

A Comprehensive Review of *Macrotyloma uniflorum*: Nutritional Composition, Health Benefits, and Potential Applications.

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❖ ABSTRACT

Macrotyloma uniflorum, commonly known as horse gram, is an underused pulse that holds great potential as a supply of nutrition and functional compounds. This review paper aims to provide a comprehensive overview of the nutritional composition, Pharmacological activities, health benefits, and potential applications of Macrotyloma uniflorum.

Horsegram has a high amount of protein, dietary fibre, and a variety of vital minerals and vitamins that make up its nutritional profile. Horsegram also has a high content of antioxidants, flavonoids, and phenolic compounds, all of which contribute to its potential health advantages. Horsegram intake has the potential to help manage a number of chronic conditions, including diabetes, obesity, cardiovascular problems, and gastrointestinal disorders, according to many studies.

The review investigates the possible health advantages of Macrotyloma uniflorum, emphasising its function in controlling blood sugar, managing weight, lowering cholesterol, and antioxidant activity. Horse gram's medicinal potential is further increased by the presence of bioactive substances that include anti-inflammatory, antibacterial, diuretic, antiobesity, analgesic, anaphylactic action, and anticancer activities.

In conclusion, this review paper presents a comprehensive evaluation of Macrotyloma uniflorum, highlighting its nutritional composition, health benefits, and

potential applications. The findings underscore the significance of horse gram as a valuable functional food ingredient and encourage further additional investigation of its therapeutic properties for human health and well-being.

KEYWORDS: *Macrotyloma uniflorum*, horsegram, antioxidants, flavonoids, phenolic compounds, poor man's pulse, traditional and medicinal plant.

❖ INTRODUCTION

Several old traditional medical systems have used medicinal plants extensively. They are abundant in bioactive chemicals, making them valuable raw materials for the creation of pharmaceuticals. They have also been a focus of research for the development of novel medications.^{1,2,3} Food legumes rank as the second-most major group of crops, behind cereals, which have been a vital part of balanced human food for millennia and is regarded as the second-most important source of plants for human and animal nourishment.⁴ Horsegram, also recognised as *Macrotyloma uniflorum* (Lam.), is a cattle feed and pulse crop native to tropical Africa and Southeast Asia. However, it is acknowledged that the principal center of origin for cultivated species of Horsegram is in southern India.^{5,6} The Greek word "makros," from which the term "Macrotyloma" is derived which signifies large, combined with "tylos," meaning knob, and "loma," meaning margin. This nomenclature alludes to the prominent knobby features found on the pods of the plant.^{7,8}

Horsegram is a food item having medicinal properties in traditional Ayurvedic cuisine. The seeds are dry, acidic, scorching, and bitter. It has an astringent, diuretic, tonic effect. Conventional uses of its decoction include treating leucorrhoea and irregular menstrual cycles in women.⁹ It is advised as part of a weight loss regimen for people with jaundice or water retention. It is considered adequate for maintaining body temperature in the winter and is useful in cases of iron deficiency.¹⁰ Seeds of *M. uniflorum* are mentioned in ancient Indian literature like Charak Samhita and Sushruta Samhita regarding the old Indian medical system as a remedy for abdominal lumps, bronchial asthma, hiccups, piles, and also in managing excessive sweating.¹¹ Different plant parts, including the leaves, seeds, and flowers, are used to treat diabetics, stones in the kidneys, urine discharges, asthma, bronchitis, and other cardiac diseases.¹²

Highly reactive free radicals, especially oxygen-derived radicals, have the ability to oxidise cellular biomolecules such as nucleic acids, enzymes, proteins, lipids, and carbohydrates, which may negatively affect immunity and cause cell death and tissue damage. These radicals are produced by exogenous chemicals or endogenous metabolic processes in the human body.^{10,13} In many pathogenic ways, oxidative damage contributes to human illnesses. Numerous diseases, including malignancy, emphysema, cirrhosis, coronary artery disease and arthritic conditions have been linked to oxidative damage.¹⁴ By using substances like ascorbic acid, tocopherol, and glutathione or catalysts like superoxide dismutase (SOD) and catalase, almost all organisms are well protected from harm caused by free radicals.¹⁵ Much emphasis has been paid to the use of antioxidants, especially natural antioxidants, to safeguard the human body from damage from oxidative stress caused by free radicals. Antioxidants play a critical role in oxidative damage. Antioxidants from food shield the body from free radicals like reactive oxygen species.¹⁶

❖ Taxonomy [7]

Macrotyloma uniflorum Linn.

