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Industrial Potential of Underutilized Plants in Nigeria

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Abstract
Nigeria is blessed with a variety of plant biodiversity. Out of more than 5,000 plant species available in the country, less than 20 are currently developed and used for food and as industrial raw materials. While some of the remaining plants are employed for various applications such as food, medicine, rope, etc., their utilisation at industrial level is presently constrained by inadequate development. In the present circumstances of the Nigerian economy occasioned by low price commanded by crude oil, it has become imperative that some of these resources be developed for various industrial applications. Available information indicated that the underutilised plants can be employed as industrial raw materials in the fats and oils, pharmaceutical, fruit juice and beverages and composite seasoning producing industries. For instance underutilised plant species such as *Dacryodes edulis, Monodora myristica, Pentachletra macrophylla*, have been reported to contain 66.87%, 42.0% and 58.15% oil respectively. Also, *Garcinia cola, Irvingia wombolu and Zanthoxylum* species have been used in disease control locally while *Dalium guineense, Parkia biglobosa* and *Tarmarindus indice* have been used locally for production or fruit juice by native communities. Species such as *Piper guineense, Oscimum gratissimum* and *Culcuma longa* have also been employed as seasoning agents. In addition, plant species such as *Sterculia setigera* and *Sterculia oblonga* have been reported to produce long fibre pulp based on their fibre characteristics. In view of their industrial utilisation potential, it has become mandatory for these plant species to be sustainably developed for industrial use in order to reduce foreign exchange expenditure on raw materials importation and to earn foreign exchange for the country through their export.
Keywords: Underutilised, Fruit Juice, Industrial Utilisation, Long Fibre, Seasoning.

1.0 Introduction

Recent developments in the industrial circle, coupled with new health challenges and climate change problems require exploitation of innovative approaches globally more than ever before. The industrial development patterns coupled with health challenges that arose in the past 50 years have necessitated the development of new pathways for solving previously unforeseen challenges. This has also brought to the fore the role of biological diversity in development patterns. While the exact number of life on earth is not yet known, some 1.75 million species have been described (CBD, 2000). However, Ryan (1992) believed this could be between 10 to 100 million. While some of these have been developed and are handled in tonnages, most forms of life are underdeveloped, underexploited and neglected (Magbagbeola *et al*., 2010). Thus, currently, only about 30 plant species are used to meet 95% of the world's food energy need (Anon, 1996) while a host of plant biodiversity remained underutilised and threatened. Some of the threatened species are responsible for mitigating pollution, ensure sustenance of human life, health and well-being (Aju, 2010). These wide range of biodiversity creates a natural wealth that constitute a priceless treasure, forming the foundation of human wellbeing (Aju, 2010). Recent occurrences of global level have however shown the potential of some of the underutilised species to become commodity crops. For instance, okra (*Abelmoscus esculentus*), a traditional Africa vegetable is now accepted in most markets around the world based on consumers interest and commercialisation strategies. Likewise, *Leratonia siliqua*, the multipurpose carob tree is generating significant demands for its pods and is contributing sensibly to the rediscovering of the reliable species.

Biodiversity in Nigeria is influenced by enormous geodiversity. The variability in the climate and geographic features endows Nigeria with one of a very rich and diverse plant and animal species. Between the mangrove forests in the Southern part to the Sahel Savanna in the North, there are more than 400 food plants, less than 20 of which have been developed and handled in large tonnages. A study by the Federal Environmental Protection Agency (FEPA) in 1992, indicated that Nigeria possessed more than 5,000 plants and 22,000 species of animals. The study also identified about 200 species of lower plants and over 5103 higher plants. With this number, Nigeria ranked 11th in Africa in terms of plant diversity. About 205 of the plant species are endemic to Nigeria, the 9th highest number among 42 countries. Of all these plant species only a few number of these have been developed for use as industrial raw materials. This development has caused the country huge expenditure in terms of foreign exchange on the importation of products that can be produced locally from the plant species. This paper examines the industrial potential of the underutilised plants in Nigeria with a view to promoting their sustainable development.

