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Nutritive Value and Inherent Anti-nutritive Factors in Four Indigenous Edible Leafy Vegetables in Human Nutrition in Nigeria: A Review

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ABSTRACT

Indigenous edible vegetable leaves such as fluted pumpkin (*Telfairia occidentalis* Hook f.), bitter leaf (*Vernonia amygdalina*), sweet potato (*Ipomea batatas*), cassava (*Manihot esculenta* Crantz) and *Moringa oleifera* are inexpensive source of cheap and abundant source of proteins, carbohydrate, minerals, vitamins and fibres to most vulnerable groups. Edible leaves from vegetable plants are rich source of beta-carotene a precursor for vitamin A. They have medicinal properties reservoir for the sick to recuperate in addition to natural source of therapeutic agents. Local vegetables are useful contributors to rural and urban people's diets in Nigeria but some contain anti-nutritional factors such as cyanogenic glucoside; oxalate; phytate; saponin and tannin to mention but a few that make them unsafe. Traditional processing methods are used to detoxify those with anti-nutrients safe for human nutrition.

Key words: Indigenous, vegetable leaves, nutrient contents, anti-nutrients, traditional processing

INTRODUCTION

Nigeria has rich genetic resources of cultivated, semi-wild and wild species of crops being used as traditional vegetables and different types are consumed by the various ethnic groups for different reasons (Denton *et al*., 1983; Mensah *et al*., 2008). Edible leaves from vegetable plants are eaten as supporting food or main dishes. They may be aromatic, bitter or tasteless (Edema, 1987) but are the cheapest and most accessible source of proteins, vitamins, minerals, essential amino acids (Okafor, 1983; Fasuyi, 2006; Mensah *et al*., 2008). Also, possess certain hormone precursors in addition to energy (Oyenuga and Fetuga, 1975). Leaf vegetables are highly beneficial for maintenance of health and prevention of diseases. They contain valuable source of food ingredients that can be utilized to build up and improve the body successfully (Hanif *et al*., 2006). They also maintain alkaline reserve of the body. They contain high carbohydrate, vitamin and mineral contents.

There are different types of vegetables and each group contributes in its own way to the diet (Robinson, 1990). Local vegetables are useful contributors to rural and urban people's diets in Nigeria (Barminas *et al*., 1998). They play prominent roles in the traditional-food culture and various ethnic groups consume a variety of different indigenous types of vegetables for different reasons, some have medicinal properties reserved for the sick and recuperation (Mensah *et al*., 2008) and others natural source of therapeutic agents (Roberts and Tyler, 1999). Non-starchy vegetables are rich sources of dietary fibre used in treatment of obesity, diabetes, cancer and gastrointestinal disorders (Iniaghe *et al*., 2009). In most local Nigerian diets, approximately half of the leafy vegetables consumed are from indigenous sources constituting significant micronutrient sources especially in times of drought and famine (Lockett *et al.*, 2000; Grivetti and Ogle, 2000). Leafy vegetables alleviate the problems of micronutrient malnutrition dominant in tropical Africa (Ejoh *et al.*, 2005). Adding a small amount of vegetable in one's food intake can prevent a disease like river blindness from occurring. Mensah (59) posited that the use of green leafy vegetables for the preparation of soups cuts across different cultures within Nigeria and other parts of West Africa with similar cultural and socioeconomic background.

