



## Promoting the Utilization of Underutilized Vegetable Crops in Food Processing: A Review

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### ABSTRACT

*There is a need to create awareness for cultivation and consumption of Underutilized Indigenous Vegetables (UIVs) considering that they are nutritious, health promoting, easy to cultivate and produce stable yields even under difficult climatic conditions. The consumption of these vegetables is capable of preventing and protecting against some of the diseases arising from the effect of oxidative damages cause by free radicals. For food welfare and livelihoods around the world, vegetables play a crucial role. Although animal foods are often too costly for low-income families, various underexploited vegetables can be a replacement for vitamins, micronutrients, and secondary plant metabolites that promote health, food security, income generation and environmental services. UIVs continue to play an important role in the subsistence and economy of poor people and vulnerable groups throughout the developing world, particularly in the agro biodiversity-rich tropics. Value-addition is a key consideration to increase the market share of indigenous vegetables. Some crops with a short shelf life can be processed to add value. Processing may include packaging, drying, salting, fermenting, pickling, canning and juice production, such as moringa juice. In addition to expanding the range of products of these vegetables and ensuring long shelf life of the value-added products, processed products are more likely to fetch a higher market value than the fresh produce. More than ever before, lies the need to exploit global innovative approaches in the industrial circle to tackle hunger, the potential of underutilized plants contributing to industrial development is high and expanding. Across the globe such contributions as food processing, food security, product development, commerce and industry have been examined. This will offset malnutrition and also provide a source of income as indigenous vegetables represent inexpensive but high-quality nutritional sources, food security for rural and urban dwellers especially where malnutrition is wide spread as in Nigeria.*

**Keywords:** Diversification, Underutilized Indigenous Vegetables, Food Security, Food Processing

## INTRODUCTION

In 2010, the Food and Agricultural Organization (FAO) reported an estimated 925 million people were undernourished with about 162 million children under the age of five in developing countries being stunted due to chronic under-nutrition and another 148 million children underweight. Approximately 2 billion people (over 30 percent of the world population) are being affected by micronutrient malnutrition with serious public health consequences. On the other hand, overweight and obesity is becoming a recognized problem, even in low-income countries. About 43 million children under five years of age are overweight and more than a billion adults included. These figures, nearly equal the number of people chronically hungry and suffering from undernourishment worldwide. Persistent under nutrition, including micronutrient deficiencies, with increased overweight and obesity is best described as the double burden of malnutrition which has become a major issue of developing countries, generating unacceptable human and economic costs and sabotaging development.

### **Promoting Biodiversity of Underutilized Vegetable Crops**

The term 'biodiversity' embraces the variations found in living organisms, both between and within ecosystems. It includes species diversity and intra-specific genetic variations. With biodiversity at the foundation of human society, we survive on the range of products and services that it provides. Biodiversity is vital for the food security, proper nutrition, income and self-reliance of human communities, and also sustenance of the environment (Bhunja *et al.*, 2009). Plant biodiversity represents the primary source for food, feed, shelter, medicines and many other products with means to make life pleasurable. Currently, there is a drastic reduction in the number of plant species used by humans around the world compared to the number of species



which generations of diverse cultures around the world had drawn up to develop crops that would meet specific needs. Diversification of most common cultivated species are known today although, many other species of local importance - the knowledge on their distribution, genetic diversity and use patterns are still largely limited. Continuous dependence on major food crops has caused a shrinking of the food basket which humankind has been relying upon for generations. However, the shrinking of agricultural biodiversity has reduced both the intra and interspecific diversity of crops, increasing the level of vulnerability (to ill health and diseases) among users, particularly among the poor, for whom diversity in crops is a necessity for survival rather than a choice. Vitamins and other micronutrients are for instance being searched in exotic (foreign) crops and plant species with less emphasis on neglected indigenous plant species and their role in combating diet imbalances. It is important to note, reduced dietary diversity has serious effects on the nutrition and health of both rural and urban populations and deprives rural farmers of opportunity to generate income from their produce, whereas, dietary diversification is widely accepted as a cost-effective and sustainable way of improving nutrition as malnutrition can lead to a lack of nutrients and diseases such as iron deficiency and anaemia, iodine deficiency and mental disability, as well as Vitamin A Deficiency (VAD) and blindness. Thus, it can be inferred that malnutrition and disease are closely related (Bhunia *et al.*, 2009; FAO, 2014; Barsha *et al.*, 2020).

