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# Therapeutic and nutritive uses of *Macrotyloma uniflorum* (Lam.) Verdc. (Horsegram), a somewhat neglected plant of the family Fabaceae

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**ABSTRACT:** Underutilized legumes are a significant group of crops that have particular importance in subsistence farming and the nutritional security of resource-poor communities in developing countries. Horsegram [*Macrotyloma uniflorum* (Lam.) Verdc.], a lesser-known neglected legume, is one such crop that is mainly cultivated in Asian and African countries as a dual-purpose crop. This climate-resilient legume is well-known for its drought hardiness and favorable agronomic features that make it suitable for cultivating dry lands under poor soil fertility conditions. It has a nutritional value comparable to other commonly consumed pulses and serves as a cheap source of nutrition for unprivileged rural communities residing in inaccessible areas. In addition, horsegram has excellent therapeutic properties and is traditionally used to cure various conditions such as kidney stones, asthma, bronchitis, leukoderma, urinary discharges, heart diseases, and piles. Furthermore, it possesses anti-diabetic and anti-ulcer activity and can help in the dietary management of obesity due to the presence of beneficial bioactive compounds. This review summarizes the nutritional composition, antinutritional factors, medicinal properties, and the potential for horsegram to be exploited as functional/medicinal food for health benefits.

## 1. INTRODUCTION

Plants are an asset to us. They provide us with food, shelter, fuel, medicines, and many other important valuables. Medicinal plants and their phytoconstituents have been used in over 80% of herbal formulations since ancient times, and they account for approximately 95% of total drugs in India (Gautam, Katoch, & Chahota, 2020; Satyavati et al., 1987). The presence of various phytonutrients such as alkaloids (colchicine, lobeline, quinine, etc.), amino acids (tryptophan, methionine, isoleucine etc.) flavonoids (cyanidin, quercetin, delphinidin etc.), phenolic compounds (vanillic acid and caffeic acid etc.), phytosterols (plant sterols and stanols), proteins (globulin, glutelins, albumins, etc.) and saponins (QS 21 adjuvant, steroid alkaloid glycosides, triterpene glycosides, etc.) in plant extracts provides therapeutic properties and nutritional value which help in treating a variety of fatal diseases Gautam, Katoch, and Chahota (2020); D. Kumar et al. (2012, 2011). As a result, the therapeutic potential of these plants has long been studied (Gautam, Datt, & Chahota, 2020). Among angiosperms, the family Fabaceae (or Leguminosae) within the order Fabales is a large, economically and medicinally important family. According to the previous studies, the family Fabaceae, or legume family, has the highest number of plant species possessing anti-urolithaiatic potential (Ahmed et al., 2017; Gautam, Datt, & Chahota, 2020). Also, members of the family Fabaceae possess oestrogenic, antibacterial, antioxidant, anti-fungal, anti-feedant, and insecticidal activities (Wanda et al., 2015). Food legumes are considered the second-most important plant source that provides a balanced human diet (Bhartiya et al., 2015; Rakash & Rana, 2013) and nourishment to animals (Bhartiya et al., 2015; Bhatt & Karim, 2009).

Underutilized (or less utilized) crops are cultivated plants that were previously used for various purposes like obtaining nutrition, fibre, oil or as medicines but have now been used less and given less importance and value. Underutilized crops are highly significant as they provide nutritional security to poor people in developing countries, for example, *M. uniflorum* which is an underutilized legume and provides national security in terms of nutrition (Bhartiya et al., 2015; Tontisirin, 2014). *M. uniflorum*, formerly known as Dolichos biflorus, is a lesser utilized (Aiyer, 1990; Prasad & Singh, 2015) and has not been explored (Prasad & Singh, 2015; Reddy et al., 2008) food legume that is drought, salinity, and heavy metal stress tolerant (Bhardwaj & Yadav, 2012; Prasad & Singh, 2015). *M. uniflorum*, a member of the Magnoliopsida class is a poor man's pulse crop that is grown in water-stressed areas of Australia (southern hemisphere), India (northern hemisphere),

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Sri Lanka (northern hemisphere), and Burma (northern and eastern hemisphere) (L.H. Gupta et al., 2011; Siddhuraju & Manian, 2007). In India, *M. uniflorum* is grown in Himachal Pradesh, Sikkim, Maharashtra, Andhra Pradesh, Karnataka, and Tamil Nadu (Gautam, Datt, & Chahota, 2020; Kadam & Salunkhe, 1985; Prasad & Singh, 2015). It is a highly nutritious vegetable pulse crop known as Kulattha in Sanskrit, Gahot in Kumaon, and Garhwal; Gahot means "stone destroyer" in the early stages (Patel & Acharya, 2020; Pati & Bhattacharjee, 2013). This pulse crop is also known as "horsegram" because it is used as a powerful fodder for racehorses. It is a kharif crop whose growth requires low soil fertility and fewer inputs (Prasad & Singh, 2015; Witcombe et al., 2008).

Its seeds are bitter and acrid in flavour but contain high amount of protein, carbohydrates, essential amino acids, and energy. Furthermore, horsegram seeds have low lipid content but a high iron (Fe) and molybdenum (Mo) content (Bravo et al., 1998; L.H. Gupta et al., 2011). Its seeds are consumed whole or as a meal after being dry roasted and then boiled or fried (Chinta et al., 2008; ) (L.H. Gupta et al., 2011). Traditional uses of horsegram seeds include curing high blood cholesterol, cough, eye-related problems, enlarged spleen, fluor albus (or leucorrhoea), menstrual problems, and disintegrating phosphate ( $[PO_4]^{3-}$) or calcium ($Ca^{2+}$) kidney stones (Gautam, Katoch, & Chahota, 2020; Nithya, 2010). This review aims to summarize the high nutritional value and remedial properties of underutilized legumes. Additionally, it discusses their potential for use as nutraceuticals, food, and forage in malnourished and drought-prone areas of the world. There are many possibilities for further exploration of horsegram, including the discovery of new phytochemicals, therapeutic uses, and the development of low-cost functional and medicinal foods.

## 2. METHODOLOGY

The present appraisal has been compiled with the help of various relevant works of literature that are liberally available on the internet via NCBI, PubMed, Web of Science, Google Scholar, Scopus, etc.

## 3. BOTANICAL CLASSIFICATION

Kingdom: Plantae; Super division: Embryophyta; Division: Tracheophyta; Subdivision: Spermatophytina; Class: Magnoliopsida; Order: Fabales; Family: Fabaceae; Genus: *Macrotyloma*; Species: *Macrotyloma uniflorum* (Lam.) Verdc.

## 4. DISTRIBUTION

The plant is primarily grown in Africa, Mauritius, the West Indies, Australia, and some Asian countries such as Burma, Malaysia, and India (Jeswani & Baldev, 1990; Prasad & Singh, 2015) (Map A and B). In India, this crop is usually grown in Andhra Pradesh, Himachal Pradesh, Maharashtra, Karnataka, Sikkim, and Tamil Nadu (Gautam, Datt, & Chahota, 2020; Kadam & Salunkhe, 1985; Prasad & Singh, 2015) (Map B). Also, horsegram cultivation occurs as a major pulse crop in the villages of Almora, Bageshwar, Nainital, Pithoragarh, and Chamoli are situated in Uttarakhand (Bharathi & Anand, 2015). Figure 1 and Table 1 shows the distribution of *M. uniflorum*. (Bhartiya et al., 2015; Chakravarty et al., 2019; Ranasinghe & Ediriweera, 2017).

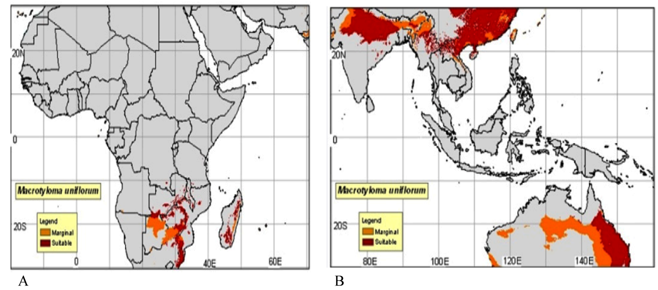


**Figure 1.** Map A. and B. Worldwide distribution of *M. uniflorum* (Ranasinghe & Ediriweera, 2017)

## 2. CHARACTERISTICS OF THE PLANT

### 2.1. Morphology

*M. uniflorum* is an annual herb which is sub-erect. It contains cylindrical stems that are slightly hairy to tomentose. It is 60 cm in height and has about 3.5–7.5 cm long trifoliate leaves (Figure 2A). It is a short-day and day-neutral plant that matures after planting in 120–180 days (Cook et al., 2005; Prasad & Singh, 2015). Its flowers are bisexual and cream-yellow with purple spots (Figure 2C). Pedicels are 0.3–0.5 cm long. Calyx is densely haired. Corolla has two larger appendages at the base and is vexillum. Pods measure 4.0-5.0 cm in length, are falcate-recurved, densely hairy, and have 4-6 seeds (Ahmed et al., 2016b) (Figure 2B). Seeds are shining brown, compressed, oval in shape, 4-6 mm in length, 3-5 mm in width, with faint mottling and small, scattered black spots (Figure 2D) (Google Sources). In the middle of the seeds, the embryo is present, which supplies nutrients. The morphological characters of *M. uniflorum* are given in Table 1.

