A Review on the Biologically Active Substances and Nutritional Value of Field Pumpkin (*Curcubita pepo* L.)

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ABSTRACT

Field pumpkin (*Curcubita pepo*) is an herbaceous annual leafy vegetable widely used as food and medicine around the world. Field pumpkin constitutes an important component in man's diet, especially in developing countries. It is one of the most palatable leafy vegetables ever known in the Southwestern Nigeria. It is needed to complement staples in diet, supplying essential minerals and vitamins that may not be obtained wholly or solely from staples. Field pumpkin have hidden sources of essential nutrients such as proteins, vitamins, dietary fibres, minerals and phytonutrients of high biological activities. The nutraceutical product, medicinal value, nutri-protective effects and its use in therapeutics has not been widely exploits. A survey from literatures shows that more than 40 different active compounds were isolated from Cucurbitaceae family. Meanwhile, different parts of field pumpkin contain high content of diverse bioactives ranging from vitamins to plant bioactives compounds. Nutraceuticals derived from different parts of this leafy vegetable can be used as products for enhancing clinical conditions like cancer, diabetes, cardiovascular diseases. It can also serve as antiinflamatory, haepatoprotective, anticancerous and neuroprotective. Exploitation of different parts of field pumpkin and their consumption can contribute and offer various nutraceuticals that can be of therapeutics and pharmacological benefits.

Keywords: *Curcubita pepo*, Leafy vegetable, Medicinal, Nutraceuticals, Nutrition, Therapeutics

1.0. INTRODUCTION

Field pumpkin (*Cucurbita pepo* Linn) commonly known called Elegede in the Southwestern Nigeria (Oloyede 2012; Ajao *et al.*, 2022), belongs to the largest group of edible plant species of family Cucurbitaceae (Paris, 1986; Smith, 1997). Field pumpkin is an herbaceous annual leafy vegetable

with viny growth and several runners, short internodes and bush type appearance domesticated in North America (Nee, 1990; Smith, 1992; Decker-Walters, 2002; Paris, 2003). The vine (stem/runner) are usually prickly and spiny, and can be rounded or angled. There are often several roots at the vine nodes. The tendrils are long and usually branched. Leaves are large, alternate, shallow to deeply lobed and palmate. Field pumpkin has highest level of polymorphism in terms of fruit shape, size, and color. The fruits ranged from scallop-shaped, globular, top-shaped, ovoid, cylindrical, club-shaped or pear-shaped. The seeds are small, medium or large, narrow elliptic, elliptic or broad elliptic, whitish or yellowish .The color of mature fruit is most often light yellow-orange but can range from greenish white to intense orange depending on the varieties. The plants are typically 1.0–2.5 feet high, 2–3 feet wide, and have yellow flowers (Nee, 1990; Paris, 2002).

Field pumpkin has a wide variety of uses, especially as a food source and for culinary purposes (McGinley, 2011; Dhiman *et al*., 2012). In Southwestern Nigeria, the field pumpkin young leaf is used as an indigenous leafy vegetable and used as a delicacy in combination with other foods. In this form, processing or pretreatment is not required or done before cooking unlike many other leafy vegetables consumed in Nigeria (Oloyede, 2012). Fresh leaves and tendrils of field pumpkin, either whole or in pieces, are usually roasted and used for food. The fruit gourds can be made into cups, ladles, and dippers and put to various uses (Perez, 2016). The mature fruit can be used to make confectionery, beverages and can be incorporated into baked goods. The leaves, tendrils and fruits serves as animal food, a poison, a medicine and food for the invertebrate. Aside it uses as food; it has environmental uses and can be for remediating purpose and fuel (Perez, 2016; FAO, 2019).

