



## Post-Harvest Management and Preservative Quality of Kola Nuts against Pest Infestation for Local and International Markets a Review

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**Abstract:** Challenges of kola nut production are low yield, lack of information on improved technology, pest and disease infestation, lack of intervention from the government, and transportation. Stored nuts were mainly attacked by weevils and rot disease. Notwithstanding, farmers in Nigeria producing States hold kola nut production in high esteem, and there is vast area of land which could be used for kola nuts production. However, there are untapped abundant resources and potential for expansion of production base and usage of products, packaging of kola nuts for export. There is need for upgrading and developing technology back up for the major commodity towards increasing production, trade/marketing, and improving the economic well-being of all stakeholders. More emphasis should be on institutionalizing of a sustainability structure for research and development, expanded production and provision of supportive policy on organized marketing and credit support to the principal partners in agricultural research for development that would be farmer centered and friendly. The report offers a comprehensive evaluation of processing, storage and marketing of kola nuts including by-products. It does so via in-depth qualitative insights, historical data, and verifiable projections about market size. By doing so, the research report serves as a repository of analysis and information for every facet of the market, including local and international markets.

**Keywords:** Challenges, Storage, Processing, Packaging, Kola nuts, Markets.

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### INTRODUCTION

Nigeria has comparative advantage over other producers in terms of climatic condition and soil factors. The cultivation of kola in Nigeria is ecologically limited to the rain forest zones of South and riverine areas of the Savannah region. In large production, the crop pattern of kola nut is interspersed with cocoa and bitter kola. Kola will do well in soils suitable for cocoa and coffee and in soils which are marginal for these two crops. According to Asogwa *et al.*, (2006) there is an abundance soils of

high, medium, and low fertility that can be strategically exploited for kolanut cultivation in an effective land utilization policy in Nigeria. An estimated 700,000 hectares of good cocoa soil harbours kola as this crop is mostly grown in mixture with cocoa in Oyo, Ogun, Ekiti and Ondo States.

### Kola nuts producing States in Nigeria

Kola cultivation can be strategically pursued on suitable soils that have long been identified in the following parts of the country which shares similar

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climatic and edaphic factors. Kola presently thrives in Ogun, Ondo, Oyo, Ekiti, Edo, Delta, Enugu, Anambra, Rivers, Cross Rivers, Abia, Akwa-Ibom and Niger States (Table 1). These suitable soils scattered all over the country should be utilized for planting of new improved seedlings to ensure high production of kolanuts for export. Production of kola nuts is determined by the land covered and major occupation of the people of the areas. The land put under cultivation varied in each state, thus only the southern parts of Edo and Adamawa State, non-

riverine areas of Delta and Rivers States, most parts of Cross River and Akwa Ibom States, Ilorin area of Kwara State, Zaria area of Kaduna State, areas around rivers and streams if irrigation is provided, especially during establishment stages in Kano State, Mokwa and large areas of the upper part of River Niger, provided irrigation is available in Niger State, Oturkpo and Kabba areas in Benue/Plateau/Kogi States and Lafia area in Nassarawa State (Asogwa *et al.*, 2006; Opeke, 2005).

**Table-1: The geo-political zones carved out based on geographic location in Nigeria.**

Geographical location	Kola producing States in Nigeria
South West	Ogun, Ondo, Oyo, Ekiti, Osun and Lagos (upperland area)
South South	Edo, Delta, Rivers, Cross River and Akwa Ibom
South East	Anambra, Enugu and Abia
North central	Kwara, Nassarawa, Niger, Benue, Plateau and Kogi
North West	Kano and Kaduna
North East	Adamawa

**Source:** Ndagi *et al.*, 2012

**Cola spp of economic importance**

Kola belongs to the family Sterculiaceae and the genus Cola. It is indigenous to Tropical Africa and has its centre of greatest diversity in West Africa. In the forest areas of West Africa, kola is perhaps second in importance only to oil palm in the list of indigenous cash crops. Kolanut has been an item of trade in West Africa and in the trans-Saharan trade routes for many centuries (Egbe and Sobamiwa, 1989). It has for hundreds of years served as an important article of internal trade in Nigeria and other parts of Africa (Nzeku, 1961). About forty (40) species have been described in West Africa, twenty five (25) of which are found in Nigeria. However, only two species – Cola nitida (Vent) Schott and Endl as well as C. acuminata (P. Beauv) Schott and Endl. are of economic importance. Both species are important economic crops in the forest area of West and Central Africa, Carribean Islands, Mauritius, Sri Lanka and Malaysia (Eijnatten, 1969; Oladokun, 1982). Kolanut is an important economic cash crop to a significant proportion of Nigerian population who are involved in kolanut farming, trading, and industrial utilization.

