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Research Article

Potentials of Some Nigerian Herbs and Spice as Source of Pharmaceutical Raw Materials: Opportunity for Global Market Competitiveness

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ABSTRACT

Food has been seen and known to be the very basis of human health and wellbeing since time immemorial. Also, ancient history and tradition, has helped to emphasize the benefits of herbs and spices in traditional medicine. Advancement in biomedical technology has led to the duty in science to study and review the interface between foods and medicines, particularly those derived from medicinal plants. Scientific supports for the health benefits of medicinal plants particularly herbs and spices, have led to increased consumer demands for some herbs and spices creating huge international demands and market. However, despite the huge resources of these raw materials in Nigeria and Africa, they remain an almost insignificant player in the global spice market. The interface between Nigerian plant products and resources used as food, herbs and spices on one hand and their potential for development as a competitive source of pharmaceutical raw material for nutraceutical industry and the global market of herb and spices on other hand, is discussed.

Keywords: Herbs; Spice; Nutraceuticals; Dietary supplement; Raw materials; Nigeria.

INTRODUCTION

The potentials of Herbs and Spice as functional food and “nutraceuticals” is generating renewed interest among researchers across the globe due to increasing knowledge and curiosity about their health benefits. Increasing scientific capabilities brought about by advancements in technology especially in the biomedical and pharmaceutical arena have led to a scientific duty and capacity to review the interface between foods and medicines that are derived from natural products particularly medicinal plants. The potentials of these resources should be explored in both directions in order to take full advantage of medicinal plants which are natural endowments. In most of African cultures there is the popular saying that “you are what you eat”. The question that we may want to ask is, do the plants used as food, herbs and spices also have pharmacologically active ingredients which may impact on human health.

This paper aims to discuss the interface between plant products used as food, herbs and spices, and medicinal plants products applied in health for the management of disease conditions on one hand, and their potential for development as a competitive source of pharmaceutical raw material for the nutraceutical industry and the local and international market of herb and spices. It is well known that medicinal plants (including herbs and spices) have been used as foods, nutraceutics, herbal medicines and as source of hit/lead compounds in the research and development of new drugs[1].

Functional foods and nutraceuticals

The term“nutraceuticals” as coined from "nutrition" and "pharmaceutical" by Stephen DeFelice in 1989, and “functional foods” are often used interchangeably though some school of thought believe that they do not mean exactly the same thing. Stephen DeFelice defined nutraceutical as "a food (or part of a food) that provides medical or health benefits, including the prevention and/or treatment of a disease"[2].

Nutraceuticals and dietary supplement are more used to refer to the same thing. Some scholars technically defined nutraceuticals as "naturally derived bioactive compounds that are found in foods, dietary supplements and herbal products, and have health promoting, disease preventing, or medicinal benefits". On the other hand, Functional foods were defined as foods or whole foods, which contain an ingredient that gives that food health-promoting properties over and above its usual nutritional value, for example, probiotic yoghurts, some fortified foods products, etc[3].

Thus, a functional food for one consumer can act as a nutraceutical for another consumer. Several naturally derived food substances have been studied in different disease therapies. Vitamin E, D, C, green tea, soy, and lycopene are examples of nutraceuticals widely studied in human health. While many of these 'natural' compounds have been found to have high therapeutic potential, future studies could include well-designed clinical trials assessing combinations of these compounds to realize possible synergies they bring to human health[2].

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According to the US Dietary Supplement Health and Education Act (DSHEA) of 1994, the term "dietary supplement" can be defined using several criteria; some of which include (a) a product (other than tobacco) that is intended to supplement the diet that bears or contains one or more of the following dietary ingredients: a vitamin, a mineral, an herb or other botanical, an amino acid, a dietary substance for use by man to supplement the diet by increasing the total daily intake, or a concentrate, metabolite, constituent, extract, or combinations of these ingredients, (b) a product not represented for use as a conventional food or as the sole item of a meal or diet, etc. "Nutraceuticals" appears to be the favoured term used by industry which includes functional foods and supplements. As yet the term has no legal status[3]. However, the true meaning of the terms nutraceuticals, dietary supplements and functional foods could be a matter of semantics as there may be no clear-cut defining lines between them, but only in the purpose of application. Questions could arise whether a nutrient used as part of a treatment for a defined disease can be considered a drug, whereas the same nutrient is used to enhance health (reduce the risk of disease), and can be considered a functional food or dietary supplement? This overlap shows interlinks that exist between functional foods and medicines[2].