Das *et al.* (2009), highlighted that human being can achieve nutritional security through horticulture among which green leafy vegetables are an important source of antioxidants, amino acids, minerals and vitamins. Some green leafy vegetables are also a rich source of medicinal components especially underutilize

vegetables. For food welfare and livelihoods around the world, vegetables play a crucial role. Although animal foods are often too costly for low-income families, various underexploited vegetables can be a replacement for vitamins, micronutrients, and secondary plant metabolites that promote health, food security, income generation and environmental services (Barsha *et al.*, 2020).

### **Features of Underutilized Vegetables Crops**

According to Padulosi (2017), plant species that have been used for centuries or more for their food, fibre, fodder, oil or medicinal properties but relegated in importance over time are termed as "neglected or underutilized" crops. Terminologies including - orphan, abandoned, lost, local, minor, traditional, alternative, niche, or underdeveloped are used to describe these crops. Reductions in use may pertain to supply or consumption constraints. These can include, poor shelf life, unrecognized nutritional value, poor consumer awareness and reputational problems (famine food or "poor people's food", sometimes due to the modernization of agricultural practices) (Williams and Haq, 2002).

Jena *et al.* (2018) expressed how difficult it is to precisely define which attributes make a crop "underutilized", but stated they often display the following features:

- Scientific or ethnobotanical proof of food value.
- Cultivated less than other conventional crops.
- Adaptation to specific agroecological niches and marginal land.
- Weak or no formal seed supply systems.
- Traditional uses in localized areas.
- Produced in traditional production systems with little or no external inputs.



- Receive little attention from research, extension services, policy and decision makers, donors, technology providers and consumers.
- May be highly nutritious and/or have medicinal properties or other multiple uses.

According to Nnamani *et al.* (2009), vegetables are important sources of protective foods, which are highly beneficial for the maintenance of good health and prevention of diseases such as cancer, cardiovascular diseases (CVDs), diabetes, inflammatory diseases and other chronic disease. Indigenous leafy vegetables are vegetables originating from a locality or an area and may or may not be confined to a particular region. These vegetables account for about 10% of the world higher plants frequently regarded to as weeds. Some indigenous leafy vegetables grow in the wild and are readily available in the field as they do not require any formal cultivation. Indigenous crop species are in a vulnerable state and are nearing extinction owing to the introduction of high yielding and short duration varieties of crops. Growth and survival of many indigenous crop species in many countries is possible due to appropriate temperature and topographic variations. With different types of climatic conditions predominant at one point of time, it allows for not only diversified crop species but also different species of insects to continue their activities as pollinators (FAO, 2014).

Nigeria has over 53 million hungry people (approximately 30% of total population) and 52% live under the poverty line of 1 US Dollar per day. This has made poverty and malnutrition inevitable, leaving many Nigerians trapped in the spiral of hardship. The situation continues to escalate even amidst abundant natural resources. The scenario gave rise to an assertion by a popular Agriculturist, "Nigeria, blessed as it is, with abundant agro-

ecological resources and diversity, has become one of the largest food importers in sub-Saharan Africa" (Ayinde *et al.*, 2016).

In Nigeria, the traditional people consume many types of plants, wild vegetables and fruits, mushrooms and nuts however, impacts of climate change, deforestation, overharvesting and rising insecurity has resulted in fluctuating availability of these foods. Therefore, the need for sustainable conservation is crucial, especially in the context of climate change, deforestation and security of lives. Vitamins and minerals can be returned to contemporary diets through the use of micronutrient-rich underutilized and neglected species by transplanting them from their wild habitats into home gardens. This will offset malnutrition and also provide a source of income as indigenous vegetables represent inexpensive but high-quality nutritional sources, for rural and urban dwellers especially where malnutrition is wide spread as in Nigeria. (FAO, 2014).

Neglected indigenous vegetables though underutilized due to lack of awareness of their nutritional values in favour of exotic ones, these vegetables, are rich sources of carotene, ascorbic acid, riboflavin, folic acid, phytochemicals and minerals like calcium, iron and phosphorous essential for healthy living (Nnamani *et al.*, 2009). George (2003), expressed that even though the bulk of their weight is water, the potassium content of leafy vegetables is good in the control of diuretic and hypertensive complications, because it lowers arterial blood pressure. The fibre content of vegetables prevents constipation and contributes to the feeling of satisfaction while the proteins are superior to those found in fruits, despite being inferior to those found in grains and legumes.





Every year, there are over ten million hunger-related death occurring in developing countries of the world (children accounting for about 50%) testify to the nations' failure to achieve global food security. Researches has established that the major cause of this malnutrition and hunger is food insecurity and one of many ways to tackle food insecurity is by retracing the neglected and underutilised crops found in numerous agricultural ecosystems and marginal areas (Ayinde *et al.*, 2016).