### 2.2. Ecology and Cultivation

*M. uniflorum* can adapt to a wide range of temperatures (Prasad & Singh, 2015; Smartt, 1985) and requires less fertile soil and inputs. It is sown late in the rainy season in India. However, seeds that were sown in the first two weeks of August and September resulted in a higher yield of grain and straw than seeds sown in the first two weeks of October (Naik, 2001; Prasad & Singh, 2015). It was found that late sowing, i.e., after August 28 each year, resulted in lower yield of crops (Bajpai et al., 1990; Prasad & Singh, 2015). Ecology and cultivation along with other characteristics of *M. uniflorum* are summarized in Table 1 .

### 2.3. Nutritional composition

*M. uniflorum* is a legume crop that has a higher nutritional value. Its seeds possess saccharides (57.2%), proteins (22%), fats (0.50%), dietary fibres (5.3%), phosphorus (311 mg), calcium (287 mg), iron (6.77 mg), and calories (321 kcal) (Bhartiya et al., 2015; Gopalan et al., 1989). Its seeds also contain thiamine

**Table 1**
General information and characteristics of *M. uniflorum*

| Characteristics | Description | References |
|---|---|---|
| 1. Macrotyloma term - i. Origin ii. Meaning | i. Greek word – makros, tylos and loma ii. Makros mean large Tylos mean knob Loma means margin Due to presence of knob like statures on pods | Blumenthal et al. (1989); Ingle et al. (2021) |
| 2. Common name | a. Horse gram (English) b. Gahot (Kumaon and Garhwal) c. Kulattha (Sanskrit) d. Kurti-kalai (Bengali) e. Dolic biflore (French) f. Kerderkorn (German) g. Muthira (Malayalam) | Ahmed et al. (2016b) |
| 3. Taxonomy Confusion | Previous genera: Dolichos (given by Linnaeus) Present genera: Macrotyloma (given by Verdcourt in 1970) On the basis of – a. Style b. Standard c. Pollen characteristics | Fuller and Murphy (2018); Ingle et al. (2021) |
| 4. Distribution i. World ii. India | i. India, Africa, Australia, Burma, Malaysia, Mauritius, and West Indies | Jeswani and Baldev (1990); Prasad and Singh (2015) |
| | ii. Himachal Pradesh, Sikkim, Maharashtra, Andhra Pradesh, Karnataka, and Tamil Nadu | Gautam, Datt, and Chahota (2020); Kadam and Salunkhe (1985); Prasad and Singh (2015) |
| Cultivated species | Only found in India | Ingle et al. (2021) |
| Wild species | Found mostly in Africa | Ingle et al. (2021) |
| Cultivation | a. Sown late in monsoon season b. August to October c. Water-stressed areas d. As Kharif crop in India | Bhardwaj and Yadav (2015); Ingle et al. (2021) |
| Ecology | | |
| Precipitation | a. 40-90 cm rainfall (Irrigation not required in this condition) | Fuller and Murphy (2018); Ingle et al. (2021) |
| Soil | Laterite, loamy | K Kingwell-Banham and Fuller (2014); Ingle et al. (2021) |
| pH | Neutral | Ingle et al. (2021) |
| Organic matter | Medium level | Ingle et al. (2021) |
| Tolerate | Drought | Ingle et al. (2021) |
| Not tolerate | a. Frost b. Water logging | Ingle et al. (2021) |
| Morphology | | |
| i. Height | 30-40 cm | Neelam (2007); Ingle et al. (2021) |
| ii. Stem | Cylindrical, weak | Ingle et al. (2021) |
| iii. Leaves | 3.5-7.5 cm long, 2-4 cm broad, trifoliate, oval, round base | Ingle et al. (2021) |
| iv. Flowers | Creamish yellow or greenish yellow, 10-12 mm long | Ahmed et al. (2016b); Ingle et al. (2021) |
| v. Calyx | Contains densely matted wooly hair-like structure, 2-3 mm long tubes and 3-8 mm long lobes | Ingle et al. (2021) |
| vi. Ovary | Attenuated, covered by mat-like structure | Ingle et al. (2021) |
| vii. Pod | Pale, 6-8 mm long, 4-5 mm broad, small black dots, contain 6-7 seeds | Prodanov et al. (1997); Ingle et al. (2021) |
| viii. Seeds that can be consumed | Light red colour but mostly brown colour, ovoid, 4-6 mm long, 3-5 mm broad, contains small and scattered black dots in center | Ingle et al. (2021) |
| Other Characteristics | | |
| Production | Low | Kharkwal and Gupta (2003); Ingle et al. (2021) |
| Reason of Low Production | Less availability of area | D. Kumar (2006); Ingle et al. (2021) |
| Harvesting (as fodder crop) | Within 6 weeks after seeds sown | V Mohamed et al. (2004); Ingle et al. (2021) |
| Consumption | a. By boiling or frying b. Along with rice c. Consumed by tribal people (due to high medicinal value) | Prodanov et al. (1997); Bravo et al. (1999); Ingle et al. (2021) |
| Uses | a. Human consumption b. Fodder crop c. Green manure | Cravotto et al. (2011); Ingle et al. (2021) |
| Beneficial effects | a. Reduces many diseases b. Improves health | P Parthsarthi and Saxena (2013); Ingle et al. (2021) |
| Challenges in India Diversity Reason | Declining Change in socioeconomic condition of farmers | Bhartiya et al. (2017); Ingle et al. (2021) |
| Solution opted to tackle this challenge | a. Agricultural Research Institute of India conserving genetic diversity of *M. uniflorum* b. Since 1970, Indian Council of Agricultural Research (ICAR) and US Department Of Agriculture (USDA) collaborated with each other to conserve germplasm of *M. uniflorum* which resulted in collection of 1627 accession. | Ingle et al. (2021) |