The Cola species of economic importance are C. acuminata and C. nitida and Nigeria accounts for about 70 percent of the total world production of kolanuts (Quarco, 1973; Daramola, 1983; Jacob, 1973). About 90% of the kolanut produced in Nigeria is consumed locally within the country while 10% is exported (Quarco, 1973). The kola nut tree is referred to as “Igi owo” (i.e. money spinner (generating) tree) by the people of Remo in Ogun State, where it is well grown. Out of these lots, are of agricultural prominence, Ijare area of Ondo State is regarded as the centre of origin of C. acuminata. Cola

acuminata is used mainly in the Southern and North-Central zones of Nigeria largely in connection with social and religious ceremonies. In these areas, C. acuminata is still considered as first choice and the demand for them remains high.

The cultivation of C. nitida in Nigeria began sometimes in the 19<sup>th</sup> Century. The nut (C. nitida) was observed to be grown plentifully in Agege and the Otta bush by 1854 while its cultivation was noted in Egba Division in 1902 and in Labochi and environs in 1901. From Agege, C. nitida cultivation presumably spread to the forest areas following first the course of the railway into Abeokuta, Ibadan and Offa replacing C. acuminata and penetrating later along stream and river banks into the Guinea Savannah and the present South-South and South Eastern States (Eijnatten, 1969). Cola nitida frequently referred to as the “true kola of commerce” has featured in the internal trade of West Africa for a number of centuries. There are two types; the white kola, which is more nearly a pale greenish-yellow, and the red kola, both being yielded by the same species, and often occurring in the same pod.

Bitter kola and piper guineensis for the treatment of typhoid. Treatment of the following diseases: liver disease, kidney disease, cancer, missiles (ground bitter kola + palm oil).

**Processing, storage and preservation of kola nuts for major uses**

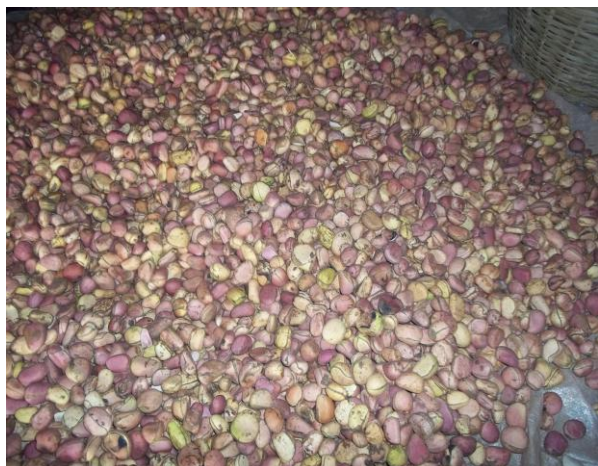
Farmers cut open the plucked pods with knife or cutlass to remove nuts embedded in the husks. Inside the kola-fruit about a dozen square and round seeds developed in a white seed shell. The

