



Review Article

A REVIEW ON GUAR (*CYAMOPSIS TETRAGONOLOBA* L.): A CASH CROP

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ABSTRACT

Guar is an essential legume domesticated mainly on marginal and sub marginal areas of arid and semi-arid regions. Generally, Pakistan yields around 15% of world wide total guar production. Its area under cultivation is more than 0.181 million hectares in Pakistan. Regarding to its demand in the foreign market, it is cultivated in Punjab, Bahawalpur, Mianwali, Bahawalnagar, Layyah, Sargodha, Muzaffargarh, Multan and Sindh province of Pakistan. Additional, its domestication is also being under consideration to take up it for irrigated conditions during summer. Guar grain (endosperm) is a basis of a 'guar gum'. It has various commercial applications mainly; oil industries, textile, well drilling, printing, cosmetics, mining, paper, petroleum, pharmaceutical and natural gas. In Pakistan, its green pods are routinely consumed locally as vegetable and are enriched in nutrients. Furthermore, guar has been described to have beneficial effects when cultivated as an intercrop. Guar meal (high content of protein) extracted from seed coat and germ cell is an excellent feed for monogastric animals. For exports, guar accessions with high content of gum (> 32%) and viscosity (4000-5000 cps) are more preferred. The statistical value of guar exports from Pakistan has increased from 229.97 crores (2008) to 312.75 crores (2017). This review emphasis mainly on the pharmacological actions of plant, traditional uses, pharmacognostical characteristics and phytochemistry. This review will highlight the various features of guar in pharmacological activities and as a valuable source for food and pharmaceutical products and its emergence as a significant cash crop.

Keywords: Guar, Cultivation, Traditional uses, Pharmacological activities.

INTRODUCTION

The word 'guar' is believed to be derived from the Sanskrit word 'go' or 'gav', meaning cow¹. Guar or cluster bean (*Cyamopsis tetragonoloba* L.) is the world's leading fodder crop. *Cyamopsis* was emphasized to be a separate genus with Africa as its probable center of origin². Guar belongs to family "fabaceae" and is a robust annual plant with a long tap root system. It is a self-pollinating species with female and male flowers at same places on the plant. The India is the largest producer of guar, accounting nearly for 80% of the total world's production, followed by Pakistan. Guar provides nutrients for humans and animals; and serve as a basic raw material for the production of oil, alcoholic beverages, guar gum, guar korma, guar churi, and more recently biogas. Guar has diverse culinary applications all over the world. The mature pods are consumed as vegetables and grains are used as cattle feed stuff in India and Pakistan. It is also used as green manure. Although, guar or cluster bean is considered to be a minor crop in many parts of world, it has a larger role among the domesticated plants. Guar plant is used as a multi-purpose, mostly used today as a source of galactomannan gum, which is used as a thickener and stabilizer in foods such as yoghurt, salad dressings

and ice cream. In traditional medicine, guar gum is used for treating irritable bowel syndrome (IBS), diarrhea, diabetes and obesity; for preventing "hardening of the arteries" (atherosclerosis) and for reducing cholesterol. The plant is pharmacologically exploited for anti-diabetic, anti-coagulant, anti-ulcer, cytoprotective, anti-cholinergic, hemolytic, anti-microbial, anti-asthmatic and anti-inflammatory properties. In Pakistan, guar is mainly grown in Punjab, Muzaffargarh, Mianwali, Layyah, Multan, Bahawalpur, Bahawalnagar, Sargodha and Sindh province, jointly accounting for over 15% of the national guar production. Guar plants can be used as cattle feed, but due to hydrocyanic acid in its beans, only mature beans can be used. The guar crop gains its economic significance after the discovery of the galactomannan, which is the gummy substance in it.

International synonyms

Synonym: *Cyamopsis psoraloides* (Lam.) DC.^{3,4}, *Cyamopsis tetragonoloba* L. subsp. *tetragonoloba* L.

Taxonomical Description

Kingdom: Plantae (Plants)
Sub-kingdom: Tracheobionta (Vascular plants)
Super-division: Spermatophyta (Seed plants)
Division: Magnoliophyta (Flowering plants)
Class: Magnoliopsida (Dicotyledons)
Sub-class: Rosidae
Order: Fabales
Family: Leguminosae
Sub-family: Fabaceae
Tribe: Indigofereae
Genus: *Cyamopsis*
Species: *Cyamopsis tetragonoloba*

Botanical description

Cluster bean grows up to 60 cm tall and is an annual herb. It belongs to family “Fabaceae” which is mainly a self-pollinated crop⁵. The botanical features of various plant parts are as follows:

Root

It has deeper tap root system in an association with symbiotic bacteria, which fixes atmospheric nitrogen in to ammonium from the air⁶.