Green leafy vegetable are cheap and abundant source of proteins. They can synthesize amino acids from a wide range of available primary materials such as water, carbon dioxide and atmospheric nitrogen as in legumes (Lewis and Fenwick, 1987; Aletor and Adeogun, 1995; Ladeji *et al.*, 1995; Fasuyi, 2006; Babu, 2000; Ajibade *et al.*, 2006; Aregheore, 2007, 2002; Oduro *et al.*, 2008). They offer the most efficient and cheapest source of minerals, fibres and vitamins to most vulnerable groups (Ejoh *et al.*, 2003); also, lower nutritional deficiency of people in poor countries where millions still suffer from nutrient insufficiency despite the availability of leafy vegetables (Ejoh *et al.*, 2005). There are over 40 indigenous leafy vegetables eaten in Nigeria and the southwest alone accounted for 24 of them (Adebooye *et al.*, 2003). Several other species have been listed in Nigeria (Okafor, 1983). For example, Mensah *et al.* (2008) identified 29 different green leafy vegetables in Edo State, Nigeria. Indigenous leaf vegetables are valuable sources of food, income and traditional medicine in Nigeria (Okafor, 1979; Awoyinka *et al.*, 1995; Schippers, 2000; Mensah *et al.*, 2008; Adebooye *et al.*, 2003).

This report is a review of four indigenous edible vegetable leaves; fluted pumpkin (*Telfairia occidentalis* Hook f); bitter leaf (*Vernonia amygdalina*); sweet potato (*Ipomea batatas*); cassava (*Manihot esculenta* Crantz) and *Moringa oleifera* in the nutrition of humans in Nigeria Although, *Telfaria* (fluted pumpkin) is comparatively expensive, it is ranked high by consumers because of its good taste. Although, some contain anti-nutritional factors such as cyanogenic glucoside; oxalate; phytate; saponinand tannin to mention but a few, they still play significant roles and have distinct advantages in the nourishment of humans. This report is a review on the nutritional importance of leafy vegetables in the diets of ethnic groups in Nigeria despite the presence of some fundamental anti-nutritive factors.

Fluted pumpkin (*Telfairia occidentalis* Hook f.): Fluted pumpkin (*Talfairia occidentialis* Hoof) belongs to the family Cucurbitaceae (Aregheore, 2007). It is a valuable commercial crop grown across the low-land humid tropics of West Africa. The leading producers of fluted pumpkin in West Africa are Nigeria, Ghana and Sierra Leone (Nkang *et al.*, 2003; Aregheore, 2007). However, there is no identifiable information on varieties of the crop (Ajibade *et al.*, 2006; FAO, 1992). It is a tropical vine grown primarily for the leaves and edible seed as an important component of food of many people in West Africa (Longe *et al.*, 1983; Fagbemi *et al.*, 2005). Young shoots and leaves are the main parts used in soup. The common names of the plant in Nigeria include fluted gourd, fluted pumpkin, iroko and ugu.

The plant is dioecious, perennial, drought tolerant and usually grows trellised. It needs a well drained soil, some water and sunlight. The vines will climb to 1.5 m. Flowers are white and dark purple. Sex of fluted pumpkin is difficult to identify until about 4 months after planting when it produces flowers, a major obstacle to its production. Housewives prefer the female leaves leading to higher demand. The young shoots and leaves of the female plant form main ingredients in edikang ikong, a soup favoured by people in Cross River and Akwa Ibong states, Nigeria.

In Southern Nigeria, "ugu" is the common name for the green leaves of fluted pumpkins. The leaves have a sweet taste. Fluted pumpkins leaves rich source of protein, oil, vitamins and minerals enhances, nourish, protect and heal the body. The leaves are low in crude fibre but, rich source of folic acid, calcium, zinc, potassium, cobalt, copper, iron, vitamins A, C and K also, have medicinal value (Ladeji *et al*., 1995; Ajibade *et al*., 2006).

