of Cucurbitaceae and their roles in food security in West Africa.

Methods: A literature search was conducted on electronic databases such as Google Books, Google Scholar, Scopus and Web of Science.

Discussions: Certain genera such as *Telfairia*, *Cucurbita* and *Citrullus* and other Egusi species are commonly cultivated in different parts of West Africa including Nigeria for their fruits, seeds and leaves because of their crucial nutrient compositions and palatability in local diets. These species and other species of Cucurbitaceae are used as traditional vegetables or African indigenous vegetables and are either sourced from the wild or cultivated in several African countries. Some of these species have played roles beyond food security but have also been crucial tools for nutritional security, especially within the low-income group and rural communities.

Conclusions: Several communities in West Africa use almost all parts of the plant (leaves, fruit, seed, flowers) of some species of this family as food or in food preparations. Their use could also lead to innovative pathways towards reducing diseases associated with malnutrition especially those related to protein deficiency.

Keywords: Cucurbitaceae species; food and nutritional security; Africa indigenous vegetables; Nigeria; West Africa.

Introduction

Food security is a challenge in Africa where an average citizen lives on less than \$1 per day. The rate of inflation across Africa coupled with corruption, unemployment and other vices have increased the burden of food insecurity. The three aspects of food security that are food availability, food access and food adequacy (Latham 1997) have been addressed in several food security projects by the government and stakeholders. However, crucial topics such as nutritional security and sustainability need to be considered to find solutions to the high rate of mortality because of food insecurity in Africa. Apart from mortality arising from diseases because of malnutrition (Mandela 2020), other devastating effects of nutritional insecurity can have a terrible impact on a populace (Govender et al. 2017).

In developing countries, the exploitation of local plant resources is undoubtedly a way to achieve food security, especially in countries with high demographic growth (Sabo et al. 2014). African indigenous vegetables (AIVs) have played a crucial role in food security and the survival of African people, especially those living in the rural areas, because they can easily source the vegetables from the wild. These plants are sources of vitamins and other vital nutrients such as protein needed in human body for proper functioning, as they are often served with starchy foods for consumption. Some AIVs are used as food additives and some plant parts are specifically known for some specific biochemical components. For instance, vital nutrients are based in the seeds (Oso & Ashafa 2021), vitamins in fruit (Pfukwa et al. 2020) and leaves (Agudo 2004), whilst antioxidants are mostly contained in fruit (Amao 2018) and flowers. Some species of the Cucurbitaceae family are good examples of such plants, and they are undoubtedly playing a major role in food and nutritional security in West Africa and other

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parts of Africa. The Cucurbitaceae is an underutilised food resource family with high medicinal value and potential of curing different diseases (Olaewaju et al. 2021). The family is moderately large, comprising about 130 genera and 900 species (Jeffrey 1964) and is represented in Nigeria by 21 genera and 41 species (Hutchinson & Dalziel 1954). These species are amongst the most important plant families, which supply humans with edible products (Bisognin 2002).

Significance of study

Many species of this family occupy a prominent place in the diet of many ethnic groups in Nigeria (Okoli 1984). The versatile nature of this family as a source of food and medicine makes them economically relevant in many West African communities. However, its impact on food and nutritional security in West African communities has not been documented. This is very important because several communities within West Africa have similarities in their local food(s), especially in the case of AIVs. Several Cucurbitaceae species are used as AIVs in Africa, as either domesticated species or vegetables sourced from the wild. Some of these species of Cucurbitaceae have almost every part of the plant being used as food or food additive. Literature shows that these plants have good nutrient composition and can be compared with most popular and exotic vegetables, which are expensive. The use of these species in African local diets is an advantage as they are easily accessible, cheap and meet the daily nutritional needs and could thus help to address the issue of increased mortality rate from diseases arising from malnutrition in Africa. For example, the seeds of several species of Cucurbitaceae are high in protein and can provide the daily protein requirement in meals when served with starchy foods. Easily accessible, cheap and nutritious food such as AIVs is a crucial tool that could help reduce hunger in Africa. Therefore, it is important to document species of this family that are used as food or food additives in different parts of West Africa and the nutritional composition of some of these species. This would highlight Cucurbitaceae species that could meet the nutritional requirements of low-income and poor communities and thus help to fulfil the sustainable development goals related to food and nutrition security in West Africa. Hence, this review aims at investigating the Cucurbitaceae species that are used as food and food additives in West Africa. The objectives are to:

1. determine which species of the Cucurbitaceae family are used in specific communities, tribes or countries in West Africa
2. investigate the parts of the plants used as food
3. investigate the nutritional composition of some of these species as reported in the literature.