Herbs and spices

Herbs and spices are also often used interchangeably. The term “Herbs” is generally used to refer to any green leafy plant or parts thereof, used to flavor or season food, or plant whose roots, leaves or seeds, etc, are used in medicine. Botanically, herbs are plants whose stem are not woody and do not persist beyond each growing season. On the other hand, spice is any plant matter used specifically to season or flavor food. Some definitions however refer to herbs as the leafy vegetables with nutritive and medicinal benefits, while spices could be the processed plant matter used for flavoring, fragrance and taste enhancement[4].

Good consumers’ awareness of the link between eating and health has created high expectation for physical expression of the acclaimed health benefits for consuming a particular food product[5,6]. Recently, food manufacturers have embarked on a health criterion in the development of “functional foods”, that is, food products that have an added positive health benefit. While some functional ingredient benefits may be perceived to enhance short-term well-being or performance ability, many such benefits concern the long-term mitigation of certain diseases[2]. Long term health benefits are generally invisible to the average consumer. Traditional foods are increasingly considered healthy and wholesome, and as a result, public interest in their nutritional and health impact has increased, as has their demand[2]. Likewise, the increasing call by WHO for the development and integration of herbal medicine in healthcare delivery is a major boost to increased consumers’ demand for functional foods, nutraceuticals as well as herbs and spices. In terms of world trade value, the important spice crops from the tropical regions are pepper, capsicums, nutmeg/mace, cardamom, allspice/pimento, vanilla, cloves, ginger, turmeric, cinnamon and cassia. Coriander, cumin, mustard seeds, sage, oregano, thyme, bay and the mints are the most important spice crops from the non-tropical environment. The global spice trade in 2004 consisted of 1.547 million tons, valued at $ 2.97 billion. Spices are popular among Africans and Nigerians in particular, although most of the Nigerian spices grow in the wild and have not been fully commercially cultivated and exploited[7].

Global demand for herbs and spices

Production

According to Eurostat survey (2015), the EU accounts for about 2% of global spice and herb production. Asia accounts for 81%, Africa for 12% and Latin America & the Caribbean (LAC) for 3.7% (Figure 1). Africa is only responsible for 6% of EU imported volume. African producers focus more on domestic and regional markets. In contrast, LAC (10% of EU imported volume) produces mainly for international markets[8].

Import/Export

In 2014, direct imports from developing countries amounted to 302,000tons, or € 1 billion, accounting for 57% of total EU imports (Figure 2). Developing countries were the source of virtually all spices traded in the EU and the main products imported were capsicums (25% of imported volume), ginger (23%) and pepper (21%)[8].

Pricing

The prices of spices imported from developing countries increased by 6.8% per year on average between 2010 and 2014. The prices of vanilla (+24% per year), pepper (+20%), cloves (+20%) and cinnamon (+10%) showed an exceptionally strong increase (Figure 3). The general upward price trend is a result of growing global demand and speculation. Prices are expected to remain high for most spices[8].

Major EU Suppliers

China is the largest supplier to the EU (35% of total imported volume from outside the EU) followed by India (17%), Vietnam (11%), Indonesia (6.9%), Brazil (5%) and Peru (2.6%). China supplies mainly ginger (51% of imported volume) and capsicums (45%). India supplies mainly turmeric (19%), pepper (17%), capsicums (14%) and cumin seeds (14%). Vietnam supplies mainly pepper (87%). Vietnam’s pepper production is mainly intended for export markets. Nigeria is not yet a major player in the EU market[8].

