REVIEW
OF
LITERATURE

Vegetables are important sources of protective foods, which are highly beneficial for the maintenance of good health and prevention of diseases (Sheele *et al.,* 2004; Nnamani *et al.,* 2007). They account for about 10% of the world higher plants often regarded as weeds (Raghuvanshi *et al.,* 2001). Although they can be raised comparatively at lower management cost and on poor marginal soil, they have remained underutilized, due to lack of awareness of their nutritional values in favour of the exotic ones (Chweya and Eyzaguirre, 1999; Odhav *et al.,*2007). Campaigns promoting these vegetables should focus on the younger generation, as they have less knowledge regarding wild green leafy vegetables (Modi *et al.,* 2006). Diet surveys tend to ignore wild plants in comparison to cultivated ones (Etkin and Rose, 1994), and this is a methodological deficiency (Bonet and Valles, 2002). There are still a large number of wild edible species which are inexpensive and commonly used by locals and whose nutritional potential have not yet been adequately studied (Sundriyal and Sundriyal, 2001).

An extensive and updated review on some common and less familiar wild leafy vegetables of the world was prepared in this chapter referring journals, reprints, books, monographs, reports, dissertation, etc. Table A, shows a compilation of some wild leafy vegetables of the world.

Table A: Wild leafy vegetables of the world

Plants	Family	Country	Recipe	Reference
Adansonia digi tata Linn.	Malvaceae	Sahalian Region of Africa	Cooked	Ezeagu *et al.* (2005).
Alternanthera sessilis (L.)R. Br	Amaranthaceae	South East Asia, India	Cooked	Anitha *et al.* (2012), Borah *et al.* (2011)
Amaranthus viridis Linn.	Amaranthaceae	Nigeria, India, South Africa	Cooked	Mnkeni *et al.* (2007), Olaiya *et al.* (2010)
Bidens pilosa Linn.	Asteraceae	South Africa, West Africa, India, North America	Cooked	Bala (2006), Ballard *et al.* (1986)
Bryonia dioica Jacq.	Cucurbitaceae	Spain, Portugal	Cooked / Raw	Tardío (2010).
Cleome gynandra Linn.	Capperaceae	East Africa, India	Cooked	Muchuweti *et al.* (2007), Narendhirakannan, *et al.* (2007)
Enhydra fluctuans Lour.	Asteraceae	India	Cooked	Sannigrahi, *et al.* (2011)
Houttuynia cordata Thunb.	Sauraceae	China, Japan, India	Cooked / Raw	Meng *et al.* (2005 a), Tapan (2011)
Leptadenia hastate (Pers.) Decne.	Asclepiadaceae	Ethiopia	Cooked	Thomas (2012)
Limnocharis flava(L). Buchenau.	Limnocharitaceae	South East Asia, Malaysia	Cooked	Saupi *et al.* (2009)
Moringa oleifera Lam.	Moringaceae	Nigeria, Ghana	Cooked	Ferreira *et al.* (2008), De Silva (2010)
Moringa stenopetala (Bak. F)	Moringaceae	Kenya, Ethiopia	Cooked	Demeulenaere (2001)
Paederia foetida Linn.	Rubiaceae	Indonesia, Malaysia	Cooked	Srianta *et al.* (2012), Khare *et al.* (2007)
Plantago major Linn.	Plantaginaceae	Europe	Cooked	Zubair *et al.* (2010)

Continued (Table A)

Portulaca oleracea Linn.	Portulacaceae	Egypt, Italy, India	Cooked	Simopoulos (2004), Sudhakar *el al.* (2010), Mohammed *e t al.* (2011)
Rumex vesicarius Linn.	Polygonaceae	Egypt, Turkey, Saudi Arabia, India	Cooked	Mohammed *et al.* (2006), Rao *et al.* (2011)
Silybum marianum (L.) Gaertn.)	Asteraceae	Europe, Egypt	Cooked	Murphy, *et al.* (2000), Gazak *et al.* (2004)
Solanum nigrum Linn.	Solanaceae	Nigeria, Kenya, India	Cooked	Fallah *et al.* (2005), Akubugwo *et al.* (2008), Jainu *et al.* (2006)
Sonchus asper (L.) Hill.	Asteraceae	Mediterranean, Europe	Cooked	Leonti *et al.* (2006), Guil-Guerrero *et al.* (1998)
Talinum triangulare (Jacq.) Willd.	Portulacaceae	Nigeria	Cooked	Akachuku *et al.* (1995), Nya *et al.* (2010)
Vernonia amygdalina Del.	Asteraceae	Sub Saharan, Region, Nigeria	Cooked	Owoeye *et al.* (2010), Yedjou *et al.* (2008), Ijeh *et al.* (1996)

***Adansonia digitata* L.**

Family: Malvaceae

Adansonia digitata L. called the baobab tree in both English and French is very characteristic of the Sahelian region and belongs to the Malvaceae family. *Adsonia digitata* is well adopted deciduous tree native to the arid parts of central Africa and widely spread in savannah regions in Nigeria (Wickens, 1980; FAO,1988). Its leaves, bark and fruits are used as food and for medicinal purposes in many parts of Africa (Ezeagu, 2005). In Sahel, the leaf is a staple, the Hausas used to make *miyan kuka,* a soup prepared by boiling the leaf in salt water and reported to be rich source of Vitamin-C. During acute seasonal food supply fluctuations or famine period, the leaves and fruits of *Adansonia digitata* are of particular importance as supplementary and emergency food (Humphrey *et al.,* 1993).

It has multi-purpose uses and every part of the plant is reported to be useful (Igboeli *et al.,* 1997; Gebauer *et al.,* 2002). The leaves, for instance, are used in the preparation of soup. Seeds are used as a thickening agent in soups, but they can be fermented and used as a flavouring agent, or roasted and eaten as snacks (Addy and Eteshola, 1984). The pulp is either sucked or made into a drink while the bark is used in making ropes (Igboeli *et al.,* 1997). The different parts of the plant provide food, shelter, clothing and medicine as well as material for

hunting and fishing (Venter and Venter, 1996; Sidibe and Williams, 2002). Baobab tree provides income and employment to rural and urban households (Coulibaly *et al.*, 1993).

Previously published biochemical analyses revealed that the leaves, the seeds and the pulp from baobab are rich in nutrients (Becker, 1983; Glew *et al.*, 1997; Diop *et al.*, 2005; Nkafamiya *et al.*, 2007; Chadare *et al.*, 2009). Literature reviews on baobab provided information on the species taxonomy, distribution, utilization, agronomy, agro-ecology, phytochemistry and pharmacology (Sidibe and Williams, 2002; Diop *et al.*, 2005; De Caluwe *et al.*, 2010). Gebauer *et al.* (2002) brought out information on baobab botany, ecology, origin, propagation, main uses, genetic improvement and especially its importance for nutrition and poverty alleviation (De Caluwe *et al.*, 2010). It tolerates a wide range of vegetation types including scrub, wooded savannah hot, dry areas, and semiarid to sub-humid tropics south of the Sahara. It prefers arid areas and well-drained sandy sites between 450 and 600 m above sea level, with a rainfall of 300 to 500 mm per year (Palmer and Pitman, 1972). In the rainy season, wild gathered foods were used as much as fresh cultivated foods (Nordeide *et al.*, 1996). The wild food resources were more frequently used in rural than in urban areas, with *A. digitata* as the dominating green leaves. Green leaves were rich in energy, protein and minerals (calcium, iron) (Nordeide *et al.*, 1996).