Leaves

Leaflets elliptical acuminate or broadly with trifoliate and alternate pattern, dentate, both surfaces pubescent^{3,4}.

Flower

It has axillary flowers, racemes with 6-30 flowered. Flower's structure is in arrangement of five. On the outer side sepals are fused and hairy. The upper calyx teeth are smaller than the lower ones. The corolla is reddish, shape butterfly (keel formed 2 fused petals, 2 wings, flag) and small. Stamens are ten in number⁷.



Figure 1: Guar plant



Figure 2: Guar Pod



Figure 3: Guar Flower

Fruit

It develops a carpel in an upright form, 3.9-5.1 cm long, slimy endosperm, these have a very well developed, sparsely haired legume with 5-6 seeds^{5,7}.

Geographic Origin and Distribution

Guar (*Cyamopsis tetragonoloba* L.) is one of the few crop species that have an uncertain origin. There might be possibility that guar was domesticated in Africa and Arabia then got its way to India, Pakistan and USA. India is the center of variability for cluster bean⁸. From India it went to Afghanistan, Arabia, Africa, Asia, China, Australia, Central Africa, Chad, China, Ethiopia, Fiji, Indonesia, Indochina, Sierra Leone, Somalia, South Africa, Africa, USA, Vietnam, Yemen, West Africa, Sri Lanka, Tanzania and Zambia.

GUAR Agronomy

Seed rate of cluster bean crop depends upon the soil condition and spacing. It varies from 15 kg to 45 kg ha⁻¹ but it mainly depends upon whether crop is cultivated for grain or fodder purpose. If we grow crop for grain purpose, then 20 kg seeds ha⁻¹ is sufficient. If grown for green manuring or fodder purpose, then 40 kg seed ha⁻¹ is needed. Apart from this, if it is cultivated under dry condition, late sowing condition and soil salinity conditions then we have to normally increase the seed rate. Pre-irrigation of 1-2 inch is required before sowing to fill the profile of soil. Broadcasting is to be done, if the crop is grown for fodder purposes, but if crop is grown for grain purposes then drilling is better and it helps better seed invigoration. For better yield, the spacing of 9 inch between the plants and 1.5 ft. between the rows is kept. The best sowing period for this crop is during the months of April to July but for grain purposes crop is sown during the months of May to July. In rain-fed regions the seeding is done after the monsoon rains. Cultivation of cluster bean in Pakistan requires maximum sunshine and moderately frequent rainfall for better growth.

GUAR in Pakistan

Pakistan produces 0.118 million tones' and accounts for 15% of the world's supply of cluster bean with 0.31275 million tones being exported to the United States and Europe⁹. Cultivation of cluster bean in Pakistan for its best growth requires full sunshine, flushing rainfalls that are moderately frequent. The most

important growing areas in Pakistan are Punjab, Muzaffargarh, Multan, Layyah, Mianwali, Bahawalpur, Sargodha, Bahawalnagar and Sindh province. Cluster bean is grown in almost 0.1925 million-hectare area in Pakistan⁹. Figure 1.2 reveals that the Punjab and Sindh provinces has greater cultivated area than KPK and Balochistan provinces.