Relative to most vegetables, its protein content is top (Ladeji *et al*., 1995; Ajibade *et al*., 2006; Aregheore, 2007). Leaves of fluted pumpkin are cheap nitrogen and mineral source (Aregheore, 2007). Ladeji *et al*. (1995) reported that the leaves contain (g 100^{-1} g, DM) 30.5 crude protein; 3.0 fat; 8.3 crude fibre and 8.4 total ash. Ajibade *et al*. (2006) reported that the leaves contain (g kg^{-1} DM) 35.1 crude protein, 9.6 fat; 12.7 crude fibre. Nutritionally, leaves of *Telfairia occidentalis* are rich in minerals antioxidants, vitamins (such as thiamine, riboflavin, nicotinamide and ascorbic acid (Kayode and Kayode, 2011). The leaf has potassium, calcium, magnesium and iron contents of ash of 594, 144, 100 and 12.0 mg 100^{-1} g DM, respectively. Young leaves also possess a high level of magnesium (8.69 mg 100^{-1}) and iron (3.60 mg 100^{-1}g) (Akwaowo *et al*., 2000) and due to its richness in iron the leaves can prevent and eliminate anaemia (Ajibade *et al*., 2006). The leaves have an excellent proportion of essential amino acids to total nitrogen but methionine is the limiting amino acid with a chemical score of 16. Badifu *et al*. (1995) reported Beta-carotene content of 98.9 mg 100^{-1} g, for fresh leaves but on blanching the value was reduced to 86.3 for steam blanches and 83.8 for water blanch. This demonstrated that processing has effects on the nutritive value of leaves of fluted pumpkin. Consumption of the leaves assist to combat certain diseases due to the presence of antioxidant and antimicrobial properties, its minerals (especially Iron), vitamins (especially vitamin A and C) and high protein contents (Kayode and Kayode, 2011).

Inherent anti-nutritional factors and detoxification: The leaves contain a considerable amount of anti-nutritive factors like high level of tannic acid and saponin. Akwaowo *et al*. (2000) reported that the young leaves often preferred for human consumption, contain high cyanide (60.1 mg 100^{-1} g DM) and tannin content (40.6 mg 100^{-1} g DM) than older ones. (Hill, 1987) reported a cyanide content of 59.80 mg 100^{-1} g for *Telferia occidentalis* (fluted pumpkin). Oxalate content (10.0 mg 100^{-1} g DM) and phytate content (48.8 mg 100^{-1} g DM) are higher in the older leaves than in the younger ones. However, the amount of phytic acid and oxalate are within the normal range in human nutrition (Ladeji *et al*., 1995). Amongst others, it contains diethylamine, dimethylamine, morpholine and ethylaniline with its secondary amine content of between 0.80-0.91 μg N kg^{-1} (Uhegbu, 1997). While some of the anti-nutrients in the leaves are above safety limits in human consumption, most are not harmful but rather have some health benefits to its consumers (Ladeji *et al*., 1995; Ajibade *et al*., 2006). However, the young leaves should be properly cooked in order to remove any inherent anti-nutrient effects before consumption.

Bitter leaf (*Vernonia amygdalina*): Bitter leaf (*Vernonia amygdalina*) is a green shrub with petiole leaf of about 6 mm diameter. The leaf has a characteristic odour and bitter taste. *Vernonia amygdalina* grows under a range of ecological zones in Africa being drought tolerant and produces large fodder biomass for both human and animal nutrition (Bonsi *et al*., 1995; Aregheore, 1998; Daodu and Babayemi, 2009). *Vernonia amygdalina* plant commonly found around homes in Southern Nigeria as a green vegetable or spice especially in the popular “bitter-leaf soup” (Igile *et al*., 1995) also widely used for both therapeutic and nutritional purposes.

Vernonia amygdalina used as a fence post and pot-herb in the home and villages is one of the most widely consumed leafy vegetables in most countries in West and Central African being an excellent source of vitamin C and total carotenoid (Ejoh *et al.*, 2005). Ejoh *et al.* (2005) reported a vitamin C value and total carotenoid level of 197.5 and 30.0 mg 100^{-1} g, respectively for bitter leaf. Besides it use as an indigenous vegetable in human nutrition, the plant has also acquired significant relevance in human medicine having been proven to possess potent antimalarial and anti-helmintic properties as well as anti-tumorigenic properties (Izevbigie, 2003) laxative and fertility inducers in infertile women (Igile *et al.*, 1995). Its therapeutic constituent (quinine) cures malaria cleans the liver and lymphatic system and lungs for smokers. It could also be given to patients suffering from hyperglycemia (excessive sugar) as in diabetes mellitus and diabetes insipidus (Akah and Okafor, 1992; Nwachukwu *et al.*, 2010). Furthermore, the leaves used as local medicine against leech that transmits bilharziose. The leaves used as vegetable stimulate the digestive system, as well as reduce fever. The tops of the shrub have some trado-medicinal value, also used instead of hops to make beer in Nigeria.

