A Review on the Economic Uses of Species of Cucurbitaceae and Their Sustainability in Nigeria

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Abstract: The Cucurbitaceae family commonly known as the gourd family is an excellent example of a plant family with many economically useful species. They are native in most countries of the world, especially in the tropics, where they are cultivated in every country, state, and province. The Cucurbitaceae consists of many important food plants such as melon, pumpkin, squash, cucumber; useful plants for the production of items of utility such as bottle gourds, loofah, ornamental gourds, etc. Some species, example, bitter melon, cucumber, musk melon, etc are considered to have medicinal properties due to the presence of cucurbitacins, etc. Others such as Luffa, Cucurbita, etc are used as complementary dietary ingredient of feed for poultry and increasingly as a protein and vitamin supplement to aquafeeds. Members of this family such as Momordica, Cucurbita, Cucumis etc are also used as remedies for livestock. In addition, seed oil of melon is a source of biodiesel. This article briefly reviews the nutritional, medicinal, ethnoveterinary and ethnomedicinal value of these plants, as well as their uses as items of utility, complementary dietary ingredient for poultry and aquafeed and as a source of biodiesel. This is an attempt to compile and document information on the different uses of these plants and to recommend that increased in production of these plants will be profitable and will contribute to food security and livelihood sustainability in Nigeria.

Keywords: Food Plants, Medicinal Plants, Ornamental Gourds, Cucurbita, Momordica, Poultry Feed

1. Introduction

The family Cucurbitaceae is an interesting and an unusual family of dicotyledons. It is a medium sized family consisting of about 120 genera and more than 800 species distributed predominantly in the tropical and subtropical regions of the New and Old world [1]. But in Nigeria, it is represented by 21 genera and 41 species [2]. The plants of the family are collectively known as cucurbits [3].

The Cucurbits are characterized by a very extensive root system which ramifies in the surface soil. They have hollow angled stems which may be glabrous, hairy or prickly, and their vascular bundles are bicollateral [4, 5]. The stems may reach great lengths, either trailing along the ground or climbing supports with their tendrils.

The leaves are large, simple but often deeply lobed, alternate or spirally arranged on long petioles. In each leaf axil, there is a flower bud, a vegetative bud and a tendril [6].

The plants are monoecious or dioecious with unisexual flowers occurring singly in the leaf axils. The hairy calyx-tube is divided into five lobes at the top, and the corolla has five petals which are fused. In female flowers, the inferior ovary consists of three united carpels with numerous ovules carried in three thick, fleshy, apparently parietal placentas. The fruits are large and fleshy, usually with a hard outer covering, a special type of berry called pepo. The seeds which are fairly flat are attached to the ovary wall in a parietal placenta.

Cucurbitaceae is of high economic value being a major source of food for man. Many species of Cucurbita (pumpkins, squashes, gourds, marrows, courgettes), Cucumis (melons, cucumbers), Cucumeropsis mannii Naud. (egusi), Colocynthis (water melon) and Sechium edule (Jacq.) Sw. (cho-cho) are cultivated for edible purposes [7]. Others such
as *Lagenaria siceraria* (Molina) Standl. (calabash, bottle gourd) and *Luffa cylindrica* (L.) Rem. (loofah) are cultivated for making items of utility such as drinking vessels, cooking pots, utensils, bath sponge, in industrial filters and in sound insulation. Other important genera of the family are *Trichosanthes*, *Benincasa*, *Mormodica*, *Citrullus*, *Bryonopsis* and *Corallocarpus*. Members of the family contain cucurbitacins, which are bitter and highly medicinal.

### 2. Cucurbits as Food Plants

*Benincasa hispida* (Thunb.) Cogn., winter melon or wax gourd, was one of two cucurbit species identified as being an underexploited tropical. This plant exhibits relatively rapid growth and grows best in temperate climates with adequate but not excessive rainfall. Plants may be grown recumbent or trellised. The primary harvested plant part is the mature fruit, although seeds are sometimes extracted, fried, and eaten like pumpkin seeds. The white, chalky wax which covers the fruit deters microorganisms and helps impart an extraordinary longevity to the melon. Winter melon fruits can be stored for as long as a year without refrigeration. The flesh is often used to make soup stock.