Alternanthera sessilis (L.) R. Br

Family: Amarantheceae

Alternanthera sessilis is an aquatic plant known by several common names, including *sessile joy weed* and *dwarf copperleaf.* It is an annual or perennial prostrate herb with several spreading branches, bearing short petioled simple leaves and small white flowers found throughout the hotter part of India ascending to an altitude of 1200 m (Wealth of India, Raw materials, 1985). Young shoots and leaves are eaten as a vegetable in Southeast Asia. Occasionally it is cultivated for food or for use in herbal medicines (Arollado and Osi, 2010). This species is classified as a weed in parts of the southern States of the USA. It is usually (but not always especially in areas of high humidity where it can even be a garden weed) found in wet or damp spots. Although it is a weed and pest, in Srilanka, this is eaten as vegetable to increase the flow of milk (Arollado and Osi, 2010). In India, *Alternanthera sessilis* is commonly known as *Gudari saag,* Matsyaakshi, and is distributed in warmer parts of India. It is used as lactogogue, galactogogue, abortifacient and febrifuge. (Kritikar and Basu, 2001). In Senegal and India, the leafy twigs are ground to a powder and applied on snakebites. The people of Nepal use its roots for the treatment of stomachache (Sreedevi and Chaturvedi, 1993). The plant consists of alpha and beta spinasterol (Rastogi, 1993), Lupeal, isolated from the roots (Gupta *et al.,* 2004). The plant also contains Beta-sitosterol, stigmasterol

etc. (Sinha *et al.,* 1984). In the indigenous system of medicine the herb has been reported to be used as galactogogue, cholagogue, and febrifuge and in indigestion problem (Anandkumar and Sachidanand, 2001). The leaves are used in eye diseases, cuts, wounds and antidote to snake bite; skin diseases (Gupta *et al.,* 2004). Petroleum ether extract of plant was reported to yield nonacosane, 16-hentriacontane, ß-sitosterol, stigmasterol and handianol (Reviews on Indian Medicinal Plants, 2004). β-sitosterol and its glycoside in *Alternanthera sessilis* possess potent anti-inflammatoray and antipyretic activity (Nayak *et al.,* 2010). Also *A. sessilis* is a potential source of natural antioxidant (Borah *et al.,* 2011*). Alternanthera sessilis* possess potent anti-inflammatory and antipyretic activity (Nayak *et al.,* 2010). Also *A. sessilis* is a potential source of natural antioxidant. Antioxidant carotene is found in large amounts in *Alternanthera sessilis,* useful in night blindness (Borah *et al.,* 2011). Antioxidant carotene is found in large amounts in *Alternanthera sessilis,* useful in night blindness. The antidiabetic activity of *A. sessilis* can be attributed to the presence triterpenoids, phytosterols and glycosides. (Rao *et al.,* 2011). Ethanolic extract of *Alternanthera sessilis* produces significant memory enhancing activity when evaluated by elevated plus maze model. (Shreya *et al.,* 2011). Both aqueous and ethanolic extracts of aerial parts of *Alternanthera sessilis* Linn. possess significant nootropic potential in the view of its facilitatory effect on the retention of acquired learning and retention

(Surendra *et al.,* 2011). The phytochemical studies on aqueous extracts of leaf showed positive result for phenols, flavonoids, tannins and saponins (Anitha and Kanimozhi , 2012). The petroleum benzene and ether extracts inhibit the growth of some human and plant pathogenic bacteria (Ragasa *et al.,* 2002). Previous studies on this plant showed that it has hepatoprotective activity (Song-Chow *et al.,* 2006). *A. sessilis* is also known to alleviate dementia (Bala and Manyam *et al.,* 1999). The ethanol extract of *A. sessilis* showed 70% free radical scavenging activity (Acharya and Pokhrel, 2006). *A. sessilis* contains β-carotene (Chandrika, *et al.,* 2006), α-spirasterol, uronic acid and β-sitosterol (Acharya and Pokhrel, 2006).

***Amaranthus virids* Linn.**

Family: Amarantheceae

Amaranthus virids commonly called *Choulai* in Hindi, has been used in Indian and Nepalese traditional system to reduce labor pain and act an antipyretic (Kirtikar and Basu, 1987). *A. viridis* considered as one of the fast growing annuals of weed is widespread throughout different habitat types in Egypt (Kosinova, 1975). It grows mainly on waste lands, along water coarses and as a weed in cultivated crops. It is known to flower all through the year and produce enormous amounts of pollen in the airspora. *A. viridis* as one of the major components of outdoor airspora (Syed *et al.,* 2007). The plant possesses antiproliferative and antifungal

properties as well as ribosome inactivating protein, β-carotene (Kaur *et al.*, 2006). The sheets and the young plant of *Amarantus viridis* are also used as fodder for cattle and like green manure (Ouedraogo *et al.*, 2011). Other traditional uses range from an anti-inflammatory agent of the urinary tract, in venereal diseases, vermifuge, diuretic, antirheumatic, antidiabetic, antiulcer, analgesic, antiemetic, treatment of respiratory and eye problems and treatment of asthma (Agra *et al.*, 2007, The Wealth of India, 1988) *A. viridis* is a common plant in certain parts of Asia especially Pakistan, where it is consumed as a leafy vegetable (Khan *et al.*, 2011). A decoction of the entire plant is used to stop dysentery and inflammation (Duke and Ayensu, 1985). The plant is antidiabetic, antihyperlipidemic and antioxidant (Ashok *et al.*, 2010). The plant is emollient and vermifuge (Chopra *et al.*, 1986). The root juice is used to treat inflammation during urination and constipation (Manandhar, 2002). The Negritos of the Philippines apply the bruised leaves directly to eczema, psoriasis and rashes et. cetera (Quisumbing,1951). *Amaranthus viridis* has inhibitory or allelopathy activities. The phenomenon of allelopathy in *Amaranthus viridis* is reflected more in dry extracts compared to fresh plant extracts (Sultana *et al.*, 2012).

Bidens pilosa **Linn.**

Family: Asteraceae

Bidens pilosa Linn. var. radiate Family, Asteraceae, known from java before 1835 but apparently not present in Kalimantan (Soerjani *et al.*, 1987). It is considered as a weed in some tropical habitats. However, in some parts of the world it is a source of food (Grubben and Denton, 2004) . The plant is an annual erect, branching herb, growing up to 1.5 m tall with quadrangular, minutely hairy stem. The leaves are opposite, toothed; simple and ovate or compound with three to five or even seven lanceolate leaflets (Morton, 1962). It is widely distributed in the sub tropical and tropical regions of the world (Deba *et al.*, 2008). As a leafy vegetable the species is an excellent source of fiber and certain mineral elements (Odhav *et al.*, 2007). The whole plant or its aerial parts is used in various folk medicines and as a popular ingredient in herbal tea for its anti-inflammatory, antiseptic, liver-protective, blood-pressure lowering, and hypoglycemic effects (Chih *et al.*, 1996; Dimo *et al.*, 2002; Ubillas *et al.*,2000; Suzigan *et al.*, 2009). Although diverse bioactivities have been identified in *B. pilosa*, its antiviral activity has not attracted attention so far. *B. pilosa* has anti-HSV activity and is thus a potentially useful medical plant for treatment of HSV infection (Nakama *et al.*, 2012). Phytochemically, the plant is rich in flavonoids, terpenes, phenylpropanoids, lipids, and benzenoids (Gupta, 1996; Abajo *et al.*, 2004;

Sundararajan *et al.*, 2006). The leaves of *B. pilosa* have been reported to contain appreciable amount of proteins, fat, fiber, carbohydrate and calorific value, mineral elements, polyphenols, and generally low level of toxicants (Odhav *et al.*, 2007). Their antioxidant and antibacterial activities further lend credence to the biological value of this plant. Thus, it can be concluded that *B. pilosa* leaves can contribute significantly to the nutrient requirements of man and should be used as a source of nutrients to supplement other major sources. (Adedapo *et al.*, 2011).