- Kingdom – Plantae
- Class – Magnoliopsida (Dicotyledons)
- Subclass – Rosidae
- Order – Fabales
- Family – Fabaceae
- Subfamily – Faboideae
- Tribe – Phaseoleae
- Subtribe – Phaseolinae
- Genus – *Macrotyloma* (Wight & Arn) Verdc
- Species - *Macrotyloma uniflorum* (Lam.) – horsegram

❖ Vernacular names / common names [17]

- | | |
|----------------------|---|
| • Sanskrit | Kulattha |
| • Marathi | Kulath, Kultthi |
| • Hindi | Gaheth |
| • English | Horsegram, Madras gram, poorman's pulse |
| • Bengali | Kurti-kalai |
| • Kumaon and Garhwal | Gahot |
| • Kannada | Huruli |
| • Malayalam | Mutira |
| • Manipuri | Ngakijou manbi |
| • Nepali | Gahat |
| • Tamil | Akkamini, Amalaikkanni, kollu |
| • Telugu | Ulavalu |
| • Chinese name | Bian Dou |

❖ Botanical Description

Horsegram is a plant that climbs and may grow as high as 60 cm. It grows annually and has a perennial fibrous rhizome stem. The stem is heavily coated with white hairs. It has a slender, erect stem with numerous branches. The plant has a tap root that develops a branching root structure with rounded, smooth nodules. The microorganisms in these nodules have the capacity to trap nitrogen. Horsegram leaves are complex and arranged alternately. They have lance-shaped stipules and are trifoliate. The length of the petiole, which joins the leaf to the stem, ranges from 1 to 7 cm. The ovate and elliptical leaflets have rounded to sharp apices

and bases. On both surfaces, the lateral leaflets vary in hairiness from glabrescent (nearly hairless) to asymmetrical. Horse gram's blossoms are short, measuring only 6-12 mm in length. They are grouped in supplementary racemes and have a cream-yellow colour with a purple mark. The blooms are bisexual and zygomorphic (bilaterally symmetrical). There are two appendages at the flower's base.^{18,19}

Horse gram's fruit might be a linear, oblong pod that is 3–8 cm long and 4–8 mm wide. The acuminate (pointed) tip of the pod slopes upward towards the apex. It has glabrous (hairless) borders and is initially densely hairy before becoming sparsely hairy. The dehiscent, or splitting open when ripe, smooth or warty pod contains five to ten seeds. The seeds have a form that is either trapezoidal, oblong, or somewhat rounded. They are 6-8 mm in length and 3-4 mm in breadth. The seeds are silky and weigh approximately 4 grams per 100 seeds.²⁰

❖ . Geographical Description

A plant species named as *Macrotyloma uniflorum*, which is native to Southeast Asia, is commonly grown in Sri Lanka, India, and other tropical areas. The Indian subcontinent, which includes Bangladesh, Nepal, and India, is where it is mostly farmed. States like Andhra Pradesh, Telangana, Tamil Nadu, Karnataka, Maharashtra, and Rajasthan all grow it in India.²¹ Another significant horse gram producer is Sri Lanka. Geographically, *Macrotyloma uniflorum* may flourish in semi-arid to tropical places with a range of climate conditions. It is especially well suited to hot and arid climates. Both cultivated and wild varieties of the plant are present.²²

❖ Chemical Constituents:

• Carbohydrate

About 50-60% of dry weight comprises of carbohydrates only. it contains both digestible and non-digestible sugars. Starch is upto 22-45% of total carbohydrate content of horsegram. Dietary fibers are about 4.3-25% and Oligosaccharides upto 1.8-18%.^{23,24,25}

• Protein

Macrotyloma Uniflorum seeds loaded with proteins and known as cheap source of plant-based protein. Range of protein content is 18-28.5%. Seed cotyledon constitute about 89% and seed coat contain 10% of total protein. Amino acids like Lysine, arginine, histidine, valine and leucine. amino acids and proteins hold antioxidant, antimicrobial activities of horsegram.^{26,27}

• Vitamins

A relatively little quantity of vitamin is needed for human development. They are crucial to the human body's regular operation. there are 3 types of water-soluble vitamins like vitamin B1 (Thiamine), vitamin B2 (riboflavin) and vitamin B3 (niacin).²⁸

- **Minerals**

Leguminous plants are good source of minerals. Phosphorus present in form of phytic acid in legumes. Horsegram includes about 57% of total phosphorus. Seeds of horsegram rich in Iron. It has significantly low amount of sodium, zinc, manganese.²⁹