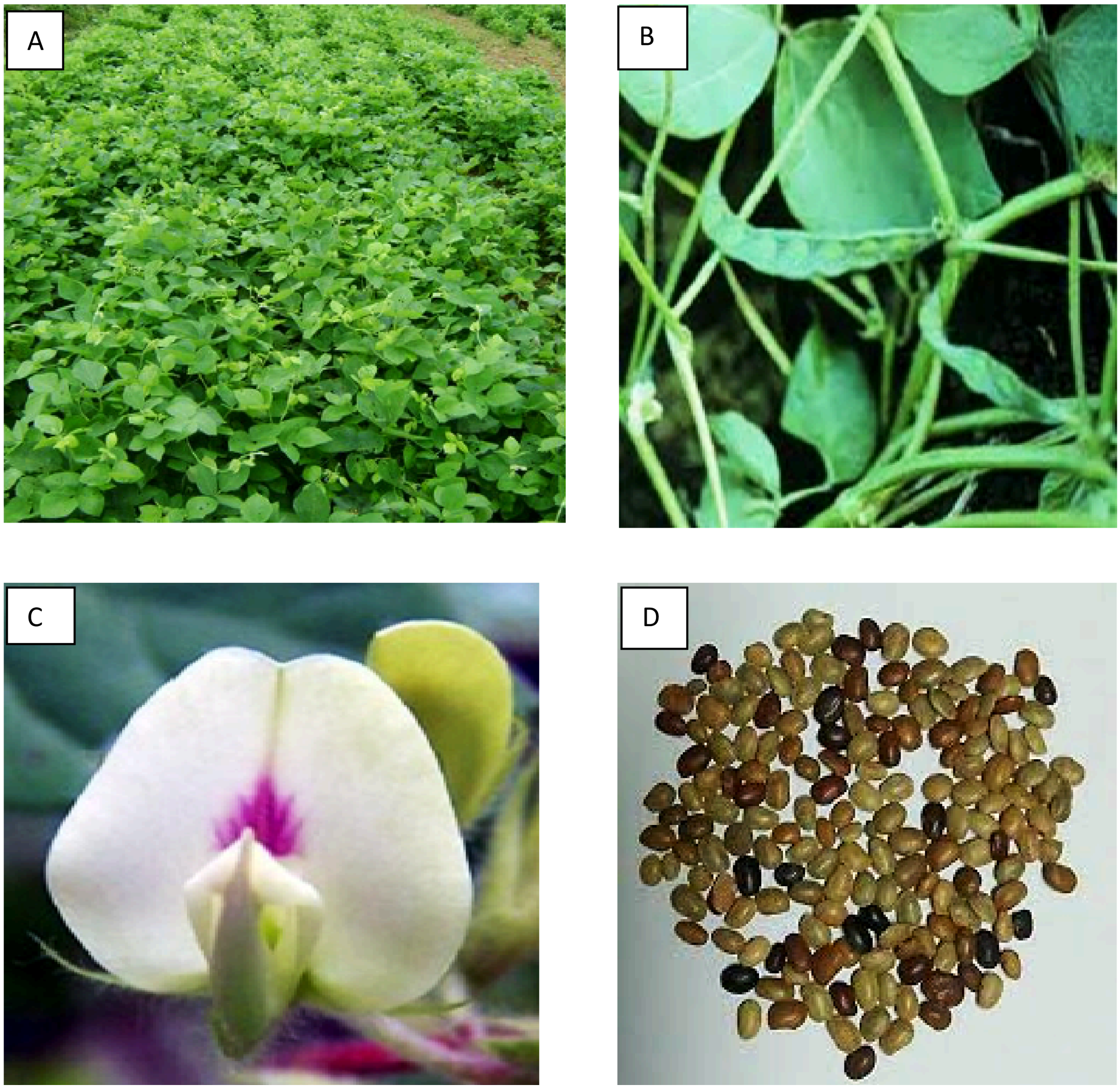


**Figure 2.** A. Field view of *M. uniflorum*; B. Plant with its Pods; C. Flower; D. Seeds (Bhartiya et al., 2017; Chakravarty et al., 2019; Rakash & Rana, 2013)

(0.4 mg), riboflavin (0.2 mg), and niacin (1.5 mg) per 100 g of dry matter (Bhartiya et al., 2015; Dhumal & Bolbhat, 2012). Its seeds are high in proteins, dietary fibres, micronutrients, and phytochemicals while low in fats (Bhartiya et al., 2015; Sreerama et al., 2012).

### 2.4. Carbohydrate

*M. uniflorum* seeds contain 57.2% carbohydrate. Whole horsegram seeds have a carbohydrate content of 51.9-60.9% and after the removal of the hull horsegram seeds have a carbohydrate content of 56.8-66.4% (Bhartiya et al., 2015; Sudha et al., 1995). Crude horsegram seeds contain 36 $\pm$ 1.17 g of starch per 100 g of dry matter, with approximately 85% digestible, 14.47% resistant, and 3.38% resistant and associated with insoluble dietary fibres (Bhartiya et al., 2015; Bravo et al., 1999). 6.38% of the total soluble sugars are present in horsegram seeds (Bhartiya et al., 2015; Bravo et al., 1999). An abundance of non-digestible carbohydrates is present in *M. uniflorum* which help in lowering glucose release into the bloodstream, thereby showing beneficial effects in managing diabetes; also, this resistant starch acts as a prebiotic (Bhartiya et al., 2015; Samanta et al., 2011) (Table 2).

### 2.5. Crude protein

Horsegram seeds are a good source of protein (22%). Horsegram is a cost-effective and abundant source of protein for both animals and humans (Bhartiya et al., 2015; Katiyar, 1984). Whole seeds of Gahot contain 17.9–25.3% protein, which is less than dehulled Gahot seeds, which contain 18.4–25.5% protein (Bhartiya et al., 2015; Sudha et al., 1995). The beneficial effects of amino acids and proteins are shown in Table 2.

**Table 2**
Beneficial effects of nutritive compounds found in *M. uniflorum*

| Nutritive components found in *M. uniflorum* | Beneficial effect | References |
|---|---|---|
| i. Carbohydrates | a. Slow and gradual digestibility b. Antidiabetic c. Prevent colorectal cancer d. Reduces risk of obesity e. Improves gut flora | Bhardwaj and Yadav (2015); Aditya et al. (2019); Ingle et al. (2021) |
| ii. Amino acids and proteins | a. Inexpensive source of protein b. Enhance Plasma Density c. Decreases protein energy malnutrition d. Increase in lean muscle mass e. Act as natural relaxant | Bhardwaj and Yadav (2015); Aditya et al. (2019); Ingle et al. (2021) |
| iii. Lipids | a. Presence of Phytosterol esters b. Antiulcer activity c. Combat acute gastric ulceration d. Shows hypolipidemic activity | Bhardwaj and Yadav (2015); Aditya et al. (2019); Ingle et al. (2021) |
| iv. Dietary fibers | a. Reduce serum cholesterol b. Reduce glucose content c. Decrease risk of cardiovascular diseases d. Decrease risk of gastrointestinal disorders and constipation | Aditya et al. (2019); Ingle et al. (2021) |
| v. Calcium | a. Make bones strong | Bhardwaj and Yadav (2015); Ingle et al. (2021) |
| vi. Vitamins | a. Promotes full growth | Bhardwaj and Yadav (2015); Ingle et al. (2021) |
| vii. Minerals | a. Decrease complications related to blood pressure | Bhardwaj and Yadav (2015); Ingle et al. (2021) |
| viii. Crystallizing inhibitors | a. Anticalcifying effect on calcium phosphate b. Removal and cure of kidney stones | Aditya et al. (2019); Ingle et al. (2021) |
| ix. Secondary metabolites (Polyphenols, tannins, flavonoids, saponins and alkaloids) | a. Antioxidant b. Free radical scavenging activities c. Decrease Ferric ($Fe^{+3}$) ions d. Positive cardiovascular effects e. Protection from ultraviolet (UV) rays. f. Protection from arthritis g. Protection from immune deficiency diseases h. Protection from ageing i. Stops calcium oxalate crystal formation j. Helps in treating cold k. Helps in curing throat infection and fever l. Reduces inflammation m. Possess antilithic activity | Bhardwaj and Yadav (2015); Aditya et al. (2019); Ingle et al. (2021) |

### 2.6. Dietary fibre

Dietary fiber is an important component in the human nutrition as it ensures proper gut function and has been linked to a lower risk of chronic conditions such as cardiovascular diseases, diabetes (primarily type 2 diabetes), and some cancers (like colon cancer and breast cancer). There are two different types of dietary fibres: soluble dietary fibre (SDF) and insoluble dietary fibre (IDF). Horsegram seeds have a total dietary fibre content of 28.8%, with IDF accounts for about 27.82% and SDF accounts for 1.13%, and their ratio accounts for 24.6 (Bhartiya et al., 2015; Khatoon & Prakash, 2004). The beneficial effects of dietary fibre are shown in Table 2.

### 2.7. Fat

Dehulled horsegram seeds have a higher crude fat content (0.81-2.11%) than whole (0.70-2.06%) seeds (Bhartiya et al., 2015; Sudha et al., 1995). Phytosterol esters present in horsegram lipids have a defensive and therapeutic impact on acute stomach ulcers caused by alcohol (Jayraj et al., 2000; ) (Bhartiya et al., 2015). The presence of phytosterol esters in horsegram lipids imparts anti-ulcer activity (Berger et al., 2004; Bhartiya et al., 2015) (Table 2). Gahot has a fat content of 0.6–2.6% (Bhartiya et al., 2015; Sreerama et al., 2010). Gahot seeds contain 72.49% unsaturated fatty acids (42.78% linoleic, 16.15% oleic, and 13.56% linolenic acid) (Table 3 and Figure 3, 4 and 5) and 27.5% saturated fatty acids (21.97% palmitic, 2.85% arachidic, 2.32% stearic acid, and 0.36% myristic), implying abundance of essential fatty acids and linoleic acid aids in treating diabetes and heart diseases (Bhartiya et al., 2015; Mishra & Pathan, 2011).