Extensive research in the last few decades have shown that B. pilosa possessed anti-hyperglycemic (Ubillas *et al.*, 2000; Hsu *et al.*, 2009; anti-ulcerogenic (Tan *et al.*, 2000), anti-inflammatory (Geissberger and Sequin 1991; Jager *et al.*, 1996), Vaso-dilative, hypertensive (Dimo *et al.*, 1998, 2001), anti-malarial (Andrade-Neto *et al.*,2004), anti-pyretic (Sunderarajan *et al.*,2006), anti-cancer and anti-tumour (Steenkamp and Gouws, 2006; Kviencinski *et al.*, 2008), anti-oxidant (Abajo *et al.*, 2004; Chiang *et al.*, 2004; Yang *et al.*, 2006) and anti-bacterial activities (Khan *et al.*, 2001; Rojas *et al.*, 2006)

***Bryonia dioica* Jacq.**

Family: Cucurbitaceae

Bryonia dioica Jacq. belongs to the family Cucurbitaceae. Young shoots of *Bryonia dioica* are richer sources of carotenoids than many of the

commercially available leafy vegetables (Garcia-Herrera et al., 2012). As in other parts of the world, wild vegetables have played an important nutritional role in the Iberian Peninsula (Tardio *et al.*, 2005). The consumption of vegetables often include various wild greens traditionally collected throughout the countries (Spain and Portugal) and consumed in different ways as a part of the Mediterranean gastronomy (Tardio *et al.*, 2005). Young shoots *Bryonia dioica* have been known to have diuretic properties since ancient times, having been reported by Dioscorides in the first century (Font Quer, 1990).

Medicinal uses of *Bryonia* have been recorded for over two millennia. Probably the earliest references are in texts attributed to Hippocrates, who lived around 460–380 BC. Other early mentions of *Bryonie* are in Dioscorides's *De Materia Medica*, written in about 65 BC, and Pliny's *Historia Naturalis*, complete in 77 BC (Beck, 2005). The reason *Bryonia* is mentioned in these and other Egyptian, Greek, Roman, Medieval, and Renaissance sources is that bryony extracts contain numerous cucurbitacins that are biologically active (Krauze-Baranowska and Ciskowski, 1995; Isaev, 2000; Sturm and Stuppner, 2000; Chen *et al.*, 2005). Young shoots, however, are eaten as an asparagus substitute (Pieroni, 2000). Today, there is a considerable market for *Bryonia* preparations, mostly for homeopathic medicine, although effectiveness remains contested (Paris *et al.*, 2008).

Cleome gynandra **Linn.**

Family: Capperaceae

Cleome gynandra L. belongs to the family Capperaceae. It is an erect annual herb. Depending on the environment conditions it can grow up 1.5 m tall. The edible leaves are gathered for use and some ethnic groups in Africa do cultivate the crop as vegetable in home gardens, or near homesteads. (Chewya and Mnzava, 1997). The species is thought to have originated in Tropical Africa and Southeast Asia, and to have spread to other tropical and sub-tropical countries in the Northern and Southern hemispheres (Kokwaro *et al.*, 1976). It is found in Asia, Africa and America where it is regarded as weed (Iltis *et al.*, 1960, 1967; Kuhn *et al.*, 1988). The plant's nutritional value may vary with soil fertility, environment, plant type, plant age and the production techniques used (Chweya, 1995). Investigations on the nutritional composition of Cleome *gynandra* L have been conducted by (Gomez, 1981; Chweya, 1985; Mwajumwa *et al.*, 1991; Mnzava, 1990; Opole *et al.*, 1995). Increased soil fertility has been reported to increase protein but decreases Beta-carotene, ascorbic acid and iron of the leaves. Increased soil fertility has no effect on the phenolic compounds, or on the calcium and sodium content of the leaves (Chweya, 1995).

Throughout Africa, the tender leaves and young shoots are and often the flowers as well, are eaten boiled as a pot herb, tasty relish,

stew or side dish. The leaves and shoots are gathered from wild or are cultivated (Chewya and Mnzava, 1997). In East Africa, fresh leaves are used as ingredients in other food mashed foods, and the dried leaves are ground and incorporated in weaning foods (Mathenge, 1995). The leaves are rather bitter, and for this reason are cooked with other leafy vegetables such as *Vigna, Amaranthus, Solanum nigrum* etc. The vegetables are rich sources of nutrients, especially vitamins A and C and minerals such as calcium and iron (Arnold *et al.,* 1985). Boiling of leaves may reduce up to 81% of vitamin C content while drying reduces the vitamin content by 95 % (Sreeramula *et al.,* 1983; Mathooko and Imungi, 1994). In India it is eaten as potherb and flavouring in sauces and in Thailand it is consumed fermented in a product called *Pak-sian-dong* (FAO 1990). The vegetable is important as leafy vegetable in several countries of Africa. The indigenous knowledge possessed by rural women in Kenya indicates that it has several nutritional uses (Opole *et al.,* 1995). The use of leaves in several indigenous medicine system in many countries have been reported by (Purseglove *et al.,* 1943; Kokwaro *et al.,* 1976; Baruah and Sharma 1984; Opole *et al.,* 1995). The plant has been observed to have insecticidal, antifeedant, and repellent characteristics (Singh, 1983a; Malonza *et al.,* 1992; Pipithsangchan, 1993). The presence of biologically active ingredients and vital trace elements in the leaves readily account for free radical scavenging property of *C. gynandra* (Narendhirakannan *et*

al., 2005). Leaf of *Cleome gynandra* consumed as leafy vegetable has anti-inflammatory and lysosomal stability actions (Narendhirakannan *et al.,* 2007), potent dose-dependent anticancer activity comparable to that of 5-fluorouracil (Bala *et al.,* 2010) and free radical scavenging activity (Muchuweti *et al.,* 2007). It is also believed to improve eyesight and provide energy (van den Heever and Venter, 2007).

***Enhydra fluctuans* Lour.**

Family: Compositae

Enhydra fluctuans family, Composite is an edible semi aquatic herbaceous vegetable plant with serrate leaves grows all over India and is widely used in traditional system of Indian medicine (Sannigrahi, *et al.,* 2011). Dewanji *et al.,* (1993) reported that the plants had high crude protein content throughout all harvesting seasons. *Enhydra fluctuans* had low ash content and was a good source of beta-carotene (Dewanji *et al.,* 1993). The leaves, which are slightly bitter, are used to treat inflammation, skin diseases, and small pox. The leaves are also antibilious and are used in nervous diseases (Rahman *et al.,* 2002), and in torpidity of liver (Chopra *et al.,* 2000). The plant possesses nutritional value and its methanol extract has been reported to have antidiarrheal activity (Uddin *et al.,* 2005).