The broad macerated green leaves used as vegetables and condiments especially in cooking soup. Arhoghro *et al.* (2009) posit that the water extract serves as tonic for the prevention of certain illnesses. In addition, the aqueous leaf extract exhibited hepatoprotective activity due to its antioxidant property attributable to its flavonoid content, as a result of the sesquiterpene lactone present in the leaves (Babalola *et al.*, 2001; Arhoghro *et al.*, 2009). The broad greenish leaves contain natural quinine with a bitter taste due to anti-nutritional factors such as alkaloids, saponins, tannin and glycoside also sesquiterpene lactone and flavonoids (Akah and Okafor, 1992). Ohigashi *et al.* (1991) and Jisaka *et al.* (1992) reported the isolation of extremely bitter steroid glycoside and Vernonioside A from the leaves of *V. amygdalina*. Washing of the young leaves often preferred for human consumption get rid of the bitter taste.

Inherent anti-nutritional factors and detoxification: The young leaves have higher cyanide (60.1 mg 100^{-1} g DM) and tannin content (40.6 mg 100^{-1} g DM) than older ones. Hill (1987) reported a cyanide content of 95.50 mg 100^{-1} g for *Vernonia amygdalina* (bitter leaf), Oxalate content (10.0 mg 100^{-1} g DM) and phytate content (48.8 mg 100^{-1} g DM) were higher in the older leaves than the younger ones. Okoli *et al.* (2003) reported 0.38% tannin; 21.10 mg g^{-1} Phytin and HCN content of 6.40 mg g^{-1} for bitter leaf. *Vernonia amygdalina* amongst other foodstuffs contains diethylamine, dimethylamine, morpholine and ethylaniline and its secondary amine content ranged between 0.80-0.91 μg N kg^{-1} (Uhegbu, 1997). Bitter leaf also contains saponins, sesquiterpene lactone, steroid glycosides, alkaloids, tannins and flavonoids (Akah and Okafor, 1992). Some of the anti-nutrients in the leaves are above safety limits for human consumption; therefore, young leaves should be properly cooked in order to remove anti-nutrient effects before consumption. The local processing method of squeeze-washing raw or boiling helps to remove the bitter taste and foam. Washed bitter leaf can be preserved by freezing or drying, however, processing results in loss of some nutrients and anti nutritional factors (Ejoh *et al.*, 2003; Bender, 1966).

Sweet potato (*Ipomea batatas*): The leaves have a CP content of 25.6 to 32.4% DM (Woolfe, 1992; Ishida *et al.*, 2000; Oduro *et al.*, 2008). The leaves in particular contain a large amount of protein with a high amino acid score. The leaves of the sweet potato are highly digestible, fairly rich in protein, a dietary source of vitamins, minerals, antioxidants, dietary fiber and essential fatty acids and free from toxins. In comparison with other vegetables, minerals and vitamins such as A, B2, C and E are high in sweet potato leaves (An, 2004). The leaves also an excellent source of beta-carotene, thiamine (vitamin B1), folic acid and ascorbic acid (Villareal *et al.*, 1985; Woolfe, 1992, CIP, 2004). The young leaves serve as a nutritious vegetable source for man, contain several nutrients such as appreciable amounts of zinc, potassium, sodium, manganese, calcium, magnesium, iron, vitamin C and fiber (Antia *et al.*, 2006). However, as vegetable it is considered a poor man's vegetable being traditionally, used as feeds for domestic animals (Oyenuga, 1968). Antia *et al.* (2006) posited that sweet potato leaves contain high concentrations of magnesium (340 mg 100^{-1} g) and phosphorus (37.28 mg 100^{-1} g), with levels for calcium, iron, sodium, potassium and manganese at 28.44, 16.00, 4.23, 4.05 and 4.65 mg 100^{-1} g, respectively. However, the leaves contain remarkably little of zinc (0 .08 mg 100^{-1} g) while copper is totally absent (0.00 mg 100^{-1} g). The Efik-Ibibio people of South-Eastern Nigeria use sweet potato leaves as vegetable in cocoyam porridges (Eka and Edijala, 1972).