### 2.8. Moisture and ash content

Higher mineral content means higher ash content. A whole horsegram seed's moisture content is 11.55% and ash content is 3.0%–3.8%, while the moisture content of dehulled horsegram seeds is 9.73% and ash content is 2.7–3.4% (Bhartiya et al., 2015; Sudha et al., 1995). Whole and dehulled horsegram seeds contain 238 mg and 223 mg of calcium per 100 g of seed, indicating that it is a good source of calcium (Bhartiya et al., 2015; Sudha et al., 1995) (Table 2). Horsegram seeds have a moisture content of 11.39 % (Bhartiya et al., 2015; Krishna et al., 1997). Horsegram is used as a leafy vegetable (Bhartiya et al., 2015; Mandle et al., 2012). Horsegram leaves have a high mineral content of about 4.50% which is higher than other regularly consumed vegetables (1.5-2.4%).

The mean concentration of macro minerals (calcium, potassium, magnesium, phosphorus, and sulphur) in horsegram is between 1.3-14 milligrams, while the mean concentration of microminerals (copper, iron, manganese, nickel, and zinc) is between 1.0-95.0 microgram per gram of dry weight (Bhartiya et al., 2015; Morris et al., 2013). Horsegram crude seeds contain about 244–312 mg of calcium (Ca) and 5.89–7.44 mg of iron (Fe) per 100 g of seed, with bioavailability of 22.50–38.50 mg of Ca and 0.26-0.85 mg of Fe per 100 g of seeds under laboratory conditions (Bhartiya et al., 2015; Khatun et

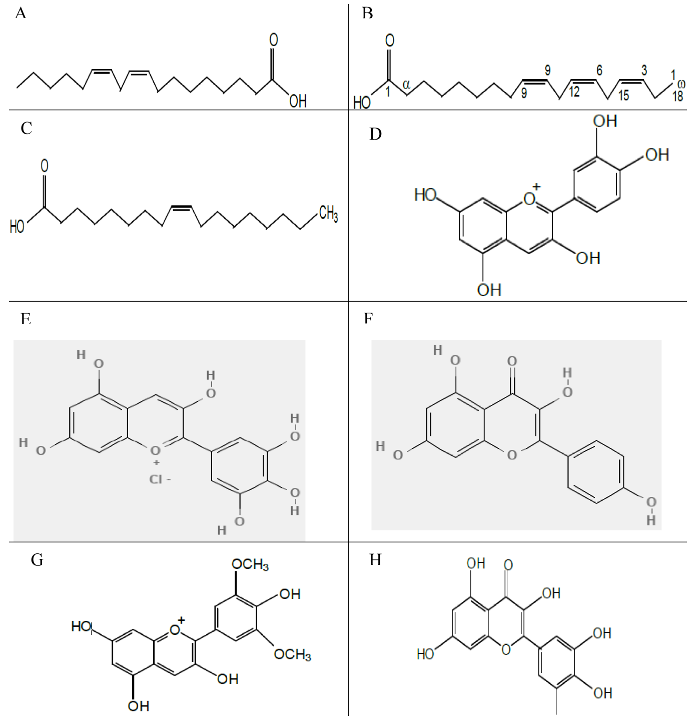


**Figure 3.** A – H. Structure of bioactive compounds found in *M. uniflorum* (Ahmed et al., 2016b); A. Linoleic acid, B. Linolenic acid, C. Oleic acid, D. Cyanidin, E. Delphinidin,F. Kaempferol, G. Malvidin, H. Myricetin

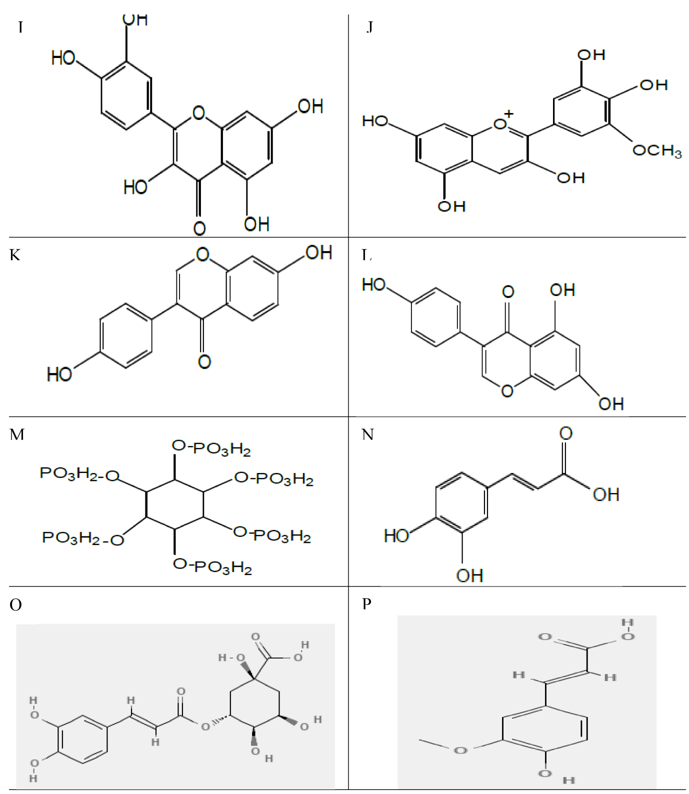


**Figure 4.** I – P. Structure of bioactive compounds found in *M. uniflorum* (Ahmed et al., 2016b); I. Quercetin, J. Petunidin, K. Daidzein, L. Genistein, M. Phytic acid, N. Caffeic acid, O. Chlorogenic acid, P. Ferulic acid

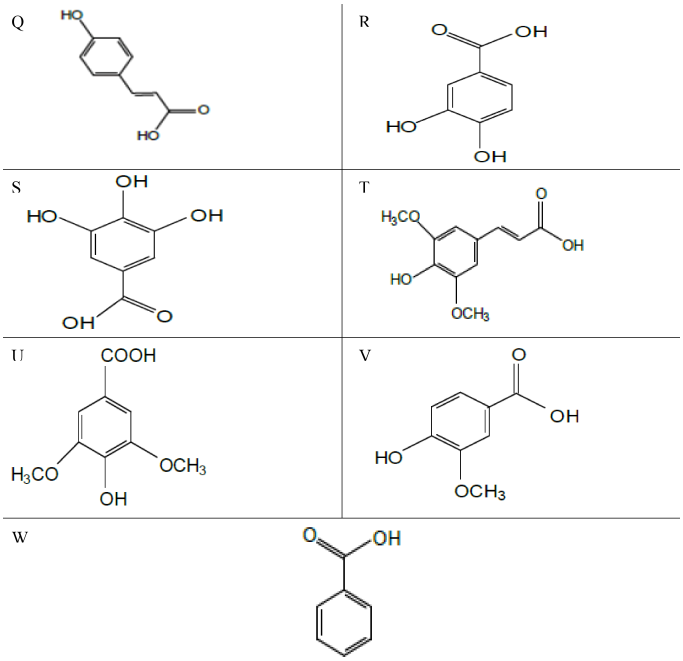

**Figure 5.** Q – W. Structure of bioactive compounds found in *M. uniflorum* (Ahmed et al., 2016b); Q. Para coumaric acid, R. Protocatechuic acid S. Gallic acid, T. Sinapinic acid, U. Syringic acid, V. Vanillic acid, W. Niacin

al., 2013). The beneficial effects of minerals are shown in Table 2.

### 2.9. Vitamins

Vitamins are a crucial part of our diet. They are needed in very little concentration for the body to function properly (Table 2). Both fat-soluble and water-soluble vitamins are present. *M. uniflorum* possesses water-soluble vitamins like vitamin $B_1$ (thiamine), vitamin $B_2$ (riboflavin), and vitamin $B_3$ (niacin) (Table 3 and Figure 5W). The concentrations of thiamine, riboflavin, and niacin in *M. uniflorum* are 0.38, 0.19, and 1.42 mg/100 mg, respectively (Ingle et al., 2021; Ryan, 1981).

Compared to other legumes, horsegram contain a lesser amount of vitamins. Lack of vitamins leads to several diseases such as beriberi and night blindness. Vitamin $B_1$ promotes cell growth, the production of new cells, and increases immunity. Vitamin $B_2$ displays antioxidant activity while vitamin $B_3$ raises the amount of good cholesterol in the human body ((Ingle et al., 2021; Ryan, 1981). After the germination of *M. uniflorum*, the content of vitamins $B_2$ and $B_3$ increases while $B_1$ decreases. After processing, the concentration of vitamins reduced in *M. uniflorum*.

