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HORSE GRAM (*MACROTYLOMA UNIFLORUM*): NUTRACEUTICAL PULSE CROP: A REVIEW

Rahul R. Kashid* and Santosh M. Talekar

PG, Department of Botany, Kesharbai Sonajirao Kshirsagar College Beed, MS.

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***Corresponding Author**
Rahul R. Kashid
PG, Department of Botany, Kesharbai Sonajirao Kshirsagar College Beed, MS.

ABSTRACT

Macrotyloma uniflorum (Lam.) Verdc commonly known as horse gram is a kind of legume of tropics and subtropics. Present review was undertaken to collect information on medicinal uses and nutritional values of *M. uniflorum*. In Ayurveda pharmacodynamics properties of *M. uniflorum* are Kashaya Rasa, Laghu, Ruksha, Tikshna Guna, Ushna Veerya and Katu Vipaka. Various medicinal preparations such as Dhanyamla and decoctions are prepared using seeds of *M.uniflorum.* It is mainly used as a tonic, astringent, diuretic and also recommended in rheumatism, neuralgia and other several diseases. Horse gram seeds are rich in natural phenols; mostly phenolic acids, flavonoids and the major anti-oxidants. Horse gram is considered as animal fodder and its full potential as a part of human diet has not been exploited completely. It can be consumed as seeds, as sprouts or as meal by itself. Horse gram is a well-known, inexpensive, underutilized source of nutrients like protein (22-24%). Seeds contain carbohydrates (57.2%), fat (1.1%), vitamins, minerals (3.2%) and good amount of soluble fibres. *Macrotyloma uniflorum* contains major bioactive constituents are acids like phenolic acid, phytic acid, proteinease enzymatic inhibitors have significant metabolic and physiological effects. Horse gram is very useful in treating kidney stones, weight loss, diabetes, cold, fever, cholesterol, throat infection, piles and jaundice and water retention. Used in weight loss diet and also because of rich in proteins(20%), because of low acceptable taste and flavor of cooked products it is used only by the farming community and low-income peoples, and called as underutilized, less expensive nutritional plant Extract of these seeds shows potent anti-adipogenic, anti-hyperglycemic anti-hypercholesterolemic activities. It acts against oxidative stress.

KEYWORDS: *Macrotyloma uniflorum*, Phytoconstituents, Hyperglycemic activity, Anti-oxidants, Food.

INTRODUCTION

M. uniflorum seeds are known as the poor man's pulse crop in Asian countries, especially India. It is commonly called as 'hulga' used for both food and fodder. The use of dry seeds of horse gram is limited due to their poor cooking quality. Recently, the US National Academy of Sciences recognized this legume as an upcoming potential food resource. In horse gram seeds are the edible part of the plant and consumed as a whole (boiled) seed, as sprouts, as a curry or as whole meal in Asia, popular especially in southern Indian states.

Macrotyloma uniflorum also described as *Dolichos biflorus* L. in the literature. Horse gram sprouts are used in eliminating kidney stones. It also helps in lowering cholesterol levels and could play a role in antioxidant. *Macrotyloma uniflorum* is commonly used as food for horses, because of this it named as horse gram. It is mainly cultivated in Myanmar, Sri Lanka, India, Bangladesh, West Indies etc.

Horse gram soup is popular dish in Telangana and Andhra Pradesh; it is served in most of the Telugu speaking people's weddings and ceremonies and tastes wonderful with boiled rice. Horse gram is used in special kinds of dishes in Kerala. Horse gram is commonly used in Tamil dishes, including kollu chutney, kollu porial, kollu avial, kollu sambar, and kollu rasam in Tamil Nadu. Horse gram is often used to make Kulith Usual, pithla and laddu in Maharashtra, and specifically the coastal Konkan region and Goa. It is used to make popular dishes like Kulitan Saaru, Kulitan Upkari, Kulitan Ghassi and idli like preparation called Kulitan Sannan.

Recent researchers reveals that many phytoconstituents such as proteins, vitamins, minerals, carbohydrates, terpenoids, tannins, phenols, flavonoids can protect human against diseases for which it is studied extensively to establish their efficacy and to understand the underlying mechanism of their action. Secondary plant metabolites have biological properties such as antioxidant activity, anti-inflammatory, stimulation of the immune system, anti-microbial activity, modulation of detoxification enzymes, decrease of platelet aggregation and modulation of hormone metabolism and anti-cancer property.