Recently the free radical scavenging potential of crude extract and different fractions have been reported (Sannigrahi, *et al.,* 2010a). Ethyl

acetate fraction of the plant exhibits anticancer activity against EAC cell in mice (Sannigrahi, *et al.,* 2010b). The leaves of *E. fluctuans* have been reported to have hypotensive activity (Joshi and Kamat, 1972; Dewanji *et al.,* 1993). Sesquiterpene lactones (Ali *et al.,* 1972), gibberellins (Ganguly, *et al.,* 1972) and cholesterol derivatives, (Krishnaswamy and Prasanna, 1975) have been reported to be present in this plant. The aerial parts of the plant has been reported to possess significant anthelmintic activity and antimicrobial activity (Ghosh *et al.,* 2007) Chemical constituents like - carotene (Krishnaswamy *et al.,* 1968), sesquiterpene lactones (Ali *et al.,* 1972), terpenes (Krishnaswamy *et al.,* 1995) have been reported from this plant. Recently, the free radical scavenging potential of crude extract and different fractions have been reported (Sannigrahi *et al.,* 2010a). Ethyl acetate fraction of the plant exhibits anticancer activity against EAC cell in mice (Sannigrahi *et al.,* 2010b). *Enhydra fluctuans* aerial parts possess central nervous system depressant activity (Roy *et al.,* 2011).

***Houttuynia cordata* Thunb.**

Family: Sauraceae

Houttuynia cordata Thunb. belongs to the family. The leaves and rhizome of this plant is used as vegetable, condiments and spices either cooked or raw (Singh, 2011). The leaves of *Houttuynia cordata* have been traditionally used as medicinal foods in East Asia (Shizuo, 2005). Similar

reports have been made from regions of the Eastern-Asia viz. Chinese, Japan and Himalaya and Vietnam of using the tender young shoots and leaves of *H. cordata*, either raw or cooked, as vegetable and leaves for flavouring salads or as a salad crop (Haywood, *Flowering Plants of the World*). Although there are reports of selling *H. cordata* in the market of some Asian countries they are sold as a creeping ornamental plant (Phillips and Rix, 1991). Plants from Japan were reported to have an orange scent, whilst those from China have a smell resembling coriander leaves (Bown, 1995). *Houttuynia cordata is* known as a medicinal plant in Japan and China (Meng *et al.*, 2005a; 2005b). Its medicinal effects are antibacterial, (Jong and Jean, 1993), anti cancer (Kim *et al.*, 2001), anti-leukemic (Chang *et al.*, 2001), and antioxidant (Chen *et al.*, 2003). The leaves of *H. cordata* have antioxidative effects on biological damage such as protein fragmentation (Shizuo, 2005). *H. cordata* known as *Jamyr-doh* in Khasi. The whole plant eaten raw. Leaf juice is taken for cholera, dysentery, curing of blood deficiency and purification of blood (Hynniewta and Kumar, 2008). Tender young shoots and leaves are eaten raw or cooked as a pot-herb (Chopra *et al.*, 1986). A decoction of this plant is used internally in the treatment of many ailments including cancer, coughs, dysentery, enteritis and fever (Chopra *et al.*, 1986). Externally, it is used in the treatment of snake bites and skin disorders. The leaves and

stems are harvested during the growing season and used fresh in decoctions. The leaf juice is antidote and astringent (Chopra *et al.*, 1986).

***Leptadenia hastata* (Pers.) Decne.**

Family: Asclepiadaceae

Leptadenia hastate (Pers.) Decne. belonging to the family Asclepiadaceae is widely used as vegetable in tropical Africa (Burkil, 1985). The majority of wild edible plants are gathered and consumed from *Duka* (March) to *Halet* (May) and from *Meko* (August) to *Tejo* (November). The vegetables are chopped and boiled to make *Belesha* (sauce) or as a relish to *Adano* (porridge) (Tilahun and Mirutse, 2010). Although, *Leptadenia hastate* were reported to be available in the rural market of Ethiopia (Balemie and Kibebew, 2006; Addis, 2009), research on market chain analysis and economic value of this plant has not yet been addressed (Ermais *et al.*, 2011). *L. hastate* is traditionally used in the management of diabetes mellitus and in the treatment of wounds and stomach ache (Bello *et al.*, 2011). The plant is medicinally important in the treatment of many ailments (Kerharo and Adams, 1974; Burkil, 1985; Oliver, 1986; Aliero *et al.*, 2001). The antibacterial and anti microbial effects of *Leptadenia hastata* have been reported by Aliero and Wara, (2009) and result of its toxicity studies showed that the plant is safe to use (Tambuoro *et al.*, 2005).

Limnocharis flava **L . Buchenau**

Family: Limnocharitaceae

Limnocharis flava L. Buchenau. Family, Limnocharitaceae is considered as an aquatic weed in paddy fields and also blocking the water ways that fed waters for irrigation. Despite of being of undesirable value to the agriculture, the floral clusters and its young leaves are locally used as raw and cooked vegetables (Saupi *et al.*, 2009). About 100 species of the 225 vegetables in South East Asia are weeds or wild plants (Grubben *et al.*, 1994). People use available natural resources as sources of food to improve their socio economy (Tawan *et al.*, 2007). *Limnocharis flava* commonly known as yellow velvet leaf, is locally called *paku rawan* or *jinjir* in Malaysia (van den Bergh, 1994; Halimatul, 2003; Samy *et al.*, 2005; Muta *et al.*, 2005). It is an emergent plant in rice cultivated areas that may become noxious by overgrowing the areas (Mashoor, 1988; Karim *et al.*, 2004). In West Java and Thailand, it is cultivated in fertile soil and harvested after 2-3 months before being marketed (van den Bergh, 1994; Maisuthisakul *et al.*, 2008). Young shoot including leaves, petioles and flower clusters (un-opened inflorescence) are collected, consumed either raw or cooked (Edwards, 1980). The edible parts of *L. flava* provide good sources of minerals such as potassium, calcium, magnesium and copper (Saupi *et al.*, 2009).

Moringa oleifera Lam.

Family: Moringaceae

Moringa oleifera Lam. tree has probably been one of the most underutilized tropical crops. Leaves of *M. oleifera* could serve as a valuable source of nutrient for all age group (Oduro *et al.*, 2008). In Senegal and Haiti, health workers have been treating malnutrition in small children, pregnant and nursing women with *Moringa* leaf powder (Price, 1985). The leaves are known as great source of vitamins and minerals being served raw, cooked or dried (Oduro *et al.*, 2008). Fugile (2005), reported that 8 g serving of dried leaf powder will satisfy a child within age 1-3 with 14 % of protein, 40 % of calcium, 23 % of iron and nearly all the vitamin A that a child needs in a day. *Moringa* leaves have not received needed research-based attention in Ghana in the midst of its well known nutritional properties (Oduro *et al.*, 2008). A diet including *Moringa oleifera* should be more palatable than that with the sweet potato leaves because dietary fats function to increase food palatability by absorbing and retaining flavours (Lindsay, 1996). *Moringa oleifera* leaves are good source of protein when compared to other vegetables such as pumpkin leaves , okra leaves (FAO, 2006b). Crude fiber content of *Moringa oleifera* is quite high and this make it more favorable vegetable since high fiber content of foods help in digestion and prevention of colon cancer (Saldanha *et al.*,1995). *Moringa oleifera* has

exceptionally high nutritional value and this positions it high in the table of *Healthy Edible Plants and Vegetables*. The leaves nutritionally prevent malnourishment in children and have the capacity to boost the immune system (Oduro *et al.*, 2008). *Moringa oleifera* leaf powder prevents malnutrition in developing countries that usually appear in children during the weaning period, between 1 and 3 years old (Oduro *et al.*, 2008). 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. *Moringa oleifera* leaves treat different ailments such as anemia, abnormal blood pressure, blood impurities, headaches, hysteria, anxiety, cholera and diarrhea, eye and ear infections, fever, respiratory disorders and asthma, bronchitis, catarrh, chest congestion, cough, tuberculosis and inflammation of mucous membranes (Fahey, 2005). 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). In relation to antinutritional factors, the leaves have a small proportion of tannins (12 g/kg dry matter); saponin content (5.0% as diosgenin equivalent), phytate (21 g/kg) and lack of trypsin and amylase inhibitors, lectins, cyanogenic glucosides and glucosinolates (Makkar and Becker, 1997). *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 *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 *et al.*, 2010).