Field pumpkin is considered as one of the underutilized leafy vegetable in Africa most especially Nigeria due to it diminished availability, consumption, cultivation and exploitation by regional specific peoples or tribes (Ayanwale & Abiola, 2008; Oloyede, 2012; Otemuyiwa *et al*., 2021). Meanwhile, field pumpkin have hidden sources of essential nutrients such as proteins, vitamins, dietary fibres, minerals and phytonutrients of high biological activities. These are also embedded with nutraceutical and medicinal components that are essential for human wellbeing and mostly significant effect on food and nutritional protection to children, women and adults (Deb *et al.*, 2018). These plant species hold grant genetic diversity, and vast heritage indigenous knowledge linked to their nutritional sources. It is needed to complement staples in diet, supplying essential minerals and vitamins that may not be obtained wholely or solely from staples (Edington & Edington, 2017; Conway, 2019). Presently, a lot of

experimental work has been carried out on the different features of field pumpkin such as ethnobotanical uses, photochemistry and pharmacological value. Little information is known about the nutritional value and biologically active substances of which are contained within different parts such as leaves, fruits and seeds of field pumpkin that can be of therapeutics and pharmacological benefits. Meanwhile, the ability of nutrient and mineral composition **t**o create favorable physiological conditions for proper bodily functions renders field pumpkin bioactive (Kainat *et al.*, 2022). The aim of this study is to provide critical evaluation and also reassessed the biologically active substances**,** medicinal properties, nutri-protective effects, and contribution of different parts of field pumpkin to therapeutics.

2.0. METHODS

Based on the latest findings on nutrient and mineral composition, medicinal and nutritional value associated with different parts of field pumpkin, the biologically active substances, medicinal properties, nutri-protective effects, and contribution of different parts of field pumpkin to therapeutics were carried out. Biologically active substances such as cucurbitacin-derived compounds, nutrient and mineral composition, and antioxidants composition of different parts of field pumpkin were reassessed. medicinal value, nutri-protective effects and contribution of field pumpkin in therapeutics were evaluated.

The information and data provided in this study were sorted from indexed and non-indexed journals by using online bibliographic data bases such as Google Scholar, Bing, PubMed, Scopus, Google, Web of Science, UGC CARE, ESCI, DOAJ, ISI Web of Knowledge and other online library sources. Comprehensive and consummate information about bioactive substances, medicinal properties, nutri-protective effects, pharmacological and therapeutic uses of different parts of field pumpkin were collated from over 20 previously published reports, reviews and research articles which were found to be potential and related studies carried out on field pumpkin. All the data were presented on tables by using 2007 Microsoft office.

2.1. Biologically Active Substances of Field Pumpkin

2.1.1. Cucurbitacin-derived compounds

Cucurbitacins are a class of highly oxidized tetracyclic triterpenoids which possess the biogenetically unusual 10α-cucurbit-5-ene [19(10 →19β) *abeo*-10α-lanostane skeleton which are well known for their cytotoxic activity (Wang *et al*., 2008; Chen *et al*., 2012; Perez, 2016). Cucurbitacins-derived compounds have been found in several plant genera of *Cucurbitaceae*, including *Cucurbita and Citrullus.* No plant foods other than from the *Cucur-*

-*bitaceae* family have ever been reported to contain cucurbitacins. More than 40 cucurbitacin-derived compounds and cucurbitacins and have been isolated from the Cucurbitaceae family and from other species of the plant (Wag *et al*., 2001; Feng *et al*., 2007; Perez, 2016). The highest concentrations of cucurbitacin-derived compounds are normally found in the roots, meanwhile roots are never consumed as food. However, roots of some species are used as traditional medicines. The major cucurbitacins-derived compounds found in field pumpkin were Cucurbitoside A, C, D, F, G, H, I and K in the seeds (Li et al. 2005; Tanaka *et al*., 2013), Cucurbitacin L 2-O-beta-D-glucopyranoside and cucurbitacin K 2-O-beta-D-glucopyranoside in the fruits (Wang *et al*., 2007), and Cucurbitacin B and E in the leaves (Attard *et al*., 2004). Others are 23, 24-dihydrocucurbitacin D, 3β-hydroxycholest-7-en-24-one and Cucurbita-glycosides A, B (Table 1).