*Citrullus colocynthis* (L.) Schrad., egusi, is native to tropical Africa and highly drought tolerant. A relative of watermelon, productivity is enhanced during dry, sunny periods and reduced during periods of excessive rainfall and high humidity. They can contribute substantially towards obtaining a balanced diet [8]. The seeds are edible and can be removed and roasted as an edible commodity, but the fruits are extremely bitter. Egusi seeds can be ground into a powder and used as a soup thickener or flavouring agent. Oil from the seeds can be extracted for cooking purposes [9].

*Coccinia cordifolia* Cogn., Ivy gourd, is a semi-perennial which grows best under conditions of adequate rainfall and high humidity. It produces best when a 1:10 ratio of male to females is used. Plants are commonly trellised. The leaves, shoots, and immature fruits are cooked and eaten, while the mature fruits are sometimes preserved.

*Lagenaria siceraria* (Molina) Standl., the bottle gourd, is said to have originated in Africa, although archaeological evidence indicates its origin in Peru, Thailand, and in Zambia. Young fruits are cooked as vegetable similar to Zucchini. Young shoots and leaves can be cooked, and seeds can be used in soups. Flesh of immature fruits can also be used in making icing for cakes, and the hard skin is sometimes sliced into thin, dry strips for cooking.

*Luffa acutangula* (L.) Roxb., the angled or towel loofah is primarily grown in India, was long considered to be *Citrullus lanatus* but was recently given its own taxonomic category due in part to its difference in monoploid chromosome number. Growth conditions and requirements are similar to those of watermelon, but the entire immature fruit is used as a cooked vegetable. The seeds can also be removed and eaten.

*Telfairia occidentalis* Hook. f., the fluted pumpkin, a dioecious perennial, grown at elevations up to 2,000 m in West Africa, is drought tolerant and is usually trellised. Shoots from the female plants can be cooked and eaten. The fruits are large (up to 13kg) and inedible, but the seeds contain up to 30% protein and can be boiled and eaten, or ground into powder for soup. Seeds can also be fermented for several days and eaten as slurry.

*Trichosanthes cucumerina* Linn., the snake melon, is an annual which requires high levels of soil moisture and trellising and a long growing season. Immature fruits are boiled and eaten, while mature fruits are used in soups.

*Cucurbita ficifolia* Bouche., the malabar gourd grows in temperate highlands at elevations up to 2,000 m. The immature fruits can be prepared and eaten similar to summer squash. Mature fruits can be preserved, and the black seeds are edible. In Latin America, the flesh is impregnated with sugar to make a candy or it can be fermented to make beer [10].

*Cyclus phaethon* Schrad., the wild cucumber, is relatively cold tolerant and adapted to elevations up to 2,000 m, but is also easy to cultivate in the tropics and subtropics. The seed cavity is spongy, and the seeds are attached to a single placenta. Seeds are usually removed and the fruits are eaten raw or cooked. They are often used stuffed with meat, fish or cheese, then baked and eaten similar to stuffed peppers. The seeds are also edible.

*Sechium edule* (Jacq.) Sw., chayote or cho-cho, is still one of the most widely cultivated of the cucurbitids in Costa Rica. Unlike other cucurbitids, the fruit contain only a single, large seed. The immature fruits can be eaten raw in salads and provide a good source of vitamin C. They can also be boiled, fried, steamed, or stuffed and baked. Young leaves and tendrils are also eaten. The large storage roots represent a rich source of starch.

The watermelon, *Citrullus lanatus* (Thunb.) Mansf. like other Cucurbits, are warm-season annuals having long, prostrate vine growth; the vines readily attain lengths of more
than 6 meters (20ft).

Seeds are roasted and ground into tsamma meal, a nutritious food with a pleasant nutty taste. Leaves and young fruits are utilized as green vegetables [11]. The peels of the fruit are traditionally used for making jam. Watermelon is an excellent source of vitamin C and vitamin A. Watermelon seeds are rich in fat and protein, and are widely eaten as a snack, added to other dishes, or used as oilseed.

The highly nutritious seeds of egusi watermelon, after decortication and powdering, are added to enrich and thicken soups [12]. The seeds may be fermented after soaking in water, boiled and further blackened with charcoal and wrapped up in leaves of Newbouldia laevis (P. Beauv.) Seeman ex Bureau, Alchornea cordifolia (Schum. and Thonn.) Stapf. or banana to form ogiri–isi, a food seasoning used in preparing certain kinds of soup or potage [13]. The seeds may also be roasted along with peanuts (Arachis hypogaea L.) and pepper (Capsicum spp.), with or without dried shrimp and ground into a fine, oily paste, ose-oji, for use in eating Oji (Kolanuts) and/or fruits of eggplant (Solanum melogena L.). The ground seeds of egusi melon are used in making a type of bread.