Therefore, the present review is an attempt to compile the best available information in the scientific literature about the medicinal significance of horse gram. Horse gram, besides being intrinsically vast in carbohydrate and protein content, also abounds in essential trace minerals like iron, molybdenum and calcium. These ensure optimal energy, muscle strength, regulated red blood cell synthesis and fortified bones. Moreover, it also supplies ample amounts of the B vitamins that guarantee the normal metabolic functioning of cells.

Hence, it comes as no surprise that horse gram is being widely consumed globally today, in the form of the sprouted or boiled seeds, as a health drink made with the ground powder, as well as in traditional Indian dishes like dals, soups and salads.

ORIGIN AND DISTRIBUTION

Native place of horse gram is the old-world tropics and indigenous to India. Around 2000 BC, there is an investigation report of archaeological department revealed that the use of horse gram as food supplement particularly in India, that the proof of origin. The genus of horse gram *Macrotyloma* contains 25 species indigenous to Asia and Africa. The main primary origin of *Macrotyloma uniflorum* as cultivated plant is in the plains and hills of low attitude extending southwards in the Western Ghats in south west India, mainly in Sahyadri hills.

During the time of Neolithic period, through counter migration of human beings, horse gram cultivation is spread over in all over India, particularly in northern and western parts of the India. In India it is grown in the states of Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Karnataka, Chhattisgarh, Maharashtra, Orissa, Bihar, Jharkhand, Uttar Pradesh and in the foot hills of Uttaranchal and Himachal Pradesh.

TAXONOMIC DESCRIPTION

Horse gram is cultivated as a low-grade pulse crop in southern Asia, mainly from India to Myanmar. It is also grown as a forage and green manure in many tropical countries, especially in Australia and South-East Asia. Horse gram, the self-pollinated crop, belongs to Fabaceae family. It is an annual herb, stem erect and branched, leaves alternate, petiolate, stipulate, trifoliolate, axillary inflorescence, flowers bracteate, bisexual, corolla papilionaceous. Yellow or greenish yellow flowers with violet blot on the standard are borne singly. Pods are 5-8cm long and 3-9mm wide with 5-8 seeds. *Macrotyloma uniflorum* is the

cultivated annual form which has wider pods. It is drought resistant but cannot withstand water logging.

BIOACTIVE COMPOUNDS

Horse gram contains various compounds that can cause various biological actions in the humans, including both useful and harmful side effects. The undesirable ones are to be considered as anti-nutrients. The presence of antinutritional factors, such as phenols, tannins, phytic acids and flatulence causing oligosaccharides are now being considered as potential anti-oxidants. These anti-nutrients cause a number of positive health effects such as a decrease risk of intestinal diseases (gallstones, diverticulosis, constipation and colon cancer), coronary heart disease and prevention of dental caries and treatment of diabetes. Saponins and another common class of antinutrients compounds have been reported to show hypocholesterolemic as well as anticarcinogenic effects.

Phytic Acids

Phytic acid or inositol hexaphosphate IP6 is a simple ringed carbohydrate with six phosphate groups attached to each carbon (a bio active sugar molecule) and a major form of phosphorylated inositol. Phytic acid exists in the form of free acids, phytate, or phytin and all of these forms are interchangeable. The concentration of phytic acid in horse gram revealed a significant quantity in embryonic axe fraction.

Phenolic Compounds

Phenolic compounds have a greatest beneficial interest on human health due to presence of antioxidant property, such as protection of oxidative damage. The principal phenolic compounds of horse gram seeds are flavonols such as quercetin, kaempferol, and myricetin, vanillic, p – hydroxybenzoic, and ferulic acids. The phenolic acids are a large family of secondary metabolites having either derivatives of benzoic acid or of cinnamic acid, which are commonly found as esters of caffeic and quinic acids and are responsible for various beneficial effects in a multitude of diseases.

Flatulence Factors

Raffinose family oligosaccharides (raffinose, stachyose and verbascose) alpha galactosyl derivative of sucrose, a low molecular weight causes accumulation of gas, discomfort, diarrhoea, pain and cramps after digestion. The cotyledon fractions contain higher

concentrations of oligosaccharides (raffinose, stachyose and verbascose), accounting for 39% of the total soluble sugars.

