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INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 11, November 2025, pp : 1939-1949

e-ISSN : 2583-1062
Impact Factor : 7.001

A REVIEW ON: ANTIOXIDANT PROPERTY OF AMARANTHUS HYBRIDUS

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DOI: https://www.doi.org/10.58257/IJPREMS45170

ABSTRACT

Amaranthus hybridus exhibits potent antioxidant properties due to its rich content of phenolic compounds and flavonoids, which are effective scavengers of reactive oxygen species (ROS) and reactive nitrogen species (RNS). Studies have confirmed its antioxidant activity using various in vitro methods, including DPPH and ABTS assays, and have identified specific compounds like rutin and phenolic acids such as caffeic acid and ferulic acid as key contributors. The extraction method significantly influences the concentration and types of these compounds, with methanolic leaf extracts showing high antioxidant activity.

The research of hydroethanol and aqueous extracts from the leaves of Hibiscus sabdariffa L. (Malvaceae), Corchorus olitorius L. (Tiliaceae), and Amaranthus hybridus L. (Amaranthaceae) served as the foundation for our work. The phytochemical screening and antioxidant activity of leaf extracts from these three Côte d'Ivoire plants are presented for the first time in this paper. These extracts' phytochemical examination showed that the three leaves contained alkaloids and polyphenols. There were differences in the extracts' total phenolic content, ranging from 13.22 to 90.89 mg GAE/g. The highest concentrations were found in the C. olitorius hydroethanol extract (90.89 mg GAE/g) and decoction (57.89 mg GAE/g). The hydroethanol extract of C. olitorius was the most active, according to the DPPH method's evaluation of reducing power (IC50 = 45.58 µg/mL). This outcome was consistent with the FRAP method's finding.

Keywords: Amaranthu Hybridus; Antioxidant activity; Phytochemical; minerals; antioxidant pigments; polyphenols; flavonoids; vitamin C.

1. INTRODUCTION

The majority of developing nations rely on starch-based foods as their primary staple food source for both protein and energy. According to the Food and Agricultural Organization, this partially explains the widespread protein deficiency in the population (Ladeji et al., 1995). Vegetables are the most affordable and accessible sources of vital amino acids, vitamins, minerals, and key proteins in Nigeria and the majority of other tropical African nations where starchy staple foods make up the majority of the daily diet (Okafor, 1983). The lack of scientific understanding regarding the nutritional potential of many local vegetable materials leads to their underutilization. There is still more to be done, despite the abundance of literature on the compositional assessment and functional characteristics of different kinds of edible wild plants used in developing nations. Numerous researchers (Lockeett et al., 2000; Akindahunsi and Salawu, 2005; Edeoga et al., 2006; Hassan and Umar, 2006; Ekop, 2007) have documented the functional characteristics and compositional assessment of different kinds of edible wild plants used in developing nations.

Fig. 1 Amaranthus Hybridus l Species.

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Amaranthus hybridus L., sometimes known as "pigweed" or amaranth, is an annual herbaceous plant that grows to a height of one to six feet. The leaves are rough, hairy, oval or rhombic, alternating petioled, 3–6 inches long, and have wavy margins. They are also dull green. The terminal panicles are either red or green, and the blooms are tiny. Long and meaty, taproot can be either pink or red. Each of the tiny, lenticellular seeds has an average diameter of 1 to 1.5 mm, and 1000 seeds weigh between 0.6 and 1.2 g. This species is quite prevalent in barnyards, cultivated fields, and waste areas. In Nigeria, soup is made from A. hybridus leaves and seasonings (Oke, 1983; Mepha et al., 2007). In West Africa and Mozambique, these boiled leaves are combined with a groundnut sauce and consumed as a salad (Oliveria and DeCarvalho, 1975; Martin and Telek, 1979). Squalene, a substance with both industrial and health benefits, has been found in high concentrations in A. hybridus (Rao and Newmark, 1998; Smith, 2000; He and Corke, 2003). Although this plant is used for these reasons, little is known about the nutritional and chemical makeup of A. hybridus leaves. Therefore, the purpose of this work is to record the chemical and nutritional makeup of A. hybridus leaves in an effort to ascertain their fitness and utility as an edible vegetable or otherwise.