The high concentration of anthocyanin and beta-carotene combined with the high stability of color extract make sweet potato leaves healthier alternative to synthetic coloring agents in the food chain systems (Bovell-Benjamin, 2007). *Ipomoea batatas* leaves are excellent source of anti-oxidative polyphenolics compared to other commercial vegetables (Islam *et al.*, 2002). Polyphenols have many physiological functions such as cancer-fighting properties (Ishiguro *et al.*, 2004). Since the leaves contain a significant amount of nutrients; they contribute to health requirements (Antia *et al.*, 2006). The low levels of anti-nutrients except for oxalate can be reduced by cooking the leaves.

Bioactive compounds contained in sweet potato leaves contribute to health promotion and chronic disease prevention. Increased consumption of this vegetable is advocated because it reduces the prevalence of chronic diseases of public health concern. The consumption of sweet potato leaves warrants further and more extensive research study (Johnson and Pace, 2010).

Inherent anti-nutritional factors and detoxification: Tannins inhibit the bioavailability of protein and minerals however, sweet potato leaves have little tannins (0.21 mg 100^{-1} g), cyanide (30.24 mg 100^{-1} g) and phytic acid (1.44 mg 100^{-1} g) (Antia *et al.*, 2006). The leaves have unusually high value of oxalate (308 mg 100^{-1} g) that may constitute potent human poisons (Akwaowo *et al.*, 2000). Proper cooking before consumption significantly reduces the total oxalate content of the leaves (Akwaowo *et al.*, 2000). Besides the high level of oxalate, the leaves contain a sufficient amount of nutrients, vitamins and mineral elements. The leaves in the human diet increase the daily allowance of the aforementioned nutrients needed by the body.

Cassava (*Manihot esculenta* Crantz): Leaves of cassava are a significant source of potential alternative protein resource for both humans and animals (Fasuyi, 2005). Cassava leaves, depending on the varieties are rich in protein (14-40 or 20-35% DM), minerals, Vitamin B1, B2, C and carotenes (Eggum, 1970; Adewusi and Bradbury, 1993). The high-protein content and nutritive value of cassava leaves alleviate nutritional deficiency in poor countries (Brown and Kane, 1994; Aletor and Adeogun, 1995). Apart from lower methionine, lysine and perhaps isoleucine content, the amino acid profile of cassava leaf protein compares favourably with those of milk, cheese, soyabean, fish and egg. The leaves contained a high level of crude protein (29.3-32.4% dry weight) compared to a conventional vegetable (Awoyinka *et al.*, 1995). The leaves have ash content of 4.6% and remarkably high dietary fibre that ranges between 26.9-39% dry weights. However, young leaves are low in crude fibre and relatively high in calcium and phosphorus (FAO, 1990). Pregnant women in some African countries such as Sierra Leone and Liberia consume cassava leaves to increase breast milk production and control of stomach worms. Cassava leaves contain high profile of most mineral particularly calcium and trace minerals. The leaves are high in phosphorus, magnesium, manganese and adequate source of calcium; however, potassium and sodium are low. With leaf maturity the value for Potassium (P), Magnesium (Mg), Phosphorus (P), Zinc (Zn) and Manganese (Mn) decreases while Ca, Na and Fe increases (Ravindran and Ravindran, 1988).