Pharmacological potentials of some nigerian herbs and spices

Modern scientific research has established the relationship between foods of plant origin and their health benefits. This has given credence to the idea and practice of functional food intake as well as natural dietary supplements. Evolving knowledge has proved plants as a huge source of bioactive compounds some of which have very beneficial pharmacological properties. For instance, conscious but `controlled dietary intake of fruits, vegetables and whole grains meals is strongly associated with reduced risk of developing chronic diseases, such as cancer and cardiovascular diseases (CVD), which are the leading causes of death in most developed society,

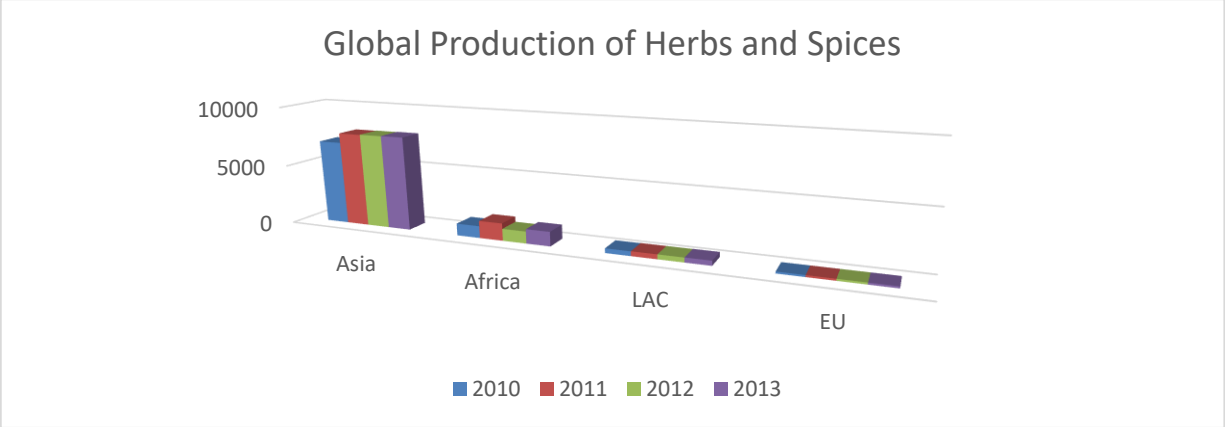

Figure 1: Global production of spices and herbs, 2010-2013, in 1,000 tons.

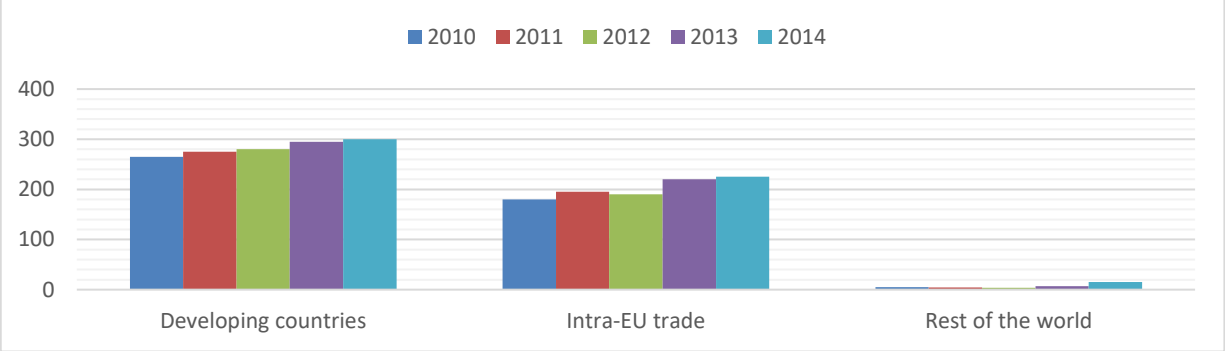

Figure 2: EU imports of spices and herbs, 2010 2014, in 1,000 tons.