*Cucumis sativus* L., cucumber, are 96 percent water, with a little fiber and only a few calories. In addition, it provides a good source of vitamins A, K, and C, as well as a large amount of potassium.

*Cucumis melo* L., cantaloupe, honey dew or muskmelon is a ‘fruit’ rather than a vegetable; the sweet, delicately flavored, juicy flesh of the pepo is eaten raw, often as a dessert. The species is variable with a considerable range of fruit types, many of them highly esteemed for their delicious flavor.

Immature melons are used fresh in salads, cooked or pickled; they are also stuffed with meat, rice and spices, and fried in oil. Mature fruits are eaten fresh as a dessert fruit, canned or used for syrup or jam.

The white-seeded melon, *Cucumeropsis manni* Naud. (Syn. *C. edulis* (Hooker f. ) Cogn.) is a species of melon which is native to tropical Africa west of the Great Rift Valley. This monococious plant is grown for food and as a source of oil. Its common names include egusi in Yoruba and agushi in Hausa. In English it is known as Mann's cucumeropsis and white-seed melon [14].

The seeds are edible and oily and used like the seeds of *Citrus lanatus*. They are ground into a vegetable paste and used in soups, sauces and cakes. It is also used for cooking oil. In some parts of Eastern Nigeria, the leaves of *Cucumeropsis manni* or those of pumpkin, *Cucurbita moschata* (Duch. ex Lam.) Duch. ex Poiré, are wrapped around fresh corn meal and winged termites, cooked and then eaten as a delicacy, mostly by women and children [15].

*C. moschata* (Duch ex Lam.) Duch. ex Poiré., the squash melon, which encompasses various cultivars of pumpkin and winter squash, is cultivated in warm areas around the world as food and animal fodder. Popular cultivars include butternut, winter crookneck, and cushaw, and numerous types developed in Japan and China. The names “winter squash” and “pumpkin” are also applied to the cultivars of *C. maxima* (Duch ex Lam.) Dutch ex Poiré, *C. mixta* Pang., and *C. pepo* L. The flowers, young stems and young and ripe fruits are eaten as a vegetable. The latter are also commonly used to prepare sweets and as fodder. The seeds are eaten whole, roasted or toasted and are ground into different stews. They have high oil and protein contents and their consumption in urban areas is also fairly common.

Pumpkins provide a number of beneficial nutrients and minerals. They contain high levels of thiamin, niacin, vitamin B6, iron, magnesium and phosphorus. They have even higher levels of vitamin C, vitamin E, potassium, copper and manganese. The flesh is a good source of dietary fiber. They are also low in saturated fat, cholesterol, and sodium. Pumpkins contain a very large amount of vitamin A, with one hundred grams of pumpkin flesh providing 148% of the percent Daily Value for the average diet. Though the seeds of pumpkin possess more fat, they make up for it with high levels of protein, magnesium and zinc.

The young shoots and leaves of the female plant species of *Telfairia occidentalis* are the main ingredients of a Nigerian soup, Edikan ikong. The large, dark-red seed is rich in fat and protein and can be eaten whole, ground into powder for a kind of soup, or made into a fermented porridge.

### 3. Cucurbits for Ethnomedicinal Purposes

[16] reported that whole plant of *Momordica charantia* (Bitter gourd/bitter melon) is used in the treatment of malaria in the south-western regions of Nigeria. The plant is reported to possess antifungal, anti-inflammatory, anti-parasitic, antisepsic properties, and act as a digestive stimulant, febrifuge, lactagogue, menstrual stimulator, purgative, vermifuge, and used in wound healing [17-19].

Generally, the fruits are used for the treatment of lots of ailments such as malaria, cholera, anaemia, jaundice, etc; they possess antiemetic, purgative, anthelmintic, and carminative properties [20]. In Turkish traditional medicine, mature fruits are used for rapid wound healing and for the treatment of peptic ulcers while the immature fruits are used for the treatment of diabetes [21].