***Moringa stenopetala* (Bak. f.)**

Family: Moringaceae

Moringa stenopetala belonging to the family Moraginaceae is endemic to East Africa, reported in Uganda and Sudan. The species is mainly present in North Kenya and leaves of *M. stenopetala* are an important ingredient in daily dish called *dama*. The leaves are called *mida* (Demeulenaere, 2001). *M. stenopetala* tree is recognized nutritious food source in East Africa (Yisehak *et al.*, 2010). Although the nutrient composition of *M. stenopetala* leaves in most cases is lower compared to *kale* and *swiss chard*, they can be a good source of nutrients in dry season potentially when other vegetables are scarce (Abuye *et al.*, 2003). However, the presence of small amount of cyanogenic glucosides in *M. stenopetala* leaves may have a health risk in areas of high incidence of endemic goiter as an exacerbating factor if consumed more for a long

period of time (Abuye *et al.*, 2003). *Moringa stenopetala* is commonly used in folk medicine as antimalarial, antihypertensive, against stomach pain, antidiabetic, antcholesterol, antispasmodic, and to expel retained placenta during birth (Mekonnen, et *al.*, 1999). The active constituent in *Moringa stenopetala* is glucosinolate, phenol carboxylic acids and fatty acids including oleic acid, palmitic acid, stearic acid eicosanic acid and lignoceric acid (Kalogo *et al.*, 2000).

***Paederia foetida* Linn.**

Family: Rubiaceae

Paederia foetida Linn. belongs to family, Rubiaceae. The plant is fast growing and shows a wide range of adaptability to different light, soil and salt conditions (Puff, 1991 a,b). It is able to establish and grow above the frost line, though some leaves may turn yellow–red or drop following a freeze. Occurs most commonly in West Central Florida (Wunderlin *et al.*, 1996), a principal and common weed in Hawaii, Brazil and a serious weed in New Guinea (Holm *et al.*, 1979). In India *P. foetida* is of medicinal value. It is usually found in the Himalayas. It is also reported to be used in gout, vesicle calculi, diarrhea, dysentery, pile, inflammation of liver and emetic (Blatter and Caius, 1981; Indian Meteria Medica, 2002). Leafy vegetable of wild (*Paederia foetida and Erechtitis hieracifolia)* are traditionally consumed in Indonesia as documented in PROSEA and

Thumbuhan Berguna, Indonesia (Heyne, 1987; Siemonsma and Piluek, 1994). It is also used as a remedial plant for diarrhea and dysentery in Bangladesh (Ghani, 1998) and to inhibit intestinal motility (Afroz *et al.*, 2006). Iridiod glycosides, paederolone, paederone, and paederenine are the phytochemicals identified in this plant (Ghani, 1998). Wong and Tan, (1994) reported number of steroids and terpenoids in the volatile oils of the leaves, stems and flower of *P. foetida*. *P. foetida* has been reported to be a potential dietary source of fiber, Sodium, Calcium, Potassium iron and vitamin-C. The leafy vegetable is a potential antioxidant source (Srianta *et al.*, 2012). The major classes of chemical constituent present in this plant are iridoid glycosides, sitosterol, stigmasterol, alkaloids, carbohydrates, protein, amino acids and volatile oil (Blatter and Caius, 1981; Khare, 2007).

***Plantago major* L.**

Family : Plantaginaceae

Plantago major L. belongs to family, Plantaginaceae. The name comes from Latin *planta*, meaning, *sole of the foot*, which refers to the broad leaves in the basal rossete, often touching the ground (Pilger, 1937). It is a temperate-zone plant with extreme ranges to the north and south, almost from pole to pole although very rare in lowland tropics. In its wild form it grows from sea level to 3500m altitude (Sagar and Harper, 1960). The

species grows best in moist areas such as river beds, seepage areas on hillsides, drains, places subjected to water runoff from buildings along roadsides and coastal areas (Webb *et al.*, 1988). *Plantago major* originated in Eurasia but is now naturalized almost throughout the world. Research on pollen has shown that this species was introduced to Nordic countries 4000 years ago (Jonsson, 1983). It is known to have been present in England in 1672 and is found in Canada since 1821. The Indians named it white *man's foot* (Samuelsen, 2000). There is an increasing interest in phytochemicals of *Plantago major* because of its potential use in functional food products and medicine. It has numerous phytochemicals in its leaves, shoots and roots, which apparently have medicinal properties and also can be used as taxonomic markers (Samuelsen, 2000). Flavones are the main flavonoids *in P. major* (Nishibe *et al.*, 1995). The concentration of verbascoside is higher in seeds and flowering stalks of *P. major*, whereas the concentration of plantamajoside is higher in leaves (Zubair *et al.*, 2008b). The antiviral activity of *Plantago major* is derived mainly from its phenolic compounds (Chiang *et al.*, 2002). Plantamajoside is the major known phenolic compound in *Plantago major*. Well documented biological effects of this compound include anti-inflammatory activity (Murai *et al.*, 1996); free radical scavenging and some anti-bacterial activity (Ravn and Brimer, 1988).

Plantago major has been used for different purposes in folk medicine all over the world. *Plantago major* has been reported to have anti-inflammatory, analgesic, antioxidant, immuno-modulating, anti-ulcerogenic, antihypertensive (Samuelsen, 2000; Nyunt *et al.*, 2007). It is also reported to be anti-leukemic, anti-carcinogenic, antiviral, (Chiang *et al.*, 2003), anticandidal (Holetz *et al.*, 2002), anti-nociceptive (Atta and El-Sooud, 2004) and reduction of immunodepressive effects of anticancer drugs (Shepeleva and Nezhenskaya, 2008). Tea made from green leaves of *Plantago major* has antioxidant properties but the antioxidant capacity is higher in fresh green leaves (Campos and Lissi, 1995).

***Portulaca oleracea* L.**

Family: Portulacaceae

Portulaca oleraceae L. commonly called *purslane,* belongs to the family portulacaceae. The name Portulaca is thought to be derived from the Latin *Porto* to carry and *Lac* meaning milk, since the plant contains a milky juice (Boulos and El-Hadidi, 1984). *Portulaca oleracea* is a nutritious vegetable for human consumption and it was mentioned in Egyptian texts from the time of Pharohs (Mohammed and Hussein, 1994). *Purslane* is eaten raw as salad and also is eaten cooked as a sauce in soups or as green. It has a slightly sour and salty taste and is eaten throughout much of Europe, the middle east, Asia, and Mexico (Byrne and Andrews, 1975).