nuts at this stage are still covered with skin or coat; this is soaked in water for about 24 hours to enhance rotting and fermentation. Fermentation is complete when the skin is soft, this is then removed with hand, washed, and drained. Washed and drained nuts are covered in basket with leaves to undergo curing and maintained under ambient room temperature for a period of three days. Defective/infested nuts are picked out during this curing process that usually involves considerable sweating to reduce the moisture content of the nuts. The nuts are then graded into sizes for proper storage in big sized baskets. According to several workers who reported that the storage baskets are first lined up with thin transparent nylon sheet followed by a layer of *Newbouldia laevis* placed with ventral (upper) surface facing downwards in the basket thereby exposing the dorsal (back) surface of the leaves to the nuts (Asogwa *et al.*, 2011). The nuts are carefully placed inside layer by layer and after each layer *Parkia biglobosa* leaves is spread out evenly on top of the nuts. *Newbouldia laevis* leaves are used to cover up the last layer of the nuts, before finally sealing up the whole thing with the first layer of polythene sheet. The *N. laevis* leaves and the polythene sheets keep the nuts in an air tight condition and prevent desiccation of the nuts in room temperature and relative humidity. The *P. biglobosa* leaves was believed to brighten the nuts, thereby giving them a bright coloration which makes them attractive (Asogwa *et al.*, 2011). During the first few months of storage, the nuts are separated every eight days (8 days). The top leaves are removed and the nuts spread out gently on a mat. Kolanut is noted for its characteristic quick shoot emergence without necessary coming in contact with any growth medium. Each nut is carefully examined and any emerged shoot is removed with a pin and coated with a film of palm oil to slow down the emergence rate and prevent the splitting of the nuts. Any defective or infested nuts are sorted out during the inspection period. This periodical inspection also helps to prevent the overheating of the nuts. During inspection the top leaves that was over dried and shrinks, are changed. After three months, the inspection period can be extended between 2 to 3 weeks depending on the quality and condition of the nuts at the last inspection. This cultural method of sorting out deformed and infested nuts during storage ensures maintenance of whole nuts and reduces or eliminates completely the chemical usage in storage. The deformed and infested nuts are sometimes processed and sold out immediately, while the whole nuts are stored for over 14 months provided processing and handling are carried out with care. Also, leaves of plantain/banana plant is used to line basket before the nuts are carefully arranged, thereafter the leaves are used to cover the top. Some farmers used

polythene nylon instead of basket to store the nuts before sale. However, to preserve the nuts in storage from insect attack, a number of methods are adopted by the farmers. Some of the farmers informed that little quantity of Gammalin 20 EC (organochlorine) is diluted with water used to finally wash the nuts before storage (Azeez, 2015b). Moreover, some of the farmers said some quantities of lime (small and bitter citrus) are cut opened and put on top of the basket containing the nuts before finally covering with dried plantain or banana leaves (personal communication). Some farmers do not put the Gammalin directly to the kolanut while in storage, rather they used it to form circle on the floor around the polythene nylon in which the kolanuts are packed (Ndagi *et al.*, 2012). Ivbijaro, (1976) reported the use of Phostoxin tablets at the rate of one tablet per 3.5 kg of nuts in air-tight 100 litre drums for about 15 hours, to fumigate kola nuts during storage is considered safe, since the consignment would be adequately aerated during marketing and before consumption. Total control of the insect pest by treating kola nuts with one tablet of phostoxin (Aluminium phosphide) in 100-litre air tight drums for 14-16 hrs at 26°C to 28°C was also achieved in the past. However, Azeez, (2015a) reported from a field survey and personal communication that a phostoxin tablet was cut into four and one quarter was enclosed in perforated envelop and placed in a basket full of kola nuts. It is placed preferable at the middle of the kola nut rather than at the top or bottom of the basket. Hence, the perforated envelop avoided contact between the nuts and phostoxin tablet. Consequently, phostoxin is poisonous and it is advisable farmers/traders should spread the stored kola nuts meant for sale in a ventilated environment so that the concentration of the chemical would diffuse into the air. Kola nuts should be handled with care because it does not require further processing before it is consumed and mindful of application rates (Azeez, 2015b).



**Fig-1: Processed Kola nuts in the storage**



**Fig-2: Preserved kola-nuts after 12 months of storage**

The nut is also known as bissya nuts, guru nuts and cola nuts. The aroma of the nut is sweet as it tastes bitter at first but sweetens upon chewing. It is used as a masticatory stimulant by Africans and has numerous uses in social, religious, ritual, and ceremonial functions by the natives in the forest region of Africa (Asogwa, 2006). It is used during ceremonies related to marriage, child naming, and installation of Chiefs, funeral, and sacrifices made to the various gods of African mythology (Daramola, 1978; Nzeku, 1961; Opeke, 2005). There is also increasing demand for its usage in pharmaceutical industries and for production of soft drinks, wines, and candles (Beattie, 1970; Ogutuga, 1975). Its uses have inevitably created a high demand in excess of its production (Oladokun, 1985). However, Kola nuts have industrial usage in the production of drugs, soft drinks, wines, candles and other potential uses in dye and livestock feed production. Saudi Arabia, Bahrain and other Middle East countries used kola as aphrodisiac for their horses during horse race competition.