Species of the Cucurbitaceae family contain a phytochemical of great interest due to its wide range of biological activities in plants and animals. This highly bitter and toxic substance is called cucurbitacins. As a result of this, there has been a lot of researches on the species of this family [22], and plant species containing cucurbitacins are good candidates in various pharmacopoeias [23].

Various parts of the plant species, *Cucurbita pepo* (Pumpkin) is used in ethnomedicine. The fruits have astringent effect on the bowels. It is also employed in the purification of blood and the treatment of leprosy in humans. The seeds are useful in the treatment of sore chests, fever, haemoptysis, and bronchitis. In addition, it is reported that they are applied in the case of benign prostatic hyperplasia...
and possess anti ulcer curcurbitan type triterpenoid [24, 25].

A specific amino acid known as cucurbitin, represented as \((-\)-3-amino-3-carboxypyrrolidine), is present in varying levels in different varieties of pumpkin and squash and as a result, their seeds are used for the elimination of tapeworms and roundworms which are intestinal parasites and treatment of enlarged prostate glands in men.

The fruits of *Cucurbita ficifolia* (Leaf gourd) are currently employed in the treatment of diabetes type 2 [26, 27]. Other uses include wound healing, treatment of fever and hemorrhoids.

*Cucumis sativus* (Cucumber) leaves contain isovitexin, saponin and various acylated flavone C-glycosides [28]. The fruit is demulcent; seeds have cooling effect, and is taken as a tonic, with diuretic and anthelmintic properties.

- The fruit of *Cucumis melo* (Muskmelon) has diuretic and diaphoretic properties and is taken as a tonic, laxative and galactagogue and also used in the treatment of chronic eczema [29].

Report indicated that the aqueous extracts of the vegetative and reproductive organs of *Citrus lycopersicum* (Bitter apple) possess analgesic, anti-inflammatory, antipyretic, anthelmintic, carminative, and cathartic activities [30]. The bitter and acrid fruits have cooling effects and are used in the treatment of hypoglycemia, tumors, leucoderma, ulcers, asthma, bronchitis and constipation. This species contains cucurbitacins A, B, C, and D, \(\alpha\)-elaterin and various other constituents [31].

- *Luffa echinata* Roxb. (Bitter sponge gourd) has been recommended for the treatment of liver ailments. It is reported to contain echinatin, saponins, cucurbitacin B and E, \(\beta\)-sitosterol, echinatol A and B, oleancolic acid [32].

*Trichosanthes kirilowii* Maxim. (Chinese cucumber) seeds are anti-inflammatory agent, a cough medicine and an expectorant. Several multiflorane triterpenoids including karounidiol and its 3-O-benzoate derivative have been isolated from the seed extract, and are expected to be potential anti-tumor promoters [33].

Whole plant of *Trichosanthes cucumerina* (Snake gourd) have medicinal properties. The root is used as a cure for bronchitis, headache and boils. A combination of the root and fruit are considered to be cathartic. Studies have shown the presence of anti-inflammatory activity in root tubers and anti diabetic activity in seeds [34].

*Trichosanthes tricuspidata* Lour. (Indrayan) plant is used as a laxative, anthelmintic and in the treatment of migraine. The root extract has shown antioxidant effect in Sildenafil induced migraine in albino mice [35].

*Sechium edule* (Chayote) is used in the treatment of kidney related diseases, circulatory system and inflammation. The antihypertensive effect of *S. edule* has been described [36]. The extract is capable of altering the bio-distribution of sodium pertechnate in rats [37].

*Lagenaria siceraria* (Bottle gourd) is used in the treatment of pain, ulcers, fever, pectoral cough, asthma and other bronchial disorders, especially syrup prepared from the tender fruits. The fruits have protective effects in myocardial infarction [38].

*B. hispida* (Wax gourd) is recommended for peptic ulcer, hemorrhages from internal organs, asthma, cough, diabetes, epilepsy and other nervous disorders. Acid neutralizing and ulcer healing activities of this plant have also been described. Effect of *B. hispida* on high glucose-induced vascular inflammation of human umbilical vein endothelial cells has been studied [39]. Seeds possess free radical scavenging, anti-inflammatory and analgesic potential [40].