Proteinase Inhibitors

Protease is a group of enzymes whose catalytic function is to hydrolyse (breakdown) peptide bonds of proteins. Proteases, is an indispensable for maintenance and survival of the organisms but have potentially damaging role in higher concentrations, thus its activities needto be regulated. trypsin, chymotrypsin, elastase, chymase, cathepsin G, plasmin, thrombin and subtilisin are classical examples of functional serine proteinases.

Nutritional Values of horse gram (*M. Uniflorum*)

1. Protein content

Horse gram is the most protein-rich lentil found on the planet. The seeds have twice the protein content as of cereal grains. Mean protein value of horse gram seeds is almost equivalent to winged bean (*Psophocarpus tetragonolobus*), gram (*Cicer arietinum*) and soybean (*Glycine max*) (Gopalan *et al.*, 1989, Mushtari *et al*., 1977).

2. Carbohydrate (CHO) content

M. uniflorum seeds contain common and abundant forms of CHO, viz sugars, fibers, and starches. The digestibility of starches as a legume is lower than that of cereal. Contain less carbohydrate (55- 65%) and energy compared to cereals. CHO available in *M. uniflorum* seeds has low glycemic index (Prasad *et al.*, 2015).

3. Fatty acid content

Saturated fatty acids level in the seeds of *M. uniflorum* is considerably low. It is about 72.49% unprocessed seeds and about 71.99% in toasted seeds. Seeds are rich sources of Linoleic acid, an essential fatty acid. Raw seeds contain 45.58% and toasted seeds contain 40.33% of Linoleic acid. (Morris *et al.*, 2013).

4. Dietary fiber content

Whole grains are the best sources to get fiber into a balance diet. Fibers are of two types, soluble and insoluble. Horse gram seed contains 28.8% total dietary fibers, mainly insoluble dietary fiber (IDF) 27.82% and soluble dietary fiber (SDF) 1.13% with IDF: SDF 24.6. (Bhartiya *et al*.,2015) Horse gram flour contains 16.3% total dietary fiber (14.9% insoluble and 1.4% soluble and 2.2% resistant starch). (Khatoon *et.al*, 2004) Seeds of *M. uniflorum*

contain more insoluble dietary fiber than kidney bean (*Phaseolus aconitifolius*) (Sreerama *et al*., 2012).

5. Micronutrient content

Horse gram has the highest calcium content among pulses. As a legume, Horse gram is deficient in methionine and tryptophan, though it is an excellent source of iron and molybdenum (Kawale *et al*., 2005, Kirtikar *et al*.,1991).

6. Anti-oxidant source

The unprocessed horse gram seed is loaded in polyphenols, flavonoids and proteins, the major anti-oxidants which are also available in fruits and other food materials. The greater part of anti-oxidant properties is limited to the outer coat of seed and its removal would eliminate these properties.

Incentives of Horse Gram (*M. Uniflorum*)

1. Traditional Medicine

Horse gram powder does wonders in treating various health issues such as asthma, bronchitis, urinary problems, jaundice, peptic ulcer, haemorrhoids and even menstrual problems. It is also beneficial for extracting phlegm, and controlling fever.

2. Glowing Skin

The astringent properties of horse gram are helpful in treating skin disease leukoderma. It is also used as a facial pack to prevent skin problems and clean the skin.

3. Controls Diabetes

Scientists from the Indian Institute of Chemical Technology have found that eating unprocessed, horse gram seeds (raw, unsprouted) following a meal can reduce the glycemic index, by slowing down carbohydrate digestion and reducing insulin resistance.

4. Promotes Weight Loss

The seeds of horse gram have natural qualities that work as fat burners. It can reduce the LDL cholesterol and increase the HDL cholesterol. Studies have proven that horse gram seeds can directly attack the fatty tissues stored in the body. It is favourable in melting body fat and gives a proper shape to the body.

5. Improves Sperm Count

The calcium, phosphorus, iron and amino acids in horse gram boost the sperm count. These minerals positively act on the male reproductive system, increasing blood flow to those organs, while the amino acids augment enzyme activity, which in turn assures optimal generation of sperms.