**Modern Packaging and Quality Standard of Indigenous Stimulus for International Markets**

Adebambo, (2015) reported the physical qualities in Kola nuts usually presented for sale, inspection, grading, and packaging that engendered maximum profits and other utility for farmers, L.B.A's and Exporters, consumers and Industrialists are as follows

Freedom from pest infestation - Pest infested nuts commands no market value and the presence of such nuts in a consignment could render the whole lot valueless as infestation spreads fast during storage/curing process.

Size of Individual nuts - On average, the bigger the individual nuts, the higher and the market value attracted and vice versa. In fact it is more profitable to sort into sizes for sale.

Colour of the nuts - Kolanut colour vary from white/cream to red or pink though White/creamy colours attracts high prices. So just as in the case of nut size, kola nuts are sometimes sorted according to colour.

Nut Quality factor however included Colour, Size, Degree of curing/ moisture content, Caffeine content presence of weevils, and mould.

Relative moisture content- Nuts for export are usually sundried to retain required moisture content though weevil infested and bruised nuts are usually included to these lots. This is a function of post-harvest length of storage/curing of the nuts up to meet up with a standard, hence the lower the moisture level the higher the price and vice versa. Table 2 showed the standard moisture content of all the samples determined and recommended for the Kola nuts meant for local and international trade.

**Table-2: Standard moisture content of kola samples in stock**

Sample type	Storage period	Sample variety	% Average moisture
Kolanut sample 1	6 weeks (old stock)	Red	53.40
Kolanut sample 2	6 weeks (old stock)	White	55.70
Kolanut sample 3	2 weeks (wet)	White	71.40
Kolanut sample 4	2 weeks (wet)	Red	66.60
Kolanut sample 5	Sundried (good)	Unknown	13.20
Kolanut sample 6	Sundried weeviled	Unknown	15.40
Bitter kola orogbo 7	18 months (good)	-	47.70
Bitter kola orogbo 8	18 month (bad)	-	50.20

**Source:** Adebambo, 2015

The safe moisture content of fresh minimally processed produce should be between 50 - 55% for chewable dried kola nuts. This level can be achieved at about 10-12 weeks after processing and or curing. Below this moisture content level, the nuts

can lose crispness and become spongy thereby make them unacceptable for chewing. It must be preserved in such a way that the nuts remain fresh and attractive. However, chewable dried bitter kola

cured for period of eighteen months and above should have between 40- 47.70% moisture content.

However, post-harvest handling of 2 weeks fresh wet nuts is absolutely insufficient period for export. Consequently, the moisture content is sufficiently high to encourage microbial growth thus rendering such kola nuts unfit for human consumption. Therefore, sundried nuts are unchewable and can only be utilized for industrial purpose. Saudi Arabia banned the export of kola nuts from Nigeria because of high content of aflatoxin due to failure of proper drying.

**Grading**

Unlike other cash crops, kola nuts cannot be graded in the sun. Grading in the sun will make the

nuts to wrinkle and this is not accepted by the final consumers. A parcel of not more than 2 metric tonnes i.e. 200 kg should be regarded as a lot presented for grading. Such kola nut should be free from extraneous matters. The lot should be spread on cemented surface or wooden platform to a depth of 6 inches for ease of sample taking. Sample should be randomly drawn from the top and bottom of the whole spread up to 50 kg weight. This sample is further spread on a separate platform and mixed thoroughly. One hundred nuts are counted from the 50 kg sample and defects such as insect damage (ID), black nuts (B), wrinkle nuts (W), and black/wrinkle nuts (BW) are sorted out separately leaving the good nuts (Table 3).

**Table-3: Proforma for the defect kola nuts during grading**

Good kola	Total insect damage	Other Defects		
		Black	Wrinkle	Black wrinkle
96	ID/IDB/IDW/IDBW	Black	Wrinkle	Black wrinkle
	1	1	1	1

From the analysis of the defects and good kola nuts in the one hundred (100) samples taken, the defect could be classified into total insect damage and other defect; GK – good kola nut; ID – Insect damage; OD- other defects.

Under insect damaged, those damage caused purely by insect, some damaged by insects and black, those damaged by insect and wrinkle and some are damaged by insect, yet black and wrinkle.

Under other defect, some are black, wrinkled, and combination of black and wrinkled nuts from the sample (Table 3). Kola nuts packaged for export should meet up with 96% grading test standard and remaining 4% as total defect for a given sample presented for grading. Therefore, size, colour, absence of weevils and mould, degree of curing etc enhance self-appeal and acceptability for domestic use. However, sundried nuts are preferable to artificially dried ones for industrial use; produced wines from white and caffeine from red nuts (Adebambo, 2015).