❖ **LIST OF BIOACTIVE COMPOUNTS PRESENT IN *MACROTYLOMA UNIFLORUM***^{30,31,32,33}

CLASS OF COMPOUND	SUB-TYPES OF BIOACTIVE COMPOUNDS
1. Flavonoids	Quercetin Myricetin Kaempferol
2. Isoflavonoids	Daidzein Genistein
3. Phenolic acids	caffeic acid 3,4-dihydroxy benzoic acid p-coumaric acid vanillic acid sinapic acid chlorogenic acid ferulic acid syringic acid
4. Fatty acids	hexanoic acid hexadecanoic acid
5. Phytosterols	stigmasterol β-sitosterol
6. Anthocyanidins	cyanidin petudin, delphinidin malvidin
7. Saponins	Soyasaponins Glycine max saponins Diosgenin
8. Other Phenolic compounds	Catechins Protocatechuic acid
9. Pterocarpan	Dolichin A Dolichin B

❖ Pharmacological Activities

1) Antioxidant

Superoxide dismutase, catalase, and glutathione content in rabbits improved significantly after treatment with an ethanolic extract of horse gram. Horsegram leaf extract demonstrated strong in-vitro evidence of antioxidant activity in the numerous free radical scavenging assays it underwent, including superoxide radical scavenging assays, ferric reducing antioxidant power test (FRAP), and reducing power assay. These radicals helped in the control of diabetes mellitus mostly by inhibiting intestinal α -glucosidase and α -amylase.^{34,35}

2) Antimicrobial activity

Horsegram has been used to treat infectious and bacterial disorders. When extracted from seed extract using methanol, a few active ingredients shown notable effectiveness against several test organisms. *Shigella dysenteriae*, *Shigella sonnei*, *Fusarium equiseti*, *Macrophomina phaseolina*, *Colletotrichum corchori*, *Diplodiatheo bromae*, *Salmonella typhi*, *Escherichia coli* M. uniflorum seed extracts showed significant activity against *B. subtilis*, *E. coli*, *S. aureus*, and *Pseudomonas aeruginosa*^{36,37,38,39}.

3) Antihypercholesterolemic and Anti-obesity activity

In its clinical testing on human subjects, the alcoholic extract of horsegram seeds was proven to be helpful in regulating the loss of weight and to be able to suppress fat accumulation and lipogenesis. Horse gramme extract's antihypercholesterolemic effect is examined in animals (rats) by examining its effects on food intake, serum glutamate oxaloacetate transaminase (SGOT), weight growth, serum lipid profile, and body fat.^{40,41}

4) Anti-ulcer activity

Antiulcer activity of *M. Uniflorum* (horsegram) was studied on experimental gastric ulcer models in albino wistar rats. Horsegram has historically been utilised as an ulcer-healing and gastro-protective medication.

The hydroalcoholic seed extract of *M. uniflorum* has notable anti-ulcer efficacy using a stress-induced ulcer model and pyloric ligation.⁴²

5) Antidiabetic activity

Horsegram seeds have the ability to inhibit alpha-amylase, which is why they reduce salivary amylase in humans as well as pancreatic amylase in rats. Additionally, it decreased the amount of blood glucose in diabetic mouse models. Horsegram seed legumes' methanolic extract has anti-lipidemic and anti-diabetic effects in rats with streptozotocin-induced diabetic hyperlipidemia⁴³. According to this type of research study, adding raw horsegram (not their sprouts) to a diabetic person's regular diet may be beneficial. For patients with hyperglycaemia, the amount of nutrients in raw, natural horsegram seeds may be higher than in horsegram sprouts.⁴⁴

6) Antihelmintic activity

Humans are right now primarily affected by helminth infections and are spread through the food, water, and air we breathe. They are brought on by human intestinal parasitic worms, which produce poisons and take resources from their hosts' bodies.¹¹ The anthelmintic properties of *M. uniflorum* seeds make them useful for eradicating parasitic worms. The anthelmintic activity of the alcohol extracts of *M. uniflorum* seeds was examined. These extracts had comparable anthelmintic activity to the standard and were highly effective against *Pheretima posthuman* albendazole.⁴⁵

7) Anti-inflammatory activity

Carrageenan is the chemical agent which triggers paw edema in albino rats due to which inflammation of the rat's paws happened. At a dosage of 50 mg/kg, 70% DME (methanolic extract of *Dolichos biflorus* seeds) demonstrated a 73% suppression of paw edema after three hours.⁴⁶ Secretory phospholipase A2 (sPLA2) is inhibited by *M. uniflorum* aqueous extracts of the coat and pulp using an invitro approach as a result of its anti-inflammatory characteristics. The drug extract had equal potency in eliminating the in vivo mouse paw edema prompted by PLA2, and it successfully countered indirect haemolytic activity.^{47,48}