Cassava leaves are accepted as vegetable in Nigeria, Sierra Leone and Zaire where its use in combination with nontoxic indigenous vegetables in yam porridge still remain dominant (UNV, 1980). In the cassava region of Africa that ranges from Senegal to Mozambique, humans use cassava leaves as vegetable in nutrition. Bokanga (1994) reported that, in much of East Africa, Central Africa and some countries in West Africa such as Sierra Leone and Liberia, cassava leaves constitute a significant component of the diet as a source of dietary protein, minerals and vitamins. In Indonesia, for example, young cassava leaves compared to other vegetables, are a popular vegetable due to their high content of protein, minerals and vitamins (Wargiono *et al.*, 2002). Malnutrition, such as anaemia, vitamin A and protein deficiencies in millions of people in tropics and sub-tropics can be reduced by introducing young cassava leaves as a vegetable in human diets (Hidajat and Wargiono, 2002). The use of cassava leaves as a human-food stand on value as a source of protein and vitamins for supplementing mostly starchy diets. The high-protein content and nutritive value cassava leaves (Aletor and Adeogun, 1995) may contribute to alleviate nutritional deficiency in poor countries (Brown and Kane, 1994; Hidajat and Wargiono, 2002) also fight against micronutrients undernourishment due to the high vitamins and minerals in the leaves. The major drawback to the widespread use of cassava leaves as food is cyanogenic glucosides scare that may be 6 times higher than the root (Yeoh and Chaw, 1976). This may limit the nutritional value of cassava leaves but if sweet cassava cultivars with low HCN content and high protein in leaves are consumed it could offer a valuable protein and other nutrients (Nassar and Marques, 2006) in the nutrition of humans in Nigeria other poor countries.

Inherent anti-nutritional factors and detoxification: Variation in the chemical composition and inherent anti-nutritional substances, in different cultivars, may restrict usage. Principal problems that could undermine its potential include high fibre content and anti-nutrients typified by cyanide, tannin and phytin. Cassava leaves have cyanide content of 52.9 mg HCN 100 g^{-1}, high tannin and phytin levels of 9.7 g 100^{-1} DM and 192.0 mg 100^{-1} gm, respectively (Fasuyi, 2005). Independent of cultivar and age of the plant, saponin levels ranged from 1.74 to 4.73 g 100 g^{-1} DM. The level of tannin and phytin retention remained high (>41%) demonstrating that residual tannin and perhaps, to a lesser extent, phytin could pose greater problem in processed cassava leaves based diets (Mkpong *et al.*, 1990). Phytin chelate with certain mineral elements, such as Ca, Mg, Fe and Zn which render them metabolically unavailable (Fasuyi, 2005). Tannins' binds with dietary proteins and digestive enzymes to form complexes (Makkar, 1991, 1993) not easily digestible by humans.

Toxicity problems that affect nutritive value of cassava leaves can be reduced by traditional preparation methods such as drying, pounding and long periods of boiling (Lancaster and Brooks, 1983; Lewis and Fenwick, 1987; Aletor and Adeogun, 1995; Fasuyi, 2005; Ajibade *et al.*, 2006). Sun-drying is an inexpensive effective method of preserving surplus micronutrient-rich foods (Tontisirin *et al*., 2002). However, loss of nutrients particularly vitamins, occurs during processing but remaining levels still contribute to the diet. Cassava leaves are highly nutritious but have anti-nutrients that cause toxicity (Achidi *et al*., 2008). The presence of the two cyanogenic glycosides, linamarin and lotaustralin, limits the leaves as food (Padmaja, 1995). Bokanga (1994) reported the cyanogenic potential of cassava leaves being 5 to 20 times greater than that of roots. Therefore, for a 70 kg weighed individual, the maximum reliable consumption of cassava leaf powder is about 110 g which is bulky because the powder presents low density (Wobeto *et al*., 2007). Osuntokun (1981) however, indicated that chronic toxicity may also occur due to the consumption of lower cyanide doses at longer timer intervals. The risk of intoxication from consuming cassava leaves reduces because during processing leaves quickly loose cyanogens (reduces HCN levels) (Lancaster and Brooks, 1983). Linamarase activity in the leaves is over 200 times greater than in the roots. The high concentration of the enzyme linamarase present in cassava leaves detoxifies the cyanogens. Although, cyanide content in pounded cassava leaves ("pondu" or "sakasaka") remains high at 8.6 mg 100^{-1} g, about 95.8% of total cyanide in leaves can be removed through further processing into soup (Mahungu *et al*., 1987). The African traditional processing techniques of pounding, crushing and cooking reduce cyanogenic and tannin levels to >99 and 55.2%, respectively (Padmaja, 1995). The different processing methods have no effect on ash, lipids, protein, fiber, total carbohydrate, carotene, calcium, magnesium, potassium, sodium, phosphorus, copper, zinc and manganese contents (Mahungu *et al*., 1987). Processing does offer a reduction in free sugars (23.2% reduction), ascorbic acid (77.7% reduction) and thiamine (37.1% reduction) levels, respectively. Grinding increases iron level three to five fold but not with pounding process.