Table 1. Proximate composition of Amaranthus hybridus L. leaves

Parameter	Concentration (% DW)
Moisture Content	83.48
Ash Content	13.80
Crude Protein	17.92
Crude Lipid	4.65
Crude Fibre	8.61
Available Carbohydrate	52.18
Calorific value (Kcal/100g)	268.92

Minerals, vitamins, dietary fiber, and proteins are all abundant in green leafy vegetables. Vegetable consumption has grown significantly in recent years, mostly as a result of their favorable correlation with the avoidance of a number of chronic illnesses. However, in the majority of emerging nations, the poor eat a diet high in cereals and low in vegetables. Therefore, boosting intake of readily available and reasonably priced native green vegetables is a workable and long-term solution to the malnutrition issues in underprivileged areas. According to studies, vegetables have a variety of bioactivities, such as hypoglycemic, anticancer, antihypertensive, antidiabetic, and anti-inflammatory qualities. Ascorbic acid, carotenoids, and phenolics are among the bioactive components that have been linked to the majority of these pharmacological, health, and nutraceutical effects.

2. MATERIAL AND METHODS

1. Plant material:

Leaves from Amaranthus hybridus L. (Amaranthaceae), Corchorus olitorius L. (Tiliaceae) and Hibiscus sabdariffa L. (Malvaceae) were collected in february 2019 in Korhogo (North of Côte d'Ivoire) and authenticated by Pr Ipou Ipou Joseph. Voucher specimens (n°10 KABLAN AH-2019, n°11 KABLAN CO-2019 and n°11 KABLAN HS-2019) were deposited in the herbarium of Centre National de Floristique (CNF), Université Félix Houphouët-Boigny, Abidjan (Côte d'Ivoire).

2. Preparation of leaves extracts:

The extraction technique is identical to the one described by Touré et al., 2020 [8]. For two weeks, the leaves were kept out of the sun after being individually cleaned, chopped, and dried. Every type of dried leaf was ground into a powder with a mechanical grinder. The powder was placed in an airtight container after being sieved with a particle size of 2 mm. A variety of extracts were made using the fine powders. Aqueous, hydroethanolic, and decoction extracts were made for each leaf species' powder. Each leaf's aqueous extract (Aq) was made by combining 100 g of powder with 1 L of distilled water and stirring constantly at 25°C for 24 hours. The mixture was then filtered using hydrophilic cotton, and the filtrate was dried in an oven set to 50°C for 48 hours. Each plant's hydroethanol extract (Et/W) was prepared by stirring 100 g of powder in 1 L of a combination of 70% ethanol and 30% water for 24 hours. Hydrophilic cotton was used to filter the hydroethanol mixture, and the filtrate was then dried for 48 hours at 50 °C in an oven. 50 g of powdered leaf material was dissolved in 1 L of distilled water to create the decocted extract (D), which was then boiled for an hour. After the boiling mixture was filtered, the filtrate was dried for 48 hours at 50 °C in an oven. Following the various extractions, the yields (R) were computed using the formula below:

$$R\ (\%) = (m / M) \times 100$$

M: mass of the vegetable powder (g); m: mass of the crude extract (g).

3. Phytochemical screening of extracts:

3.1 Thin Layer Chromatography TLC:

A 20 cm by 20 cm TLC aluminum plate containing the silica gel (stationary phase) was divided into tiny 7 cm x 5 cm TLC plates. Each little plate was then marked with the front and starting lines. Capillary tubes were used to spot a few drops of each leaf extract on the starting line on the TLC plate, and the drops were then allowed to air dry. Three solvents made up the mobile phase (eluent), which was a combination of methanol, ethyl acetate, and dichloromethane in equal amounts. The chromatographic tank holding the eluent was filled with the TLC plate containing the various extracts. The TLC plate is taken out of the tank, exposed, and allowed to air dry once the eluent has reached the front line. Following the separation of the spots with a pencil, they are examined in visible light first, followed by a revealing reagent called "vanillin" that is made up of 1 g of vanillin, 100 mL of methanol, and 2 mL of sulfuric acid. Following UV/visible examination of the chromatograms, the bands seen were encircled. An ultraviolet lamp was used to observe the colors of the bands on the chromatographic plate, and the frontal ratio (Rf) was computed using the following formula:

Rf = (Distance of substance) / (Distance of solvent front).