Table 1: Morphological traits of some guar varieties*

Variety	Year of Release	Yield Potential (Kg ha ⁻¹)	Salient Features
BR2/1	1984	Grain Yield = 1200 Kg ha ⁻¹ Fodder Yield = 26 t ha ⁻¹	Hairy, Long stature, long duration, branched, grain bold and dark brown, suitable for fodder purpose.
BR-90	1991	Grain Yield = 1400 Kg ha ⁻¹ Fodder Yield = 28 t ha ⁻¹	Hairy, short stature, long duration, profusely branched, golden grain colour, suitable for fodder and grain purpose
BR-99	2000	Grain Yield = 1900 Kg ha ⁻¹ Fodder Yield = 30 t ha ⁻¹	Hairy, Single stemmed, no branching, medium duration, seed colour-grey, tolerant to sucking pests and diseases, suitable for grain, fodder and vegetable purposes.
BR-2017	2017	Grain Yield = 2400 Kg ha ⁻¹ Fodder Yield = 35 t ha ⁻¹	Hairy, erect type, 0-1 branch, higher gum and protein contents, early maturing and short duration variety with heavy fruiting, requires very low inputs, tolerant to sucking pests and diseases, suitable for grain, fodder and vegetable purposes.
S-5274	-		Approved as BR-2017
S-5733	Advance line under testing in yield trials	Grain Yield = 1800 Kg ha ⁻¹ Fodder Yield = 29 t ha ⁻¹	Hairy, erect type with 1-3 branches, long duration, tolerant to insect pests and diseases suitable for fodder and seed purposes.
S-5742	-do-	Grain Yield = 1750 Kg ha ⁻¹ Fodder Yield = 32 t ha ⁻¹	Hairy, single stemmed with no branch, early maturing, tolerant to insect pests and diseases, suitable for seed and vegetable purposes.
S-5747	-do-	Grain Yield = 1900 Kg ha ⁻¹ Fodder Yield = 26 t ha ⁻¹	Hairy, erect type with no branch, short duration, tolerant to insect pests and diseases, suitable for seed and vegetable purposes.
S-5759	-do-	Grain Yield = 1700 Kg ha ⁻¹ Fodder Yield = 27 t ha ⁻¹	Hairy, erect type with no branch, short duration, tolerant to insect pests and diseases, suitable for seed and vegetable purposes.
S-5761	-do-	Grain Yield = 1900 Kg ha ⁻¹ Fodder Yield = 30 t ha ⁻¹	Hairy, 0-1 branch, early maturing and short duration, tolerant to insect pests and diseases, suitable for seed, fodder and vegetable purposes.
S-5765	-do-	Grain Yield = 2000 Kg ha ⁻¹ Fodder Yield = 34 t ha ⁻¹	Hairy, no branch, erect type, early maturing and short duration, tolerant to insect pests and diseases, suitable for seed, fodder and vegetable purposes.
S-5784	-do-	Grain Yield= 1800 Kg ha ⁻¹ Fodder Yield= 24 t ha ⁻¹	Hairy, non-branched, early maturing, tolerant to insect pests and diseases, suitable for seed purpose.
S-5785	-do-	Grain Yield = 2200 Kg ha ⁻¹ Fodder Yield = 22 t ha ⁻¹	Hairy, branches 2-4, long duration, tolerant to insect pests and diseases, suitable for seed purpose.
S-5797	-do-	Grain Yield = 1400 Kg ha ⁻¹ Fodder Yield = 34 t ha ⁻¹	Hairy, branches 6-10, long duration, tolerant to insect pests and diseases, suitable for fodder purpose.
S-5798	-do-	Grain Yield = 1300 Kg ha ⁻¹ Fodder Yield = 33 t ha ⁻¹	Hairy, branches 8-10, long duration, tolerant to insect pests and diseases, suitable for fodder purpose.
S-5825	-do-	Grain Yield = 1500 Kg ha ⁻¹ Fodder Yield = 32 t ha ⁻¹	Hairy, branched, long duration, tolerant to insect pests and diseases, suitable for fodder purpose.

*, Courtesy Regional Agricultural Research Station, Bahawalpur, Pakistan.

Table 2: Guar Seed Composition

Part of seed	Protein (%)	Fibre (%)	Type of sugar
Hull (14-17 %)	5	36	D-Glucose
Germ (43-47 %)	55.3	18	Glucose
Endosperm (35-42 %)	5	1.5	Galactomannan