Purslane is a common weed in turf grass areas as well as in field crops (Uddin *et al.*, 2009).

The use of this plant as a vegetable, spice and medicinal plant has been known since the times of the ancient Egyptians and was popular in England during the Middle Ages (Lanska, 1992), why it has fallen into obscurity is quite strange. *Purslane* in ancient times was looked upon as one of the anti-magic herbs, and strewn around a bed was said to afford protection against evil spirits (Grieve *et al.*, 1998). It was supposed to protect from evil spirits and if carried was supposed to attract love and luck. It was carried by soldiers to protect themselves in battle. If laid on the bed, it was believed to protect that person from having nightmares. (Lavender and Franklin, 1996). It is under the dominion of the moon (Leyel, 1987) and is supposed to work on the psychic senses and taken regularly helps develop clairvoyant faculties (Lavender and Franklin, 1996). *Purslane* is currently considered very interesting from a food point of view (van Wyk, 2005), so much that it is included in the list of *World Economic Plants* (Wiersema and Leon, 1999). The National Institute of Rural Sociology comprises *Portulaca oleracea* within the category of regional herbs of the Emilia Romagna Region (Picchi and Pieroni, 2005) . *Purslane* provides a rich plant source of nutritional benefits (Sudhakar *et al.*, 2010). It is one of the richest green plant sources of omega-3 fatty acids and a-linolenic acid (Simopoulos and Salem, 1986). In areas where

this weed is eaten, there is low incidence of cancer and heart disease, possibly due to purslane's naturally occurring omega-3 fatty acids (Simopoulos, 1991). It has been used as an antiseptic, anti-diurectic, vermifuge in oral ulcer and urinary disorders. Recent researches show that it exhibits a wide range of biological effects, including skeletal muscle relaxant effect (Parry *et al.*, 1993), analgesic and anti-inflammatory effects (Chan *et al.*, 2000), antifungal activity (Oh *et al.*, 2000) and anti-fertility effect (Verma *et* al., 1982). Also it has shown other beneficial effects such as anti-diabetic (Gong *et al.*, 2009) and wound healing properties (Rasheed *et al.*, 2003). In addition, *purslane* may have a protective effect against oxidative stress caused by vitamin A deficiency (Arruda *et al.*, 2004).

Purslane has potential as an animal feed, in aquaculture (Simopoulos *et al.*, 1995). It contains numerous common nutrients, including: vitamins (A, B_1, B_2, C, niacinamide, nicotinic acid, α-tocopherol, β-carotene, et. cetera); minerals (especially potassium); fatty acids, especially omega-3 acids whose concentration in *purslane* is the highest (Leung and Foster, 1996). Other constituents include mucilage composed of an acidic and a neutral fraction with structure determined, calcium oxalate, malic and citric acids, dopamine and dopa, coumarins, flavonoids, alkaloids, saponins, and urea among others used (Leung and Foster, 1996). It also contains vitamin A, C and E as well as dietary minerals such as calcium, potassium, magnesium and iron, pigments,

bitacyanins with potent anti-oxidants property (Ezekwe *et al.*, 1999). The plant has been examined for its anti-inflammatory, analgesic and antifungal activities both *in vitro and in vivo* studies (Rasheed and Dislam, 2010). The mixture of phytochemicals present in many of these plants contributes to their protective and health effects (Chu *et al.*, 2002). The water extracts of *P. oleracea* showed no cytotoxic or genotoxic effects, and has been certified safe for daily consumption as a vegetable (Yen *et al.*, 2001). Recent research has shown that *P. oleracea* is a rich source of omega-3 fatty acids, which is important in preventing heart attack and strengthening the immune system (Simopoulos, 2004).

***Rumex vesicarius* L.**

Family: Polygonaceae

Rumex vesicarius L. family Polygonaceae is a wild edible plant used as a sorrel, collected in spring time and eaten fresh, or cooked. *Rumex* the ancient Latin name for the *docks or sorrels, vesicarius,* vesica, a *bladder;* from the inflated pods following the flowers on these herbs (Rao, 2011). This leafy wild plant is common in different parts of the world (Tukan *et al.*, 1998). The fresh leaves may also be added to meat during cooking or as a soup ingredient (Tukan *et al.*, 1998). Green leafy vegetables are, in general, good sources of vitamins, minerals, and fibers (FAO, 1988). The chemical composition of the *Rumex vesicarius* leaves

indicate that they are good sources of minerals, a moderate source of protein and ascorbic acid, and that they are high in oxalic acid and low in tocopherol and lipids. There is a need to reduce the oxalic acid (Mohammed, 2006). The species has been reported to have many important medicinal uses such as treatment of tumors, hepatic diseases, bad digestion, constipation, calcules, heart troubles, pains, diseases of the spleen, hiccough, flatulence, asthma, bronchitis, dyspepsia, piles, scabies, leucoderma, toothache and nausea. The plant is also used as antioxidant, cooling, laxative, stomachic, tonic, analgesic, appetizer, diuretic, astringent, purgative, antispasmodic, aphrodisiac and antibacterial agents. The roasted seeds were eaten for the cure of dysentery. The plant can also be used to reduce biliary disorders and control cholesterol levels. The medicinal importance of this plant is a reflection to its chemical composition since this plant contains many bioactive substances such as flavonoids, anthraquinones particularly in roots quinones, carotenoids, vitamins (especially vitamin C), proteins, lipids, carbohydrates, reducing sugars, phenols, tannins, saponins, triterepenoids and organic acids. This plant is also a good source of minerals, such as; K, Na, Ca, Mg, Fe, Mn, Cu (Mostafa *et al.*, 2011; Prasad and Ramakrishnan, 2012 a,b,c). The bioactive phytochemicals found in *Rumex vesicarius* (such as polyphenols, flavonoids, carotenoids, tocopherols and ascorbic acid) have a role as antioxidant and detoxifying agents (Rao, 2003; Matkowski, 2008). Several

C-glycosides, Flavonoids and Anthraquinones are known to be constituents of this plant. The folklore claims that the plant is a potent diuretic, astringent, carminative, stomachic and tonic (Madhavashetty *et al.*, 2008; Nardkarnis et *al.*, 2002; Pullaiah, 1997). Anti-bacterial and Antioxidant activities of *Rumex vesicarius* was reported reported by Mostafa (2011).

Silybum marianum (L.) Gaertn.