Methodology

A literature search was conducted on electronic databases such as Google Books, Google Scholar, Scopus and Web of Science. The search was performed using several terms and free text words (such as Cucurbitaceae species, West Africa,

rural communities, wild Cucurbitaceae species, AIVs, food security and nutritional security) combining them in an appropriate manner. The search also focused on old literature (from Google Books) with crucial information about the relevance of Cucurbitaceae species in the history of the West African people. The authors further set inclusion and exclusion criteria to screen for relevant articles such as excluding articles with focus on other parts of Africa whilst including the ones that focus on West Africa. Each of the identified articles was independently reviewed to determine eligibility and extract study information.

Ethical considerations

This article followed all ethical standards of research without direct contact with human or animal subjects.

Result and discussion

The bottle gourd (*Lagenaria siceraria*), snake tomato (*Trichosanthes cucumerina*), sponge gourd (*Luffa aegyptiaca*) and other *Luffa* species, fluted pumpkin (*Telfairia occidentalis*), *Citrullus lanatus* L., *Citrullus vulgaris* Schrad, *Citrullus colocynthis*, *Cucumeropsis mannii* Maud-Holl, *Cucurbita maxima* L., *Cucumis melo* and *Cucumis melo* var. *agrestis* Schrad are economically important food resources in south-western Nigeria and other West African nations. A variety of other Cucurbitaceae species are edible and serve as a source of food and food ingredients or additives in West African countries. Some of these species have been used by the West African people for several decades. Hence, records of their uses as food have been documented in some old literatures.

The snake tomatoes

The snake tomato or 'snake gourd', *T. cucumerina*, is a species of the family Cucurbitaceae, which is sometimes used as an alternative to tomatoes when tomatoes are scarce and expensive (Onagoruwa 2002). The name 'snake tomato' was derived from its shape (snake-like), and it is locally grown as a vegetable in various home gardens across Africa. The pulp of ripe snake tomato is often blended with red pepper and ripe red tomatoes to cook the popular Nigerian dish called 'Jollof rice'. The palatability and presentability of 'Jollof rice' are highly dependent on its red colour, which results from the combination of red pepper and berry tomatoes used in the preparation. Also, snake tomato is often used in the preparation of the dish, especially when berry tomatoes are scarce or expensive. Similarly, *T. cucumerina* is often substituted for solanaceous tomato in Sierra Leone, Liberia, Côte d'Ivoire (Ivory Coast), Ghana and Benin Republic in food preparations (Grubben 2007). Apart from the red colour of the pulp that makes it highly sought after, it is also rich in nutrients.

Fluted pumpkin, an iron-rich edible leafy green vegetable

Fluted pumpkin (*T. occidentalis*) is a strong, climbing, perennial vegetable widely cultivated in eastern Nigeria for

its nutritious leaves and seeds (Okoli 1984). It is an important vegetable indigenous to south-eastern Nigeria (Odiaka, Akoroda & Odiaka 2008). The stems of the plants have branching, long, twisting tendrils and the leaves are divided into three to five leaflets with terminal leaflets up to 15 cm long. *Telfairia occidentalis* grows in the forest zone of west and central Africa especially in Nigeria, Benin Republic and Cameroon (Kayode & Kayode 2011).