Previous reports on the effects of cucurbitacin-derived compounds on humans and animals indicated that cucurbitacin E has also been shown to have immunomodulary effects on peripheral human lymphocytes (Attard *et al*., 2005). Concentrations of cucurbitacin E and cucurbitacin B, less than 1 μM, was shown to inhibit adhesion of transformed B cells (Musza *et al*., 1994). 23,24-Dihydrocucurbitacin F and 3β-(β-D-glucosyloxy)-16α,23α-epoxycucurbita-5,24-dien-11one were shown to inhibit growth of P-388 murine leukemia cells, and A-549 human lung A-549 human lung carcinoma and HT-29 colon carcinoma cells (Delporte *et al.*, 2002). Furthermore, Cucurbitacin I β-D-glucopyranose from fruits of field pumpkin inhibit Growth of human hepatocellular carcinoma HepG2 cells, Cucurbitacin L caused Reduction in protein synthesis in two human carcinoma cell lines, while Cucurbitacin K reduce in protein synthesis in two human carcinoma cell lines (Bartalis & Hala-weish, 2005). Recent studies show that anticancerigenic activity is due to the content of cucurmosin. Cucurmosin is a novel type 1 ribosome-inactivating protein (RIP) isolated from fleshy part of field pumpkin. Due to its cytotoxicity, cucurmosin can inhibit tumor cell proliferation through induction of apoptosis on tumor cells (Xie *et al*., 2012; Zhang *et al*., 2012).

2.2.2. Nutrient and mineral composition of field pumpkin

Past work on the nutrient composition of field pumpkin leaves reveals that the leaf has high content of protein which is comparable with that of soybean (Duke and Ayensu,1985; Feng *et al*., 2007); rich in essential fatty acids like palmitic acid, oleic, linolenic and stearic acids (Chen *et al*., 2012); minerals such as iron, potassium, calcium, magnesium; vitamins such as niacin, riboflavin, phytin, tannin (Glew *et al*., 2006; Oloyede, 2012) and also good source of dietary fibre, and different sterol compounds (Glew *et al*., 2006). The young tender stem has high moisture content, crude fibre, rich in B-carotene, vitamin E, folic acid, ascorbic acid, calcium, iron and

protein (Sabudak, 2007; Stevenson *et al*., 2007; Oloyede, 2012).

Table 1: Some cucurbitacin-derived compounds in Fluted Pumpkin

Cucurbitacin-derived compounds	Plants Parts found	Reference
Cucurbitacin L 2-O-beta-D-glucopyranoside	Fruits	Wang *et al*., 2007
cucurbitacin K 2-O-beta-D-glucopyranoside	Fruits	Wang *et al*., 2007
Cucurbitoside A, C, D, F, G, H, I and K	Seeds	Li *et al*., 2005 Tanaka et al. 2013
3α-Acetoxymultiflora-5(6):7:9(11)-triene-29-benzoate	Seeds	
Cucurbitacin B and E.	Leaves, seeds	Attard *et al*., 2004
3β-hydroxycholest-7-en-24-one	Seeds	Feng *et al*., 2007
23, 24-dihydrocucurbitacin D	Fruits, Seeds	Park *et al*., 2004
Cucurbitaglycosides A, B	Seeds	Feng *et al*., 2007

The mineral analysis indicated that the fruit of field pumpkin pulp contained high levels of Maganese, iron, Copper, lead, Phosphorus, Nikel, Calcium, Magesium, sodium and potassium (Paris *et al*., 2004; Adedayo *et al*., 2013; Kates *et al*., 2017; FAO, 2019). Seeds contain oil with the main fatty acid components being palmitic, palmitoleic, stearic, Oleic, Linoleic, Linolenic, Gadoleic, total saturated fatty acids and total unsaturated fatty acids (Rabrenovic *et al*., 2014; Kates *et al*., 2017). The seeds also contain various components such as *p*-aminobenzoic acid, γ-aminobutic acid, polysaccharides, peptides, proteins, carotenoids as lutein, lutein epoxide, 15-cis-lutein (central-cis)-lutein, 9(9')-cis-lutein, 13(13')-cislutein, α-carotene, β-carotene violaxanthin, auroxanthin epimers, flavoxanthin, luteoxanthin, chrysanthemaxanthin, α-cryptoxanthin, β-cryptoxanthin (Rabrenovic *et al*., 2014) (Table 2). Through the high content of essential nutrients, fibers and minerals (Al-Anoos *et al*., 2015), field pumpkin can serve in the treatment of digestive disorders and intestinal disorders, constipation treatment (Usha *et al*., 2005) and has antiypertensive, antidyslipidemic, antioxidative, anticarcinogenic, antidiabetic and antimicrobial effects. Field pumpkin protein isolates were found to aid in the prevention of the development of diabetes mellitus by mimicking the actions of insulin, act as antioxidants and aid in cancer prevention. The elements magnesium, calcium, zinc, phosphorous,