### 2.10. Antinutritional factors

Antinutritional factors are found in pulses and cause a decrease in nutrient bioavailability (Bhartiya et al., 2015; Jain et al., 2009). Horsegram flour contains oligosaccharides (26.8 mg/g), polyphenols (14.3±0.4 mg GA/g), phytic acid (10.2±0.4 mg/g), and trypsin inhibitor activity (9246±18 TIU/g) (Bhartiya et al., 2015; Sreerama et al., 2010). The trypsin-inhibiting activity shown by horsegram makes it a functional food (Blanca et al., 2009; Ingle et al., 2021). Phytic acid found in *M. uniflorum* shows antioxidant and anticarcinogenic activities (Graf & Eaton, 1990; Ingle et al., 2021) (Table 3, Figure 4 M). Horsegram is rich in antinutritional compounds such as enzyme inhibitors, oligosaccharides, tannins, haemagglutinin activities, polyphenols and phytic acid, whose harmful activities can be decreased to produce beneficial effects by processing like de-husking, germination, cooking, and roasting (Bhartiya et al., 2015; Bolbhat & Dhumal, 2012; Kadam & Salunkhe, 1985; Sharma, 2011). Additionally, certain typical antinutritional substances like tannin, phenol, and phytic acid are now thought to have antioxidant properties that may have a positive impact on health.

### 2.11. Total free phenolics and tannins

Relatively to other legumes, gahot seeds are abundant in polyphenols (like vanillic acid, and caffeic acid) and tannin (Bhartiya et al., 2015; Kadam & Salunkhe, 1985). Phenolic compounds and tannins give taste, flavour, and appearance of foodstuffs (Pugalenthi et al., 2005) and also provide therapeutic advantages to humans (Alonso & Arellano, 2005; Bhartiya et al., 2015) (Table 2). Black seeds contain more tannin and phenol than brown seeds (Bhartiya et al., 2015; Siddhuraju & Manian, 2007). The most abundant phenolic acids in the extract of horsegram were p-coumaric acid and p-hydroxybenzoic acid which were found in concentration of 8.95 mg and 7.81 mg per 100 g of dried material (Bhartiya et al., 2015; Kawsar et al., 2008). There are 763.7 to 895.9 mg/100 g of tannins in gahot samples (Sudha et al., 1995). Total free phenolics are found at a concentration of 1.670 g/100 g (Bhartiya et al., 2015; Sundaram et al., 2013). Through the manifestation of its antioxidant, free radi$^{ca}$l scavenging, and metal ion chelating capacities, phenolic compounds found in *M. uniflorum* can play a significant role in disease prevention, consequently enhancing health (Borade et al., 1984; Ingle et al., 2021; Kawsar et al., 2008). Phenolic compounds help reduce the harmful effect of mutagens (Ingle et al., 2021; Lairon & Amiot, 1999) and show microcidal activities (Ingle et al., 2021; Sundaram et al., 2013). Phenolic acids found in *M. uniflorum* are shown in Table 3 ,Figure 4 N-P, and Figure 5 Q -V (Google Sources).

### 2.12. Flavonoids

Flavonoid is an essential compound that is present in legumes. Flavonoids express antioxidant activity. An abundant amount of flavonoids is found in *M. uniflorum*. Flavonoids found in *M. uniflorum* are kaempferol, quercetin, and myricetin while isoflavonoids found in M. uniflorum are daidzein and genistein [Table 3,Figure 3 D-H) and Figure 4 I-L)] (Google Source). The content of quercetin, kaempferol, and myricetin in M. uniflorum is 129.5 mg, 117.2 mg, and 35.5 mg/ 100 g

**Table 3**
Bioactive compounds found in *M. uniflorum*

| Class of Compound | Name of Compound | Chemical Formula | References |
|---|---|---|---|
| a. Fatty acids | Linoleic acid | $C_{18}H_{32}O_2$ | Ahmed et al. (2016b); Ranasinghe and Ediriweera (2017) |
| | Linolenic acid | $C_{18}H_{30}O_2$ | |
| | Oleic acid | $C_{18}H_{34}O_2$ | |
| b. Flavonoids | Cyanidin | $C_{15}H_{11}O_6{}^+$ | Ahmed et al. (2016b); Ranasinghe and Ediriweera (2017) |
| | Delphinidin | $C_{15}H_{11}ClO_7$ | |
| | Kaempferol | $C_{15}H_{10}O_6$ | |
| | Malvidin | $C_{17}H_{15}O_7{}^+$ | |
| | Myricetin | $C_{15}H_{10}O_8$ | |
| | Quercetin | $C_{15}H_{10}O_7$ | |
| | Petunidin | $C_{16}H_{13}O_7{}^+(Cl^-)$ | |
| c. Isoflavonoid | Daidzein | $C_{15}H_{10}O_4$ | Ahmed et al. (2016b) |
| | Genistein | $C_{15}H_{10}O_5$ | |
| d. Inositol phosphates | Phytic acid | $C_6H_{18}O_{24}P_6$ | Ahmed et al. (2016b) |
| e. Phenolic acids | Caffeic acid | $C_9H_8O_4$ | Ahmed et al. (2016b); Ranasinghe and Ediriweera (2017) |
| | Chlorogenic acid | $C_{16}H_{18}O_9$ | |
| | Ferulic acid | $C_{10}H_{10}O_4$ | |
| | Gallic acid | $C_7H_6O_5$ | |
| | Para coumaric acid | $C_9H_8O_3$ | |
| | Protocatechuic acid | $C_7H_6O_4$ | |
| | Synapinic acid | $C_{11}H_{12}O_5$ | |
| | Syringic acid | $C_9H_{10}O_5$ | |
| | Vanillic acid | $C_8H_8O_4$ | |
| f. Pyridinecarboxylic acid | Niacin | $C_6H_5NO_2$ | Ahmed et al. (2016b) |

of dry weight, respectively (Ingle et al., 2021). Daidzein and Genistein are present in *M. uniflorum* at concentrations of 22.2 mg and 100mg/100g, respectively (Ingle et al., 2021; Setchell, 1998; Sree et al., 2014). In the seed coat of *M.uniflorum* maximum amount of quercetin, kaempferol, and myricetin are found in comparison with cotyledon and embryonic axis. Isoflavonoids are present in higher concentrations in the embryonic axis in comparison with seed coat and cotyledon. Also, genistein is absent from the seed coat and cotyledon portion in *M.uniflorum* (Ingle et al., 2021).

Flavonoids protect seeds from infection by microbes and stresses caused by the environment by acting as phytoalexins. Isoflavonoids help decrease the occurrence of cardiovascular attacks, breast cancer, and prostate cancer. Isoflavonoids also play an important role in stopping the activities of tyrosine kinase and topoisomerases I and II which disrupts the growth of cells (Ingle et al., 2021; Mathers, 2002; Sengupta et al., 2012). The beneficial effects of secondary metabolites (Flavonoids, alkaloids, etc.) are shown in Table 2.

## 3. THERAPEUTIC AND NUTRITIVE USES: A DISCUSSION

### 3.1. Anti-microbial activity

Microbes are a cause of several diseases. Antimicrobial activity is very important as it helps to eliminate microbes thereby protecting from several diseases. Studies were done to investigate the antimicrobial activity of *M. uniflorum*. In a study, significant anti-microbial activity is shown by extracts of *M.uniflorum* seeds against Gram-positive bacteria- *Bacillus subtilis*, *Staphylococcus aureus*, and Gram-negative bacteria - *Escherichia coli*, and *Pseudomonas aeruginosa* (S.K. Gupta et al., 2005; Kawsar et al., 2008; Ram et al., 2004; Ranasinghe & Ediriweera, 2017).

In another study, methanol and ethanol extract of *M. uniflorum* was taken and its anti-microbial activity was evaluated with the help of the agar well diffusion method (Ahmad & Beg, 2001; Chakraborty & Abraham, 2016; Srinivasan et al., 2001). Nine pathogenic bacteria were used in this study (Chakraborty & Abraham, 2016). The zone of inhibition was checked after a period of incubation to evaluate anti-microbial activity. Results indicated that methanolic extract was able to inhibit the activities of gram–negative bacteria such as *Pseudomonas aeruginosa*, *Serratia sp.*, *Salmonella sp.*, *Klebsiella sp.*, and *Escherichia coli*.

The ethanolic extract inhibited fewer bacterial pathogens among nine test microbes compared to the methanolic extract. The zone of inhibition shown by ethanolic extract is prominent. The ethanolic extract inhibited the activities of *Klebsiella sp.* and Proteus sp. In this study, it was found that methanolic extract of *M. uniflorum* can inhibit both Gram-positive and Gram-negative bacteria. These studies prove that extracts of *M. uniflorum* possess anti-microbial activity (Table 4) (Google Scholar).