The vegetable is famous in Nigeria and is believed to have originated from the south-eastern part of the country (Kayode & Kayode 2011). Amongst the important indigenous vegetables, *T. occidentalis* is mostly cultivated and utilised for its edible and succulent shoots and by the Igbo tribe (Odiaka et al. 2008). The spread of Igbo people across the country has greatly influenced the cultivation of fluted pumpkin to almost all parts of the country (Akoroda 1990). The vegetable has various traditional names amongst different tribes in Nigeria, including 'Ugu' in Igbo, 'Iroko' or 'Aporoko' in Yoruba, 'Ubong' in Efik, 'Umeke' in Edo and 'Umee' in Urhobo (Akoroda 1990). The fruit is cultivated in the Middle Belt region of Nigeria at all seasons for both subsistence and commercial purposes (Odiaka et al. 2008). It produces lush and edible green leaves known to be highly rich in vitamins (e.g. thiamine, riboflavin, nicotinamide and ascorbic acid), minerals (e.g. iron, potassium, sodium, phosphorus, calcium and magnesium), antioxidants and phytochemicals (Kayode & Kayode 2011). The seeds are roasted or boiled and eaten the same way as the seeds of breadfruit (*Treculia africana*) or used as soup thickener; the iron-rich leaves play a significant role in curing anaemia and are highly utilised for lactation amongst nursing mothers (Okoli & Mgbeogu 1983). The leaves are also consumed by pregnant women because of the high iron content.

'Egusi' species and its dietary and economic importance in West Africa

The 'Egusi' species that exist in Nigeria include *Citrullus lanatus* L., *Citrullus vulgaris* Schrad, *C. mannii* Maud-Holl, *Cucurbita maxima* L., *Cucumis melo* and *Cucumis melo* var. *agrestis* Schrad (Adekunle 1996). 'Egusi' species are commonly cultivated in various West African countries. However, they remain wild species in other African countries (Van der Vossen, Denton & El Tahir 2004). In Namibia and Botswana, *Citrullus lanatus* seeds are mostly harvested from the wild (Van der Vossen et al. 2004). The word 'Egusi' or melon in each West African country is dependent on the species that have been domesticated and cultivated over the years. *Citrullus colocynthis* (Egusi) and *Cucumeropsis manni* (Werewere) grow widely in West Africa where they are commonly planted in cropping systems (Opoku-Boahen, Novick & Wubah 2013). These vegetables grow wild in rainforests but can be harvested for human consumption (Opoku-Boahen et al. 2013). Both vegetables play crucial roles in many regional cultures, as they are used for culinary and medicinal purposes across West Africa (Egunjobi & Adebisi 2004). The seeds are an important part of the vegetables that are harvested and traded in Ghana (Opoku-

Boahen et al. 2013). These seeds are often pulverised to flour and added in dumpling form to soups to enhance the nutrient content of a meal. Cucurbit species are sought after for their oleaginous seeds (Gbogouri et al. 2011).

Citrullus lanatus (Thunb.) Matsum. and Nakai subsp. *mucospermus* (Egusi melon) is the biological ancestor of watermelon, which is now globally cultivated (Ojeh et al. 2007). It is often referred to as Egusi watermelon (Van der Vossen et al. 2004) and is native to West Africa (Ojeh et al. 2007). Egusi watermelon is an unusual seed mutant in watermelon (*Citrullus lanatus* var. *lanatus*) and has seeds with a fleshy pericarp, commonly referred to as Egusi seeds (Gusmini, Wehner & Jarret 2004). Fruits harvested from the wild and semi-wild plants are used in Sudan and the Kalahari region as a drink (Van der Vossen et al. 2004). The Egusi watermelon is commonly known in Nigeria and the Republic of Congo as wild watermelon, Egusi melon or 'Tbara' (Gusmini et al. 2004). Unlike the common watermelon with red and sweet juicy flesh, the flesh of Egusi melon is pale yellow and green with a bitter taste (Ojeh et al. 2007). 'Egusi' (in Yoruba) or 'Agushi' (in Hausa) melon is a creeping annual herb with hairy stems, forked tendrils and three-lobed hairy leaves (Ojeh et al. 2007), cultivated mainly for its seeds (Achigan-Dako et al. 2008a). The seed is composed mainly of unsaturated fatty acids (Ogbonna & Obi 2010) with nutritional and cosmetic importance (Ojeh et al. 2007). The seeds could serve as a good source of essential amino acids such as isoleucine, leucine and arginine (Ojeh et al. 2007). The Egusi watermelon is widely cultivated in Nigeria (Anuebunwa 2000). The highly prized vegetable oil extracted from the seed is of high dietary value, which adds a unique aroma to cooked food. The protein-rich seeds are delicious when cooked and used as a regular part of the diet and popularly served at ceremonies. In the cropping system, 'Egusi' is commonly introduced as live mulch to control weeds as it provides good vegetative cover, which naturally suppresses weed growth (Anuebunwa 2000).