### **Challenges for Underutilization of Indigenous Vegetables**

A number of factors are responsible for the underutilisation of some crops. Lack of nutritional and agronomic information, policies that do not recognize sufficiently the important role of these foods in food processing, food security, health and lack of advocates and champions to promote traditional and indigenous foods are all constraints. Some of such factors are outlined by Jena *et al.* (2018) and Karigidi (2018);

- Lack of awareness among the farming community about the nutritional and medicinal value of underutilized vegetable crops.
- Lack of researches.
- Lack of desirable seeds and planting material.
- Limited application of advance on-farm agro techniques.
- Lack of application of innovative and novel technologies such as biotechnology, plasticulture for enhancement of productivity.
- Lack of about post-harvest management practices.
- Limited and inadequate marketing supports and infrastructure facilities for transportation, storage and processing.
- Poor recognition of these crops in horticulture promotion programmes.
- Improper institutional arrangements and limited role played by financial Institutions in setting up of agro industrial and horticulture based industrial units.

- Urbanization
- Absence of strategic policy

Since diversification of food crops has the potential to meet increasing demand for food, it should be encouraged rather than attention placed on a few staple foods. Since underutilised crops are often rich in nutrients and health-promoting agents, diversifying the food value chain through food processing to include these underutilised species could be an effective tool to curb malnutrition and promote well-being by eliminating hunger. Green leafy vegetables have the potential to assume a more important role globally in the sustainable supply of diverse and nutritious food if given appropriate attention by the government and other developmental stakeholders (Ayinde *et al.*, 2016; Karigidi, 2018).

### **Health and Nutritional Benefits of Underutilized Indigenous Vegetables (UIVs) in Nigeria**

Nigeria is blessed with vast amount of vegetable which are consumed as food and also used for medicinal purposes. A number of indigenous vegetables in Nigeria have been identified and classified as underutilized by the Nigeria indigenous vegetable project (2015). Over 40 indigenous leafy vegetables are eaten in Nigeria, with the south-western part accounting for 24 of them. Various ethnic groups consume varieties of different indigenous types of vegetables for different reasons as they play an important role in traditional-food culture. Approximately half of the leafy vegetables consumed in most Nigeria diets are from indigenous sources and they constituent significantly micronutrients. Green leafy vegetables used for soup preparation native to regions cuts across different cultures within Nigeria and other parts of West Africa with similar cultural and socio-economic background. An insignificant proportion of our





indigenous vegetable species are cultivated domestically while some are seen growing in the wild (Mensah *et al.*, 2008; Kadiri and Olawoye, 2015). According to Kadiri and Olawoye (2015), epidemiological studies revealed that consumption of vegetable and fruit can protect humans against oxidative damage as they are rich in antioxidants. Antioxidants prevent oxidative damage by inhibiting the action of free radicals and reactive oxygen species (ROS). Despite the nutritional and antioxidant content inherent in vegetables, just few scientific studies have been done to establish a seed germplasm for these vegetables and roles they could play in the formulation of healthy nutrient packed diet rich in natural antioxidants.

Table 1: Underutilized indigenous vegetables.

English Name	Botanical Name
Waterleaf	<i>Talinum triangulare</i>
Snake Tomato	<i>Trichosanthes cucumerina</i>
Garden Egg	<i>Solanum macrocarpon</i>
Drumstick Tree	<i>Moringa oleifera</i>
Fire Weed	<i>Crassocephalum crepidoides</i>
Catholic Vegetable	<i>Jatropha tanjorensis</i>
Amaranth	<i>Amaranthus virides</i>
Indian Spinach	<i>Spinacia oleracea</i>

Source: NIVP (2015)

The table 1 highlights some underutilized indigenous vegetables in Nigeria. The purpose of this study is to review research findings and recommendation related to promoting utilization of indigenous green leafy vegetables cultivated primarily in Nigeria. The underutilization of Waterleaf, Drumstick tree, Catholic vegetable and Indian spinach will be discussed.

### **WATERLEAF (*Talinum triangulare*)**

Waterleaf (*Talinum triangulare*) is a non-conventional vegetable crop of the *Portulacaceae* family which originated from tropical Africa and is widely grown in West Africa, Asia, and South America (Enete and Okon, 2010; Oluwalana *et al.*, 2011).

It is used as a "softener" when cooking fibrous vegetables such as *Afang* (*Gnetum africanum*), *Atama* (*Heinsia crinata*), and fluted pumpkin (*Telferia occidentalis*). Enete and Okon (2010), noted that the leaves and young shoots are used to thicken sauce and it is consumed in large quantities in the Southern part of Nigeria especially among the Ibibio's in Akwa Ibom State. Nutritionally, waterleaf has been proven to be high in crude protein (22.1%), ash (33.98%), and crude fiber (11.12%). It also has some medicinal potentials and acts as green forage for rabbit feed. Production of this indigenous vegetable, provides a complementary source of income to small-scale farming households as demand for waterleaf increase among the inhabitants of the country, thus widening the domestic demand and supply gap of the product.