6. Protects Liver Functions

The raw seeds of horse gram are a powerhouse of potent plant substances, namely flavonoids and polyphenols. These compounds confer hepatoprotective properties towards the liver and gall bladder, safeguarding their key roles in filtering and purifying the blood and detoxifying chemicals in the body.

7. Treats Kidney Stones

Kidney stones occur due to crystallization of calcium phosphate salts in the body. Horse gram seeds, being infused with powerful antioxidants, play a central role in inhibiting this salt hardening process. Thus, it is very efficacious in eliminating harmful free radicals from causing injury to healthy kidney cells. Horse gram is also a dynamic ingredient in promptly remedying kidney disorders.

8. Diarrhoea

Horse gram consists of good amount of fiber which helps with digestion and soaking up additional fluids from the intestine and the stomach. This reduces the occurrence of diarrhoea and loose motion, and allows normal bowel movements to happen. One should have a handful of pre-soaked horse gram legumes early each morning, which encourages the digestive system to work better.

9. Conjunctivitis

The person suffer from conjunctivitis, use water of pre-soaked horsegram seeds overnight, to wash eyes with it. The antioxidant levels in the water help combat the infection and keep the eyes soothed and calm, without the irritation. Thrice a day the water should be used to wash the eyes with.

10. Menstrual Disturbances

Menses problems are very disturbing, painful and energy draining. For overcoming this painful situation, the soup of horse gram or have salads which helps bring down the levels of

irritation related with menstrual disturbances. In irregular menstrual cycles or excessive bleeding, it is the high iron content in horse gram which will help maintain the levels of haemoglobin in the body. This is why, holistic experts recommend horse gram to women with menses issues.

11. Cholesterol

Horse gram helps bring down the levels of LDL or bad cholesterol in the bloodstream. Bad cholesterol levels which stuck in the veins would be removed when horse gram is consumed, the levels of lipids in it that work its magic.

12. Constipation

Constipation is caused due to the lack of fiber in the diet, lack of water intake, lack of minerals and also due to an unhealthy lifestyle, stress and many more reasons. This happens when the intestines and the stomach lining just above the duodenum are not in a position to expand and contract normally for the waste matter to get released. Since horse gram has powerful nutrients in it and also has plenty of fibre too, it can help combat the problems of constipation. Horse gram in such cases should be pre-soaked and eaten as a salad in raw form.

13. Piles

Piles happen when the veins in the rectum swell up and turn inflamed or painful. Instead of rushing to the pharmacy for medication and treatment, holistic experts recommend the use of horse gram. Soak a cup of horse gram overnight and consume the water the next day, and eat the horse gram raw as a salad embellishment too. The roughage in it along with the fiber helps treat piles effectively.

14. Skin Rashes and Boils

Horse gram can also be used as a topical face pack to treat rashes, boils and disorders of the skin to some extent as well. This is because it is antimicrobial and antibacterial, and has plenty of antioxidants in it along with minerals to nourish, replicate the healthy lipid layers of the skin and more.

15. Common Cold and Fever

The ancient scholars of Ayurveda have recommended the consumption of horse gram when you have fever, coughs and cold, bronchial problems and asthma too.Horse gram should be

consumed as soups, which helps relieve the congestion and makes the nasal tracts open up by allowing the mucus membranes to soften up and melt. This helps with easy breathing since the required nutrients are boosting the metabolism of the body and the immunity too.

16. Urinary Discharge

Women suffering from urinary discharge can also suffer from embarrassment too. This is especially when urinary discharge is thick, inconsistent at times, foul smelling and continuous in some cases. There could be pains, infection and inflammation around the cervix and the vagina too. This happens when there is an irritation to the lining of the membrane, and the discharge can be foul smelling or thick, with a quantity increase when puberty hits or when sexual arousal is at its peak. Ayurveda opines, one should soak a handful of horse gram overnight in a bowl of water, and boil it the next day. This water should be consumed thrice a day to treat symptoms of the same.

17. Diabetes

Scientists from the Indian Institute of Chemical Technology have found that unprocessed raw horse gram seeds not only possess anti-hyperglycemic properties but also have qualities which reduce insulin resistance. This is possible since horse gram has the power to display ways to combat the formation of hyperglycemic properties in the body. In turn, horse gram helps bring down insulin resistance in the body too. Blood glucose levels are brought down and controlled, and it can help reduce the carb digestion rates as well, in turn bringing down the levels of blood glucose too. This is why it is used as a super food to treat type 2 diabetes in most cases.