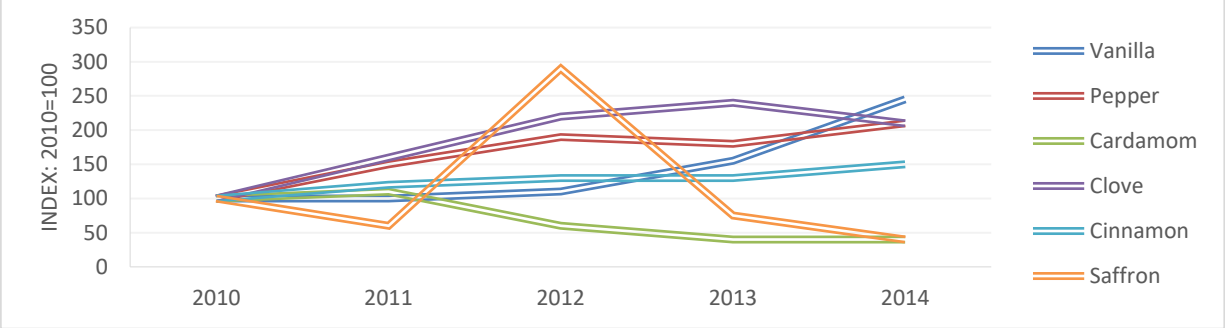

Figure 3: EU import prices of spices from developing countries showing the strongest fluctuations¸ 2010-2014.

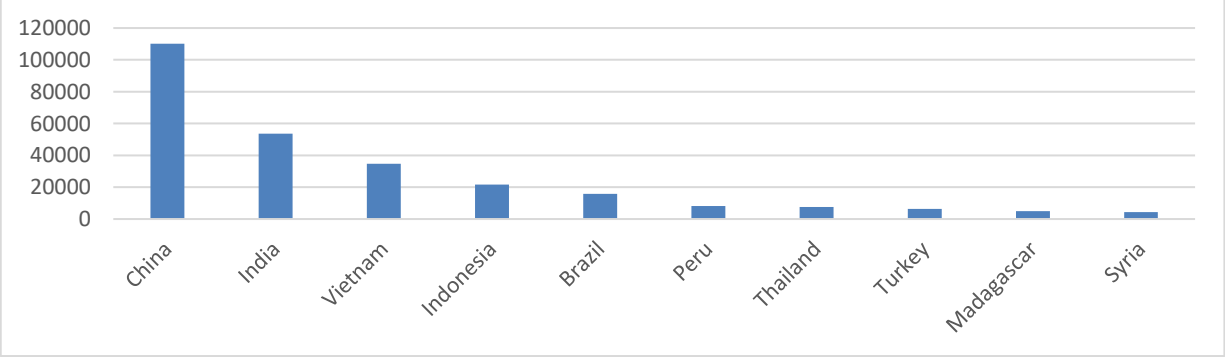

Figure 4: Major EU suppliers.

surpassing infectious diseases[9,10]. Based on results from human epidemiologic studies and animal studies, similar effects of plant based diets are consistent for cancers of the stomach, esophagus, lung, oral cavity and pharynx, endometrium, pancreas, and colon. The types of vegetables or fruit that most often appear to be protective against cancer are raw vegetables, followed by allium vegetables, carrots, green vegetables, cruciferous vegetables, and

tomatoes. It is estimated that one-third of all cancer deaths in industrialized countries could be avoided through appropriate dietary formulations suggesting that dietary behavioral changes, such as increasing consumption of fruits, vegetables, and whole grains, and related changes in lifestyle, are practical strategies for significant reduction of the incidence of certain diseases[11].

Research has also linked CVD and most other non-pathogenic diseases to cumulative oxidative stress. Several researches have proved that most spices and herbs exhibit antioxidant properties, and indeed contain several secondary metabolites with antioxidant activity, which research has shown to be useful in many therapeutic applications. The knowledge of the nature and mode of some of these plants metabolites has promoted their emphasis in foods and food supplements. In some case foods rich in some of these metabolites are developed and packages as nutraceuticals for specific health benefit.

It is now almost common knowledge among scientists that the additive and synergistic effects of the complex mixture of phytochemicals in fruits and vegetables, herbs and spices are largely responsible for their health benefits. Some wild vegetables have been reported to contain comparatively high amounts of Vitamins A and C and other antioxidant micronutrients, which promote good health by assisting in preventing cancer and high blood pressure, stimulating the immune system, improving drug metabolism, and tissue regeneration.

Fortunately, some common Nigerian herbs and spices have been reported to possess similar pharmacological activities such as anticancer, anti-inflammatory, laxative, etc[12]. Examples include:

Ginger - *Zingiber officinale*: The root lowers blood cholesterol level and increase HDL. It reduces blood pressure and decreases cardiac workload[13]. It has been reported with a prospective relevance in oral hygiene and possess antimicrobial activities against some oral pathogens[14,15]. It also possessesanticancer, antitumor, anti-inflammatory and analgesic properties. Some of the active compounds include zingiberene, gingerol, shogaols, ß-sesquiphelandrene and ar-curcumene. Nigeria is one of the largest producers and exporters of ginger in the world, especially the split-dried ginger. India and China remains strong competitors in export. Nigeria produced 156,000 MT of ginger in 2012, accounting for 7% in the world and ranking 4th globally.