### 3.2. Antidiabetic effects

Type II diabetes is a lifelong disease that impairs the way the body regulates and uses sugar (glucose) as a fuel, eventually resulting in high blood sugar levels. Due to this high sugar level in the blood - cardiovascular, neurological, and immune system-related disorders can occur. Impaired secretion of insulin causes type II diabetes mellitus (previously known as adult-onset diabetes). In type II diabetes, high postprandial glucose levels are detected. To manage type II diabetes and minimize its repercussions, postprandial hyperglycaemia needs to be controlled (Ali et al., 2006; L.H. Gupta et al., 2011; Subramanian et al., 2008). To reduce postprandial hyperglycaemia, one approach is to prevent carbohydrate absorption after food intake. Pancreatic $\alpha$–amylases (E.C. 3.2.1.1) and other $\alpha$–glucosidases (E.C. 3.2.1.20) are responsible for digesting carbohydrates in the intestine. Complex oligosaccharides like acarbose block this enzyme which reduces the breakdown and absorption of starch after eating a meal (Davis et al., 2001; L.H. Gupta et al., 2011). The $\alpha$–amylase inhibitor plays a significant part in regulating and altering the activity of $\alpha$–amylase which eventually influences tests for blood glucose, serum insulin, and starch loading tests in animals and humans (L.H. Gupta et al., 2011; Puls & Keup, 1973). Plants and synthetic sources of $\alpha$–glucosidase inhibitors are used, and their screening is expanding.

L.H. Gupta et al. (2011) isolated $\alpha$-amylase inhibitor from *M. uniflorum* seeds and tested its anti-diabetic potential in mice induced by compounds -streptozotocin and nicotinamide to create a diabetic model. A carboxymethyl cellulose (CMC) column was used in this study to purify $\alpha$–-amylase inhibitor. Kinetic studies were conducted using pancreatic $\alpha$–amylase in mice and salivary $\alpha$–amylase in humans. Total serum cholesterol, aspartate aminotransferase (AST), and alanine aminotransferase (ALT) levels were found. Also, tissue samples of pancreas, kidney, and liver tissue were examined for pathogenicity. Mice in this study were divided into 5 groups: Group I contained control mice; Group II contained diabetic control mice that were given 2 percent starch solution; Group III contained mice that were given acarbose; Group IV contained mice that were given *M. uniflorum* $\alpha$–amylase inhibitor or MAI (1 mg/kg); and Group V contained mice that were given MAI (1 mg/kg) with 2 percent of starch solution, in which mice received oral doses of acarbose and MAI. The findings of this study revealed a decrease in the level of serum glucose in treated diabetic mice with fewer changes in pathology when compared to diabetic controls. *M. uniflorum* $\alpha$–-amylase inhibitor (MAI) was also discovered to inhibit both mouse pancreatic $\alpha$–amylase and human salivary–amylase (Table 4). MAI inhibited mouse pancreatic and human salivary $\alpha$-amylase in vitro in a non-competitive manner with low Ki values of 11 and 8.8 $\mu$M, respectively. This suggests that MAI has a strong affinity for both amylases. A significant decrease in serum total cholesterol was found in MAI and MAI + 2 percent starch solution treated mice in comparison with diabetic mice. Compared to control mice, the level of high-density lipoprotein was found elevated in MAI and MAI + 2% starch solution treated mice. Triglycerides, low-density lipoprotein, and very low-density lipoprotein levels did not change much in control mice and MAI and MAI + 2% starch solution treated mice. Also, levels of AST and ALT showed not much of a decrease in MAI, acarbose, and MAI + 2 percent starch solution treated group in comparison to the control group. Normal structure of the pancreas, kidneys, and liver is seen in non-diabetic mice, and diabetic control mice show decreases in islet size, tubular dilation, thickening of the glomerular basement membrane, interstitial inflammation, mesangial hyperplasia, and moderate inflammation of the liver, while MAI, acarbose and MAI + 2 percent starch solution-treated group show islets of usual size, minimal pathological changes in the kidney, and mild lobular inflammation in the liver. The effectiveness of MAI in treating non-insulin-dependent diabetes mellitus was discovered in this study due to its role in carbohydrate metabolism by binding to amylase, resulting in delayed digestion and absorption of carbohydrates. When MAI is used in combination with a 2 percent starch solution, it is more effective than using MAI individually, probably due to the induction of more amylase by the starch, resulting in more inhibition of amylase. It was found with these results that MAI reduces glucose levels in the blood and thus can be used for treating Type II diabetes mellitus (L.H. Gupta et al., 2011).

### 3.3. Anti-hypercholesterolemic effect

Hypercholesterolemia means an increased levels of low-density lipoprotein cholesterol (LDL-C) or non-high-density lipoprotein cholesterol. Hypercholesterolemia is a type of hyperlipidaemia. High levels of lipids (or fats) like cholesterol and triglycerides are called hyperlipidaemia. Hypercholesterolemia causes the heart disease like atherosclerotic coronary heart disease that had caused premature death globally and by 2010 was a major reason of death in India (D.S. Kumar et al., 2013; Verlecar et al., 2007). According to the World Health Organization (WHO), high cholesterol levels causes one-third (33.33%) of all cardiovascular disease globally, and 10 crore 50 lakh Americans have cholesterol levels that make them susceptible to cardiovascular disease (D.S. Kumar et al., 2013; Milias et al., 2006).

The main objective of reducing the high level of lipids in the blood is to decrease the occurrence of stroke, coronary artery, or cardiac diseases (D.S. Kumar et al., 2013; Smith & Pekkanen, 1992). Lipid-lowering medications lead to adverse effects on the body, in hepatic issues are a major side effect among many others (Brown, 1996; D.S. Kumar et al., 2013). Intake of allopathic medicine can give rise to diarrhoea, myositis, dry skin, gastritis, elevated uric acid levels in the blood, and abnormal hepatic functions (D.S. Kumar et al., 2013; Speight & Avery, 1987).

The use of herbs in treating hypercholesterolemia is very advantageous as it is effective in reducing levels of lipids, has fewer side effects, is inexpensive, and is available locally (Berliner & Heinecke, 1996; D.S. Kumar et al., 2013). Medicinal plants demonstrate hypolipidemic activity. Leaves of medicinal plants lower lipid levels by inhibiting hepatic cholesterol biosynthesis and reducing the absorption of lipids in the intestine. The therapeutic effect shown by *M. uniflorum* against hypercholesterolemia and obesity was demonstrated by D.S. Kumar et al. (2013). In this research, rats were used to test the anti-hypercholesterolemic effect of *M. uniflorum* extract by observing the animal's dietary intake, body weight increase, serum lipid panel, aspartate aminotransferase (AST or serum glutamate oxaloacetate transaminase or SGOT), alanine transferase (serum glutamate pyruvate transaminase or SGPT), and fat level of the body (D.S. Kumar et al., 2013; Ranasinghe & Ediriweera, 2017). Rats of the Sprague Dawley strain that were albino in colour and weighed 150 to 170 grams were used. Rats were divided into seven groups. Group I was given a standard diet. Group II was given a diet rich in fat (HFD) with the standard cholesterol-lowering drug – Atorvastatin in the concentration of 10 mg/kg, while Groups IV and V were given HFD with an ethanolic extract of horsegram in concentrations of 100 mg/kg and 200 mg/kg, respectively. Groups VI and VII were given HFD with an aqueous extract of horsegram in concentrations of 100 mg/kg and 200 mg/kg, respectively. *M. uniflorum* ethanol and water extracts were found to contain phenolic compounds, tannins, flavonoids, carbohydrates, and saponins. A substantial reduction in the level of triacylglycerol, bad cholesterols (LDL or low-density lipoprotein and very low-density lipoprotein or VLDL), total cholesterol, AST, and alanine transferase was found while the large increase in good cholesterol (high-density lipoprotein or HDL) was found when rats consumed ethanolic and aqueous extract of horsegram for 35 days. Furthermore, the ethanol extract-treated group had eliminated higher concentrations of cholesterol in their faeces than the aqueous extract-treated group. It was discovered that rats that were given a standard diet consumed less food than other groups. Intake of food decreases in extract-treated groups, which indicates that administration of extract leads to a reduction in appetite. In the extract-treated group, body weight reduction was found to be dose-dependent. The group treated with aqueous extract had a much lower body weight than the group treated with ethanolic extract. A water extract of *M. uniflorum* was found to reduce maximum body weight. Due to the reduction in weight of the extract-treated group, a huge amount of body lipid gets lost, and protein preservation takes place. As a result, protein increased while lipid decreased.