8) Anti-allergic activity

Research results showed that ethanolic extracts of horse gram at concentrations of 280 mg/kg and 560 mg/kg had effective anti-allergic activity in mice, demonstrating strong inhibition of milk-induced leucocytosis

and eosinophilia. Furthermore, rats pre-treated with the extract exhibited protection from degranulation. In addition, when the rodents were given doses of 100, 200, along with 400 mg/kg, there was a notable decrease in paw volume following 0.5 to 4 time intervals. These findings indicate that further research on this specific plant extract may be warranted for possible therapeutic applications.^{11,49}

9) Antiurolithiatic and Anticalcifying Activities

In kidney stone mainly solidification of calcium phosphates and calcium oxalates takes place. it was found that horsegram seed extract contain at least two components which inhibits the crystallization of calcium phosphate and oxalate. these ingredients are heat stable, dissolves in water and non-proteinous part.⁷

The horse gram extract has been found to be effective in the treatment of urolithiasis, and its efficacy is equivalent to that of cystone-like marketed formulations.⁵⁰ The extract is a potent dissolver of calcium oxalate crystals and decreases their size significantly.⁵¹ In addition, the supplement was also found to increase renal excretion of calcium and phosphate in ethylene glycol-fed rats. Results showed that both the aqueous and alcohol extracts reduced urinary oxalate levels, with the alcoholic extract being more effective than the aqueous form. These findings demonstrate that supplementation with both forms of horse gram extract can lower stone formation levels significantly in calculogenic rats.^{52,53}

10) Diuretic activity

Methanolic horsegram seed extracts were tested for diuretic activity in mice. At 300 mg/kg and 500 mg/kg, the extract produced higher urine volumes (1.33 0.13 and 2.66 0.31) than the drug furosemide (20 mg/kg), which was tested in the experiment.^{11,52}

It was found that ethanolic seed extracts of *M. uniflorum* increased urine volumes and electrolyte contents like bicarbonate, chlorides, sodium, and potassium in albino rats when administered at doses of 200 mg/kg and 400 mg/kg, respectively, thus exceeding the effects of a control dose of furosemide (5 mg/kg)^{47,50}

11) Hepatoprotective activity

Researchers studied rats to assess the protective effect of a hydroalcoholic extract from the seeds of *Macrotyloma uniflorum* (MUSE) on ethanol-induced hepatotoxicity. After administering 4g/kg ethanol per or a single time a day for 21 days, the researchers administered MUSE (250 and

500 mg/kg) or silymarin (100 mg/kg) orally to the rats for 28 days. This treatment started 7 days before ethanol was introduced into their system⁵⁴ Strong antioxidant ferulic acid demonstrated to be a successful hepatoprotective agent with no negative consequences in alcohol- and PUFA-induced liver toxicity as well as in CCl₄-induced acute liver damage.^{55,56} P-coumaric acid is another phenolic acid that is most abundant in horse gram. This substance showed to be a potent hepatoprotective that enhanced nearly all hepatic damage markers affected by CCl₄.⁵⁷ The hepatoprotective activity of hydroalcoholic seed extract of horsegram was found against paracetamol induced hepatotoxicity in wistar albino rats.⁵⁸

12) Anticancer activity

Horsegram should be used as an effective food to enhance dietary status in people since its extracts have demonstrated anti-cancer activity in opposition with human osteosarcoma cells (MG-63). Horse gram extracts in methanolic as well as ethanolic forms were tested for their ability to fight cancer in the MG-63 cell line. Cell viability was lowered and there was some anti-cancer activity in methanolic extracts. Additionally, at a 200 µg/ml concentration, methanolic and also ethanolic extracts produced cell viability of 82 and 74%, correspondingly.⁵⁹ Multiple types of Bowman-birk inhibitors (protease inhibitors) can be found in horse gram seeds. Proteinase inhibitors are crucial in the management of proteases.⁶⁰ The anticipated ability of Bowman-Birk type inhibitors (BBIs) to lower carcinoma formation makes them crucial for human health.^{61,62} BBI have the inherent potential to slow down serine proteases, which are involved in the development of cancer.⁶³

13) Anti-HIV activity

The two pterocarpanes such as Dolichin A and B purified from seeds of *M.uniflorum* (horsegram). Pterocarpanes are natural isoflavonoids with anti-HIV properties, making them the second-largest of their kind. To evaluate their potential effectiveness, two ligands, namely Dolichin A and also Dolichin B, were docked with three replication enzymes: reverse transcriptase, protease, and integrase. Investigation indicated that protease enzyme had a greater capacity than the other two enzymes, namely reverse transcriptase and integrase for binding to both ligands.^{11,64}

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