Family: Asteraceae

Silybum marianum (L.) Gaertn. *Milk Thistle* has been used medicinally in Europe since the first century. It was also mentioned in the writings of Dioscorides, Jacobus Theodorus and Culpepper (Luper, 1998). *Silybum marianum* is a wild growing annually herb that is abundantly found in the Nile region (Delta) and Fayium region near water streams (Hassan *et al.*, 2003). Its leaves, flowers and roots have historically been considered a vegetable in European diets, and its fruits, which resemble seeds, have been roasted for use as a coffee substitute. The leaves of the plant are eaten in fresh salads and as a spinach substitute, the stalks eaten like asparagus (Murphy *et al.*, 2000). The dried seeds contain 1-4% silymarin flavonoids (Schulz *et al.*, 1997). Silymarin is a mixture of at least three flavonolignans, including silybin, silidianin, and silychristin. It is the primary active ingredient in milk thistle (Schulz *et al.*, 1997). Milk

thistle is used as an antidote for *Amanita* mushroom poisoning and to protect the liver and kidneys from toxic medications (Flora *et al.*, 1998). The German Commission recommends it for the treatment of dyspeptic complaints, toxin-induced liver damage, and hepatic cirrhosis and as a supportive therapy for chronic inflammatory liver conditions (Blumenthal M, 1998). In addition, milk thistle contains apigenin, silybonol, myristic, oleic, palmitic and stearic acids and betaine hydrochloride, which may have a hepatoprotective effect (Varma, 1980). The extracts of the flowers and leaves of *Silybum marianum* have been used for centuries to treat liver, spleen and gallbladder disorders (Rainone, 2005). The plant and its extracts are reported to possess hepatoprotective, antioxidant (Morazzoni and Bombardelli, 1995), anticancer (Zi X *et al.*, 1997) and antidiabetic (Maghrani *et al.*, 2004). It contains flavonolignan silymarin, which is an important bioactive principle having anticancer, anti-inflammatory, antioxidant, and immunomodulatory effects (Katiyar, 2005). Methanolic extract of leaf and leaf callus of *Silybum marianum* possesses a potent anti-inflammatory activity (Balian *et al.*, 2006). One of the important issues about plant *S. marianum* is that it may be accepted as a safe herbal product, since no health hazards or side effects are known in conjunction with the proper administration of designed therapeutic dosages (Med. Economic Company, 2000). Recently oxidized derivatives of silybin (the

major component forming 70–80% of silymarin) and their antiradical and antioxidant activity was studied by Gazak *et al.* (2004).

***Solanum nigrum* L.**

Family: Solanaceae

Solanum nigrum belonging to the family Solanaceae, commonly named *Black Morelle* is an annual herbaceous plant of 10 to 60 cm tall, with green, smooth and semi climbing stem. The leaves are eaten as vegetables in Congo (Dhellot *et al.*, 2006). It is a common species in arable lands, near rivers and old walls, grows everywhere in Africa and America (Edmonds and Chewya, 1997). *Solanum nigrum* is a popular leafy vegetable .in Kissi district of South west Kenya. This vegetable is nutritious and rich in beta-carotene, minerals such as iron and calcium and protein, especially methionine, an essential amino acid, (Onyango, 1993; Chweya, *et al.*, 1992). The vegetable is also high yielding compared to other indigenous vegetables (Onyango, *et al.*, 1993; Murage, *et al.*, 1990). The leaves and berries are used as vegetable in soup, Yam and coco yam porridges and as spinach in some parts of Nigeria particularly among the Igbo and Efik-Ibibio people of Southeastern Nigeria. Besides being used for human consumption, the leaves serves as fodder and browse for domestic herbivorous animals. In India *S. nigrum* mixed with other herbal medicines have hepato-protective effects in cirrhotic patients.

These protective effects can be attributed to the diuretic, anti-inflammatory, anti-oxidative and immuno-modulating properties of the component herbs (Fallah, *et al.,* 2005). It also protects against hepatitis - B virus infection (De silva, *et al.,* 2003; Galitskii, *et al.,* 1997; Kalab and Krecher, 1997). The extract of its fruits have anti- tumor and neuro-pharmacological properties and it can be used as an antioxidant and cancer chemo-preventive matter (Son, *et al.,* 2003; Perez, *et al.,* 1998). *S. nigrum* possess various compounds that are responsible for diverse activities. The major active components are glycoalkaloids, glycoproteins, and polysaccharides. It also contains polyphenolic compounds such as gallic acid, catechin, protocatechuic acid, caffeic acid, rutin and neringenin (Sikdar and Dutta, 2008).

***Sonchus asper* (L.) Hill**

Family: Asteraceae

Sonchus asper (L.) Hill commonly called spiny sow thistle belongs to the family Asteraceae. A native of Europe but is now a cosmopolitan weed is an annual plant with spiny leaves and yellow flowers resembling those of dandelion. The plant can reach a height up to 6ft. (Wagner *et al.,* 1999). The plant is a common weed in North American roadsides, landscapes and pastures. Its edible leaves make a palatable and nutritious leafy vegetable. It is believed that *Sonchus asper* could be used for

nutritional purposes, due to the high concentrations of nutrients that they contain. (Guil-Guerrero *et al.*, 1998). *Sonchus asper* is eaten cooked and raw in salads in Africa, Madagascar (Grubben and Denton, 2004) and in the Mediterranean (Leonti *et al.*, 2006). *S. asper* prefers well drained, slightly acid to alkaline soils, but are tolerant of saline soils (Lewin *et al.*, 1948; Hutchinson *et al.*, 1984). Their range in Canada suggests a broad tolerance to climatic variation (Hutchinson *et al.*, 1984). Occurs from 750-2550 m in altitude (Grubben and Denton, 2004). Its roots, stem, leaves, juice, latex or whole plant has also been used to treat a vast variety of conditions, ailments and diseases. These include treatment of wounds, boils, asthma, bronchitis, gastrointestinal infections, malaria, venereal disease and many more (Khan and Yadava, 2010). The latex has also been used to treat warts (Grubben and Denton, 2004). Chemical analysis of *S. asper* has confirmed that it contains large quantities of phenolic compounds, flavonoids, ascorbic acid, carotenoids and a variety of other antioxidants. *S. asper* extract protects rats from renal damage associated with CCl4 Khan and Yadava, 2010). The extract of *S. asper* is applied to wounds and boils. The leaves and roots of the plant are used in indigestion and as a febrifuge, while its roots act as a vermifuge. Its stems are given as a tonic and sedative (Ambasta, 1986). *Sonchus asper* is apparently restricted to coastal areas north of 64°N in Norway (Lid and Lid, 1998) and is only very rarely encountered in northern Scandinavia (Lewin *et al.*, 1948). *Sonchus asper* is a

colonizer of waste places, disturbed sites, roadsides, and cultivated areas (Hutchinson *et al.*, 1984; Di Tomaso and Healy 2007). In undisturbed areas, it will have no impact (Hutchinson *et al.*, 1984). *Sonchus asper* is a host for several nematode and aphid species and supports several major plant viruses (Hutchinson *et al.*, 1984). The plant is edible and may be grazed by herbivores (Lewin *et al.*, 1948). Because *Sonchus asper* is insect pollinated, its presence could alter plant-pollinator interactions. The leaves have prickly, spiny margins (DiTomaso and Healy 2007). *Sonchus asper* is able to compete with native species but only in disturbed areas (Hutchinson *et al.*, 1984). *Sonchus asper* does not form thickets, nor does it climb or smother surrounding vegetation (DiTomaso and Healy, 2007). *Sonchus asper* is a common annual weed in agricultural fields in Canada (Hutchinson *et al.*, 1984) and Europe (Lewin, 1948). Historically, it has been grown as a potherb in Europe and as a food source for edible snails (Lewin *et al.*, 1948).