*M. uniflorum* extract had a moderate effect on hyperlipidaemia while lowering bad cholesterols, AST, and SGPT less effectively than standard cholesterol-lowering drugs. Both the water and ethanol extracts of *M. uniflorum* were able to reduce hypercholesterolemia. These extracts most likely boosted the breakdown of cholesterol to bile acid and decreased the absorption of cholesterol in the intestine. Furthermore, LDL receptor activity and faecal cholesterol excretion are increased by many phenolic compounds present in the extract of *M. uniflorum*, thereby making it capable of showing hypolipidemic and anti-hypercholesterolemic activity. This study suggested the effectiveness of an extract of M. uniflorum in treating hypercholesterolemia and obesity, thereby supporting folk information (Table 4).

### 3.4. Anti-helminthic activity

Because of its anthelmintic activity, *M. uniflorum* can aid in the elimination of worms (Philip et al., 2009; Ranasinghe & Ediriweera, 2017). Alcoholic extracts of Gahot seeds showed significant anti-parasitic activity against *Pheretima posthuma*, and the anthelmintic activity exhibited by the extract was comparable to that of standard, albendazole (Ranasinghe & Ediriweera, 2017; Sree et al., 2014) (Table 4).

### 3.5. Wound healing and anti-inflammatory effects

For faster healing and prevention of infection, proper dressing of open burn wounds is required. In a study on the experimental wounds of rats, a wound dressing material in sheet form was applied that contained fibrin that was physiologically clotted, collagen of fish scales, and extract of horsegram. Administration of extract of horsegram to wound dressing material expedited the repair of wounds and repressed cyclooxygenase-2 and inducible nitric oxide synthase expression, which ultimately diminished inflammation. These results indicate that the extract of *M. uniflorum* exhibits wound healing and anti-inflammatory effects (Muthukumar et al., 2014) (Table 4).

### 3.6. Cardioprotective activity

Ischemic heart disease is a major cause of mortality worldwide. Heart ischemic tissue produces reactive oxygen species and other free radicals that result in oxidative stress to the lipid layer of membrane, saccharides, and proteins which thereby causes alterations in the myocardium qualitatively and quantitatively (Burton et al., 1984; Panda et al., 2016). Long-term myocardial ischemia results in myocardial infarction. Myocardial infarction results in permanent destruction of the heart muscle. To cure ischemic diseases, reactive oxygen species scavengers can be used.

The phenolic acids in *M. uniflorum* are antioxidants that scavenge reactive species (Panda et al., 2016; Siddhuraju & Manian, 2007). Dietary factors have a significant impact on the likelihood of myocardial infarction and other cardiovascular diseases (CVD). An increase in CVD is seen when a high-fat diet is consumed instead of a grain-based diet. Consuming a diet rich in fruits, pulses, and vegetables decreases the chance of CVD. As *M. uniflorum* is abundant in polyphenols such as ferulic acid and p-coumaric acid and is low-priced, it should bead to people's diets.

Seed extract and phenolic acids particularly ferulic acid (FA) and p-coumaric acid (CA) of Gahot were taken to investigate their cardioprotective activity in rats with myocardial infarction caused by isoproterenol. The Wistar strain albino male rats weighing between 150 and 200 g have been utilized. It was found that FA is present at 0.4655% w/w and CA is present at 1.375% w/w in the seed extract of Gahot (Panda et al., 2016).

Gahot seed extract and its phenolic acids dramatically reduced malondialdehyde, total cholesterol, uric acid, triacylglycerol, C-reactive protein, and the serum marker enzymes that

**Table 4**
Therapeutic and nutritive uses of *Macrotyloma uniflorum*

| Therapeutic and nutritive uses | Plant Part | Extractor compounds | Effects | References |
|---|---|---|---|---|
| Antimicrobial activity | Entire plant | a) Methanolic b) Ethanolic | Inhibits – i. *Pseudomonas aeruginosa* ii. *Serretia sp.* iii. *Salmonella sp.* iv. *Klebsiella sp.* v. *Escherichia coli* Inhibits – i. *Klebsiella sp.* ii. *Proteus sp.* | C Chakraborty and Abraham (2016); R Ranasinghe and Ediriweera (2017) |
| | | c) Ethyl acetate | Inhibits – i. *Bacillus subtilis* ii. *Staphylococcus aureus* iii. *Escherichia coli* iv. *Pseudomonas aeruginosa* | Ram et al. (2004); S.K. Gupta et al. (2005); Kawsar et al. (2008);R Ranasinghe and Ediriweera (2017) |
| Antidiabetic activity | Seeds | $\alpha$–amylase inhibitor | i. Decrease in serum glucose level ii. Minimum pathological changes iii. Inhibit mouse pancreatic and human salivary $\alpha$– amylase | L.H. Gupta et al. (2011) |
| Anti- hypercholes-terolemic activity | Entire plant | Aqueous Ethanolic | Decrease in – i. Total cholesterol ii. Triglycerides iii. Low-density lipoprotein iv. Very low density lipoprotein v. Serum glutamate oxaloacetate vi. Serum glutamate pyruvate transaminase vii. Appetite Increase in – i. High density lipoprotein Fecal excretion of cholesterol level – Ethanol extract treated group > Water extract treated group | D.S. Kumar et al. (2013); R Ranasinghe and Ediriweera (2017) |
| Anti-helminthic activity | Leaves | Ethanolic | Inhibit – Pheretimaposthuma | Philip et al. (2009); Sree et al. (2014); R Ranasinghe and Ediriweera (2017) |
| Wound healing and anti-inflammatory activity | Whole plant | Plant extact | Increases wound healing process Decreases – i. Cyclooxygenase – 2 ii. Inducible nitric oxide synthases iii. Inflammation | Muthukumar et al. (2014) |
| Cardioprotective activity | Seeds | Seed extract and its phenolic acid (p-coumaric acid and ferulic acid) | Decreases – i. Isoproterenol – elevated levels of serum marker enzymes ii. Glutathione iii. Antioxidant enzymes Restores – i. Isoproterenol – depleted marker enzymes ii. Isoproterenol – altered electrocardiogram pattern and haemodynamic parameters | Panda et al. (2016) |
| Anti-obesity Anti-urolithiatic activity | Seeds, Leaves Seeds | Ethanolic extract Aqueous extract | Inhibits activity of pancreatic lipase Increases – i. Urine volume ii. Urolithiatic inhibitors like magnesium and citrate iii. Stone inhibitors iv.Crystal dissolution Decreases – i. Saturation of oxalate and calcium ions ii. Stone promoters iii. Calcium oxalate nucleation iv. Calcium oxalate aggregation and growth | Vadivelu et al. (2019) Das et al. (2005); Ahmed et al. (2016a); Chaitanya et al. (2010); Patel and Acharya (2020) |
| | | Methanolic extract | Decreases – Stone promoters Increases – Stone inhibitors | Chaitanya et al. (2010); Patel and Acharya (2020) |

were increased by isoproterenol such as aspartate transaminase, and lactic acid dehydrogenase. The extract also restored the level of glutathione, antioxidative enzymes, and marker enzymes that were reduced by isoproterenol.

Administration of seed extract and phenolic acid of Gahot to rats with myocardial infarction led to recovery of ECG pattern and hemodynamic parameters. In this study, it was found that seed extract of Gahot possessed a significant cardioprotective effect (Table 4). It was speculated that the cardio-protective effect of Gahot extract is probably due to the strong antioxidative properties of phenolic acids found in its seeds. These phenolic acids rescue cardiac muscle from the damaging effects of isoprenaline (Panda et al., 2016). Good antioxidant activity is observed in ferulic acid and p-coumaric acid due to the presence of phenolic methoxy and phenolic hydroxyl groups in them, respectively. Additionally, FA and CA side chains that were unsaturated easily form phenoxy radicals stabilized by resonance thereby increasing the antioxidant activity of FA and CA.

*M. uniflorum* contains abundant protein, complex carbohydrates, and dietary fibre. Essential minerals and nutrients are present in it. The presence of low fat, cardioprotective activity, and the above-mentioned nutritional components of *M. uniflorum* makes it suitable for prescription for cardiac and obese patients.