2.0 The Underutilized Industrial Plants in Nigeria

Underutilized plants are those species which are generally underexploited but which have potential to contribute

to food security, health (nutrition/medicine), general income and environmental services (Anon, 2006). They have inherent potential to contribute to socio-economic and industrial development, and poverty alleviation. The Northern region of Nigeria has 39 endemic species, while the West and Central parts of the country have 38. It has been estimated that the highest degree of endemism occurs in low land forests of the South Eastern part which has 128 endemic species (NEST, 1992).

The underutilized industrial plants in Nigeria include many species with traditional values as food items, medicine and for various domestic uses. A number of these plant species have been catalogued in specific areas of the country (Aju, 2010). Nigeria has been catalogued as an epicentre of diversities of wild varieties of plant species, most especially, wild fruits, trees and shrubs. Examples of the fruits include the West African Rice (*Oriza sativa*), yams (*Dioscorea spp*), Bambara groundnuts (*Vignus subterranean)*, African yam bean (*Sphenostylis stenocarpa),* and winged bean (*Psophocerpus tetragonobis)* (NBSAP, 2002). Others are shrubs such as *Sterculia* species, most especially *S. setigera* and *S. oblonga,* medicinal plants and spices whose barks, leaves, tubers, roots, herbs and extracts are used to treat various ailments. Examples are *Khaya senegalensis*, *Citrus aurantifolia, Venola amygdalina, Allium sativa, etc,* and industrial plants such as *Acacia species,* most especially, *Acacia senegal*. Some of the important indigenous plant species are shown in Table 1.

3.0 Industrial Potential of Some Underutilized Plants

The potential of underutilized plants to contribute to industrial development is high and expanding. Their contributions to food security, commerce and industry have been examined in various communities across the globe. An important phenomenon is that about 50% of the world's food dry weight is derived from four cereals: rice and wheat (which account for 22% each), maize and barley. These crops are widely and intensely cultivated and have been selected from a large agro biodiversity basket containing more than 7,000 food species (Wilson, 1992). Also, all modern crop varieties are produced using land races developed by farmers from wild plants. Wild relatives of these crops still represent important reservoir of genes that are essential for improving the crops or developing new strains to keep them from being overwhelmed by stresses such as climate change or evolution of new pests, parasites and diseases. According to IIED (2000), an estimated 4% of the global economy is based on biological products and processes. Timber has remained the largest contributor to industry with a world trade of US$40 billion per year. The production of oil from threatened plants is also on the increase while biodiversity contribution to health, is also on the increase, despite the enormous progress made in synthetic chemistry and biotechnology. The major industrial application of underutilised plants are subsequently discussed.

3.1 Fats and Oils

Fats and oils could be sustainably produced from many underutilized industrial plants in Nigeria. Among the species of importance for oil production area are *Dacryodes edulis, Elaeis guineensis, Irvingia gabonesis, I wombolu, Ricinodendron heudelotii*, etc. (Okafor, 2012). Chemical composition of the fruits, seeds and leafy vegetables of these species have been reported by several authors. Okafor (1997) show the oil content of *D. edulis* to be 66.87%, *Monodora myristica*, 42.0%, *Pentachletra macrophylla,* 58.15% and *Plukenetia conophora*, 61.04%, respectively. The increasing role of fats and oil in the food and industrial sectors have recreated the need to develop appropriate strategies to harvest the potential of these resources. With the current low price commanded by petroleum, oil from these sources is bound to assume greater importance industrially. A number of vegetable oil mills were established by government and private entrepreneurs in the 1960's. However, some of the mills do not have adequate raw materials. The development of these natural resources will assist in the provision of raw materials to industries, thereby, reducing expenditure on importation of fats and oils (Ogunwusi, 1992).

Since fats and oil from the underutilized plants can be used as raw materials, strategies aimed at increasing their production level, must focus on post-harvest technologies, especially in the area of storage, oil extraction and application of new and emerging technologies (Talabi, 1990). Such a holistic approach will reduce dependence on foreign sources in the medium term and provide more sustainable systems of oil supply and utilisation in the long run. Different sources of oil are suitable for different purposes, since each source has its unique characteristics. First are those who are merely for edible purposes; secondly, those suitable for both edible and industrial purposes; and thirdly those suitable for only industrial purposes. Thus categorization of the various sources of oil seeds is imperative for development purposes. For sustainable development of these oil sources, there is need for consistent government policy on fats and oil production from underutilized raw materials locally.