**Fig-4: Graded Kola-nuts by Kola traders ready for packaging**

**Packaging**

The graded kola nuts are then packaged in baskets of varying weight sizes e.g. 10 kg, 20 kg, 25 kg etc. The baskets are lined inside with brown paper and later Dorax sp or abora leaves before parking the kola nuts, then covered top with abora leaves (Daramola, 1985). The brown papers should be big enough to enclose the graded kola nuts wrapped with abora leaves. The baskets are finally tied with thick twines after which it is ready for export. Changes in packaging from basket (it harbor insect pest) to polythene bag is an improvement on the use of baskets. The transformation of packages is probably market promoting strategies.

Adebambo, (2015) reported that the grading Officer attaches his official seal to the tip of the basket and stamped the brown paper as



**Fig-3: Selection/sorting of preserved Kola-nuts by traders for grading**

veritable evidence of grading. The baskets are weighed and arranged in metric ton, thus 1000 kg weight makes one metric ton. The exportable kola nuts are then issued with Evacuation Certificate containing the details of Inspection on transit from the grading state to the port areas where it is further subjected to check testing by the Federal Produce Inspection Service (F.P.I.S.).

After it has passed the check test at the port areas warehouse, the consignments are re-issued with certificates of weight, inspection, packaging and fumigation which is tendered to the Overseas buyers or International marketers. It is equally stamped and sealed by the F.P.I.S. as an evidence of check-test.

However, any exported kola nut and other produce that does not pass through this process of grading is deemed smuggled. The quality should be certified and fumigation carried out by Ministry of Agriculture, Inspectorate Division. However, quality kola nut give crisp sound when cut with teeth.



**Fig-5: Packaging process of Kola-nuts**



**Fig-6: Packaged Kola-nuts ready for sales**

## **KOLA TRADE/MARKETING**

### **Local Trade**

Nigeria is a major consumer of the commodity with its consumption majorly

concentrated in the Northern part of the country including Kano, Kaduna, Sokoto and Katsina states, reports Independent. Kola nut is produced in the southern part of Nigeria and largely marketed and consumed in the Northern part of Nigeria (Ndagi *et al.*, 2012). This is corroborated by the finding of Akinbode, (1982) who reported that Kolanut is unique from other crops because of the fact that it has the largest section of its utilization market and marketing within Nigeria, although increased unofficial trade (i.e. smuggling) render this assertion doubtful. Many Nigerians earn their living as kola nut producers, traders, middlemen or professional packing men. Most of the retailers/farmers sell their products in smaller units such as cups and bowls. There is no standard local price or grading for kola nut in Nigeria, however information on market transaction, especially with reference to price determination, measurements, sizes of nuts as well as quality of nuts/grading are based on mutual knowledge and understanding of the buyers and sellers. Kola nut output in 1966 was 66,000 metric tons and 130,000 metric tons in 1970 with a revenue of #23 million and #28 million respectively (Akinbode, 1982). Estimates put Nigeria's kola nut output at about 153, 100 metric tons in 1993 (FOS, 1997) at a price #50,000 per tonne, kola nut can be said to be contributing 6.8% to Nigeria's GDP and 17.9% to the agricultural sector of Nigeria's GDP (CBN, 2000; Sanusi and Ndubuaku, 2001; and FOS, 2001).

### **Kola nut by-products (kola nut testa and pod husk) – Wastes to wealth**

It has been estimated that about 2 million metric tons of kola pod husk (KPH) and about 1 million metric tons of kola nut testa (KNT) were being wasted annually on kola farms in Nigeria (Oluokun and Oladokun, 1999). With a 44.3% of KPH in a kola fruit (Hamzat *et al.*, 2007) and a production estimate of 153, 100 metric tons (FOS, 1997), about 676,823 metric tons of dry KPH are hitherto being allowed to waste in Nigeria. Apart from being allowed to waste where KPH were dumped, farmers incur costs in removing KPH from their farms. Un-removed KPH serves as reservoir of pathogens, which are detrimental to the health and yield of the crop. However, KPH and KNT have been proved to have significant "economic" utilization value. Moreover, the kola pod husk has been used in the manufacture of poultry feeds and soap making (Yahaya *et al.*, 2002).