Garlic - *Allium sativum* L.: Garlic reduces cholesterol synthesis by inhibiting 3-hydroxy-3-methylglutaryl-CcoA. It has been shown to inhibit LDL oxidation, platelet aggregation, arterial plague formation, and decrease homocysteine, lower blood pressure and improve microcirculation[13]. Antimicrobial, anti-inflamatory, insecticidal, antifungal, antioxidant, antisickling properties have been reported. It contains Diallyl disulfide, flavonoids, carotenoids, ascorbic acid, etc., as active constituents.

Pepper - *Piper guineensis* Schum. & Thonn and related Piper spp.: The fruit contains piperine, wisanine, dihydrocubebin, guineensine, etc, and exhibit antifungal, antimicrobial, anti-tumour, hypotension, bradycardia (slow heartbeat), immunomodulatory, antiulcerogenic, contraceptive, central nervous system depression, analgesic, antipyretic, anti-inflammatory, antioxidant and antisickling activities. Species of the same genus have also been reported to contain similar or derivatives of piper alkaloids found in *P. guineensis*. Some of the ingredients are used as enhancers in pesticides and drug formulations[16].

Bitter leaf - *Vernonia amygdalina* Del.: The leaf has been used as antidiabetic, antimalarial, antisickling, antioxidant, anticancer, cough, etc. Contain saponins, alkaloids, sterol-terpenes, sesquiterpenes lactones, phenolic acids, coumarins, lignans, xanthones etc. Active compounds like luteolin, luteolin 7-O-glucosides and luteolin 7-O-glucuronide (Flavonoids), vernonioside A, A1, A2, A3, A4, B, B2, B3, D and E (sterol glycosides), vernodalin, vernomygdin, vernodalol, epivernodalol (sesquiterpenes lactones), and elemanolide have been isolated[17].

Sorghum - *Sorghum bicolor* L. (Moench): The Leaf/stalls/grain extracts exhibit anti-sickling, antioxidant, hypocholesterolemic and anti-inflammatory properties, etc. It contains tannins, flavonoids, phenolic acids,*p*-hydroxybenz-aldehyde, phenylalanine, tryptophan, phytosterols, etc. In comparison with most cereal, it is rich in fibre, protein, niacin, riboflavin and thiamin as well as calcium and iron[18].

Lemon grass - *Cymbopogon citratus* (DC., ex. Nees) Stapf.: The leaf infusion is drunk as tea. It is usually part of most antimalarial recipe in ethnomedicine. Antimicrobial, antitumor, antinociceptic, anti-sickling properties have been reported on the plant. The plant is also rich in essential oil (0.2-0.5%), which is used in flavoring and preservation. Some of the reported volatile constituents include α-citral, β-citral, nerol, geraniol, citronellal, terpinolene, geranyl acetate, myrecene and terpinol methylheptenone. Neral usually constitutes 25-38% while general constitute 40-62% of its essential oil components. The mixture of neral and general is referred to as citral. Flavonoids like luteolin, isoorientin 2'-O-rhamnoside, quercetin, kaempferol and apiginin have also been reported[19].

King of Bitters – *Andrographis paniculata* Wall: The leaf infusion is taken as tea or added to drinks to enhance bitter taste. It has antibacterial, antioxidant, anti-inflammatory, antidiarrhoea, antimalarial, anticancer, hypotensive, immunomodulatory, hepatoprotective, etc. The major active constituents include andrographolides and its derivatives[20]. The entalabdane diterpene lactones, andrographolide iis believed to be largely responsible for its pharmacological activities. Flavones, noriridoides, xanthones and polyphenols have been reported from the plant[20].