In Ghana, the fruit juice of *Cucumoperopsis manii* mixed with other ingredients is applied to the navel of newborn babies to accelerate the healing process until the cord-relics drop off. Macerated leaves are used in Gabon for purging constipated suckling babies. In Sierra Leone, cattle boys traditionally use the dried fruit-shell of an egusi-ito type with small elongated fruits as a warning horn.

The fluted gourd of *Telfairia occidentalis* has high protein content and has been traditionally used by indigenous tribes as a blood tonic [41]. The plant can also be used to treat sudden attack of convulsion, malaria, and anaemia; it also plays a vital and protective role in cardiovascular diseases.

### 4. Cucurbits as Items of Utility and Cosmetics

*Lagenaria siceraria* fruit comes in a variety of shapes and sizes. In Nigeria, the fruits are used for various purposes. Medium-sized calabashes are used for the production of ladles, boxes, water jugs, planters, flutes, sitars, and other musical instruments. Various objects such as shells, bones, beads or metals are attached around carved gourds to form rattles. The dry rinds are employed as containers for palm wine, water, and floats by fishermen for fishnets and rafts, gun powder and seeds. [42] reported the use of gourds as receptacles for fish in the Argungu Fishing Festival in Sokoto State of Nigeria. Fulani women and young girls hawking madara (fresh milk), fermented milk (nono) and/or kunu, gruel from guinea corn in the Northern part of Nigeria use giant, beautifully tattooed calabash basins. They are also used for the production of masks or native artifacts.

The cucumber is highly valued in cosmetic industry because the fruit is excellent for rubbing over the skin for softness and whiteness; it is cooling, healing, and soothing to the skin irritated by the sun, also used in soap making. Cucumber scent is linked to female sexual arousal.

The mature fruits of *Luffa aegyptiaca* are the source of the spongy reticulated material known as the domestic loofah. These loofahs are used for sponges and filters, and for stuffing pillows, saddles, and slippers. They can also be used for insulation and are attractive sources for packing materials [9, 28]. There is an increasing interest in domestic production since the United States is the major market and imports millions of loofahs from Asia each year [43].
5. Cucurbits as Complementary Dietary Ingredient of Feed for Poultry and Aqua Feed

[44], in their investigation on the replacement of soybean meal with *Luffa cylindrica* in the diet of *Claria gariepinus* fingerlings in Nigeria, reported that wider utilization and availability of this conventional source for fish feed is limited by increasing demand for human consumption and by other animal feed industries [45]. This has encouraged the need to look for cheaper alternative protein sources, hence the need to focus on using less expensive and readily available plant protein sources to replace soybean meal without reducing the nutritional quality of fish feeds [46].

*Luffa cylindrica* syn. *L. aegyptica* is a tropical running vine with rounded leaves and yellow flowers [47]. They have nutritional quality comparable to other oilseed proteins, including soybean and other conventional legumes. The results of the study showed that it is possible to replace soybean meal in the diet of *C. gariepinus* fingerlings with cooked *L. cylindrica* seed meal, with optimum growth response at a 15% replacement level.

A research study was carried out by [48], on the effects of replacing fishmeal with squash seed meal (*Cucurbita maxima*) on performance of juvenile Nile tilapia (*Oreochromis niloticus*). They reported that the formulation of fish feed using a cheap, locally available and highly nutritious terrestrial resource such as *C. maxima* seeds is needed [49]. They reported that the crude protein levels of *C. maxima* seeds and kernels are comparable to high-protein-containing seeds and legumes such as soybeans and cowpea; while lipid content of *C. maxima* kernels is comparable to sunflower, soybeans and cotton seeds [50]. The results showed that fish fed 5% Squash seed meal exhibited numerically highest growth performance and feed utilization efficiency. They recommended diet inclusions of 5 to 20% Squash seed meal as these were found to be efficiently utilized by *O. niloticus* fingerlings as well.

[51] carried out an investigation on the effect of squash seed meal (SSM) (*Cucurbita moschata*) on broiler performance, sensory meat quality, and blood lipid profile. Squash pulp is consumed but the seeds are not used as human food or animal feed, and consequently, thousands of tons of seeds, containing 940 g/kg dry matter and significant amounts of proteins, amino acids, unsaturated lipids, phytosterols, squalene, dietary fiber, and minerals, are wasted. Squash seeds produce 225 to 248 kg crude protein/hectare and 240 to 255 kg ether extract/hectare, which could potentially be used for poultry feeding [52].