Cucumeropsis mannii, often referred to as 'true Egusi' or 'Egusi itoo', is native to West Africa where it is utilised in the same way as *Citrullus lanatus*. Its young leaves are often used as a leafy vegetable in the Adja community and Bariba of Benin Republic (Maundu, Achigan-Dako & Morimoto 2009). *Cucumeropsis mannii*, known as 'Egusi Tchigan' (the prestigious 'Egusi'), is often presented as a gift in recognition of the social status of the giver (Maundu et al. 2009), an act of friendship and indication of a good harvest (Achigan-Dako et al. 2008a). The plant *C. mannii* is both cultivated and found in the wild in Ghana, Sierra Leone, Cameroon, Gabon, Congo and Angola (Dokosi 1998). *Cucumeropsis mannii* grows in the wild and can be found in the east of Guinea Bissau, southern Sudan, southern Uganda and southern Angola but it is mostly cultivated in west Africa (especially in Nigeria) and occasionally in other African countries such as Côte d'Ivoire (Ivory Coast), Cameroon and the Central African Republic (Egunjobi 2004). 'Egusi-itoo' was an important seed vegetable in West Africa at a time when there were many forests to

practice shifting cultivation (Egunjobi 2004). In Ghana, it is called 'Werewere' amongst the Twi people and can be distinguished from 'Egusi' or 'Akatoa' (*C. colocynthis*) by the seeds, which are smaller in 'Werewere' (Opoku-Boahen et al. 2013). The seed is the only edible part of the 'Werewere' plant (Opoku-Boahen et al. 2013). The seed of *C. mannii* is an important source of lipid, proteins (Achigan-Dako et al. 2006) and calcium (Fokou, Achu & Tchounguep 2004). The African traditional societies place high importance on *C. mannii* because it can be used to prepare dough or sauces (Ponka et al. 2006).

The *Cucurbita* species are often referred to as pumpkins or squashes. The species *Cucurbita maxima* is known as pumpkin or winter squash in English, 'Kabewa' in Hausa, 'Ebeshe' in Nupe, 'Ogbokolo', 'Okoro', 'Anyia' in Igbo and 'Elegede', 'Tsi' in Yoruba (Mohammed et al. 2013). It is utilised as fruit and vegetable and the leaves are sold in markets in various African countries (Maundu et al. 2009). In Nigeria, it is a traditional vegetable that is mainly cultivated for its leaves, fruits and seeds (Mohammed et al. 2014). The seed of *C. maxima* is rich in essential amino acids such as lysine, histidine, threonine, leucine, isoleucine, methionine and phenylalanine and non-essential amino acids such as arginine, aspartic acid, glutamic acid, valine, cystine, glycine, proline, tyrosine and alanine. It is a good source of protein, fats, fibre and essential minerals such as sodium, potassium, iron, phosphorus, zinc and calcium (Mohammed et al. 2014).

Cucumis melo var. *cantalupensis* originated from Africa (Sabo et al. 2013) but has been domesticated in different parts of the world. It is an important commercial crop that is mostly cultivated in temperate regions of the world because of its good adaptability to temperate soil and climate conditions (Zulkarami, Ashrafuzzaman & Razi 2010). *Cucumis melo* var. *agrestis* is cultivated in the Middle Belt (Niger and Benue states) of Nigeria (Adekunle & Oluwo 2008) and the northern region, where it is popular for its sweet pulp and pleasant aroma (Villanueva et al. 2004).