### 3.7. Anti-obesity

Obesity is a universal problem caused by consuming more food and spending less energy, which leads to the accumulation of fats in muscle, adipose cells, liver, islets of Langerhans, and other parts of the body that play a role in metabolism. Obesity ultimately causes coronary heart disease, cancer, glucose intolerance, dyslipidaemia, and metabolic-associated fatty liver diseases (Vadivelu et al., 2019). Worldwide, obesity affects 600 million people, and cases of overweight are found in 19 billion adults (Vadivelu et al., 2019; Wang et al., 2016). Because of a diet high in energy and a modified lifestyle, the chances of becoming obese have increased (Hasani-Ranjbar et al., 2013; Vadivelu et al., 2019).

Many anti-obesity drugs are found but they cause serious side effects which lead to the use of medicinal plants and their crude extracts and compounds isolated from them to bring about weight reduction and avert obesity caused by diets (Matson & Fallon, 2012; Vadivelu et al., 2019). *M. uniflorum* is used to cure anti-obesity in the traditional system of India.

In a study, ethanolic extracts of Gahot leaves (EMUL), seeds (EMUS), and seeds and leaves were coupled together (ESLC) to evaluate whether they work against obesity (Vadivelu et al., 2019). The potential of these extracts to inhibit the in vitro activity of pancreatic lipase (PL) was seen. Also, the effect of *M. uniflorum* extract on male albino Wistar rats that were administered a diet rich in fat was seen. The results showed that EMUL inhibited PL activity by 46.2%. EMUS depicted a 47.8% inhibition of PL activity. ESLC depends on dose to inhibit PL activity. 61.1% inhibition of PL activity was shown by the standard drug orlistat, and 58.9% inhibition of PL activity was shown by ESLC when taken at 50 g/mL. ESLC showed significant inhibition of PL activity with an IC50 value of 30$\mu$g/mL. ESLC activity was comparable to the drug orlistat. ESLC also showed hepatoprotective activity by decreasing liver enzyme levels. When *M. uniflorum* leaves and seeds are used in combination, the obesity of rats administered with a diet rich in fat decreases (Table 4). This proves that *M. uniflorum* can be used to cure obesity.

### 3.8. Anti-urolithiatic effect

Urolithiasis is characterized by the development of urinary calculi, which are composed of calcium oxalate, calcium phosphate, 20% magnesium ammonium phosphate, uric acid, cystine, and other crystals in the urinary tract (Ahmed et al., 2017; Gautam, Datt, & Chahota, 2020; Vidhya et al., 2013).

Development of stones in the urinary system takes place due to complex processes such as an increase in stone-producing substances above saturation point(supersaturation), crystallization or nucleation, growth and aggregation of crystals to a clinically relevant size, and retention inside the tubules of the kidney (Gautam, Datt, & Chahota, 2020; Yadav et al., 2011).

The third most widespread disease is urolithiasis. The formation of urinary stones block the urinary tract which results in serious infection and bleeding (Gautam, Datt, & Chahota, 2020; Hajzadeh et al., 2007). Synthetic drugs such as diuretics and narcotic analgesics are available for the treatment of this disease, but overconsumption of these drugs causes serious problems. So, natural remedies are preferred. Natural drugs reduce the chances of recurrence of diseases because natural drug have antioxidant potential (Binu & Vijayakumari, 2014; Gautam, Datt, & Chahota, 2020; Santhoshi et al., 2015). *M. uniflorum* is widely used in the Indian traditional system to cure urolithiasis. It undoubtedly possesses high potential for the treatment of urinary stones. In research, adult albino male rats of the Wistar strain were administered ethylene Glycol induced urolithiasis, and the impact of water extract of horsegram seeds were investigated and positive results were seen (Patel & Acharya, 2020). Water extract from horsegram seeds inhibited EG-induced urolithiasis by increasing urine volume, decreasing calcium ($Ca^{2+}$) ion and ethanedioate ($C_2O_4{}^{2-}$) concentration, and preventing calcium oxalate stone formation in the urinary system.

In addition, urolithiatic inhibitors such as citrate and magnesium (Mg) increased in rats administered with water extract, confirming *M. uniflorum*'s anti-urolithiatic potential (Patel & Acharya, 2020). Chaitanya et al. (2010) reported similar anti-urolithiatic activity in methanolic and aqueous extracts of seeds due to a decrease in stone promoters and an increase in stone inhibitors.

In an in vitro study, it was found that an aqueous extract of *M. uniflorum* seed decreases calcium oxalate crystallization, agglomeration, and proliferation and enhances the solubilization of crystal (Ahmed et al., 2016b; Das et al., 2005).

All of these findings indicate that water extract of seeds of *Macrotyloma uniflorum* possesses significant anti-urolithiatic activity (Table 4). In another study, *M. uniflorum* seeds were taken from various regions of the Himalayas in Himachal Pradesh, India. These seeds were then taken and tested for their ability to inhibit the formation of crystals of calcium oxalate. Additionally, antioxidant and amino acid profiles were created (Gautam, Datt, & Chahota, 2020) . Nucleation, artificial urine, and agar-gel overlay methods were used for testing water, ethanol, and 50% ethanol extracts of *M. uniflorum* and then the results were compared with marketed products.

Results indicated that maximum inhibition of calcium oxalate crystals was depicted by an aqueous extract of Sundernagar seeds, which is roughly 45 % in nucleation and 24% in an artificial urine method. Also, compared to alcohol and hydro-alcohol extracts of *M. uniflorum*, Sundernagar, and Rampur seeds were better. The aqueous extracts of Sundernagar and Rampur seeds inhibited the formation of calcium oxalate crystals in the range of 9.0±0.81 mm. Of all the samples that were taken of *M. uniflorum*, aqueous extract, and buffer revealed the maximum potential for inhibiting calcium oxalate crystal, after which hydro alcohol and alcohol followed. 11 amino acids were found in Sundernagar seeds. Additional amino acids found in Sundernagar seeds were arginine, asparagine, and methionine. Secondary metabolites of *M. uniflorum* have been found to inhibit the formation of calcium oxalate crystals. High-altitude seeds had a higher antioxidant capacity. According to these studies, *M. uniflorum* has a lot of potential for treating kidney stones.

### 3.9. Uniflorum AS FUNCTIONAL FOOD AND FEED

Horsegram is a legume that has great potential as both a food source and feed for animals. It has been suggested by experiences worldwide that its nutritious composition, medicinal properties, and indomitable pest resistance make it a rich yet cheap source of food, fodder, fuel supplement, and green manure. The U.S. National Academy of Science (NAS) has identified horsegram as a potential food source for the future. With the inception of the nutraceutical concept and health consciousness among the masses, there has been an increase in the utilization of potential antioxidants from legumes, including horsegram. Its consumption reduces the risk of intestinal diseases, diabetes, coronary heart disease, and prevention of dental caries, etc., due to the presence of bioactive compounds. Raw horsegram seed, in particular, is a rich source of antioxidant activities that are concentrated more in the seed coat of the seeds. Therefore, consumption of food items prepared with unprocessed raw horsegram seeds may have more health benefits for hyperglycemic individuals (Bhartiya et al., 2015).

## 4. CONCLUSION

Horsegram is a significant food and feed crop that has traditionally been grown in arid regions of the developing world. It is often considered a minor, neglected, underexploited, or poor man's pulse. Its inherent ability to withstand various climate conditions makes it a suitable alternative in the current era of climate change. Horsegram is a storehouse of therapeutic and bioactive compounds, as well as excellent nutritional quality, making it a wholesome food that should be included in the regular diet. Although the western world has recently recognized the health benefits of horsegram, the Indian ”Ayurvedic” system has known about its ability to prevent and cure various diseases for centuries. Moreover, there is still great potential for this legume to be explored in terms of its chemo profile, pharmacology, biological evaluation, toxicological consequences, innate health-promoting aspects, and many undiscovered phytochemicals. It is necessary to promote and support initiatives that make the most of this indigenous underutilized legume in addressing food and nutritional security concerns.

## 5. LIMITATION AND FUTURE PROSPECTS

Though every effort has been taken to give all-inclusive information regarding the *Macrotyloma uniflorum* in this study, it is possible that some information was overlooked due to the lack of reprints and internet resources. However, in its current state, this page will be useful to anyone seeking a more full understanding of the medicinal and nutritional uses of *M. uniflorum*.

## 6. CONFLICTS OF INTEREST

There are no conflicts of interest relevant to this article, according to the authors.

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## AUTHOR CONTRIBUTIONS

AA - Research concept and design, SS, PB - Collection and/or assembly of data, SKS, PB - Data analysis and interpretation, SS - Writing the article, SKS, AA - Critical revision of the article, SS, SKS, AA, PB - Final approval of the article.

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