3.2 Health Benefits

Interest in medicinal plant uses has been on the upsurge in recent times. Humans depended on plants for cure of most ailments, until scientific advances introduced chemical synthesis. The search for viral disease using plants has greatly reawakened interest in ethno botany, especially in the western world. New ethno botanical drugs are now needed for cardiovascular diseases, cancer, microbial infections and neoplasms. According to Balick and Cox (1996), the three factors of immobility, carbohydrate production and diverse biochemistry make plants far

more useful to humans than any other kingdom of organisms. Despite the various progress in synthetic chemistry and biotechnology, pharmacy is still prevailingly based on plant substance (Aju, 2010). Homeopathy, a complementary disease treatment system in which a patient is given minute doses of natural substances and similar practices have enjoyed a certain renaissance in Western countries, while plant remedies are still the basis for primary health care of most people in developing countries (Meduna *et al*., 2008). In Nigeria, thousands of plant species are used by traditional healers (Myers, 1984). The active principles of a number of traditional plants have provided stimulus for the synthesis of many elegant therapeutic agents. It has been estimated that about 25% of the world's pharmaceutical products are derived from plants. More recently, the renewed interest in plant products has led to prescription lists in modern pharmacies to contain up to 50% of the pharmaceuticals that are based on natural products. A number of these consist of the development and utilization of aloes, lecithin's, shea butter and other naturally occurring products, rather than synthetic terponoid compounds. According to RMRDC (1998), demand for botanicals has also increased as a result of a coordinated international effort at re-examining plants used in therapeutic agents for the treatment of diseases and some of the plant extracts are gradually finding their ways unto modern medicine. The United States Cancer Research Institute examined over 70,000 plant extractives from 7,500 species. 700 of the species have been confirmed as being active tumour inhibitors and several of them have been evaluated clinically. The most prominent among these include *maytensine acer saponin P, thalicarpines, tatrophine, D-tetrandinca, Campthotheum, tylocrebine and elliptiane* (RMRDC, 1998). An estimated 98% of the plants that yield these compounds are found in the tropics and nearly all of them are found in Africa. There is also a good market for purified plant isolates as chemical specialities.

Okafor (2009) outlined the medicinal values of 25 indigenous plant species with outstanding medicinal values in Nigeria. The plant species and their medicinal uses are shown in Table 2. From the table, species such as *Garcinia cola, Moringa oleifera, Irvingia wombolu and Zanthoxylum sp* have been used for disease control locally. While some of these are cultivated to a reasonable extent, a number are still in the wild. The United Nations Industrial Development Organization (UNIDO) also prepared a list of plants that could be used for production of pharmaceuticals in developing counties. Some of the plants in the list include *Azadirahta indica, Allium sativum, Aloe spp. Carica papaya, Cymbopogum flexuosus Capsicum annum, Cola nitida*, etc. which are already being used without plans for their sustainable development in Nigeria (RMRDC, 1998).

3.3 Fruit Juice and Beverages Production

Fruit juice connotes a product which is 100% liquid extract of the particular fruit obtained by mechanical expression (Aluko, 2013). Some of the underutilized plants have nutritional components which have been used for production of fruit juice and beverages locally. Some of these include *Issungia gabonomis, Dalium guineense, Parkia biglobosa, Hibisicus sabdariffa* and *Tamarindus indica* (Okafor, 2012). Seeds of species such as *Treculia africana* have been used to produce non-alcoholic beverages in Nigeria (Ejiofor *et al*., 1988), while *Spondia mombim* and *Diospyrous mespiliformis* have been used to produce alcoholic beverages (Okafor, 2000). Their fruits are nutritious. The drinks produced from them contain vitamins and minerals, particularly vitamins C and B complex (RMRDC, 2003).