The different processing methods tremendously reduced ant-nutrients with minimal loss in the nutrients. Adequate processing detoxifies cassava leaves for human consumption with considerable nutrient retention (Mahungu *et al*., 1987; Bokanga, 1994; Achidi *et al*., 2008). Processing methods reduces available cyanide to harmless levels but less effective with tannin and phytin. Dietary phytin is of importance in humans' nutrition. However, human lacks the enzyme phytase to break down phytin to release phosphorus for metabolism (Fasuyi, 2005). However, there should be no danger in direct use of cassava leaves as a good source of leafy vegetable. The nutrient value of processed cassava leaves makes it a potential source of raw material for formulating weaning foods especially for the underdeveloped world (Mahungu *et al*., 1987; Bokanga, 1994; Achidi *et al*., 2008). Drying is most prevalent processing method used in many tropical countries as it eliminates more cyanide than oven drying. Also, sun drying prolongs exposure time between linamarase and glucosides in detoxifying the leaves (Padmaja, 1995).

Moringa oleifera: *Moringa oleifera* tree is the most underutilized tropical shrubs. Traditional dishes around the world include green leafy vegetable sources substituted or augmented with *M. oleifera* leaves (Lockett and Grivetti, 2000). *M. oleifera* is a nonconventional plant with substantial nutritional value (Sanchez-Machado *et al*., 2010). Barminas *et al*. (1998) compared other nutrient-dense leafy vegetables in Nigeria and posited that no other plant, compares favorably with that of *M. oleifera*, nutritional profile or match its combination of overall utility, micro and macronutrient composition, rapid growth habit, high yield leaf production and survival in harsh climates which suggest that *M. oleifera* is a unique pan-tropical dietary plant.

Among leafy vegetables, the cost of nutrients is the lowest in *Moringa* (Babu, 2000) and for all age groups, leaves of *M. oleifera* serve as a valuable source of nutrient (Oduro *et al*., 2008). The young leaves are edible and can be consumed fresh, cooked and eaten like spinach or used for soups and salads. The powder has the highest protein content than any other vegetable. Fresh leaves of *Moringa oleifera* contain at least twice more proteins than milk and half the proteins of eggs (D'Souza and Kulkarni, 1993; Broin, 2006).