Plate I: *Talinum triangulare* leaves and flower



### Benefits of Waterleaf

- i. Aja *et al.* (2010), Okpala (2016), reported that waterleaf contain a reasonable proportion of bioactive compounds that are essential for preventing and treating various ailments. Waterleaf have been used in many ways to serving diverse ranges of medicinal purposes. Its juice, stem, leaves and roots are all considered effective as they have proven successful in the treatment of measles. It can also treat insomnia, anaemia, malaria, arthritis reduces blood sugar and blood pressure. It is also used in the treatment of diarrhoea, improve weakness and more.
- ii. Disu (2010), Okpala (2016) reported that waterleaf is eaten cooked as a pet-herb and in vegetable soups (*Edikaiko, Ofe Mgbolodi, Gbure, Afang*). It is also used as a condiment in sauces or raw in salad, besides, very rich in mineral salts and amino acids as well as having anti-scorbutic properties i.e., prevention against scurvy.

**Table 2:** Biological uses and the function of waterleaf

Treatment/ Effect	Medicinal	Function
Antioxidant and disease	Hepatic	Suppression of oxidative damage of liver cells
Liver Disease		Helps to enhance liver function
Enhancement of function	cerebral	Reduce oxidative stress, supports neurons of cerebrum and enhances cerebral function.
Laxative effect		Antioxidant activity helps to treats mild laxative problem and constipation.
Diabetes		Essential for managing diabetes mellitus, its high dietary content helps to slow down digestion and conversion of starch to simple sugar.

Regulation of cholesterol level	Dietary fibre present in the plant helps to reduce absorption of cholesterol level from the gut, thereby preventing the body from bad cholesterol associated diseases.
Cancer prevention, Management of cardiovascular disease	Antioxidant activity makes it important in preventing cancer and tumour growth, Regular consumption helps to reduce risk of contracting stroke.
Body weight management	The high dietary fibre prevents obesity and excess body weight.
Prevent anaemia and boost blood level, especially for pregnant women	Helps to prevent anaemia and boost blood level by clearing bilirubin from blood, thus helping red blood cells to remain longer and effectively utilized by the body.

Source: Bioltif and Edward (2020)

Waterleaf has shown to contain high medicinal potentials, interestingly and also to be ethnobotanically important, notably its leaves. Studies shows that waterleaf contains lots of water and nutrients such as minerals (Ca, K and Mg), vitamins (C and E), crude fibre, dietary fibre, soluble fibre (pectin), lipids, crude protein, omega 3 fatty acids and beta-carotene. These vitamins and minerals contribute to a high antioxidant value thus, making it nutritious and medicinal in several ways.

### **DRUMSTICK TREE (*Moringa oleifera*)**

Commonly called drumstick tree or horseradish tree by locals, *Moringa oleifera* is a cruciferous plant that belongs to the *Moringaceae* family. It is a popular staple in different parts of the world including northern Nigeria. *M. oleifera* is consumed not only for its nutritional values but also, its medical benefits. *Moringa oleifera* is a small native tree of the sub-Himalayan regions of North West India, which is now indigenous to many



regions in Africa, Arabia, Southeast Asia, Pacific and Caribbean Islands and South America. Among commoners, it has earned its name as 'the miracle tree' due to its amazing healing abilities for various ailments and even some chronic diseases. The leaves are rich in beta-carotene, vitamin C, vitamin E, and polyphenols and are a good source of natural antioxidants. *M. oleifera* is at present reported to enhance a broad range of biological functions which include anti-cancer, anti-inflammatory, hepatoprotective, and neuroprotective functions. In addition, many studies have revealed its therapeutic value including anti-atherosclerosis, anti-diabetes, anti-depression, anti-infertility, anti-rheumatoid arthritis, pain relief, diuretic and thyroid regulation (Razis *et al.*, 2014; Kou *et al.*, 2018). According to Kou *et al.* (2018), *M. oleifera* has gained tremendous attention over the last decade due to its bioactivity which has led to the increasing discovery and comprehension of its pharmacological functions and fundamental mechanisms. *M. oleifera* can reduce the risk of cancer and modulate blood glucose, although the underlying mechanisms remain to be further explored. Consequently, *M. oleifera* provides the potential for the prevention or treatment of a series of chronic diseases.



Plate II: Moringa leaves, pod and seeds.