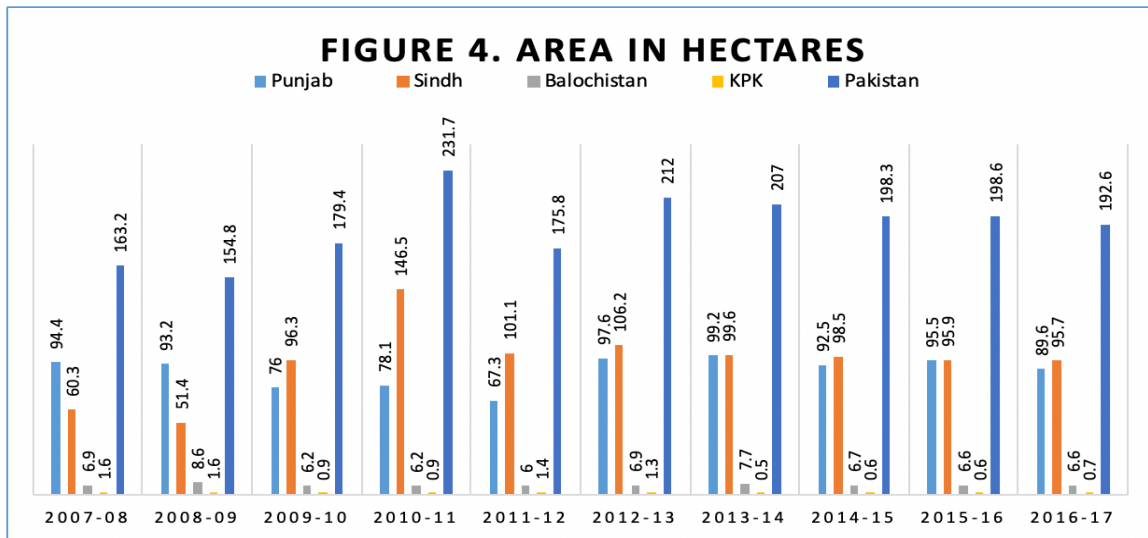


Figure 4: Area in Hectares
(Source: Pakistan Bureau of Statistics, 2017)

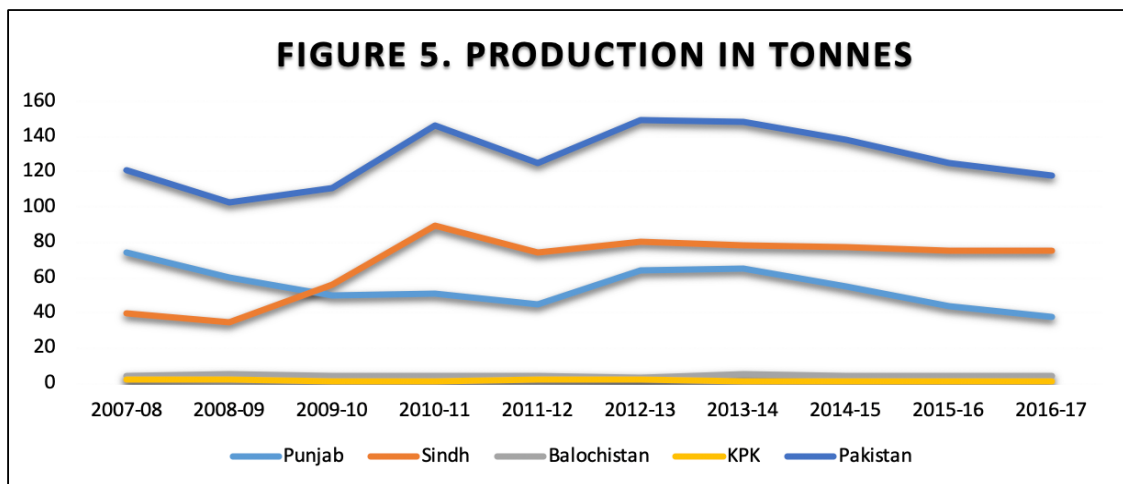


Figure 5: Production in Tonnes
(Source: Pakistan Bureau of Statistics, 2017)