Squash seed meal is rich in proteins, but its inclusion in diets for monogastric animals has shown poor results [89]. However, literature search has not retrieved sufficient information on the use of full-fat squash seeds in poultry diets, particularly in broiler diets.

They discovered that the inclusion of 0, 33, 66 and 100 g/kg of Squash Seed Meal in broiler diets, partially replacing soybean meal and vegetable oil, improved live performance and edible portions yield.

The better performance obtained with the inclusion of 33 and 66 g SSM/kg feed as compared to control diet may be due to the flavor enhancement promoted by unsaturated fats. [53], showed that when unsaturated fat levels were increased in broiler diets, feed intake and final body weight was higher than that obtained with the control treatment. [54, 55], demonstrated a linear increase in broiler daily gain with increasing dietary fat inclusion levels. The results of the present study showed that SSM acts as a natural growth promoter in broilers when added up to 66 g/kg of feed.

6. Cucurbits of Ethnoveterinary Importance

Ethnoveterinary medicine, which is traditional animal healthcare practices, provides low cost alternatives in situation where western type drugs and veterinary services are not available or are too expensive [56]. Plant remedies are still the most important and sometimes the only source of therapeutics for nearly more than 90% livestock population [57]. Ethnoveterinary medicine offers medicines which are cheap and locally available than pharmacotherapy. Farmers can prepare and use homemade remedies without any expenditure.

[58], reported that the tuber of *Cucumis ficifolius* A. Rich., Fig leaf cucumber, is used for the treatment of black leg, colic and emaciation in animals such as cow, bovine, etc, and the leaves of *Cucurbita pepo* is used for the treatment of trypanosomosis in animals; leaves and seeds of *Lagenaria siceraria* is used to treat rabies and trypanosomosis; *Momordica foetida* Schum. & Thonn., Snake food or wild cucumber, is for fracture, rabies, trypanosomysis, myiasis, lice and some ectoparasite infestation. It also has sedative effects on animals. *M. foetida* and *C. ficifolius* were reported to have broad spectrum activity and known as “master of medicinal plants” and this is in support of earlier reports by [59]. A single plant part was occasionally observed to be used for treatment of multiple ailments; the same applied to combination of plant parts. One or more or whole parts of the plants were added to many home made remedies. The herbalists believe that these plants have low antagonist and very high synergistic effect when they are utilized with others.

[55], reported that the root decoction of *Citrullus colocynthis* is given to the animals to cure constipation. The plant is also mixed with honey, mustard oil and applied internally for easy opening of the uterus during delivery.

7. Cucurbits for the Production of Biodiesel

Biodiesel is defined as the mono alkyl esters of long chain fatty acids obtained from renewable feedstock, such as
vegetable oil or animal fats, for use in compression ignition engines. It is more attractive because it is environmentally friendly, derived from renewable resources, biodegradable and non-toxic in nature [60]. Biodiesel acceptance as a substitute for fossil-derived diesel has grown the world over. *Citrullus colocynthis*, egusi melon seed oil was studied for the first time as a potential feedstock for biodiesel production. The major sources of the world’s energy needs are petroleum, coal and natural gases which are fossil-derived and non-renewable. Scarcity of traditional petroleum fuels, its over dependence by nations, increasing emissions of combustion-generated pollutants and their increasing costs have made renewable energy sources more attractive. Seeds of cucurbits are sources of oils and protein with about 50% oil and up to 35% protein. Specifically for these reasons they are cultivated and consumed world over.

*Citrullus colocynthis* L. is among the 300 species of melons that are cultivated for its seeds, which are rich in oil (53%) and protein (28%). Various studies have reported predominantly high linoleic fatty acid content in egusi melon seed oils. Due to the unsaturated fatty acid composition of its oil, it was reported to resemble that of safflower, corn, cottonseed, sunflower, soybean and sesame oil which are already been used for as feedstock for biodiesel production.

8. Conclusion

From the papers used in this review, it is clear that members of Cucurbitaceae have multipurpose functions in the lives of humans and animals. They can be employed in the nutritional, medicinal, ethnoveterinary needs of any nation, as well as in the production of items of utility and biodiesel and as complementary dietary ingredient for poultry and aquafeed. It is recommended that there should be increased in the production of these plants which will be profitable and will contribute to food security and livelihood sustainability in Nigeria in particular and other parts of the world in general.

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