A high frontal ratio of 0.3–0.5, will characterize the apolar compounds, 0.2-0.4 for average polar compounds and 0.1 0.2 for polar compounds.

3.2 Secondary metabolites tests:

A) Alkaloids:

After migration and air dried of particles of different extracts, chromatographic plates were impregnated with Dragendorff reagent. The presence of orange stain in the plate revealed that the extract contains alkaloids

B) Polyphenols:

After migration of particles, the chromatographic plates for polyphenols test were treated with 2 mL of ferric chloride (2 %). The appearance of blue-blackish or green coloration more or less dark showed the presence of phenolic compounds in tested extract

C) Flavonoids Flavonoids:

were revealed with Godin's reagent on chromatographic plates. The appearance of yellow, pink and orange staining at 365 nm indicates the presence of flavonoids

D) Saponins:

The various extracts were taken up in 5 mL of distilled water, then introduced into a test tube and stirred vigorously. The formation of a foam (height 1 cm) stable for 15 minutes, revealed the presence of saponins

E) Terpenes:

2 g of powder of leaf were mixed in 20 mL of hexane for 24 hours. The mixture was filtered, and 10 mL of filtrate were put in crucible to evaporate solvent. The evaporated extract was taken up with 1 mL of anhydride acetic acid and 1 mL of chloroform before putting this mixture in test tube. A volume of 1 to 2 mL of sulfuric acid was added to the contents of tube. The appearance of a brown-red or violet ring in the test tube reveals the presence of terpenes in extract

F) Cardiotonic glycosides:

To 5 g of each extract in test tube was added 2 mL of glacial acetic acid containing a drop of a ferric chloride solution. 1 mL of concentrated sulfuric acid was then added to the whole. Cardiotonic glycosides in extract were revealed by a brown ring observed in test tube characteristic of a desoxy sugar of cardenolides. In addition, a purple ring appears below the brown ring, while a greenish ring is gradually formed in the acetic acid phase.

4. Determination of total polyphenols:

The Folin-Ciocalteu (0.5N) colorimetric technique was used to measure the total polyphenols in the methanol extracts of the various leaves [12]. Two milliliters of a sodium carbonate solution, 2.5 milliliters of Folin-Ciocalteu reagent, and 0.5 milliliters of each extract diluted (1/100) were added. After 15 minutes of incubation at 50 ° C in a water bath, the absorbance at 517 nm was measured against a reference tube containing 0.5 mL of 100% methanol. Under identical conditions as the sample, the total phenolic compounds were measured using a linear calibration line ($y = ax + b$) of gallic acid (standard) at various concentrations (0.05 to 0.15 µg/mL). The quantities of total phenolic compounds (Q), expressed in gallic acid equivalent (GAE), per dry matter of extract were determined using the following formula:

$Q = (V \times C \times d) / m$

V: volume of crude extract (mL),

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C: average concentration (µg/mL),
d: dilution factor,
m: mass of sprayed dry matter (g).

5. Evaluation of antioxidant activity of extracts:

Extracts that showed high polyphenol contents were used to evaluate their antioxidant potencies with methods of 2,2 diphenyl-1-pycrylhydrazyl (DPPH) scavenging activity and reducing power of iron (FRAP).

5.1. DPPH (2,2-diphenyl-1-pycrylhydrazyl) scavenging activity:

The 2,2-diphenyl-1-picrylhydrazyl (DPPH) test was used to measure the extracts' in vitro antiradical activity using a modified version of Parejo et al. (2002)'s methodology. 0.5 mL of various concentrations (0-200 µg/mL) of the extracts and the standard (vitamin C) were combined with 2 mL of DPPH methanol solution (100 µM). After 15 minutes of darkness at 25°C, the mixture was measured for absorbance at 517 nm using a spectrophotometer. The formula below is used to determine the percentage of inhibition (PI):

PI = [(A0 - A1) /A0]x100

PI (%): Percentage of inhibition;

A0: absorbance of DPPH solution without extract (white);

A1: absorbance of DPPH solution with extract (test). The concentrations of extracts or vitamin C for 50 % of inhibition of the DPPH radicals were determined by graph representing (% Inhibition DPPH = f [extracts]).