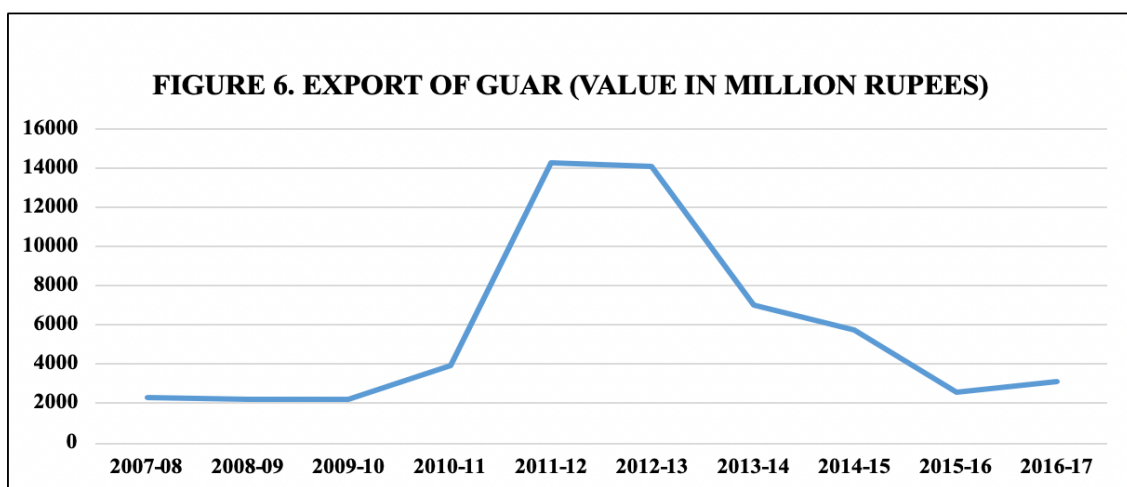


Figure 6: Export of Guar (Value in million rupees)
(Source: Pakistan Bureau of Statistics, 2017)

Traditional uses

Fruit

Used to cure night blindness and treat nausea and vomiting⁷.

Seeds

Used to treat stretch, arthritis and inflammations, used as an antibilious, laxative and as an antioxidant agent. Dry seeds used as trypsin inhibitor and boiled seeds are used to treat hepatomegaly, swelling near joints and brain swelling⁷.

Leaves

Boiled as well as fried leaves, pods and seeds are used as gum thickener. Leaves used to treat asthma and night blindness¹⁰.

Pods

Ethanol extract prepared from powdered pods used as an antisecretory, antiulcer and have several cytoprotective effects on lesions in rats⁷.

Guar gum

Fiber obtained from seed of the plant can be used as cathartic for treating irritable bowel syndrome (IBS), constipation and diarrhea, dyspeptic issues, diabetes, obesity, prevent from hardening of arteries, night blindness, anorexia nervosa and agalactia^{3,11}. In old world medicine or in Ayurveda, its use for this purpose in tablet form, is now banned in UK^{4,12}.

Pharmacological activities

Antidiabetic effect

In alloxan and normal diabetic rats, blood glucose level is significantly reduced when an aqueous extract of guar plant pods at 250 mg/kg body weight dose is directed¹³. On total lipid serum, esterified and free cholesterol, phospholipids and triglycerides effects observed under guar feeding¹⁴. In normal rat glucose level of blood, guar showed high blood glucose effects¹⁵.

Anti hypercholesterolemic

Hypercholesterolemic potential and antidiabetic potential examined due to guar gum reactions obtained from seed endosperm on indication of protein involvement. Instead of these facts, blood lipids increased due to diabetes and guar gum reduces cholesterol triglycerides serum. A considerable high level of HDL/LDL cholesterol was observed with an increased level in HDL-cholesterol. Diabetic rats can be raised and improved by guar gum protein utilization and absorption^{15,16}.

Antiulcer effect

Hypothermic restraint stress caused gastric lesions and at 500 mg/kg rate, guar extract reduced indomethacin significantly¹⁷.

Cytoprotective effect

Against necrotizing agents, guar has noticeable effects. Guar extracts enhanced mucus of gastric wall and restore depletion of sulfhydryl content (non-protein) that is induced by ethanol¹⁷.

Anticholinergic effect

Anticholinergic activities of extracts of guar restricts acetylcholine effects and reduced the contraction of separated guinea pig ileum^{17,18}.

Anticoagulant activity

To check anticoagulant effects from seeds of guar, sulphate derivatives with less molecular weight of galactomannan was examined. For this purpose, depolymerization of galactomannan was done by using enzymes. Different ranges of molecular weight were obtained (12.6 –245.6K). Sulfate derivatives prepared. Results obtained and it was concluded that all assemblage expressed anticoagulant activities and activity of anti thrombin was up to 65-87U/MG and it was independent of sulfate derivatives¹⁹.

Hemolytic activity

Guar meal used to prepare saponin rich extract to check hemolytic activity against blood samples from mature roosters chicken. Hemolytic evaluation carried out in 96- microplates and hemolysis initial scanning done at 405 nm, 455 nm, 520 nm and 650 nm respectively. Results indicated that methanol fraction at 100% concentration was hemolytic but at 0.25 mg fraction/ml dilution or less than this value non-hemolytic results obtained. On cell membrane, permeability rate effected by hemolytic action due to formation of pores, by altering Na⁺-K⁺ and Ca²⁺-Mg ATPase actions in membrane and hydrophobic saponin nucleus insertion in lipid bilayer¹⁹.