Okra (*Abelmoschus esculentus* L. Moench): Leaves, fruits and seeds are consumed as vegetables in many traditional medical practices in Asia, Africa and Latin America, and are rich in mucilage, fibre, proteins, oil, vitamins and phenolic compounds. The mucilage is use as plasma replacement for expanding blood volume, and also binds cholesterol reducing the risk of heart attacks. The seed contain oil rich in linoleic acid and polyunsaturated FAs

which are also heart friendly[21,22]. The pod contains carotene, folic acid, thiamine, riboflavin, niacin, vitamin C, oxalic acid and amino acids. The gum is made up of random coil polysaccharide with repeating units of galactose, rhamnose, and galacturonic acid. Compounds like hyperoside, quercetin, coumarin, scopoletin, uridine, and phenylalanine have been reported. It seed has also be identified with antioxidant activity most of which has been attributed to the quercetin derivatives (quercetin 3-O-xylosyl (1"→2") glucoside, quercetin 3-O-glucosyl (1"→6") glucoside, quercetin 3-O-glucoside and quercetin 3-O- (6"-O-malonyl)- glucoside)[23]. Flavonoids such as 5, 7, 3', 4'-tetrahydroxy-4"-O-methyl flavonol-3-O-β-D-glucopyranoside and 5, 7, 3', 4'-tetrahydroxy flavonol-3-O-[β-D-glucopyranosyl- (1→6)]-β-D-glucopyranoside have also been reported. The seed is used in some countries like India as coffee substitute and in Egypt as additive to corn flour for better dough used in bread production[24].

Moringa - *Moringa oleifera* L.: Leaf and seed which are eaten as vegetable are rich in flavonoids, terpenoids and vitamin C, etc., and use for management of many ailment including skin and intestinal diseases[25].

Bitter cola - *Garcinia kola* Heckel: The seed possess antioxidant property and is used in sickle cell disease. It had been reported to contain tannins, and an active biflavanone mixture called kolaviron. The seed extract has been reported to exhibit hepatoprotection, antidiabetic properties and antigenotoxic potentials[12,17].

Kola nut – *Cola nitida* (Ventenat) Schott and Endlicher: *Cola nitida* seed which is a known stimulant has been well studies and reported to contain alkaloids, saponins, tannins, polyphenols, and reducing compounds. Plant of the same genus has been found to posess similar pharmacological characteristics and constituents. It major stimulating alkaloid content is caffeine which is about 2-3.5% in the seed. Theobromine and theophylline are other important and major constituents of the plant. Phlobaphen, epicatechin, D-catechin and tannic acid have been reported. The seed and pod are rich in proteins, fiber, polyphenols and mineral elements. Extracts of the plant have been reported to exhibit antioxidant and antimicrobial activities[26]. The starch from the seed compares favourably with corn starch and can be used as a good gelling agent and a fat replacer in the food and pharmaceutical industry[27].

Pawpaw - *Carica papaya* L.: Papaya leaves are made into tea as a treatment for malaria and help raise platelet levels in blood. It contains papain alkaloid, tyrosine, phenylalanine and tryptophan. Antioxidant, antimicrobial and anti-sickling properties have been reported from the plant[28].

Bean (*Vigna unguiculata* L. Walp): The seed which is a staple food in Nigeria and other West African communities is also used in antisickling recipes by most traditional healers. It has been reported to contain saponins, reducing carbohydrate, fats and oil, steroids, glycosides, alkaloids, etc.[12].

Guayava - *Psidium guajava* L.: Leaf, fruit, stem bark are used in fever, malaria, gastroenteritis, vomiting, diarrhoea, dysentery, wounds, ulcers, toothache, coughs, etc., contains terpenoids, saponins, tannins, flavonoids, glycosides, etc. Modern research has demonstrated that it exhibit antioxidant, anti-allergy, anti-inflammatory, anticancer, hepatoprotective, antimicrobial, antiparasite, antidiabetic, and antinociceptive activities. The triterpenoid guajanoic acid, sitosterol, uvaol, oleanolic acid, ursolic acid and the flavonoid quercetin and its derivatives have been reported[29,30].