5.2. Ferric Reducing Antioxidant Power (FRAP) of extracts:

The extracts' FRAP was conducted using the methodology outlined by Pulido et al. (2000). 2.5 mL of the ferric tripyridyltriazine solution (10 mM in 40 mM HCl), 2.5 mL of hydrated iron chloride (20 mM), and 25 mL of acetate buffer (300 mM sodium acetate, pH l o 3.6 with acetic acid) were combined to create a new solution of FRAP reagent (10 mM). 3500 µL of the FRAP reagent was added to 140 µL of test compounds that had been dissolved in methanol. The absorbance at 593 nm was measured using the Trolox as a control after these mixes had been incubated in the dark for 30 minutes.

6. Mineral composition of Amaranthus hybridus L. leaves:

Amaranthus hybridus L. leaves are a rich source of essential minerals, including potassium (54.20 mg/100 g DW), calcium (44.15 mg/100 g DW), magnesium (231.22 mg/100 g DW), phosphorus (34.91 mg/100 g DW), iron (13.58 mg/100 g DW), and zinc (3.80 mg/100 g DW), as well as sodium and other important nutrients. These leaves are considered nutritionally significant and are often included in diets, particularly in regions like Nigeria, where they are a staple leafy vegetable.

Table 2. Mineral composition of Amaranthus hybridus L. leaves.

Mineral element	Composition (mg/100 g)
Sodium (Na)	7.43
Potassium (K)	54.20
Calcium (Ca)	44.15
Magnesium (Mg)	231.22
Iron (Fe)	13.58
Zinc (Zn)	3.80
Phosphorus (P)	34.91
Na/K	0.14
Ca/P	1.26

7. Vitamin composition of Amarathus hybridus L. leaves:

Amaranthus hybridus leaves are rich in several vitamins, including vitamin C, vitamin A (beta-carotene), and B vitamins like riboflavin, niacin, and pyridoxine. This nutritional profile makes them a valuable dietary source of these essential vitamins.

Table 3. Vitamin composition of Amarathus hybridus L. leaves.

VITAMIN	Composition (mg / 100 g)
β-Carotene (Vitamin A)	3.29
Thiamine (Vitamin B_1)	2.75
Riboflavin (Vitamin B_2)	4.24
Niacin (Vitamin B_3)	1.54
Pyridoxine (Vitamin B_6)	2.33
Ascorbic acid (Vitamin C)	25.40
α-Tocopherol (Vitamin E)	0.50

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8. Amino acid profile:

amaranthus hybridus L. leaves contain a wide range of amino acids, including high concentrations of glutamic acid and leucine, which are considered essential and non-essential amino acids, respectively. Seventeen amino acids were identified, with leucine being the most abundant non-essential amino acid and tryptophan being a limiting essential amino acid. The leaves are a good source of protein and essential amino acids, making them a valuable dietary supplement.

Table 4. Amino acid composition of Amaranthus hybridus L. leaves.

Amino acid	Concentration (g/100 g protein)
Isoleucine	3.39
LEUCINE	6.70
LYSINE	3.03
METHIONINE	1.76
CYSTEINE	0.46
TOTAL SULPHUR AMINO ACIDS (TSAA)	2.22
PHENYLALANINE	4.00
TYROSINE	3.05
TOTAL AROMATIC AMINO ACID (TARAA)	7.05
THREONINE	2.62
VALINE	3.50
HISTIDINE	2.15
ALANINE	3.35
ARGININE	3.94
ASPARTIC ACID	5.40
GLUTAMIC ACID	15.79
GLYCINE	3.81
PROLINE	3.43
SERINE	3.04

9. Chemical composition of Amarathus hybridus L. leaves:

Amaranthus hybridus L. leaves are rich in macronutrients such as protein and carbohydrates, and also contain essential minerals like magnesium, potassium, calcium, and iron. Key vitamins found in the leaves include beta-carotene, thiamine (B1), riboflavin (B2), niacin (B3), pyridoxine (B6), ascorbic acid (C), and alpha-tocopherol (E). Additionally, the leaves contain various phytochemicals such as flavonoids, phenols, and amino acids, with some evidence suggesting a good balance of essential amino acids.