Antimicrobial activity

C. tetragonoloba methanol extracts of different concentrations (20%, 60%, 100%) observed against *S. typhimurium*, *E. coli* and *S. aureus*, *Lactobacillus spp.* Results showed that 20% and 60% methanol extracts had antibacterial observations with *Lactobacillus spp.* 3.13 and 0.78 fraction/ml value of MIC observed for methanol extract in counter to *Lactobacillus spp.* and *S. aureus*. Same results of MIC obtained when *S. typhimurium* and *E. coli* treated with 100% methanol extract¹⁹.

Antiasthmatic activity

Guar plant aqueous and alcoholic extracts reduce shrinkage of separated muscles when these extracts prepared *in-vitro* at dose of 100 µg/ml and reduced bronchospasm due to 1% histamine also observed due to these extracts. Amplified eosinophil and leukocytes due to hypodermic injections also observed by these extracts. Antiasthmatic actions of guar contributed to antiallergic, antihistaminic and adaptogenic effects and it has been observed due to application of these extracts²⁰.

Anti-inflammatory activity

Aqueous and alcoholic extracts prepared from seeds of Guar for anti-inflammatory action and evaluated for neurogenic, acute and sub-acute inflammations against additive agents' carrageenan, xylene and formaldehyde that causes paw edema. Significant inhibitory results obtained by ethanol extracts for inflammatory agents in quantity dependent methodology. According to various previous reports, high saponin and flavonoid contents may be positively correlated with anti-inflammatory actions^{20,21}.

Reversible antifertility effect

On male Swiss Albino mice, anti-fertility reversible effect of guar gum analyzed. For this purpose, crude ethanol extract (200 mg/kg and 400 mg/kg body weight) orally provided to mice for forty days. By RIA applications, testosterone level was examined, fertility rate and effects on reproductive organs were also checked. Ethanol extract with low dose of 200 mg/kg body weight resulted in 50% depletion in fertility rate of mice while high amount of 400 mg/kg body weight of ethanol extract deplete 100% fertility rate in mice²².

Anthelmintic activity

From plant parts (stem, leaf and fruit) of guar extracts (aqueous and ethanol) with 12.5, 25, 50 and 100 mg/ml concentrations are prepared to analyze anthelmintic possibilities against test worms that were *Pheretima posthuma*. Significant results obtained for fruit and leaf extracts but stem extracts showed non-significant results. As an anthelmintic agent, leaf and fruit extracts hold up for positive results²³.

Wound healing activity

Fruits and leaves of guar are used to prepare hydrogels to check the mitigate results on incision and excision wounds on Swiss Albino mice. Two types of hydrogels prepared: one with 5% w/w fruit ethanol and other with 5% w/w leaf ethanol. Both gels showed different but quite similar results. In excision wound model, 99% healing results obtained with fruit extract gel and 90% results observed by leaf extract gel. Results compared with control and conventional metro gel (1% w/w) on twelfth day of wound. Tensile strength significantly increased in incision wound representation ($p < 0.001$) and results showed that gel has capability to cure wounds²⁴.

Other Studies

It is used as an antioxidant as well as to undertake anti-cataract effects^{25,26}.

Applications in pharmaceutical formulation

In cosmetics, guar gum is frequently used. In the form of tablet, Guar gum has also been used to abolish hunger but legally prohibited in UK due to certain reasons²⁷.

CONCLUSION

Guar is Pakistan's number one field crop. Guar leads all other pulse crops in volume and value of production. Guar has diverse culinary applications all over the world. The mature pods are consumed as vegetable and grains are used as cattle feed stuff in India and Pakistan. The pharmacological actions, pharmacognostical characteristics, phytochemistry and traditional uses and of plant does much more than feed people and livestock. Physio-chemical studies have shown that presently, a significant part of commercial guar gum is sold as guar gum derivatives. By virtue of guar gum stabilizing power and better thickening along with sound safety profile, galactomannan content has attained a wide consideration in food and cosmetics industry. Pharmacological studies show its remarkable medicinal properties such as antioxidant, antifatigue, hypoglycemic and effective diuretic agent. Therefore, guar has recently become a cash crop among modern youth.

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