potassium, sodium and selenium found in different parts of field pumpkin make them a nutritional powerhouse and a weapon in the fight against diseases such as arthritis, inflammation and prostate cancer. High amounts of B-carotene plant sterols, and tocopherols present in pumpkin seed positively affect wound healing, cause antiulcerative effect by protecting gastric mucosa in a dose-dependent manner (Bardaa *et al*., 2016; Gill & Bali, 2011).

Table 2: Nutrient and mineral composition of field pumpkin

	Concentration in Plants Parts			Reference
	Seeds	Fruits	Leaves	
Nutrient composition				
Crude protein	27.48-30	15.50-17	23.95-25.00	Adewusi *et al*., 1995; Oluyemi *et al*., 2006, Oloyede, 2012
Crude fat	38-40	0.11-0.18	6.57	Kwiri *et al*., 2014; Hashash *et al*., 2017
Carbohydrate	28.30	48.40	19.45	Oluyemi *et al*., 2006;Oloyede 2012
B-carotene	Nil	3934.02	7519	Oluyemi *et al*., 2006, Hashash *et al*., 2017
Others				Oloyede,2012; Hashash *et al*., 2017,
Macronutrients				
Ca	9.78	0.60-1.00	0.57-1.00	Martínez-Valdivieso *et al*., 2014
Mg	67.41	0.45	0.78	Guthrie 1989; Martínez-Valdivieso *et al*., 2014
P	47.68	0.62	0.74	
Na	170.35-175	0.33-0.50	0.33-0.50	MartínezValdivieso *et al*., 2014
K	237.24	0.67	0.83	Hashash *et al*., 2017
Micronutrients				
Fe	3.75	0.65	0.78	Hashash *et al*., 2017
Zn	14.14	0.74	0.80	Martínez-Valdivieso *et al*., 2014
Mn	0.06	0.64	0.67	Martínez-Valdivieso *et al*., 2014

2.2.3. Antioxidants composition of field pumpkin

Antioxidants are a diverse group of phytochemicals present in leaves, seeds and fruits of field pumpkin. These compounds can benefit human health by scavenging free radicals and preventing oxidative stress in the body. They also influence a wide range of biological functions and enzyme inhibitory activity. A large difference in the composition and concentrations of antioxidants were found among the different parts of field pumpkin. The leaves of field pumpkin contain flavonoids, and other different metabolites such as phytosterols, tannins, glycosides, phenol, galacto-glycerolipid, fatty acids and volatile oil (Kumar *et al*., 2012). Different active principles like riterpenes, asiatic acid and madecassic acid and their derived triterpene ester glycosides, asiaticoside copaene, caryophyllene, trans- farnesene, germacrene-D can be found in the fruits and seeds (Sabudak 2007; Stevenson et al. 2007; Rabrenovic *et al*., 2014). Phytosterols and phytonutrients are found in abundance in field pumpkin pulp (Immaculate *et al*., 2020; El Khatib *et al*., 2020) (Table 3).

The positive health effects of field pumpkin have been attributed to the relatively high antioxidant concentration in leaves, fruits and seeds ((Sabudak, 2007; Stevenson *et al*., 2007). Antioxidants derived from field pumpkin have physiological effects that can benefit humans. According to studies, a diet rich in antioxidants such as phytosterols, tannins, glycosides, phenol, galacto-glycerolipid reduces the incidence of diabetes, cancer, and cardiovascular disease. In seeds of field pumpkin, the greatest concentrations of squalene were found. Squalene is a compound that has positive effects in the treatment of certain types of cancer (Rohini *et al.*, 2017). Antioxidants are naturally present in fruits and vegetables, and serve as an analgesic, particularly for earaches, headaches, stomachache, constipation, conjunctivitis or thread-worm infection They can help to lower blood sugar levels in animals with impaired glucose metabolism.17 Antioxidant intake and consumption is associated with a decreased risk of Alzheimer, a type of neurodegenerative diseases, and could help to prevent wide range of diseases (Hu, 2003; Agudo, 2005). Moreso, oxidative stress is brought about by decrease in insufficient antioxidant levels in the body (Kainat *et al.*, 2022).