### Benefits of Drumstick Tree

- i. According to Zaku *et al.* (2015), moringa is an effective source of natural antioxidants due to the presence of several sorts of antioxidant compounds such as flavonoids, ascorbic acid, carotenoids, and phenols. Reports from Fahey *et al.* (2001), Fahey (2005), Amaglo *et al.* (2010) and Razi *et al.* (2014) stated that each part of the drumstick tree has beneficial properties that can serve medicinal, nutritional, and therapeutic purposes to humanity. Furthermore, moringa was found to have a group of unique compounds containing sugar and rhamnose, which are uncommon sugar-modified glucosinolates. These compounds were reported to demonstrate certain chemo-preventive activity, by inducing apoptosis.
- ii. A research study published in the *Journal of Medicinal Food* has validated the effectiveness of its leaves against the liver damage caused by anti-tubercular drugs as well as its stimulating effects in speeding up the recovery process. Moringa extracts exert a hepatoprotective effect on the liver. It helps to restore the levels of glutathione content in the body and prevents radiation-induced hepatic lipid peroxidation. This protective effect is attributed to the presence of phytochemicals such as catechin, epicatechin, ferulic acid, and vitamin C found in the drumstick (Nagdeve, 2019).





**Table 3:** Nutritional compositions and medicinal uses of different parts of moringa.

Part of tree	Medicinal uses	Nutrients
Leaves	Treat asthma, hyperglycemia, Dyslipidemia, flu, heart burn, syphilis, malaria, pneumonia, diarrhea, headaches, scurvy, skin diseases, bronchitis, eye and ear infections. Also reduces, blood pressure and cholesterol and acts as an anticancer, antimicrobial, antioxidant, antidiabetic and anti-atherosclerotic agents, neuroprotectant	Fiber, fat, proteins and minerals (Ca, Mg, P, K, Cu, Fe, S). Vit-A ( $\beta$ -carotene), B-choline, B1-thiamine, riboflavin, nicotinic acid, C-ascorbic acid. Various amino acids like Arg, His, Lys, Trp, Phe, Thr, Leu, Met, Ile, Val are present. Phytochemicals like tannins, sterols, saponins, terpenoids, phenolics, alkaloids and flavanoids like quercetin, isoquercetin, kaemfericetin, isothiocyanates and glycoside compounds are present.
Seeds	Treatment of hyperthyroidism, Chrohn's disease, antiherpes-simplex virus arthritis, rheumatism, gout, cramp, epilepsy and sexually transmitted diseases, can act as antimicrobial and anti-inflammatory agents.	Contains oleic acid (Ben oil), antibiotic called pterygospermin, and fatty acids (Linoleic acid, linolenic acid, behenic acid), Phytochemicals (tannins, saponin, phenolics, phytate, flavanoids, terpenoids and lectins). Fats, fiber, proteins, minerals, vit- A, B, C and amino acids.
Root Bark	A cardiac stimulant, anti-ulcer and anti-inflammatory agent.	Alkaloids like morphine, moriginine, minerals (Ca, Mg, Na).
Flower	Act as hypocholesterolemic, anti-arthritic agents can cure urinary problems and cold.	Calcium, potassium, amino acids and nectar.
Pods	Treatment of diarrhea, liver and spleen problems, and joint pain.	Rich in fiber, lipids, non-structural carbohydrates, protein and ash. Fatty acids like oleic acid, linoleic acid, palmitic acid and linolenic acid are also present.

Source: Gopalakrishnan *et al.* (2016)

The research on *M. oleifera* is yet to gain importance in Nigeria. It is essential that the nutrients of this wonder tree are exploited for a variety of purposes. Numerous health problems, diseases, vitamin and mineral deficiency, malnutrition can be tackled, at the same time, it can be a useful natural resource to the population and industry.

### **CATHOLIC VEGETABLE (*Jatropha tanjorensis*)**

A lot of attention has been drawn to the catholic vegetable due to its potential health benefit, availability and affordability, its primary use is for fencing and as medicine. *Jatropha tanjorensis* is a member of the family of plants called *Euphorbiaceae*. It is commonly consumed as vegetable in many parts of southern Nigeria. It is commonly called 'hospital too far', lapa-lapa (in southwestern Nigeria) (Falodun *et al.*, 2013). Bioactive elements such as alkaloids, flavonoids, tannins, cardiac glycoside, anthraquinones and saponins have been discovered from phytochemical screening of *Jatropha tanjorensis* (Falodun *et al.*, 2013). According to Omoregie and Sisodia (2011), some wide range of biological activities, which include antihypertensive, antioxidant, antimicrobial, antimalarial, hypoglycaemic, hypolipidemic and haematological activities have been observed through pharmacological studies. However, the plants popularity was doused by unproven claims that the whitish latex emanating from the leaf stem and stalk may be toxic to man.