Table 5. Chemical composition of Amaranthus hybridus L. Leaves.

Phytochemicals	Composition (mg/100 g)
Alkaloid	3.54
Flavonoid	0.83
Saponin	1.68
Tannins	0.49
Phenols	0.35
Hydrocyanic Acid	16.99
Phytic Acid	1.32

ANTIOXIDANT PROPERTY OF AMARANTHUS HYBRIDUS:

Amaranthus hybridus, also known as African spinach or pigweed, possesses significant antioxidant properties due to its rich composition of phytochemicals, vitamins, and other bioactive compounds. Studies have shown that both the

leaves and seeds of this plant exhibit a strong ability to scavenge free radicals, which are unstable molecules that can cause cellular damage and contribute to chronic diseases.

- **antioxidant compounds:**

A. hybridus contains a wide variety of antioxidant molecules, including:

- **Phenolic compounds and flavonoids:** These are powerful plant antioxidants that protect against oxidative stress. They are highly concentrated in the plant's leaves and include compounds such as rutin, quercetin, kaempferol, vanillic acid, and gallic acid.
- **Betalains:** The red-colored varieties of amaranth are particularly rich in betalain pigments, which are potent antioxidants. Studies show that red-colored Amaranthus genotypes have abundant betalain pigments, which are strongly correlated with high antioxidant activity.
- **Carotenoids:** These pigments, which include beta-carotene, zeaxanthin, and lutein, act as antioxidants and are vital for eye and skin health.
- **Vitamins:** A. hybridus is an excellent source of essential antioxidant vitamins, especially vitamin C, which is a powerful water-soluble antioxidant. It also contains vitamins A and E, which provide further protection against free radicals.
- **Polysaccharides:** Extracts of polysaccharides from A. hybridus have demonstrated strong antioxidant activity in laboratory tests.
- **Evidence of antioxidant activity:**

Multiple studies using various in vitro and in vivo models have confirmed the antioxidant effectiveness of A. hybridus:

- **Radical scavenging assays**: Extracts have shown strong radical scavenging activity in tests like DPPH (2,2-diphenyl-1-picrylhydrazyl) and ABTS (2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid)), confirming its ability to neutralize free radicals.
- **Hepatoprotective effects:** An animal study found that leaf extracts of A. hybridus protected the liver from oxidative stress and damage caused by the toxin thioacetamide. The extract increased the activity of antioxidant enzymes like superoxide dismutase (SOD) and catalase, while reducing biomarkers of oxidative stress.
- **Dependence on extraction method:** The concentration of bioactive compounds and the resulting antioxidant potential can vary depending on the extraction method used. For example, a methanolic extract of the leaves has shown particularly high levels of antioxidant polyphenols.
- **Health implications:**

The robust antioxidant properties of A. hybridus support its use as a functional food with a range of health benefits:

- **Prevention of chronic disease**: By neutralizing harmful free radicals, the antioxidants in A. hybridus can help mitigate the oxidative damage that contributes to many chronic diseases, including heart disease, cancer, and neurodegenerative disorders.
- **Anti-inflammatory effects:** The plant's high antioxidant content is directly linked to its anti-inflammatory potential, which helps protect the body from a variety of inflammatory conditions.
- **Nutritional sufficiency:** Including A. hybridus in the diet can help meet daily requirements for vitamins, minerals, and antioxidants, helping to prevent deficiencies.

PHARMACOLOGICAL PROPERTY OF AMARANTHUS HYBRIDUS:

Bioactive substances like flavonoids, phenolic acids, and betalains are responsible for the pharmacological characteristics of Amaranthus hybridus, which include antibacterial, anti-inflammatory, and antioxidant activities. Additionally, it exhibits neuroprotective, antiviral, anti-diabetic, hepatoprotective, and anti-carcinogenic properties. It has historically been used to treat ailments like microbial infections, oxidative stress, and inflammatory illnesses.