The development of underutilised industrial plants for use in this subsector of the food and beverages sector has become imperative as the fruit juice industry in Nigeria has traversed a variety of circumstances. While the first fruit juice factory was established in Nigeria in 1956, the factory became moribund after operating for 30 years. The industry did not enjoy rapid growth until 2002, when government banned importation of fruit juice retail packages into the country (Aluko, 2013; Ibrahim, 2015). Among the major problems militating against the development of this sector are dearth of investment and absence of adequate varieties of raw materials (Jolaoso, 2014). While the ban on fruit juice importation has led to the growth of the local fruit juice industry, the assumption that fruit juice concentrate importation will be phased out through expected increase in fruit production has remained a more dream (Aluko, 2013). Thus the incorporation of the underutilised plant species unto the mainstream of raw materials for juice and beverages production in Nigeria has the potential of increasing varieties and activities in the sector (Ogunwusi, 2002).

3.4 Composite Seasoning

The seeds of several indigenous underutilised plant species can also be blended into seasoning. Examples of these are *Mondora myristica, Piper guineense, Tetrapluera tetraptera and Xylopia aethiopica* (Ajayi, 1986). Other species of importance in Nigeria for seasoning production are *Culcuma longa and Oscimun gratissimam* and *Oscimum basilicum*. The seeds and leaves of *Piper guineense* are used mostly as condiments and leafy vegetables respectively (Okafor, 1997). Harvesting and trade in the products are conducted both during the dry and wet seasons for the seeds and leaves respectively (Amusa *et al.*, 2011). The wild underutilised species constitute about 48% of all species of local origin. *T. tetraptera* is common on the fringe of West African rainforest belt and are found mostly in the southern states of Nigeria (Burkill, 1985). The plant has a range of utilisation potential which varies from food, through perfumes and tannin production to traditional medicine (Onwualu *et al*., 2013). The

principal chemical component of the species include Polyphenols, 38.05 to 2907.15mg; flavonoid, 10.30 to 410.75mg; Saponin, 60.80 to 953.40mg, tannin,135.50 to 1097.50mg and Phylate, 1021.00 to 5170.00mg respectively (Onwualu, 2013).

In addition, a wide range of flavourings and colourings exist in Nigeria (RMRDC, 1998). A great majority of these are currently underutilised. The utilisation of some of them is constrained by absence of organized primary production and lack of appropriate technology to enhance quality and packaging of the products (RMRDC, 1998). For instance, the African nutmeg, *Monodora myristica*, which mainly occurs in the southern part of Nigeria contains about 10% essential oil, which is mostly composed of terpene hydrocarbons, terpene derivatives and phenyl propanoids (Onwualu *et al*., 2013). *Afromomum melegueta*, popularly known as alligator pepper is mostly served along with kolanuts to guests for entertainment. The result of the chemical analysis of the seed showed it to contain aromatic ketones such as (6) paradole which gave their pungent, peppery taste. *Oscimum basilicum* is mostly found in the rainforest mangrove ecological zone in Nigeria. The species have different scents as a result of the different essential oils they contain. The strong clove scent of sweet basil is derived from eugenol, the same chemical found in gloves. The citrus scent of lemon and lime in basil reflects a significant proportion of citral which causes this effect in several plants, including lemon scent while limonene gives the peel, its scent. The African blue basil has a strong camphor smell because it contains camphor and comphene in high proportions. Licorice basil contains anethole, the same chemical that makes anise smell licorice. Other chemicals that help to produce the distinctive smell of many basils depending on their proportion in each specific breed include citronellon, linalool, myrlene, trans-olimene, pinenc, terpencol, linalyl autate, fenchyl aletae,1, 8- cineole, camphor octanance, methyl eugenol, eugenol and beta caryophyllene.

The global market for spices is valued at 2.3 billion US dollars in 2010 with the United States of America as the major importer, followed by Germany. Nigeria is only involved in ginger trade and import substantial quantities of other types of spices. The development of locally available, underutilized spices and condiments for both local utilization and export will create a healthy economy, most especially in the post oil era in the country (Onwualu, 2013; Okafor, 1997; Ogunwusi, 1992).