Plate III: Leaves and seeds of *Jatropha tanjorensis*.

## Benefits of Catholic Vegetable

### i. Medicinal Properties

For many years, catholic vegetable has been used locally as a source of leafy vegetable and as medicinal plant. *Olayiwola et al.* (2004) reported that *Jatropha tanjorensis* is popular as a natural remedy against diabetes in Southern Nigeria. And the plant's leaf has also been shown to improve haematological indices. *Jatropha tanjorensis* has also been shown to exhibit antibacterial activity. It is used in the treatment of hypertension. Extracts from the plant leaves have also been used in Nigeria to control sickle cell anaemia. The leaf extract also has antioxidant property and is effective in the treatment of malaria in southern Nigeria (*Falodun et al.*, 2013).

### ii. Antioxidant Properties

According to *Falodun et al.* (2013), reports have shown that *J. tanjorensis* is rich in antioxidant nutrients such as phosphorus, selenium, zinc, and vitamins C and E7. Antioxidant properties of plants have direct relationship with the polyphenol content in that plant. In view of this, *J. tanjorensis* have been shown to be rich in both free and bound phenols and flavonoids. It is widely used for the treatment of tropical

diseases and other infections. Antioxidant properties of this vegetable such as free radical scavenging, Iron (II) chelating, ferric reduction, hydroxyl radical scavenging and lipid peroxidation activities have been studied.

### iii. Antimicrobial Properties

*Jatropha tanjorensis* contain antimicrobial properties which are activity against Gram positive *Staphylococcus aureus*, *Bacillus cereus*, *Bacillus subtilis*, and Gram- negative *Escherichia coli* and *Mycobacterium pheli* bacteria. Phenolics including tannins are used topically for the care and healing of skin wounds. Tannins have been shown to be toxic to filamentous fungi, yeast and bacteria as reported by Viswanathan *et al.* (2012).

### iv. Prevents Cardiovascular Diseases

High levels of LDL cholesterol increase health problems and cardiovascular disease, and are often called "bad cholesterol" as opposed to HDL which are referred to as "good cholesterol" or "healthy cholesterol". It has been reported by Falodun *et al.* (2013), that extract of *Jatropha tanjorensis* has shown significant reduction in serum total lipids, total cholesterol and LDL cholesterol with no significant difference in the levels of serum triglycerides and HDL cholesterol. Thus, reduction in serum total lipids, total cholesterol and LDL cholesterol by the extract implies that it can be used to prevent cardiovascular complications arising from hyperlipidaemia which explain the traditional use of the leaf extract as a natural remedy against heart diseases in the West Africa sub-region. It was reported that those with higher levels of HDL cholesterol seem to have fewer problems with cardiovascular diseases, while those with low HDL cholesterol levels have increased rates of heart disease.

### v. Hematological Properties

Catholic vegetable is a rich source of iron. High concentration of iron in the extract increases the amount of iron available for



erythropoiesis which promotes an increase in the production of red blood cells and haemoglobin.

Various studies suggest that *J. tanjorensis* leaves are nutritionally rich and possess abundant anti-oxidant properties that could effectively ameliorate malnutrition, the effects of oxidative stress and free radicals from metabolic reactions. This vegetable can improve the quality of nutrients in the diet rural and urban dwellers.

### **IMPORTANCE OF UTILIZING INDIGENOUS VEGETABLES**

Barsha *et al.* (2020) and Madhvi *et al.* (2020) highlighted the importance of UIVs stating they continue to play an important role in the subsistence and economy of poor people and vulnerable groups throughout the developing world, particularly in the agrobiodiversity-rich tropics. They have great potential to contribute to poverty eradication through employment and income generation, dietary diversification (of diet leading to more balanced source of nutrients and minimization of over dependence on a small number of major crops) and the provision of micronutrients and other health promoting factors including high antioxidant activity. Alongside their commercial potential, many of the underused crops also provide important environmental services, as they are adapted to marginal soil and climate conditions. Utilization can be for industrial, medicinal, therapeutic, fodder, oil or nutritional purposes and are consumed raw, processed (as condiments, fortifiers, juices, cooked) or as traditional delicacies providing global food security.

### **Enhancing Utilization of Indigenous Vegetables**

Utilization of indigenous vegetables can be enhanced through seed production and variety release support whereby; sufficient quantities of quality seeds of the improved varieties must be

available and accessible to allow farmers to capitalize on new market opportunities.