### **International Trade**

The international trade has been on for long in the trade routes of the sub-Saharan Africa. Kola nut has for some hundreds of years served as an important article of trade in Nigeria and other parts of Africa (Nzekwu, 1961; Asogwa *et al.*, 2011). In

Africa, Kola nuts production is mostly recorded in West African countries including Nigeria, Ivory Coast, Cameroon, Ghana and Sierra Leone with a production capacity of; 140.84, 54.83, 43.64, 23.88 and 8.26 metric tonnes respectively. Nigeria has emerged as the global leading producer of Kola nuts accounting for 52% of the total world’s production (FAO, 2019). As a top producer, Nigeria is estimated to generate US\$141million annually from the sale of the commodity at the international market which is currently estimated at about US\$272million. However, *C. nitida* is the only kola nut of inter-regional and international trade. Kola nut is exported in substantial quantity to other African countries as well as to Europe and North America, which generate the necessary foreign exchange earnings to Nigerian government (Asogwa *et al.*, 2011).Table 4 showed top World rank producer of kola nuts which includes Nigeria, Ivory Coast, Cameroun, Ghana, Sierra Leone and Republic of Benin. The countries are ranked according to production volume and commensurable price (Table 4). Kola nuts (fresh and dry) were exported in large quantities to top export destination countries like Egypt, Malaysian, Belgium, United States of America (USA), Germany, United Kingdom (UK), The

Netherlands, and Senegal (Table 5). However, top import origin of Nigeria Kola nuts are Ghana, Morocco, China, Niger Republic, India, USA, UK, United Arab Emirate (UAE) and South Africa (Table 5). In the past, it was estimated that the internal kola nut market in Nigeria worth about thirty million naira (#30,000,000), while in 1970 Kola nut export fetched USD\$157,500 to Nigerian government (Pala, 1976). Available export statistics for 1992, 1993 and 1995 to these countries from the Federal Office of Statistics (FOS) were 65, 000 kg, 139, 000 kg and 2, 031,500 kg respectively. The increased rate of export is due to the uses found for kola type beverages, liquor in wine industries, a type of essential oil savouring in the confectionary industries, alkaloids, theobromine, laxatives, heart stimulants and sedatives in pharmacological industries. Production of the high caffeine rich seeds in Nigeria is estimated to stand at 140,842 tonnes annually against the 272,000 tonnes of kola nuts produced globally on an annual basis. According to a recent study by the Global Info Research, the global caffeine is expected to grow at a compounded annual growth rate (CAGR) of about 7.6% to US\$520 million over the next five years up from US\$340 million to US\$ in 2017(Tridge, 2019).

**Table-4: Top World rank producer of kola nuts**

Country	Rank	Production Volume	Production Price	Export value in 2018
Nigeria	1	143.83k	\$973.70	\$429.69k
Ivory coast	2	55.24k	\$661.20	\$6.64k
Cameroun	3	43.27k	\$0.00	\$16.36k
Ghana	4	23.62k	\$0.00	\$743.66k
Sierra Leone	5	8.13k	\$3,770.50	\$1.66k
Republic of Benin	6	6.13k	\$0.00	\$4.00k

Source; Trudge, 2019

**Table-5: Percentage contribution of countries to Export and Import value**

Country	Top Export Destinations from Nigeria		Country	Top Import Origin of Nigeria	
	Export value in2018	Shares in Export		Import value in 2018	Shares in Import
Belgium	\$118.38K	27.5%	Ghana	\$723.58K	64.7%
Netherland	\$114.50K	26.6%	China	\$122.56K	11.0%
Senegal	\$50.36K	11.7%	Niger	\$115.79K	10.4%
US	\$49.95K	11.6%	Morocco	\$80.97K	7.2%
Germany	\$46.29K	10.8%	India	\$21.77K	1.9%
Malaysia	\$16.71K	3.9%	UK	\$15.92K	1.4%
Egypt	\$10.35K	2.4%	South Africa	\$13.46K	1.2%
-	-	-	US	\$8.68K	0.8%
-	-	-	UAE	\$7.08K	0.6%