Moringa oleifera leaves have nine essential amino acids that comprise the sulphur-containing amino acids methionine and cystine (Makkar and Becker, 1997; Sena *et al*., 1998) higher than levels recommended by the Food and Agriculture Organization (Ferreira *et al*., 2008; WHO, 1985) with patterns similar to those of soybean seeds. Its beta-carotene content is 3 to 5 times more than in carrots. Beta carotene is extremely beneficial in healing and bone development, control of cholesterol and anti-cancer protection. The leaves are exceptionally reliable source of minerals. Its iron content is richer than lentils and beef meat. The iron is three times higher than the level found in spinach. The potassium content is also three times more than in bananas; also richer in calcium than milk. Lockett *et al*. (2000) reported that in North Eastern Nigeria; zogale (*Moringa oleifera*) serves as a good source of protein, fat and an excellent source of calcium and iron or copper and zinc. In addition, it has a high level of pro-vitamin A and C; at least as rich as carrots in vitamin A. Vitamin A is the most prominent vitamin essential for immune protection against all infections. The vitamin C in the leaves is 6 to 7 times more than the amount of vitamin C in orange juice. The vitamin E is 10 times more than the daily recommendation of vitamin E. It also has high levels of vitamins B (Vitamin B1, B2 and B3) among many other medicinal benefits. The most notable feature is the sustainability of the vitamins with cooked leaves (Ferreira *et al*., 2008; De Silva, 2010).

Moringa oleifera has exceptionally high nutritional value and this position it high in the table of "Healthy Edible Plants and Vegetables" (http://www.themoringa.com/nutritional-value). In populations that practice traditional medicine they preferred, *M. oleifera* as a way of treating under-nutrition. The leaves nutritionally prevent malnourishment in children and have the capacity to boost the immune system.

Moringa oleifera leaf powder prevents malnutrition in developing countries that usually appear in children during the weaning period, between 1 and 3 years old. Broin (2006) reported that 30 g of leaf powder can cover one third of the daily allowance for proteins, 75% of the calcium needs and more than half of iron necessary for children under than three years in age. In addition, it provides the totality of the recommended dietary allowance for vitamin A and nearly one third of the needs in vitamin C. The leaf powder also is a fascinating dietary supplement for pregnant and lactating women to increase milk production and expel intestinal worms. Mosquin (2008) reported that the leaves can be used to complement modern medicines in chronically ill people including those suffering from AIDS and HIV related illnesses (http://www.draqasikesat.com/MORINGA.html). Research has proved the leaves as a bio-enhancer of drugs and nutrients due to its antibiotic activity.

For centuries, people in many countries have used *Moringa* leaves in traditional treatment for various common ailments. Traditionally, fresh or dried *Moringa oleifera* leaves treat different ailments such as anaemia, abnormal blood pressure, blood impurities, headaches, hysteria, anxiety, cholera and diarrhoea, eye and ear infections, fever, respiratory disorders and asthma, bronchitis, catarrh, chest congestion, cough, tuberculosis and inflammation of mucous membranes. The leaves are also used to treat hepatitis, impotency, infertility and low sperm count, in addition to treating glandular swelling, sprain, joints pain, pimples and psoriasis. The plant is rich in compounds containing the sugar, rhamnose, also rich in a unique group of compounds called glucosinolates and isothiocyanates (Fahey, 2005).

Inherent anti-nutritional factors: In relation to antinutritional factors, the leaves have a small proportion of tannins (12 g kg^{-1} dry matter); saponin content (5.0% as diosgenin equivalent), phytate (21 g kg^{-1}) and lack of trypsin and amylase inhibitors, lectins, cyanogenic glucosides and glucosinolates (Makkar and Becker, 1997). In addition, the low anti-quality factors contribute to the wide acceptance of *Moringa oleifera* as a leaf vegetable.

CONCLUSION

Wild and cultivated indigenous vegetables contribute to food security in times of hunger (Humphry *et al.*, 1993; Zinyama *et al.*, 1990; Grivetti and Ogle, 2000; Ogle *et al.*, 2001; Keding *et al.*, 2007; Lockett and Grivetti, 2000). Based on available literature, traditional vegetables contain much more vitamin A and other micronutrients than introduced exotic vegetables. Also, have medicinal values, not restrict to treat disease but also improve overall health due to their vitamin and other nutrient contents. However, some contain anti-nutrients typified by cyanide, tannin and phytin, lectins, saponins. Several traditional methods that include drying are used to detoxify those with anti-nutrients to make them safe in human nutrition. However, Aletor and Adeogun (1995) posited that dry vegetables generally had higher phytate and oxalate values than the fresh ones.

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