3.5 Long Fibre Pulp Production

The major wood resources of the tropical forests of Nigeria are mainly mixed hardwoods (Ogunwusi, 1991). Apart from exhibiting heterogeneous properties, the fibre lengths of hardwoods are generally shorter than those of softwoods (Oluwadare, 2010). These have placed considerable limitations on their utilization as pulpwood raw materials. Nevertheless, the increasing scarcity of softwoods supply to the pulp and paper industry has generated renewed interest in the use of hardwood and minor forest resources as raw materials for pulp & paper production, and the innovation is yielding commendable results in most parts of the world. For instance, substitution of softwood with hardwood fibres in the paper production process is on the increase in the United States of America and Japan (Mc Govern, 1981). Furthermore, this imperative has led development of Kenaf (*Hibiscus cannabinus*) as a viable substitute to softwoods in the pulp and paper production process (Ogunwusi, 2002).

In Nigeria, considerable efforts have been made to incorporate indigenous hardwoods into the mainstream of pulpwood raw materials in order to reduce production cost, increase productivity and capacity utilization of the nation's integrated pulp and paper mills. However, this initiative has not been very successful in view of the heterogeneity of the properties of mixed hardwoods and their tendency to deposit (Ogunwusi, 1991).

Various studies have however reported some underutilised plant species have long fibre characteristics. Examples of the plant species in this category are *Sterculia setigera* and *Sterculia oblonga* (Ogunwusi, 2003).

Ogunwusi (1991) reported the pulping properties of *Sterculia setigera* to be similar to those of long fibre pulp. The study observed that the fibre length of *S. setigera* to increase from 2.47mm in the heartwood zone to 2.50mm in the transition zone and decreased to 2.26mm in the sapwood zone. The mean fibre length was reported to be 2.41mm. As a result of its mean fibre lenght value, *S. setigera* can be regarded as a medium/long fibre wood species in accordance with the classification of RMRDC (1996). Among the most important properties of wood that qualifies it as a suitable raw material for pulp and paper production is the fibre length. Dinwoodie (1965) reported fibre to be an important factor influencing strenght development in paper. Casey (1980) also noted that the differences observed in comparing the properties of paper from different types of pulp are mainly due to the influence of fibre characteristics. Consequently, *S. setigera* may produce pulp with properties reminiscent to those of long fibre pulp.

The mean alcohol/benzen soluble extractable content of *S.setigera* was reported to be 3.50%. This was reported to be within the range of 2 to 4% observed as suitable for pulp and paper production in hardwoods (Panshin and de zeew, 1980). As wood extractives are the major course of pitch deposition in pulp and paper mills, the higher the extractive content of hardwoods, the greater the probability of their depositing pitch during pulping (Allen, 1988). In addition, the results of the quantitative charactreization of wood elements of the plant species shows the vessel elements, fibres , axial and ray parenchymous tissues to constitute 17.9%, 24.4%, 45.4% and 12.3% of the volume fractions of the wood elements respectively (Table 3). The number of vesssels per mm^2

of the wood was observed to be 17.4 while those of fibres were 1,458 respectively. The proportion of fibres plays an important role in the determination of the usefulness of wood species for several end uses. The relatively low proportion of fibres per mm^2 observed in *S. setigera* may be reponsible for its low density (Ogunwusi, 1991). Based on the result of the study, Ogunwusi (2002) concluded as follows:

Table 1: Some Local Examples of Food Plants with Outstanding Medicinal Uses

S/N	Species	Family	Life Form/Food Classes	Medicinal Uses	Status Domestication	Distribution
1.	*Asystacia gangatica*	Acanthaceae	Herbs, vegetable	Asthma, worms, internal heat	Wild	Frequent
2.	*Chryophyllum albidum*	Sapotaceae	Tree, fruit	Fertility in women	Cultivated	Frequent
3.	*Dacyodes edulis*	Burseraceae	Tree, fruit, seed	Kidney stone	Cultivated	Frequent
4.	*Garcinia kola*	Guttferae	Tree, seed	Hepatitis, diabetes or cough, aphrodisiac, snake repellent	Cultivated	Occasional
5.	*Gongronema latifillium*	Asclepladaceae	Climber, leaves	Diabetes, catarrh, cough	Semi wild	Occasional
6.	*Moringa oleifera*	Moringaceae	Tree, leaves, bark of flower	Migraine, aches, pains, STD, Bimp, (Ozumba,2008)	Cultivated	Occasional
7.	*Nauclea lotifolia*	Rublaceae	Shrub, fruit	Malaria, filariasis	Wild	Frequent
8.	Ocimum gratissimum	Labiatae	Shrub, leaves	Diarrhea, piles, diabetes, vomiting and convulsion	Cultivated	Occasional
9.	*Ricinus communis*	Euphorbiaceae	Shrub, seed	Laxative, Hernia, STD, convulsion	Cultivated	Occasional
10.	*Spondias mombim*	Anacardiaceae	Tree, fruit	Fibroid, sore throat, toothache	Semi wild	Occasional
11.	*Uvoria chamae*	Annonaceae	Shrub, fruit	Rheumatism, gout, dysmenorrhoea used with Spondias mombim for toothache	Semi wild	Occasional
12.	*Vitex daniona*	Verbanaceae	Tree, uchakora, mbembe	Tender leaves used for diarrhoea, abdominal discomfort	Wild	Rare
13.	*Xylopia aethiopica*	Annonaceae	Tree, uda (spice)	Malaria, typhoid, infective, hepatitis, amenorrhoea used as preservative in decoction.	Semi wild	Rare
14.	*Monihot esculenta (cassava)*	Euphorbiaceae	Leaves, pulveri seed and used in washing head to induce sleep	Insomnia and used to wash hair to induce sleep	Cultivated	Common
15.	*Irvingia gabonensis (ugiri)*	Irvingiaceae	Leaves used as in cassava	Insomnia	Cultivated	Occasional
16.	*Irvingia womboli (ogbono)*	Irvingiaceae	Leaves	Worm expeller	Cultivated	Occasional
17.	*Mangifera indica (mango)*	Anacardacae	Seed and stem bark	Worm expeller and haemoglobin respectively	Cultivated	Common
18.	*Zea mays (maize)*	Gramineae	Corn silk	Prostate, height loss, and fibroid	Cultivated	Common
19.	*Talinum triangulare*	Portulaceae	Roots	Prostate disease	Semi wild & Cultivated	Frequent
20.	*Musa paradisiacal*	Portulaceae	Roots	Prostate disease	Cultivated	Frequent
21.	*Cola acuminate, Musa paradisiaca elaeis guineensis (bunch)*	Sterculiaceae, Musaceae and Palmae respectively	Ash from kola pod, unripe plantain peel and palm kernel (bunch)	Stroke ointment prepared with ashes and palm kernel oil	Cultivated	Frequent
22.	*Cola acuminate*	Sterculiaceae	Pod socked in honey	Erection and sperm count in men	Cultivated	Frequent
23.	*Piper guineense with Xylopia aethiopico and Gongronema latifolim*	Piperaceae, Annomaceae & Asclepladaceae	Seeds and leaves of utazi	Blocked fallopian tube in woman	Wild and cultivated	Occasional
24.	*Cajanus cajan*	Papllionaceae	Sickle cell anaemia, measles	Leaves	Cultivated seed edible	Frequent
25.	*Zanthoxylum sp*	Rublaceae	Sickle cell anaemia	Root	Wild leaves edible	Occasional

Source: (Okafor, 2009)