18. Digestion

After a hearty meal, should feel acidic or don’t feel easy on the stomach within minutes to an hour or more; chances are you are suffering from indigestion pangs. This can lead to issues such as GERD and acid reflux, and this is what can make you feel uncomfortable too. This is why, horse gram is recommended to be the first thing in the morning on an empty stomach. This helps encourage the digestive tract and makes digestion an easy affair.

19. Leucorrhoea

Leucorrhoea is known to be a common and a normal discharge from the vagina. It can have a change in its consistency or colour, and often is related with pains, infection and inflammation around the cervix and the vagina too. This happens due to an irritation to the

lining of the membrane, and the discharge can be foul smelling or thick, with a quantity increase when puberty hits or when sexual arousal is at its peak. Ayurveda opines, one should soak a handful of horse gram overnight in a bowl of water, and boil it the next day. This water should be consumed thrice a day to treat symptoms of leucorrhoea.

20. Ulcers

Horse gram can be very beneficial in treating various forms of ulcers, but not gastric ulcers. There are lipids in horse gram that come in very handy when the legume is consumed by those that suffer from peptic and mouth ulcers. In Ayurveda, it is shown that mashed horse gram when consumed twice a day releases the lipids much needed for the body to heal itself from the ulcers.

Pharmacological activities of Horse gram (*M. Uniflorum*)

1. Analgesics and anti-inflammatory effect

Aqueous extracts of *M. Uniflorum* coat and pulp by in vitro method for inhibition of human secretory phospholipase A2 (sPLA2) as a function of anti-inflammatory activity. The extract effectively neutralized indirect hemolytic activity and showed similar potency in neutralizing the in vivos PLA2 induced mouse paw edema. (Giresha *et al.*, 2015).

2. Anticalcifying activity

In vitro effect of the immature seeds of Dolichosbiflorus on crystallisation of calcium phosphate shared significant results. They noticed that the anticalcifying activity was lost completely by treating with activated charcoal, which was not recovered or eluted by solvent. (Peshin *et al.*,1995).

3. Anti-choliolithic activity

M. uniflorum seed exerted anticholithogenic influence by decreasing the formation of lithogenic bile in mice. Both the methanolic and acetone extracts (ME and AE) were capable of decreasing cholesterol hyper-secretion into bile and increasing the bile acid output. The maximum effect was found in the AE as it decreased the papillary proliferation of gallbladder and hepatic fatty degeneration. Antioxidant property of polyphenol and tannin in AE may provide its potential anticholithogenic effect. (Bigoniya *et al.*, 2014).

4. Antidiabetic effect

The antidiabetic effect of α-amylase inhibitor isolated from the seeds of *Macrotyloma uniflorum* in streptozotocin-nicotinamide induced diabetic mice. (Lakxmi *et al.*, 2011).

5. Anti-helmintic activity

The seeds of *M. uniflorum* have anthelmintic activity which can be beneficial in eliminating worms. The alcohol extracts of *M. uniflorum* seeds for their anthelmintic activity. These extracts exhibited potent anthelmintic activity against *Pheretimaposthuma* and its activity was comparable with that of the standard, albendazole (Varicola *et al*., 2014).

6. Anti-HIV Activity

Dolichin A and Dolichin B (isomers of 3, 9-dihydroxy-l0-(2'-hydroxy-3'- methyl-3'-butenyl) are two pterocarpans extracted from horse gram. These pterocarpans constitute the second largest group of natural isoflavonoids with anti - HIV activity was performed by two ligands, i.e., Dolichin A and Dolichin B with the three replication enzymes, i.e., reverse transcriptase, protease and integrase). The protease enzyme has more effective ability to dock with ligands Dolichin A and Dolichin B effectively than reverse transcriptase, protease and integrase. (Auxilia *et al.*, 2013).

7. Anti-microbial activity

The extracts from *M. uniflorum* seeds had shown significant activity against *Bacillus subtilis*, *Staphylococcus aureus*, *Escherichia coli* and *Pseudomonas aeruginosa*. (Kawsar, et al.,2008, Ram, et al., 2004, Gupta, et al., 2005).