Chemical studies of *Sunchus asper*, indicated a high content of vitamin-C (Afolayan and Jimoh, 2008) , carotenoids, and type ω-3 fatty acids (Guil-Guerrero *et al.*, 1998; El-Zalabani *et al.*, 1999). Phenolic compounds, which are secondary metabolites in plants, are one of the most widely occurring groups of phytochemicals that exhibit a wide range of physiological properties, such as antioxidant, anti-allergenic, anti-microbial, anti-artherogenic, anti-thrombotic, anti-inflammatory,

vasodilatory, and cardioprotective effects (Middleton *et al.*, 2000). Chemical characterization of *Sonchus asper* methanolic extract (SAME) has shown the presence of ionone derivatives of glycosides and sesquiterpene lactone glycosides (Helal *et al.*, 2000). These bioactive compounds have been shown to possess strong antioxidant and anti-inflammatory properties (Alpinar *et al.*, 2009). *Sonchus asper* methanolic extract has diuretic, refrigerant, sedative, and antiseptic properties that are used in the treatment of cough, bronchitis, and asthma (Koche *et al.*, 2008) as well as kidney inflammation (Zabihullah *et al.*, 2006), and its decoction is used in the treatment of impotence (Kareru *et al.*, 2007). *Sonchus asper* is used in various human disorder including wounds and burns (Rehman, *2006*; Qureshi *et al.*, 2009; Hussain *et al.*, 2008), cough, bronchitis and asthma (Ahmad *et al.*, 2006; Koche *et al.*, 2008), gastrointestinal infection, inflammation, diabetes and cardiac dysfunction (Sabeen and Ahmad, 2009), kidney and liver disorders (Zabihullah *et al.*, 2006; Rivera, and Oben, 1993), reproductive disorder like impotence (erectile dysfunction) in humans (Kareru *et al.*, 2007), jaundice (Jan *et al.*, 2009) and cancer (Sammon, 1997; Thomson and Shaw, 2002). *S. asper* contains flavonoids (Giner *et al.*, 1993; Manez *et al.*, 1994), glycosides (Shimizu *et al.*, 1989) ascorbic acid and carotenoids, possess antioxidant, anticancer; anti-inflammatory properties (Guil-Guerrero *et al.*, 1998).

Talinum triangulare (Jacq.) Willd.

Family: Portulacaceae

Talinum triangulare belongs to the family Portulacaceae. It is a herbaceous, perennial, caulescent and glabrous plant, widely grown in tropical regions as leaf vegetable (Ezekwe *et al.*, 2001). *Talinum triangular is* a non conventional vegetable crop which is originated from Tropical Africa and is widely grown in West Africa, America and Asia (Schippers *et al.*, 2000). It is consumed as a vegetable and a constituent of sauce or a softener of other vegetable species in vegetable soups (Aja, *et al.*, 2010). The leaves contain an appreciable amount of bioactive compounds such as flavonoids, alkaloids, saponins tannins. Medically the presence of these phytochemicals explains the use of this vegetable in ethno medicine for the management of various ailments (Aja *et al.*, 2010).

Nutritionally, *Talinum triagulare* leaf has been shown to posses the essential nutrients like Beta-carotene, minerals such as (calcium, potassium, and magnesium), pectin protein and vitamins (Ezekwa *et al.*, 2001). The plant has also been implicated medically in the management of cardiovascular diseases like stroke, obesity, etc. (Adewunmi and Sofowara, 1980). Water leaf as a vegetable has some inherent characteristics which makes it attractive to small holder farmers and consumers. Firstly, it is short duration crop, which is due for harvest between 35 to 45 days after planting (Rice *et al.*, 1986). Secondly it is used

as a softener when cooking fibrous vegetables such as *Gnetum africanum, Heinsia crinata* and *Telferia occidentalis*. It also has some medicinal use in humans and act as green forage for rabbit feed management (Ekpenyong, 1986). In addition, it also provides a complimentary source of income to small scale farming households (Udoh, 2005). Most research on water leaf production Ikwa Ibom state, Nigeria have focused on resource utilization (Udoh, 2005; Umoh, 2006; Udoh and Etim,2008). The anti-oxidant and hepato-protective activities of polysaccharides from *T. triangulare are* were reported by Liang *et al.*, 2011. The leaves of *T. triangulare* have hepatoprotective activity (Adefolaju, *et al.*, 2009).

***Vernonia amygdalina* Del.**

Family: Asteraceae

Vernonia amygdalina, Del. Belonging to family, Asteraceae has a rough bark with dense black straits, and elliptic leaves that are about 6 mm in length. The leaves are green and have a characteristic odour and bitter taste (Singha *et al.*, 1966). It is variously known as bitter leaf (English), oriwo (Edo), ewuro (Yoruba), shikawa (Hausa), and olubu (Igbo), is a tropical shrub, (Igile *et al*, 1995). The species is indigenous to tropical Africa and is found wild or cultivated all over sub- Saharan Africa (Bosch *et al*, 2005). The leaves are eaten, after crushing and washing thoroughly to remove the bitterness (Mayhew and Penny, 1998). *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* 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).

Oboh and Enobhayisobo, (2009) reported that fresh green *Vernonia amygdalina* contain moisture, 83.0% (dry matter, 17.02%), protein, 1.30% and ash 0.50%. Mineral content has been reported to be, phosphorus, 61.55 µg g-1; selenium, 8.2x10-3µg g-1 ; iron, 4.71µg g-1 and zinc, 1.13µg g-1, based on fresh weight of leaves. Both the roots and leaves are used in phyto-medicine to treat fever, hiccups, kidney disease and stomach discomfort, among others (Gill, 1992; Hamowia and Saffaf, 1994). Anti-helmitic and anti-malarial properties (Abosi and Raserika, 2003) as well as anti-tumourigenic properties (Izevbigie *et al*, 2004), have also been reported for extracts from the plant. Other studies have demonstrated hypoglycemic and hypolipidaemic effects of the leaf extract in experimental animals (Akah and Okafor, 1992; Nwanjo, 2005). *V amygdalina* Del. has been shown to contains Significant quantities of lipids (Ejoh *et al.*, 2007; Eleyinmi *et al.*, 2008), proteins with high essential amino acid score (Igile et al., 1994; Udensi *et al.*, 2002; Ejoh *et al.*, 2007; Eleyinmi *et*

al., 2008) that compare favorably with values reported for *Telfairia occidentalis* and *Talinum triangulare* (Ijeh *et al.*, 1996), carbohydrates (Ejoh *et al.*, 2007) and fiber (Udensi *et al.*, 2002; Ejoh *et al.*, 2007). The plant has also been shown to contain appreciable quantities of ascorbic acid and caroteinoids (Udensi *et al.*, 2002; Ejoh *et al.*, 2007). Calcium, iron, potassium, phosphorous, manganese, copper and cobalt have also been found in significant quantities in *Vernonia amygdalina* (Bonsi *et al.*, 1995; Ejoh *et al.*, 2007; Eleyinmi *et al.*, 2008).

In many parts of West Africa, the plant has been domesticated (Igile *et al.*, 1994). It is known as *Grawa* in Amharic, *Ewuro* in Yoruba, *Etidot* in Ibibio, *Onugbu* in Igbo, *Ityuna* in Tiv, *Oriwo* in Edo and *Chusar-doki'*in Hausa (Egedigwe, 2010). *Vernonia amygdalina* is drought tolerant (though it grows better in a humid environment). It thrives on a range of ecological zones and is used as a hedge plant in some communities (Bonsi *et al.*, 1995). *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 is used 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). 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 (Nwachukwu *et al.*, 2010). 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 (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. Bitter leaf also contains saponins, sesquiterpene lactone, steroid glycosides, alkaloids, tannins and flavonoids (Akah and Okafor, 1992). 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 *et al.*, 1966).