Tobacco – *Nicotiana tabacum*: The leaf of the plant which is central nervous system (CNS) active is usually processed into spice and used as part of recipe for the management of many traditional ailments by herbal practitioners. Extracts of the plant has been well studies and reported to exhibit antinociceptive activity in mice, antibacterial activities, anti-tubercular activity against H37RV strains of *M. tuberculosis*, antifungal and anthelmintic activity[31]. The plant contains alkaloid, saponins, tannins and cardiac glycosides and also contains reasonable levels of potassium and zinc[32]. Nicotine, solanesol, malic and citric acid are constituent compounds which are characteristic of the plant. Nicotine which is the major component responsible for the CNS and PNS (peripheral nervous system) activities of the plant, has been specified for the treatment of Alzheimer disease, Parkinson disease, schizophrenia, depression and anxiety, attention deficit hyperactivity disorder (ADHD), pain, and obesity[31].

Potential herbs for pharmaceutical industry

Some of the Nigerian herbs and spice discussed above have potential for becoming international commodities as pharmaceutical raw material due to their inherent health benefits and the bioactive compounds found in them. Extracts of these plants could be sources of important molecules that could be used to produce nutraceuticals. For instance, *V. amygdalina* (bitter leaf) which had been demonstrated to possess antioxidant and antidiabetic properties, *M. oleifera* (moringa) with antioxidant and anti-inflammatory properties, *Z. officinale* (ginger) with antioxidant, anti-inflammatory and anticancer properties, *A. paniculata* (king of bitters) with antimalarial, hypotensive and antioxidant properties, and *A. sativum* (garlic) with hypotensive, antimicrobial, antisickling activities, *N. tabacum*, *C. nitida* and *G. kola* with their CNS and cardiovascular activity, etc. Unprocessed plant and active extracts or compounds from these plants could be exploited as pharmaceutical raw materials.

Challenges and way forward

The confounding factors in the development of local herbs and spice among West African communities lies with identifying those with key economic potentials, identifying the market or creating the needed market through basic knowledge sharing and exploiting the identify raw material in a more sustainable way. These lead to other secondary considerations of how much of the existing global market is contributed to by Africa? What is the level of market involvement? How much is been produce for export beyond domestic consumption? For Nigeria and other developing countries of Africa to leapfrog as a global player in herbs and spice commodity trade the present status quo must be edited by undertaking the following:

Market development: Key herbs and spice where there is competitive advantage in production should be identified and international market developed for them. The government with huge intelligence capacity and diplomatic status should play a crucial role through identifying potential market, and ensure enabling diplomatic cooperation.

Production volume: Most of the herbs and spice produced in Nigeria and West Africa are consumed locally with no focus on the international market. There is the need to increase production volume in order to enhance market prospect for industries with desires to use such products as substitutes.

Acquire preservation technologies: There is currently very low capacity for preservation of local herbs and spice due to the dearth of processing and preservation technologies locally. It is estimated that about 40-60% of agricultural produce in the region goes to waste due to lack of appropriate preservation technology. The countries in the West African region need to invest massively in process and preservation technologies to handle the required volume of trade and excess production for export and future out-of-season demands.

Develop or acquire value-addition technologies: Value addition to crude raw materials, through processing and proper packaging is critical if we are to become significantly relevant in the global spice market.

Expand existing market/ensure good practices/standardization: Without product standardization through R&D, and implementation of "Good Practices" (such as GAP, GMP, GCP), developing countries like Nigeria and other west African may not achieve market competitiveness, neither for food nor medicinal commodities. But with the assistance of government, the local and international market could be expanded, with products of international standard.

CONCLUSION

Apart from fruit juice and dairy foods producers, many local manufacturers are yet to take advantage of the huge gap in local demand for nutraceuticals and functional food. Manufacturing and Packaging of local herbs and spice as currently being done by some Nigerian manufacturers (Intercedd, Dudu Osun, Pax herbal, etc) applying the principles of good manufacturing practice (GMP) are steps in the right direction. Though spice import to Nigeria seems low, there exists a big gap in the international scene which Nigeria can fill. Nigeria being richly endowed with these plant resources should take reasonable advantage. The global demand forecast for herbs and spices, especially for use as nutraceutical or dietary supplement in complementary alternative medicine or orthodox medical practices, shows that it will continue on the upward trend, and this provides opportunity for pharmaceutical raw materials development.

At NIPRD, Niprisan remains a flagship product. Niprisan plus, Niprimune and Niprimal, are some of the drug candidates in the phytomedicines development pipeline. Some of these products contain substances used as herbs or spices.

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