Table 2: Chemical Analysis of Fruits, Nuts, Seeds and Leafy Vegetables

S/N	Scientific Name	Plant Part	Moisture %	Ash %	Oil %	Protein %	Na ppm	K ppm	Ca ppm	Mg ppm	Fe ppm	Zn ppm	Cu ppm
1.	*Chrysophyllum albidum*	Pulp	73.66	1.22	6.94	5.43	1.3	2	2.70	4.25	1.69	0.17	0.05
2.	*Dacryodes edulis*	Pulp	58.94	3.39	66.87	3.63	15.0	74	3.92	3.50	1.33	0.30	Nil
3.	*D. edulis var. parvicarpa*	Pulp	70.25	4.65	36.63	2.55	23.0	98	6.79	11.00	0.75	0.27	0.08
4.	*Dennettia tripetala*	Carpel	70.86	4.92	1.92	15.41	21.0	78	4.17	6.50	1.15	0.29	Nil
5.	*Garcinia kola*	Seeds	50.27	1.30	5.31	2.47	12.0	30	2.70	2.25	2.22	0.48	Nil
6.	*G. kola*	Pulp	85.94	1.52	10.38	1.69	-	-	-	-	-	-	-
7.	*Gnetum africanum*	Leaves	37.39	4.72	14.20	10.18	28.0	126	28.35	41.75	5.23	0.49	0.06
8.	*Gongronema latifillium*	Leaves	71.14	10.94	18.17	25.66	58.0	336	20.75	56.00	8.17	0.90	0.12
9.	*Irvingia gabonensis*	Seeds	4.53	2.65	66.26	10.62	8.8	70	11.26	20.50	1.87	0.37	0.12
10.	*I. gabonensis*	Pulp	38.26	2.29		10.18	9.4	82	9.31	16.50	1.78	0.67	0061
11.	*Monodora myristica*	Seeds	10.41	2.12	41.15	9.25	8.2	62	3.04	13.50	1.42	0.32	Nil
12.	*Pentaclenthra macrophylla*	Seeds	4.34	2.50	58.15	26.71	8.4	66	4.51	10.75	1.69	0.51	0.06
13.	*Piper guineense*	Leaves	78.58	15.56	9.30	18.54	35.0	320	7.00	147	6.12	2.05	0.15
14.	*P. guineense*	Seeds	66.13	2.34	11.53	10.80	38.0	200	15.04	23.00	5.76	0.37	0.15
15.	*Plukenetia conophora*	Seeds	49.80	6.09	61.04	18.27	21.0	109	14.63	40.25	1.24	0.68	0.10
16.	*Pterocarpus soyauxii*	Leaves	74.69	2.83	3.60	31.84	1.8	11	19.37	35.50	3.79	0.84	0.21
17.	*Trecullia africana*	Seeds	42.92	2.12	15.65	14.00	8.3	50	3.75	7.50	1.60	0.50	0.08
18.	*Vernonia amygdalina*	Leaves	79.67	10.13	4.50	23.24	46.0	304	40.00	58.00	4.72	0.81	0.10
19.	*Xylopia aethiopica*	Carpel	14.52	4.59	26.85	9.86	17.0	140	16.30	24.75	4.08	0.65	0.10

Source: (Okafor *et al*., 1997)

Table 3: Means and Standard Deviation of Point Counts for Cell Types of *Sterculia setigera*

Cell Types	Point Counts Lumen%	Wall	Total
Vessels			
Mean	7.8	10.1	17.9
SD	0.07	0.03	0.05
Fibre			
Mean	32.9	12.0	24.4
SD	0.05	0.01	0.10
Axial parenchyma			
Mean	32.9	12.5	45.4
SD	0.05	0.07	0.12
Ray parenchyma			
Mean	9.2	3.1	12.3
SD	0.09	0.05	0.08
No. of vessels/mm^2			
Mean	17.4		
SD	0.71		
No. of fibres/mm^2			
means	1458.33		
SD	59.02		

*Each value was calculated from a toal of 4 streolgical observations.

Based on the results of the study, Ogunwusi (1991) made the following observation:

1. Based on its fibre length, *S. setigera* can be classified as a medium/long fibre indigenous hardwood species.
2. The major problem likely to hinder the utilization of the plant species for commercial production of long fibre pulp is its low density. With a mean density of 249kg/m^3, the value is likely to result in low digester

packing capacity and consequently low yield.

3. The low density of the species may arise from the low count of fibre per mm^2 in the wood.
4. In view of the inherent properties of trees of the same species, growing in the same environment to have significantly different fibre length and density values, it is possible for silviculturits to select and breed *S. setigera* plants of superior fibre length and density values for purpose of long fibre pulp production in the country.

The major problem limiting industrial utilisation of this plant is absence of pilot scale facilities to scale up the laboratory studies.