- **Antidiabetic effects:** Some studies suggest that A. hybridus may have antihyperglycemic properties, which could be beneficial in managing diabetes.
- **Antioxidant activity:** The plant is rich in flavonoids and other phenolic compounds that act as antioxidants. These compounds help neutralize harmful free radicals, reducing oxidative stress that can lead to chronic and degenerative diseases like heart disease and cancer.
- **Anti-inflammatory effects:** Studies have shown that A. hybridus can inhibit inflammation by down-regulating pro-inflammatory markers. This property may help alleviate conditions such as arthritis.

- **Antimicrobial potential:** Extracts from the leaves and stems of A. hybridus have demonstrated the ability to inhibit the growth of certain bacteria and fungi. Research has found that amaranth extracts can be effective against both Gram-positive and Gram-negative bacteria, including Pseudomonas aeruginosa and Staphylococcus aureus.
- **Hepatoprotective (liver-protective) function:** The plant and its oil have been shown to protect the liver. Amaranth oil, rich in the antioxidant squalene, can help regulate lipid metabolism and protect hepatic cells. The herb's extracts have also shown protective effects against drug-induced liver damage.
- **Fertility-enhancing and protective effects:** Experimental studies in rats found that extracts of A. hybridus can help prevent the toxic effects of certain anticancer agents on ovarian function. It was shown to help normalize estradiol levels, restore ovarian weight, and preserve ovarian tissue.
- **Anticancer (cytotoxic) activity:** Extracts of A. hybridus have demonstrated cytotoxic and antiproliferative effects in various cancer cell lines. This suggests the potential for its compounds to induce apoptosis, or programmed cell death, in cancer cells.
- **Hypolipidemic (cholesterol-lowering) properties:** Animal studies have indicated that amaranth, especially its oil, can lower total and "bad" (LDL) cholesterol levels. While research on humans is still needed, this points to its potential for managing cardiovascular risk factors.
- **Neuroprotective and antidepressant-like properties:** Bioactive compounds found in amaranth may offer protective effects on nerve cells and have shown antidepressant-like activity.
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- **Neuroprotective and antidepressant-like properties:** Bioactive compounds found in amaranth may offer protective effects on nerve cells and have shown antidepressant-like activity.
- **Bioactive compounds responsible for these effects:**

The therapeutic effects of Amaranthus hybridus are attributed to its diverse phytochemical profile, including:

- **Phenolic compounds and flavonoids:** These potent antioxidants are crucial for scavenging free radicals and inhibiting inflammation.
- **Alkaloids**: Nitrogen-containing compounds with various pharmacological actions, including antimicrobial effects.
- **Saponins:** These can contribute to antimicrobial and other activities.
- Tannins and triterpenes: Other bioactive compounds that contribute to the plant's overall therapeutic profile.
- **Vitamins:** The plant's leaves are an excellent source of vitamins C, E, K, and B-complex vitamins, which provide antioxidant and other health benefits.
- **Minerals:** It is also rich in essential minerals like iron, calcium, and potassium.
- **Traditional and Modern Applications:**
- **Traditional Use**: In ethnomedicine, Amaranthus hybridus has been used to treat conditions like menorrhagia, diarrhea, fever, and blood disorders.
- **Modern Potential:** Due to its diverse pharmacological properties, it is being explored for the development of nutraceuticals, supplements, and as a source for natural colorants and medicines.