Biochemically, healthy melon seeds contain 63% oil, 3.8% proteins and 1.0% carbohydrate (Coursey 1964). 'Egusi' species from *C. mannii* Naudin [syn. *Cucumeropsis edulis* (Hook.f.) Cogn.], known as the true 'Egusi' (Burkill 1985), and *L. siceraria* (Molina) Standl., known as the bottle gourd, includes non-hard-coat varieties such as 'Aklamkpa' or 'Accra-kakoun' (Achigan-Dako et al. 2006; Achigan-Dako, Vodouhe & Sangare 2008b) are often cultivated in some other west African countries. In these countries, great value is placed on them as a significant component of the local soups.

The significance of 'Egusi' melon species for food and nutritional security in Yoruba land

The cultivation of 'Egusi' melon species does not only serve as a source of income for the rural dwellers of West African countries but also a source of protein and other vital nutritional components. 'Egusi' species have been a crucial tool for food security in West Africa since ancient times. They are prepared for consumption by parching and pounding to free the seed coat from the kernel, which can either be

consumed raw or cooked (Burkill 1985). 'Egusi' soup is often cooked as dumplings together with green leafy vegetables such as *Corchorus olitorius*, known as 'Ewedu', *Solanum macrocarpon* ('Igbagba') and *T. occidentalis* and is used to eat starchy carbohydrates such as pounded yam, 'Fufu', 'Amala' and 'Eba'. The presence of the *T. occidentalis* and 'Egusi' in the meal helps to supply the most crucial nutrients needed for nourishment. The development of food products from seeds of some Cucurbitaceae species could help to provide adequate protein sources for food preparation and suitable nutrition for low-income families.

The use of Cucurbitaceae species in the south-east and eastern parts of Nigeria

Use of Cucurbitaceae species in the traditional food system of the south-east and eastern region of Nigeria

In some parts of eastern Nigeria, the leaves of *C. mannii* or those of pumpkin, *Cucurbita moschata* (Duch. ex Lam.) Duch. ex Poiret, are wrapped around fresh cornmeal and winged termites, cooked and served as a delicacy mostly to women and children (Dike, Obembe & Adebisi 2012). A fermented product of *Citrullus vulgaris* is used for cooking soups whilst *Cucurbita pepo* is cooked until tender and used for soups. It can also be added as a food additive when cooking yam or cocoyam in Igbo land (Okeke et al. 2008).

The use of Cucurbitaceae species in the northern region of Nigeria

Cucurbita moschata is cultivated in northern Nigeria for its fruit and in southern Nigeria in a largely unimproved form for both fruit and leaves (Agbagwa, Ndukwa & Mensah 2007). The leaves are utilised as vegetables and the cooked pulp of the fruit is also eaten (Okoli 1984). *Cucurbita pepo* and *C. maxima* are mostly cultivated in the northern parts of Nigeria, and these species constitute an important part of their diet. They are cooked and the pulp is eaten alone or with yam or potato or used in making a palatable stew (Agbagwa & Ndukwa 2004). Sometimes, their pulp may be eaten without cooking whilst the seeds are often fried before consumption (mostly by children). Tender shoots of *Momordica balsamina* are cooked together with okra by the Kanuris of Borno State where the plant is locally consumed as a vegetable (Jabeen & Khanum 2017). Amongst the Hausa people in Nigeria and Republic of Niger, the leaves are cooked together with other green vegetables for post-natal women and it is believed to help the nursing mother to restore blood lost during labour and to cleanse her breast milk (Molehin & Adefegha 2014).

Use of the Cucurbitaceae species in other West African countries

Niger Cucurbitaceae species are unexploited, but they have the potential to effectively contribute to the achievement of the Millennium Development Goals, especially in the aspect of food security and the fight against poverty (Sabo et al.

2014). They also represent an important source of income for the population (Sabo et al. 2014). *Citrullus colocynthis* (Linn.) Schrad and *L. siceraria* (Molin.) Standl products and by-products are frequently used for food in the Zinder region of Niger because of their high nutritive value (Sabo et al. 2014).