It is essential to gain adequate knowledge on improved production practices to enhance utilization of indigenous vegetables as it is crucial to understand adequate pre and postharvest handling techniques required to ensure that quality products will reach markets and the end-user. Such techniques will facilitate harvesting, minimize contamination and spoilage and help farmer deliver quality products to the market or end users. Value-addition is a key consideration to increase the market share of indigenous vegetables. Some crops with a short shelf life can be processed to add value. Processing may include blanching, drying, salting, fermenting, pickling, canning and juice production, such as moringa juice, tea and oil. In addition to expanding the range of products of these vegetables and ensuring long shelf life of the value-added products, processing is essential as processed products are more likely to fetch a higher market value than the fresh produce (Than *et al.*, 2002). According to Grumezescu and Holban, (2018), food processing involves the transformation of agricultural products into food, or one form of food into other forms. Food processing include many forms but are not limited to grinding food material into flour or paste, home cooking to complex industrial methods. Foods have been processed since communities first came together thousands of years ago and most foods need some form of processing/preparation to make them palatable. Food processing therefore is beneficial by:

- Breaking down complex food structures to simpler ones;
- Increasing the variety of foods in the diet;
- Creating opportunities for income generation;
- Creating special foods for cultural or religious occasions, thus reinforcing cultural identities.





However, processing does more than changing the organoleptic properties of UIVs. All green leafy vegetable are biological materials which begin to decay as soon as they are harvested thus, processing slows or stops deterioration and allows preservation of vegetables for extended use. Its benefits are:

- Increased shelf life for postharvest UIVs will extend availability of food against time of shortage to increase food security (by ensuring sufficient food is available and the essential nutrients are eaten throughout the year).
- Innovative approaches to food processing techniques such as drying and blanching of fresh green UIVs have resulted in new options for storage and nutrient retention thus ensuring more nutritious meals.
- Increased market opportunities (dry vegetable packets last longer and can be transported further and more cheaply on a cost by weight basis).
- It enables diversification of vegetable products (fortified cookies, teas, oil extracts, juices and beverages).

### **Industrial Potential of Underutilized Plants In Nigeria**

More than ever before, lies the need to exploit global innovative approaches in the industrial circle to tackle hunger (malnutrition), climate change problems and hence health challenges as wide range of biodiversity constitutes a natural wealth that compose a priceless treasure, forming the foundation of human wellbeing. Some of the UIVs are responsible for diminishing pollution, guarantee sustenance of human health, life and wellbeing (Aju, 2010). According to Ogunwusi and Ibrahim (2016), the potential of underutilized plants contributing to industrial development is high and expanding. Across the globe such contributions as food processing, food security, commerce and industry have been examined. The production of oil from underutilized 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 (IIED 2000).

The major industrial application of UIVs include:

**i. Composite Seasoning Production**

Seeds of several indigenous underutilised plant species can be blended into seasoning. Examples of these are *Moringa oleifera*, *Mondora myristica*, *Piper guineense*, *Tetrapluera tetraptera* and *Xylopia aethiopica*. Other species of importance in Nigeria for seasoning production are seed of African bush mango, *Culcuma longa* and *Oscimun gratissimam* and *Oscimum basilicum*. The seeds and leaves of Benin pepper (*Piper guineense*) are used mostly as condiments and leafy vegetables respectively. These plants have a range of utilization potential which varies from food, through perfumes and tannin production to traditional medicine (Onwualu *et al.*, 2013; Ogunwusi and Ibrahim, 2016). Nigeria imports substantial quantities of other types of spices and is only involved in ginger trade. 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 (Ogunwusi, 1992; Onwualu, 2013).

**ii. Fats and Oils Production**

Fats and oils could be produced sustainably from many underutilized industrial plants in Nigeria. Among the species of importance for oil production area are *Moringa oleifera*, *Dacryodes edulis*, *Elaeis guineensis*, *Irvingia gabonensis*, *Iwombolu*, *Ricinodendron heudelotii*, etc. (Okafor, 2012). Chemical composition of the fruits, seeds and leafy vegetables of these species have been reported by several authors. Ogunwusi and Ibrahim (2016), reported the oil content of *M. oleifera* to be 42.00%, *D. Edulis*, 66.87%, *Monodora myristica*, 42.0%, *Pentachletra macrophylla*, 58.15% and *Plukenetia conophora*, 61.04%, respectively as 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. Due to 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 however, some of the mills do not have adequate raw materials. Development of these natural underutilized crops will assist in the provision of raw materials for industrial use, thereby, reducing expenditure on importation of fats and oils (Ogunwusi and Ibrahim 2016). To enhance sustainable development of these oil sources, there is need for consistent government policy on fats and oil production from underutilized raw materials locally.