8. Antiobesity activity

Bhuvaneshwari *et.al.*2014, have reported that the hot Extract of *Dolichos biflorus* (Horse gram) on Body Weight in Overweight or Obese Human Volunteers. The *Macrotyloma uniflorum* exhibited significant antiobesity activity.

9. Anti-oxidant activity

M. uniflorum extract to rabbits with high-fat diet induced oxidative stress, showed improvement in anti-oxidant enzymes such as superoxide dismutase, catalase and increased glutathione concentration (Ravishankar, *et al.*, 2012).

10. Anti-peptic ulcer activity

The antiulcer activity of the hydroalcoholic extracts of the seeds of *M. uniflorum* (MUSE) and p-coumaric acid against indomethacin (non-steroidal anti-inflammatory drug) and absolute ethanol (necrotizing agent) induced ulcers in rats. MUSE and p-coumaric acid elicited significant antioxidant activity by attenuating the ulcer elevated levels of malondialdehyde and restored the ulcer depleted levels of reduced glutathione and the antioxidant enzymes superoxide dismutase, catalase, glutathione peroxidase and glutathione reductase (Panda *et al.,* 2015).

11. Anti-urolithiatic activity

M. uniflorum was found to be effective in preventing the deposition of the stones. The antiurolithiatic activity of aqueous and alcohol extracts of *M. uniflorum* seed on ethylene glycol induced urolithiasis in albino rats. An excessive urinary excretion of oxalate, calcium and phosphate was resulted after the feeding of ethylene glycol. The seeds of *M. uniflorum* are endowed with significant antiurolithiatic activity and the alcoholic extract of *M. uniflorum* showed better anti urolithiatic activity than aqueous extract. (Das, *et al*.,2005, Chaitanya *et al.,* 2010, Atodariya, *et al.*,2013 Bijarnia, *et al.*, 2009).

12. Diuretic activity

The urine volume, Sodium, Potassium, Chloride and Bicarbonate contents were measured after the oral administration of extracts at doses of 200mg/kg and 400mg/kg. Diuretic effect was significant in experimental animals treated with of M. uniflorum extracts compared to the control, Furosemide (5mg/kg). (Ravishankar, *et al*., 2012).

13. Free radical-scavenging capacity

The various extracts, 70% acetone extracts of dry-heated samples of brown variety of *M. uniflorum* as well as raw and dry-heated samples of black variety exhibited significantly ($P < 0.05$) higher hydroxyl radical-scavenging activity. Generally, all extracts showed good antioxidant activity (53.3-73.1%) against the linoleic acid emulsion system but were significantly ($P < 0.05$) lower than the synthetic antioxidant, BHA (93.3%).

14. Hemolytic activity

The presence of compounds such as methyl ester of hexadecanoic, ethyl ester of hexadecanoic acid mixture and n-hexadecanoic could be constituted a possible chemotaxonomic marker (Kawsar *et al.*, 2009).

15. Hepatoprotective activity

Parmar, *et al*.2012, discovered the significant hepatoprotactive properties of *M. uniflorum* seeds against D-Galctosamine and paracetamol induced hepatotoxicity in rats.

16. Hypoglycemic Activity

Macrotyloma uniflorum α-amylase inhibitor (MUAI) inhibited both the mouse pancreatic and human salivary α-amylase in a non-competitive manner with *Ki* values of 11 and 8.8 μM and IC50 value of 30 and 12.5 μg/mL, respectively. It decreased the serum glucose level in the treated diabetic mice. Histological findings suggested minimum pathological changes in the treated diabetic mice as compared to the diabetic control. (Laxmi *et al*., 2011).

CONCULUSION

Horse gram (*Macrotyloma uniflorum*) contained carbohydrates, alkaloids, proteins, glycosides, saponins, phenolics, flavonoids, tannins, steroids, gum, reducing sugars and triterpenoids. It exerted many pharmacological activities including antimicrobial, antidiabetic, antioxidant, anti-inflammatory, anti-histamine, heptoprotective, cytotoxic, hypolipidemic, gastro protective, anti-urolithic, anti-helminthic and many other pharmacological effects. This review paper will highlight the chemical constituents and pharmacological effects of Macrotyloma uniflorum.

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