2.2.4. Medicinal Value of field pumpkin

Field pumpkin has been exploited for treating numerous diseases such as an antiinflammatory, antiviral, analgesic urinary disorders, anti-ulcer, antidiabetic and antioxidant (Quanhong *et al*., 2005; Sedigheh *et al*., 2011; Brown *et al*., 2012). In one study, hiperplasia of the rat prostate was induced by a subcutaneous injection of testosterone at a dose of 0.3 mg/100 g daily for 20 days. Administration of field pumpkin seeds oil (14 mg/kg) daily for 30 days inhibited testosterone-induced hyperplasia of the rat prostate involving a direct inhibition of growth of the prostate. In a double-blind, placebo controlled study

with curbicin isolated from seeds of field pumpkin in the treatment of patients with symptoms of prostatic hiperplasia over a three-month period. The cubicin dose administered to 55 patients was of 160 mg of standardized extract from field pumpkin (80 mg). After treatment with cubicin micturition time, frequency of micturition, urinary flow, and residual urine were significantly improvement (Gossell-Williams *et al*., 2006; Perez, 2016).

Traditional medicine, particularly Ayurvedic systems and Chinese have used different parts of the plant such as the flesh of the fruits and seeds to cure leucoderma, inflammation, bronchitis and biliousness (Bandyopadhyay & Mukherjee 2006; Bhavithra *et al*., 2019). Reports shows that field pumpkin exhibit important physiological properties as wound healing, hypoglycaemic effects, tumour growth inhibition, and immunomodulating (Bal, 2003). The seeds are used to treat problems associated with urinary system, vermifuge, hypertension, prevents the formation of kidney stones, enhanced the erysipelas skin infection and alleviate prostate disesases (Sarma et al. 2014). The Leaves of field pumpkin are laxative and antibilious, useful in skin and nervous affections; also useful in tropidity of the liver (Sarma *et al.,* 2014). Specifically, fruits of field pumpkin are found to be beneficial in blood cleansing, purification of toxic substances and good for digestion, besides giving the required energy to improve human health (Table 4).

Table 3: Antioxidants composition of field pumpkin

Antioxidants	Plants Parts found	Reference
Phenolic content	seedsand shell	Saavedra *et al.*, 2015
Tocopherols, sterols, β-carotene, and lutein	Seeds	Hautrive *et al.*, 2019
flavonoid, antioxidant, and anthocyanin	Flower	Ghosh *et al.*, 2021
Pectin, polysaccharides	Fruits	Hussain *et al.*, 2022
terpenoid-metabolites	Fruits, Seeds and leaves	Montesano *et al.*, 2018
Flavonoids, phytosterols, tannins, glycosides, phenol, galacto-glycerolipids	Leaves	Kumar *et al*., 2012
riterpenes, asiatic acid and madecassic	Fruits, Seeds	Rabrenovic *et al*., 2014
Fatty acids and phytosterols	Seeds	Feng *et al*., 2007

Table 4: Medicinal value of Field pumpkin

Plants Parts	Medicinal Values	Reference
Leaves	Healing, hypoglycaemic effects, tumour growth inhibition, and immunomodulating	Bal, 2003
	Used as laxative and antibilious, useful in skin and nervous affections; treat tropidity of the liver.	Sarma *et al.*, 2014
	Antimicrobial, antioxidant, antiinflamatory, haepatoprotective, anticancerous and neuroprotective	Jayaprakasam *et al*., 2003
Seeds	Cure leucoderma, inflammation, bronchitis and biliousness	Bandyopadhyay & Mukherjee, 2006; Bhavithra *et al*., 2019
	used to treat problems associated with urinary system, vermifuge, hypertension, kidney stones, skin infection and alleviate prostate disesases	Sarma *et al*., 2014
Fruits	Anticancerous and neuroprotective	Jayaprakasam *et al*., 2003
	cure leucoderma, inflammation, bronchitis and biliousness	Bandyopadhyay & Mukherjee, 2006; Bhavithra *et al*., 2019
	cardio protective action,	
	Used in the curing of fatness, gastric problems, irritable bladder in children	