### iii. Health Benefits

Aju (2010), claimed that despite progress in synthetic chemistry and biotechnology, pharmacy is still predominantly based on plant substance as interest in medicinal plant uses has been on a surge in recent times. Humans depended on plants for cure of majority of diseases, until scientific milestone introduced chemical synthesis. The probe/examination for viral disease using plants has greatly reawakened interest in ethnobotany, especially in the western world. Reformed ethnobotanical drugs are now needed for treatment of cardiovascular diseases, cancer, microbial infections and neoplasms (Ogunwusi and Ibrahim 2016). UIV species with outstanding medicinal values in Nigeria such as *Jatropha tanjorensis*, *Garcinia cola*, *Moringa oleifera*, *Irvingia wombolu*, *Talinum triangulare* and *Zanthoxylum spp.* have been used for disease control locally by consuming them either as food or food ingredients.

### iv. Fruit Juice and Beverage Production

Fruit juice signifies a product which is 100% liquid extract of a particular fruit obtained by mechanical expression. Some of

the underutilized vegetables have nutritional components which are used for production or as ingredient of local fruit juice and beverages. Some of these include *Vernonia amygdalina*, *Ocimum gratissimum*, *Parkia biglobosa*, *Moringa oleifera*, *Hibiscus sabdariffa*, and *Telfairia occidentalis* (Okafor, 2012). Seeds of species have been used to produce non-alcoholic and alcoholic beverages in Nigeria. Their fruits are nutritious. The drinks produced from them contain antioxidants, vitamins and minerals, particularly vitamins C and B complex (Ogunwusi and Ibrahim 2016).

#### **v. Water Purification and Clarification**

Zaku *et al.* (2015), reported between 30-42% oil in moringa seeds and the press cake from the oil extraction process contained a very high level of protein. Some of the proteins (approximately 1%) were active cationic polyelectrolytes with molecular weights between 7-17 K Dalton and the cationic polyelectrolytes neutralize the colloids in turbid water since the majority of these colloids had a negative electrical charge. This protein can therefore be used as a non-toxic natural polypeptide for sedimenting mineral particles and organics in the purification of drinking water, for cleaning vegetable oil, or for sedimenting fibers in the juice and beer industries. The proteins work as a primary coagulant and continuously forms natural bridges between the colloid particles. Some industrial coagulants are expensive, toxic (such as alumina) and requires qualified personnel for proper use which majority of underdeveloped countries lack (Gopalakrishnan *et al.*, 2016).

Moringa seed extract can eliminate heavy metals (such as lead, copper, cadmium, chromium and arsenic) from water. *M. oleifera* is also beneficial in surface water treatment by lowering settling time when functionalized with magnetic nanoparticles such as iron oxide. Seed extracts have anti-microbial properties that inhibit bacterial growth, which



implies preventing waterborne diseases. These properties of *M. oleifera* seeds have wide applicability in averting diseases and can enhance the quality of life in rural communities as it is highly abundant (zaku *et al.*, 2015).

#### vi. Product Fortification and Supplementation

Various researches have proven that green leafy neglected vegetables can be used as fortificants Owusu and Oduro (2011) also used moringa as a fortificant and produced cream and butter crackers with moringa and *Ipomoea batatas* as fortificants, with the hope of adding additional nutrients to snacks. Bolarinwa *et al.* (2017) reported the use of moringa seed powder to fortify bread producing a nutrient dense loaf, while Sengev *et al.* (2013) also reported the use of moringa leaf powder to supplement the quality characteristics of wheat bread.

### CONCLUSION

The current imbalance in agricultural investment must be redressed to unleash the potential indigenous vegetable crops hold to alleviate poverty and malnutrition in the developing world. Underutilized vegetable crops require special attention and must be popularized in order to utilize their potential to treat many lifestyles related diseases. Research in the direction of domestication and utilization is of profound importance as far as nutritive value is concerned. The increase in area and production of these vegetable crops will not only provide nutritional security and save money on import but also export of fresh vegetable crops and seed is further expected to boost region economy. Underutilized vegetable crops also provide many fold employment opportunities in agro-based industries, packaging, storage, preservation, canning and transportation.

## RECOMMENDATIONS

- i. Documentation of traditional knowledge and practices, encompassing all aspects of UIVs in society, from traditional beliefs to agronomic practices, which can be useful for product development and awareness campaigns should be employed.
- ii. Policy-makers should be engaged in promoting indigenous vegetable crops. Major public sector organisations that may have to be involved in Nigeria include the Federal Ministry of Agriculture, Forestry Research Institute of Nigeria under the Federal Ministry of Environment, the Colleges/Departments of Agriculture and Forestry in the various universities and research institutes, the Small and Medium Enterprises Development Agency and the Raw Materials Research and Development Council at both the Federal and State levels.
- iii. Integrate food biodiversity in government policies and programmes.

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