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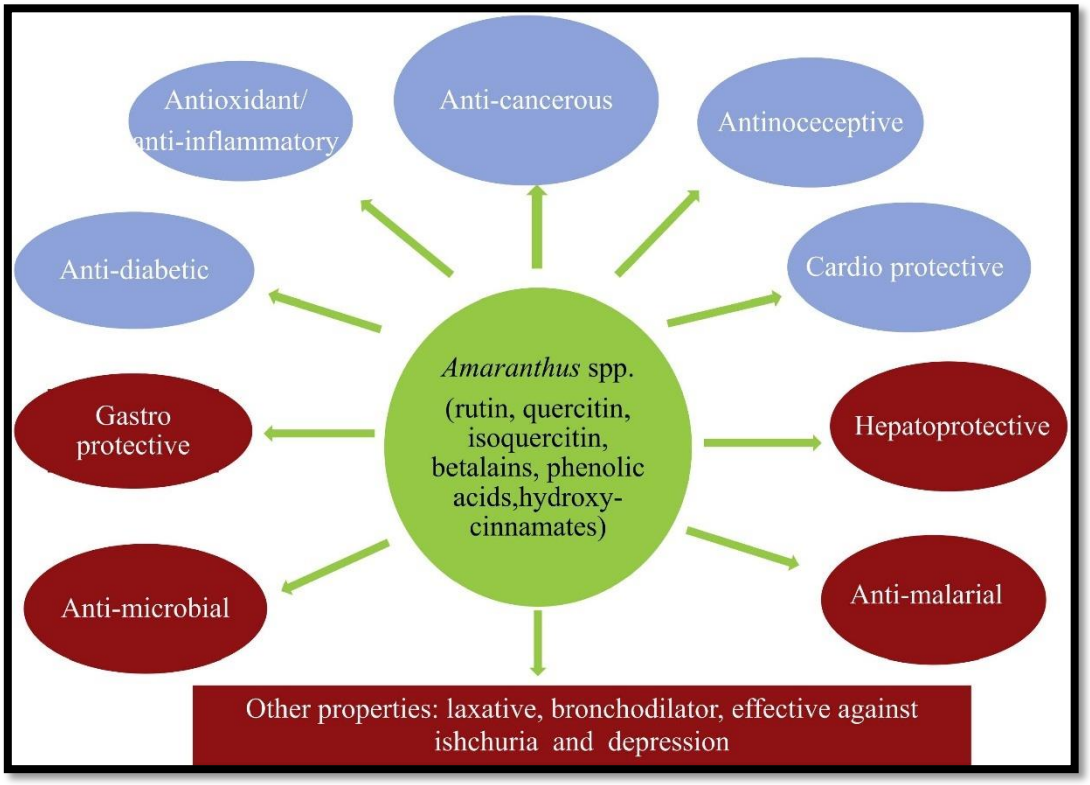

Fig. 2 Diagrammatic representation of pharmacological properties of Amaranthus spp. due to its major active components based on in vitro and in vivo studies.

AMARANTHUS HYBRIDUS NUTRITIONAL VALUE:

Amaranthus hybridus, also known as smooth amaranth or pigweed, is a highly nutritious, gluten-free plant. Both the leaves and seeds are rich in protein, vitamins, minerals, and antioxidants. Research shows that A. hybridus leaves contain higher concentrations of nutrients compared to other leafy vegetables, including iron, calcium, and vitamins A and C.

1. **Macronutrients (per 100 g dry weight) :**

- Crude protein: 17.92%
- Crude fiber: 8.61%
- Available carbohydrate: 52.18%
- Crude lipid (fat): 4.65%
- Energy: 268.92 Kcal

2. **Minerals (per 100 g dry weight) :**

- Magnesium: 231.22 mg
- Potassium: 54.20 mg
- Calcium: 44.15 mg
- Phosphorus: 34.91 mg
- Iron: 13.58 mg
- Sodium: 7.43 mg
- Zinc: 3.80 mg

3. **Vitamins (per 100 g dry weight) :**

- Ascorbic acid (Vitamin C): 25.40 mg
- β-carotene (Vitamin A): 3.29 mg
- Riboflavin (Vitamin B2): 4.24 mg
- Thiamine (Vitamin B1): 2.75 mg
- Pyridoxine (Vitamin B6): 2.33 mg
- Niacin (Vitamin B3): 1.54 mg
- α-tocopherol (Vitamin E): 0.50 mg
- Vitamin K: Higher quantity than most green leafy vegetables.