The red, sweet-fleshed types of watermelon are dominant in the humid areas of West and Central Mali as a cash crop whilst the white flesh types are mainly cultivated for their seeds in the North (Dolo Nantoumé 2012). The type that grows naturally in the wild is also edible and is used as food (Dolo Nantoumé 2012). Its seeds are often processed into sauces, snacks and porridge and used as source of fat and protein in a diet. Some of the landraces possess traits of interest such as tolerance to high heat and drought, which enhances food security in the arid and desert areas of Mali (Dolo Nantoumé 2012). In the Bougouni region of Mali, there are home gardens of *C. pepo* exclusively for leaf production (Maundu et al. 2009). *Cucurbita pepo* and *Cucumis sativus* are sold in some food markets in Burkina Faso (Achigan-Dako et al. 2006). Among the Moré people of Burkina Faso, *Luffa acutangula* (L.) Roxb., is often referred to as the 'Queen's okra' and is utilised as a vegetable (Maundu et al. 2009).

Kernels of some cucurbits are consumed in a soup called pistachio soup in Côte d'Ivoire (Ivory Coast) (Gbogouri et al. 2011). Certain species of cucurbit are cultivated at small scale for their oily seeds (Gbogouri et al. 2011). *Citrullus lanatus*, *C. mannii* and *Cucumeropsis melo* are abundant compared with *C. pepo* and *L. siceraria* (Zoro et al. 2006). Zoro et al. (2006) reviewed the inter- and intra-species diversity of cucurbit species consumed in sauce in Ivory Coast. Literature shows that different methods are used in different parts of Africa to prepare edible species of Cucurbitaceae for consumption (as shown in Table 1). Methods used for the preparation of a variety of species have been reported whilst some others are reported to be edible but without records of the method of preparation or plant part used. This could be because almost all plant parts (except for the roots) of most species are used as food. However, records of the use of flowers for food purposes are quite few compared to the use of leaves, fruits and seeds which are the most common. The nutritional values of some species are well documented in the literature, highlighting the fact that the consumption of fruits, leaves or seeds of these plants could supply daily nutritional needs.

Nutritional value of some Cucurbitaceae species

The pulp of *T. cucumerina* fruit is rich in ascorbic acid, lycopene, phenolics, flavonoids and antioxidant activity that are comparable to that of tomato. According to Adebooye et al. (2006), nutrient composition analysis indicated that seeds of *T. cucumerina* are a good source of crude protein (26.2 /100 g – 26.6 g/100 g), fat (44.6 g/100 g – 57.2 g/100 g), phosphorus (78.0 mg – 81.5 mg/100 g) and calcium (41.0 mg/100 g – 46.7 mg/100 g). Arowora et al. (2017) revealed presence of 18 amino acids including alanine, aspartic acid, glycine, glutamic acid, histidine, lysine, methionine, tryptophan, cysteine, leucine, arginine, serine, threonine,

phenylalanine, valine, tyrosine, proline and isoleucine in the leaves of *T. occidentalis*. However, Okonwu, Akonye and Mensah (2018) revealed 20 amino acids including asparagine and glutamine. *Telfairia occidentalis* seeds contain significant amounts of essential nutrients such as crude protein (3.47%), crude fat (31.38%), moisture (10.93%), ash (2.02%), carbohydrate (50.08%), fibre (2.12%), calcium (280 µg/g), phosphorus (21000 µg/g), iron (69 µg/g), sodium (10.80 µg/g), potassium (1280 µg/g), vitamin A (890 IU) and vitamin C (0.7 µg/g) (Christian 2007).

Lagenaria siceraria seeds contain 4.0 g/100 g moisture, 47.8 g/100 g crude fat, 35.0 g/100 g crude protein and 7.3 g/100 g carbohydrates (Ogunbusola 2018). *Lagenaria sphaerica* seeds are rich in protein (23.48%) and minerals (73.12%) and lipid levels (44.54%) (Chinyere et al. 2009).