2.2.5. Nutri-protective Effects of Field pumpkin

The different parts of field pumpkin contain micronutrients and macronutrients that possess ability to neutralize free radicals or their actions (Nishimura *et al.*, 2014). Free radicals have been implicated in the etiology of several major humans ailments such as joint pain, diarrhoea, inflammation, appetizer, fever, piles, abdominal pains and burning sensations. From a study on the extracts derived from

leaves of field pumpkin displayed the largest spectra of activity against *Providencia stuartii, Pseudomonas aeruginosa, K. pneumoniae, Escherichia coli, Enterobacter aerogenes* and *Enterobacter cloacae (*Noumedem *et al*., 2013*)*. Another study also shows the bioactivity of methanolic extract of fruit of field pumpkin extract showed moderate to high activity against strains of *Bacillus cereus, Bacillus subtilis, Escherichia coli, Enterobacter aerogenes, Enterobacter agglomerans, Salmonella enteritidis, SalmoneIla cholerasius, Staphylococcus aureus, Pseudomonas aeruginosa, Candida albicans, Penicillium chrysogenum, Enterobacter faecalis, Klebsiella pneumonia, Bisphericus, B. thruengenesis* and *Cryptococcus meningitis* (Dubey *et al*., 2010). Regular consumption of leaves, stem and fruits of field pumpkin can serve the body with different types of neutraceuticals such as essential vitamins such as Vitamin C, Vitamin E, cysteine, lycopene and it can prevent from different forms of illnesses. Some biotransformed products derived from field pumpkin are effective against colon, liver, lung, breast and kidney diseases (Shokrzadeh *et al*., 2010; Rios *et al*., 2012).

2.2.6. Contribution of Field Pumpkin in Therapeutics

Neutraceutical products from field pumpkin can provide several pharmacological benefits like anti-aging, protection against some chronic diseases, maintaining body homeostasis, cardiovascular diseases, neurodegenerative diseases, and metabolic disorders like diabetes, degenerative diseases like cancer, protein deficiency, ophthalmic complications, allergic problems and Parkinsonism (Zhao, 2007).

Diabetes, cardiovascular disease such as cardiac failure, vesicular blockage, hypertension, stroke, alzheimer and ophthalmic disorders are common metabolic disease and are one of the top ten mortality cause as per World Health Organization. Most of the cases it is related with the obesity. More than 50 % of the global populations are suffering from these diseases due to lifestyle changes. Availability of anti-diabetic, Cardiovascular, alzheimer and ophthalmic disorders medicines from diverse adverse effects so there is huge demand for alternatives for the management of diseases (Nasri *et al*., 2014). In recent years in some scientific reports has shown that some herbal medicine and herbal dietary supplements are in preclinical trial level in the management of these diseases (Shahbazian, 2013). Meanwhile, exploitation of different parts of field pumpkin can contribute and offer various nutraceuticals that can be of therapeutics and pharmacological benefits.

3.0. CONCLUSION

The different parts of field pumpkin is considered to be a rich source of bioactive compounds including cucurbitacin-derived compounds, essential mineral

nutrients, phytochemicals and antioxidants, and also certain types of vitamins and minerals. The compounds possess specific properties that are beneficial to human health in several ways. The cucurbitacin-derived compounds inhibit growth of tumour cells which are likely to cause diseases such as cancer, leukemia, and shown to have immunomodulary effects on peripheral human lymphocytes. The leaves, fruits and seeds of field pumpkin pulp contained high levels of mineral nutrient ts that can serve in the treatment of digestive disorders, intestinal disorders, constipation and among can acts as antiypertensive, antidyslipidemic, antioxidative and anticarcinogenic. The positive health effects of field pumpkin have been attributed to the relatively high antioxidant concentration in the leaves, fruits and seeds which help to prevent wide range of diseases.

With the presence of these bioactive compounds in different parts of Field pumpkin, it is therefore considered to be of medicinal value and can be exploited for treating numerous diseases, use as nutri-protective Effects against certain pathogens, and can offer various nutraceuticals that can be of therapeutics and pharmacological benefits.

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