Source; Trudge, 2019

**Industrial extraction of Kola nut and uses for health benefits**

Kola nuts are edible seeds rich in caffeine and whose extracts are widely used for industrial purposes in the beverage sector as well as in

pharmaceutical industry for medicinal applications. Thus, the extract is obtained from the seed of kola tree which is native to Africa's tropical rainforest. The kola nut is boiled for extraction which has a high amount of caffeine content. Kola nuts contain

between 2 to 3 percent caffeine and 1 to 2 percent theobromine, both of which act as stimulants; when consumed which has been implicated to dispel sleep, thirst and hunger. High percent of the caffeine is used as a flavoring ingredient in beverages. Kola nut increased utilization in the beverage (as well as pharmaceutical) industry, has been viewed to potentially contribute significantly to the caffeine industry (Tridge, 2019). Among some of the major beverage segments that have successfully incorporated kola nut extracts include; wine, chocolate and soft drinks. However, kola nuts are utilized at an industrial level mainly in Europe and America in the production of beverages with the United States being the leading importer. The nuts are also nutritious, containing nearly 1 % protein, 1.35% fat and 45% starch. Kola nut extract can help with drowsiness and gastrointestinal fatigue problems, atonic diarrhea and dysentery. It also helps in stimulation of gastric acid production and aids digestion (Asogwa *et al.*, 2006). The stimulants present in the extract dilates blood vessels and increases the blood flow as a result increases the blood flow to the head and helps in the treatment of a migraine. The extract is said to create a feeling of euphoria and also stimulates mental focus and is useful as an aphrodisiac. It is also termed as a cardiotonic that strengthens and stimulates the heart. Kola nut extract is also considered as an excellent remedy for food poisoning, as it contains antioxidants it enhances the immune and protects the cells. It is also used for bronchodilator and diuretics (Tridge, 2019).

#### **Market dynamics and side effects of kola nut extract**

The global kola nut extract market is driven mostly by pharmaceutical and nutraceutical industries as it has curative properties and also by food and beverage industry as a flavoring agent since it has a unique taste. Kola nut extract was once used to make the popular soft drink coco-cola in America, and thus was used as a primary ingredient in the beverage. The key factors restraining the global kola nut extract market is due to the use of synthetic derivatives in beverages that mimic the flavor of kola nut extract. However, regularly chewing the kola nut can stain the teeth giving a rusty color. The kola nut extract also has a high level of nicotine content which would affect the body chemistry. High intake of the kola nut extract would lead to insomnia, high heartbeat, high blood pressure, and high-level toxicity, locomotive effects and over stimulation (Tridge, 2019).

#### **Market Segmentation and segmentation overview**

On the basis of end user industry, global kola nut extract markets are segmented into: Food

industry, Beverage industry, and Pharmaceutical industry and Nutraceutical industry. Whereas, on the basis of product type, global kola nut extract can be segmented into: Liquid and Powder (Tridge, 2019). The beverage industry has a higher rate of usage of kola nut extract followed by pharmaceutical and food industry. However, the nutraceutical industry is rising due to the use of kola nut extract in weight loss supplements. However regional overview is based on the geographies, the global fumaric acid market is fragmented into seven key regions- North America, Latin America, Eastern Europe, Western Europe, Middle East & Africa, Asia-Pacific except Japan, Japan. Among the regions mentioned above in the Middle East and Africa, the production of kola nut extract is maximum as kola nut trees are commercially grown in Africa. The kola nut extract is a cherished commodity that has increased into enormous economic prospects with kola nut extract trade with North America and Asia-pacific. With the increase in awareness and people becoming more concern about health the use of kola nut extract is expected to grow in the regions of western and Eastern Europe and Latin America. Overall the market for kola nut extract is expected to grow in the forecasted year due to increase in the use of the extract in beverage instead of synthetic products (Tridge, 2019).

#### **Market Players**

Some of the market players identified in the global kola nut extract market include: Indigo herbs ltd mood & mind llc, eternal delight center chem inc.ec21 inc. feed stimulants baldwin & co, the happy herb shop ecuadorian rainforest (Tridge, 2019). The report offers a comprehensive evaluation of the market. It does so via in-depth qualitative insights, historical data, and verifiable projections about market size. The projections featured in the report have been derived using proven research methodologies and assumptions. By doing so, the research report serves as a repository of analysis and information for every facet of the market, including but not limited to: Regional markets, technology, types, and applications.