Steiner-Asiedu et al. (2014) investigated the nutritive content of dry decorticated seeds of four Cucurbitaceae species. *Cucumeropsis mannii*, *Cucumis melo*, *C. pepo* and *Citrullus lanatus* had protein content of 36.00 ± 0.24 , 35.00 ± 0.39 , 36.00 ± 0.94 and $30.00 \pm 0.39\%$; fat (lipid) contents of 44.00 ± 0.58 , 50.00 ± 0.37 , $46.00 \pm 0.57\%$, $56.00 \pm 0.29\%$; iron content of 7.10 ± 0.00 , 8.50 ± 0.01 , 6.50 ± 0.000 and 5.60 ± 0.00 mg/100 g; zinc content of 5.00 ± 0.07 , 5.80 ± 0.03 , 7.10 ± 0.04 and 5.10 ± 0.02 mg/100 g; and fibre content of 2.00 ± 0.31 2.00 ± 0.33 2.40 ± 0.48 1.90 ± 0.39 (Steiner-Asiedu et al. 2014). *Cucurbita maxima* powdered seed proximate compositions were reported by Shahangir (2015). The moisture, ash, crude fibre, total lipid, total protein, total soluble protein, sugar and starch content were 4.06%, 3.80%, 2.91%, 36.70%, 34.56%, 18.10%, 1.08% and 2.15%, respectively, whilst mineral composition was nitrogen 5.53%, phosphorus 0.71%, sodium 4.80 Cmol/kg, potassium 20.00 Cmol/kg, Calcium 4.40 Cmol/kg, magnesium 348.7 ppm, iron 290.0 ppm, copper 70 ppm, zinc 39.9 ppm and manganese 17.9 ppm (Shahangir 2015).

Conclusions and recommendations

Cucurbitaceae plants have played multidimensional functions in the lives of the African people in the provision of accessible medicinal species, source of food and nutritional security and sources of income. In-depth research is suggested to identify underutilised species of Cucurbitaceae that could offer valuable nutrients and aid food security, especially in low-income communities. The extent to which the existence of this family contributes to food and nutritional security is highly dependent on the ability of humans to domesticate wild but edible species of this remarkable plant family. Research into the identification and effective taxonomy keys needs to be developed to enable adequate differentiation of edible species from poisonous ones. A remedy from plant origin to counter the effect of poisonous species consumed because of wrong identification needs to be researched.

Well-strategised, detailed research into some of these species could further help to enhance food security in West Africa. A further step into aspects of horticulture and food development such as postharvest and product development could open innovative pathways into effective storage

TABLE 1: Summary of Cucurbitaceae species used for food purposes in West African countries.