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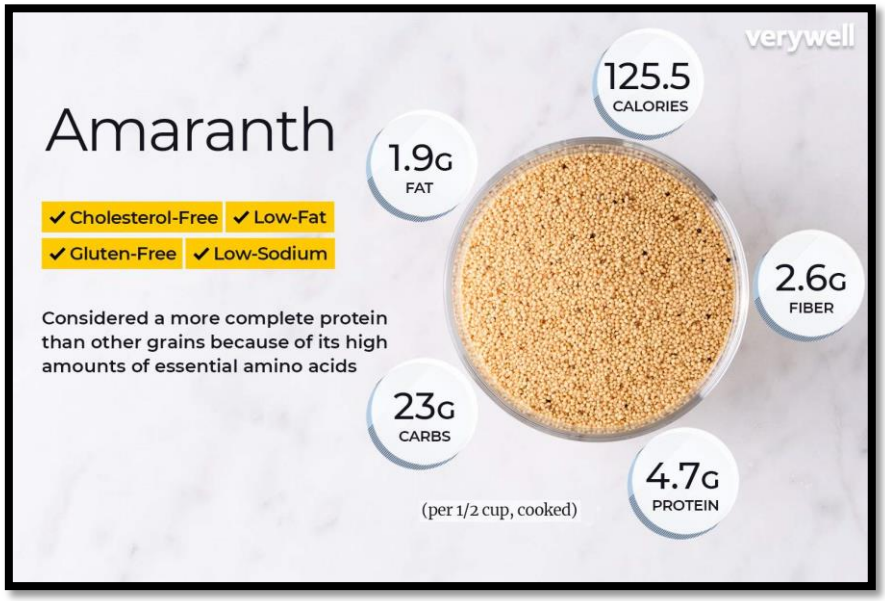

Fig. 3 Amaranth Nutrition Facts and Health Benefits.

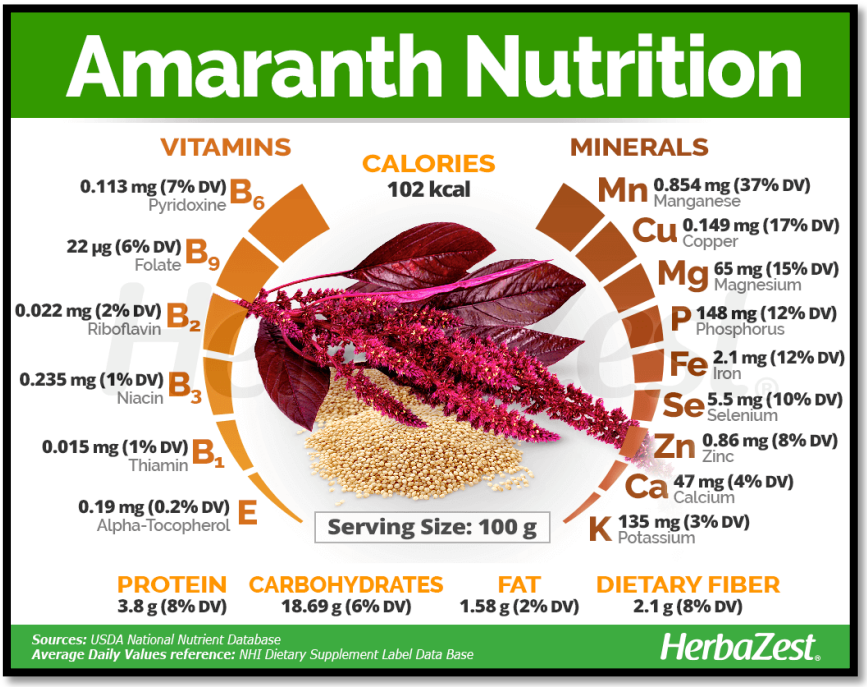

Fig. 4 Amaranthus Hybridus Nutrition.

3. CONCLUSION

According to our research, A. hybridus leaves have a low level of toxicants overall and a significant amount of proteins, lipids, fiber, carbohydrates, and calorific value in addition to mineral elements, vitamins, and amino acids. Therefore, it can be said that A. hybridus leaves can provide a substantial contribution to human nutrient needs and ought to be used as a supplement to other important sources of nutrients. However, the only standard used to evaluate this plant's nutritional worth should not be chemical analysis. Other factors must be taken into account, such as the impact of processing on the plant's chemical and nutritional value and the biological assessment of the plant's nutrient content to ascertain the nutrients' bioavailability. The same authors are currently conducting research on how processing affects the plant's chemical and nutritional qualities.

ACKNOWLEDGEMENT

I extend my gratitude to all the staff at Shivajirao Pawar College of Pharmacy Pachegaon, for their assistance and guidance in the preparation of this review article. A great thankful for **Miss. Nandini A. Patil** & **Dr. Megha T. Salve.**

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