#### **Research Institutes Intervention**

Nigeria is the only country in the whole world where any elaborate form of active and focused research is being done on kola. Increasing demand of the commodity has attracted major research institution in Cocoa Research Institute of Nigeria (CRIN) and recently International Institute of Tropical Agriculture (IITA) in a bid to ensure adequate supply at the international market. Therefore CRIN is the only Research Institute where details information and update on kola could be obtained. The cocoa Research Institute of Ghana also carries out research on kola but at a much lower



level of activity. Kola tree is by nature self-sterile and however may remain unproductive except animals or insects and man pollinates it artificially. Therefore, the major production constraint to kola is largely genetic, being its relatively low yield due to self and cross incompatibility among trees, thus partial and total sterility and inefficient natural pollination. Other factors are old age of trees, field and storage pests and diseases. Among the intervention by the research institutes especially CRIN which addressed the problems highlighted above. Some of the achievements from these researches are as follows:

Promising early maturing (in less than/about 5 years) hybrids of improved *Cola nitida* (Kola) have been developed; with an annual average yield of about 2000-3000 nuts/tree/year of marketable sizes (12-15 g) compared with 250 nuts/tree/year of the unselected materials used by the farmers presently.

Some "super trees" of *C. nitida* and *C. acuminata* genotypes have been selected and are being subjected to rapid propagation using biotechnology tools to further enhance the total yield per tree of kola on farmers' fields.

Vegetative propagation techniques for kola have been developed whereby rooted cuttings are produced which start to yield fruits in about three years after field planting compared to seven years gestation period of seedlings.

On-shelf hand pollination technique has been used to identify/confirm sterility or incompatibility towards rehabilitation of old moribund farms and solving problems of sudden occurrence of unproductiveness in farmers' orchards.

Scarification technique has been established to facilitate rapid and uniform germination of kola nuts during seedling production.

Some alternative insecticides like Basudin 600 EC and Uden 20 EC have been found promising to be effective in protecting kola trees in the field to replace the hazardous Gammalin 20 EC and other hitherto recommended chemicals.

Complete package of production techniques (including field establishing and management techniques, methods of controlling pests and diseases as well as post-harvest handling practices) have been developed and recommended for use by kola farmers.

Edible salts and wood ash have been successfully used to protect fresh and stored kola nuts from fungal diseases.

In the area of processing and utilization (especially the by-products), several commercialisable products have been developed by CRIN. Thus

- (i) Kola flavoured wines and chocolate have been produced from kola nuts.
- (ii) Kola testa is processed as major feed for snail rearing
- (iii) Kola pod husk-based diet is incorporated into poultry feed formulation replacing 60% of maize component
- (iv) Kola pod husk is used for soap making, and
- (v) It is a major component of organic fertilizer for production of vegetable crops.

### Areas requiring further intervention

There is need to

- (i) characterize and ranking through a baseline survey the production potential of current kola producing States
- (ii) proper identification by molecular techniques of genetic diversity of Kola germplasm in Nigeria
- (iii) proffer solution to incompatibility in kola tree, the major contributing factor to low productivity
- (iv) Carry out further studies on non-chemical methods of controlling field-to-store pest since kola nut is largely consumed in the fresh state
- (v) Intensify further studies on in-vitro rapid multiplication of kola genetic resources towards mass production of kola seedlings to meet up with anticipated demand for seedlings.
- (vi) Carry out additional in-depth studies of kola floral pattern towards enhancing pollination of flowers to improve fruit formation
- (vii) train kola scientists, especially breeders and crop protectionists on modern biotechnology tools to imparting on research areas
- (viii) strengthen and support kola farmers Association and youths in agriculture against exploitation by middlemen, stabilization of price for kola as done for other economic agricultural products, and enliven kola farmer-marketer-industry (user) linkage

### CONCLUSION

Finally, if kola production and trade is to be increased for Nigeria to maximize the benefit of dominance in kola genetic diversity and production; further intensive research on breeding factors militating against kola must be pursued with added vigour. Also, research findings must be transferred to farmers in participatory mode of sustainability, and seedlings of the improved kola varieties made

available to farmers. The modern trend is full participation of government that would encourage Non-Government Organizations and International Development Agencies to partner (in fact drive) local partners (farmers and R&D agencies) in the emergent organ/body for sustainable production, trade and utilization of these commodities. The report offers a comprehensive evaluation of the market. It does so via in-depth qualitative insights, historical data, and verifiable projections about market size. The projections featured in the report have been derived using proven research methodologies and assumptions. Government intervene through agency like NEXIM bank by granting loans to farmers as seed money to exporters or ameliorate paucity of funds for farmers.

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