4.0 Challenges and Prospects of Development and Industrial Utilisation of Underutilised plants in Nigeria

Lack of attention and neglect by research have remained the two major constraints to the development and industrial utilisation of underutilised plant species in Nigeria. While information on some of these species are available in different research institutes and universities in Nigeria, little or no concerted efforts have been made to pool available information for development purposes. While the Nigeria Natural Medicine Development Agency has documented some of the plant materials used in medicine, little or no effort has been made to look at other areas of industrial application based on available information. This lack of attention place the underutilised plant species in danger of continued erosion and disappearance, apart from limiting access to their optimal utilisation potential. For promotion of underutilised plant species to be a reality in Africa, a large cadre of well trained and motivated African agricultural scientists will have to play a critical role in providing the farmer with a steady flow of new technologies (improved farming practices, newly developed varieties, etc. (Dansi *et al*., 2012). Closely allied with this, is the need for prioritisation. Priority should be given on the basis of extent or level of current development through R&D, industrial potential and socio economic contributions of the plants to local communities. For example, avocado pear is fast becoming known globally for its role as a plant with adequate nutritional potential and for its industrial utilisation tendencies. Focus on the development of such a plant species in Nigeria will not only promote socio-economic development of communities where they are found, but, also, substantially improve foreign exchange earnings locally in view of the global demand for the plant and its products. For the promotion of such neglected and underutilised crops, it will be important to put in place a national and special research and development programme under the joint umbrella of the Ministry of Environment, Agriculture and Rural Development coupled with the Ministry of Science and Technology. All possible actors, including researchers, developers, producers and finance institutions should be involved.

Many of the underutilised species have multiple applications. As such, they do not belong to one specific category of crops (GFAR, 1991). The key to unlock their true potential rest in the ability to harness their multiple uses. The chain linking farmers up to final end users should be explored and exploited. This will play a critical role in securing revenues to rural communities, and, thus, fuel the mechanism that will maintain the diversity of the species. Among the areas that will facilitate the development and industrial underutilisation of the plant species are new market opportunities. This will be promoted by the availability of biotechnological tools, which has the capability to transform useful plants species into diverse products from plastics to surgical tissues or to extend shelf life of perishable crops (GFAR, 1999). This will aid commercialisation and strengthen marketing systems of underutilised plants.

Some of the strategies that will eventually promote the development of the underutilised plant species in Nigeria according to GFAR (1999), include participatory research involving farmers, members of the local community, forest dwellers, scientists and policy makers. This should be engendered and actively fostered among primary and secondary stakeholders. Allied with this is the need for promoting both in situ and ex situ conservation of the plant species. These will form the basis upon which to characterise, develop or restore the plants. Documentation of the plant species and dissemination of information to stakeholders would also play critical roles in the enhancement and utilisation of the crops. Currently in Nigeria, there is no recent information on plant biodiversity of the country. The latest information obtained through a holistic and detailed study took place in the 1980's by the Federal Environmental Protection Agency (RMRDC, 1991). Thus, there is urgent need for a detailed study of the plant biodiversity resources of the country. The most immediate step in the field of documentation is to take stock of available information on current activities and provide necessary information for the development of national programmes. Crop improvement activities should be initiated, maintained and sustained. These should address storability and development of simple processing methods and tools. Research on market development should also be promoted. The development of new markets and gregarious exploitation of the old markets should be encouraged. This is the method adopted for Roselle (*Hibiscus sabdariffa*) known for centuries in sub-Saharan Africa which eventually become a well-established beverage in Europe due to simple marketing strategies (GFAR, 1999). Fortunately, the rural farmers subsists on some of these underutilised plant species. A national programme directed towards their development will be applauded by farmers if they observe sincerity of purpose in such intensions.

5.0 Conclusion and Recommendations

Nigeria contains a pool of plant biodiversity that can be adopted for fighting poverty locally. Some of these underutilised plant resources could be veritable industrial raw materials if developed in a comprehensive and sustainable manner. The development of the plant species will assist the country to navigate the problems it is currently facing in terms of foreign exchange acquisition, unemployment, poverty alleviation and underdevelopment. The development of underutilised plant resources for oil production alone could generate more than 250 million US dollars for the country on annual basis. This however requires a multidisciplinary approach that will involve major stakeholders such as farmers, scientists, industrialists, finance institutions with resolute participation by the public sector. Major public sector organisations that may have to be involved in Nigeria include the Forestry Research Institute of Nigeria under the Federal Ministry of Environment, the Colleges/Departments of Forestry in the various universities and research institutes, the Small and Medium Enterprises Development Agency, the Raw Materials Research and Development Council and the policy makers in the Budget and Planning Ministry at both the Federal and State levels.

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