SN	Country	Species	Plant part used/mode of preparation	References
1	Niger	<i>Citrullus colocynthis</i> (linn.) Schrad <i>Lagenaria siceraria</i> (Molin.) Standl	The seeds are used to make dough, cakes and edible oils in the Zinder region	Sabo et al. 2014
2	Mali	Watermelon <i>Cucurbita pepo</i> L.	Both the red, sweet flesh and white flesh are consumed as food. The seeds are often processed into sauces, snacks and porridge. It is consumed in the west, central and northern parts of Mali Consumed in Bougouni region	Dolo Nantoumé 2012 Maundu et al. 2009
3	Burkina Faso	<i>Citrullus colocynthis</i> (linn.) Schrad <i>Cucurbita pepo</i> L. <i>Cucumis sativus</i> L. <i>Luffa acutangula</i> (L.) Roxb (Queen okro)	Leaves are consumed Sold in food markets and used as vegetables Sold in food markets and used as vegetables. It is consumed by the Moré people	Mertz, Lykke & Reenberg 2001 Achigan-Dako et al. 2006 Maundu et al. 2009
4	Republic of Benin	<i>Luffa acutangula</i> (L.) Roxb, <i>Luffa cylindrica</i> (L.) M. Roem, <i>Adenopus breviflorus</i> Benth., <i>Momordica foetida</i> Schumach. and Thonn. <i>Momordica cissoides</i> Planch. ex Benth. <i>Cucumeropsis mannii</i> Naud. <i>Cucurbita moschata</i> Duchesne, <i>C. maxima</i> Duchesne <i>Cucurbita pepo</i> L. <i>Momordica charantia</i> Linn. <i>Lagenaria siceraria</i> (Molin.) Standl <i>Citrullus lanatus</i> (Thunb.) Matsum. and Nakai. <i>Trichosanthes cucurberina</i> Linn. <i>Luffa aegyptiaca</i> Mill <i>Cucurbita pepo</i> L. (gboro)	Traditional vegetable species utilised in different villages and zones of the Republic of Benin. Plant parts used and method of preparations could differ within different villages The leaves are widely used by the Bariba communities in northern Benin	Dansi et al. 2009 Maundu et al. 2009 Dansi et al. 2009 Archigan-Dako et al. 2010 Maundu et al. 2009
5	Ghana	<i>Citrullus lanatus</i> (Thunb.) Matsum. and Nakai. <i>Cucumeropsis edulis</i> (Hook. f.) Cogn <i>Momordica charantia</i> Linn. <i>Sechium edule</i> (Jacq.) Sw. <i>Lagenaria siceraria</i> (Molin.) Standl <i>Luffa cylindrica</i> (L.) M. Roem, <i>Telfairia occidentalis</i> Hook. fil. <i>Cucurbita pepo</i> L. <i>Cucumis melo</i> Linn., <i>Momordica charantia</i> Linn.	Utilised for food purposes in Ghana Seeds serve as food and food additives in Ghana Dried leaves are mashed and added to food in southern Ghana	Abbiw 1990 Steiner-Asiedu et al. 2014 Steiner-Asiedu et al. 2014 Asase and Oppong-Mensah 2009.
6	Côte d'Ivoire (Ivory Coast)	<i>Citrullus lanatus</i> (Thunb.) Matsum. and Nakai. <i>Cucumeropsis mannii</i> Naud <i>Cucumis melo</i> Linn., <i>Cucurbita pepo</i> L. <i>Lagenaria siceraria</i> (Molin.) Standl <i>C. melo</i> Linn., <i>Citrullus lanatus</i> (Thunb.) Matsum. and Nakai	Seeds are used in food preparations Seeds are toasted, ground and used as a sauce thickener Amongst the cucurbits cultivated for food purpose in Côte d'Ivoire (Ivory Coast), <i>Citrullus lanatus</i> is the most common	Zoro et al. 2006 Gbogouri et al. 2011 Gbogouri et al. 2011
7	Senegal	<i>Cucurbita maxima</i> Duchesne <i>Cucurbita pepo</i> L. <i>Momordica balsamina</i> Linn.	Tips of young leaves are cooked or dried to be stored. The fruit can be eaten cooked, baked, boiled, fried, steamed or mashed; usually used as fillings in pies and cakes. Seeds are consumed either raw or roasted or ground into a meal. Male flowers are used for food after stamen and calyx are removed Young fruits are cooked by boiling, steaming or frying and eaten. They are used as components of pie, stews, soup and cakes. Cooked young leaves and ripe seeds are also eaten. Seeds are eaten as a snack after processing by drying, salted and then toasted. Oil is also extracted from seeds and whole seeds are used in salads. Flower buds can be dried and stored for future use or boiled fresh for food Young fruit are boiled or eaten raw as a vegetable. They are also used in stew and pickled. The seeds are steeped in salt water and cooked before eating. The ripe fruit can cause diarrhoea. Cooked fruit of <i>Sechium edule</i> is edible; can be pickled, baked, steamed or made into puddings. Young leaf tips are eaten; seeds can be eaten cooked or fried whilst the fleshy root too can be eaten cooked, boiled or baked	Food Plant Solution 2018

of excess production of these edible species and development of cheap and affordable food products that could serve the people in times of food scarcity. Proper exploitation of edible plants from this family could open more pathways to access vital food nutrients needed to keep a healthy population in West Africa and Africa and thus fulfil the food and nutritional security goals of various governments in Africa.

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Authors' contributions

With the submission of this manuscript, we would like to undertake that this work is originally put together by the authors and no part thereof has been submitted nor published elsewhere. All authors agree with the contents of the manuscript and its submission to the journal. All authors listed have contributed significantly to the work and agree to be in the author list. No part of the research has been published in any form elsewhere.

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