# A review of Guar seeds (*Cyamopsis tetragonoloba*) processing and its potential Utilization

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**Abstract**

India is the largest producer of Guar, contributing 80% of global production annually. Cluster bean (Cyamopsis tetragonoloba) commonly known as Guar is native to India and has been used traditionally as vegetables, cattle food, and green fodder in agriculture. Guar seeds consist of three parts; seed coat or hull, endosperm, and germ. Hull consists of (14-20%) of guar seed by weight, endosperm (35-45%), and germ (43-47%) (Srinivasan., 2020). The endosperm contains a natural polysaccharide named guar gum and is non-toxic, eco-friendly, and easily available. The polysaccharide is mainly composed of galactose and mannose unit that provide gelling effect to the gum. Guar lipids are a rich source of antioxidants, used as a stabilizer, and help to increase the shelf life of oils and fats. It is known for its potential in various industries such as food, textile, bakery, and dairy, pharmaceuticals, cosmetics, miming, oil drilling, and explosive industry (Mudgil, et al., 2014). Guar gum acts as gelling, binding, ice crystal inhibitor, and thickening agent in the beverages industry. Guar seeds contain chlorogenic acid, gallotannins, and gallic acids as phenols. The sterols present in guar seeds are sitosterol, campesterol, brassicasterol, and cholesterols. (Thombare, et al., 2016) *Cyamopsis tetragonoloba* is well known medicinal plant useful in lowering low-density lipoproteins and improving heart health. It is rich in folic acid and iron content which helps to increase hemoglobin production and oxygen binding to blood. Cluster beans contain a good amount of calcium and phosphorous, which improves bone health. Anticancer, and antimycoplasmal activities are found in Guar seeds.

Keywords: Antioxidants; chlorogenic acid; gallotannins; gallic acids, sterols

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**Introduction:**

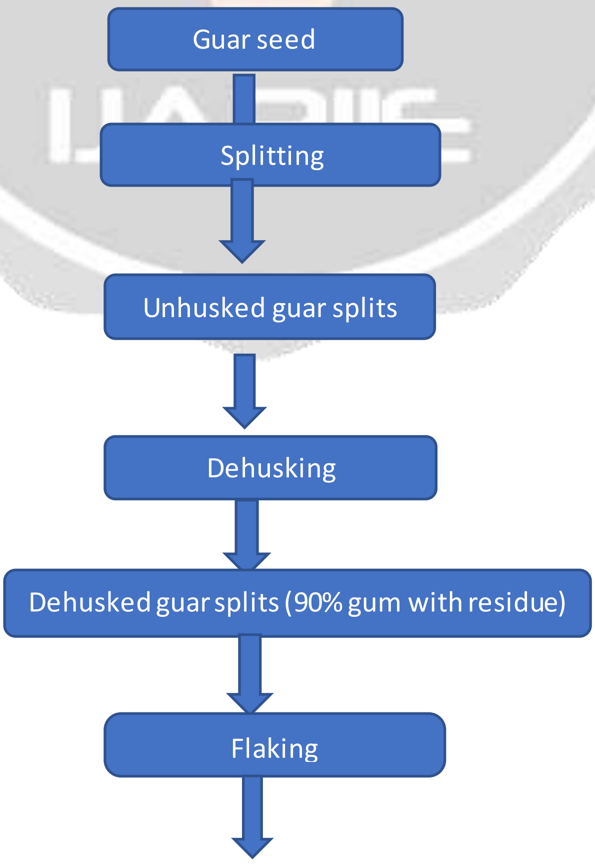
India is one of the major growers of oilseeds. Due to diversity in agri-ecological and climatic changes India produces more than 15 oilseeds crops annually. Natural occurring substances are getting more important because of their eco-friendly, biodegradable, non-toxic, and easily available nature. Cluster bean (*Cyamopsis tetragonoloba*) commonly known as Guar is native to India and traditionally used as a source of vegetable, cattle feed, and fodder. (Micheal et al. 2015). Commercially, guar gum is the most important derivative of guar seed and is used in a variety of industries such as food processing, oil, gas, paper, textile, cosmetics, mining, and explosives. Gums are water soluble, plant derivatives, mainly carbohydrates by nature, and are often misunderstood with rubbers, resins, and latex of any plants (Heyne et al. 2014). These are majorly used with beverages, processed cheese, bakery, frozen foods, canned foods, dairy products, and water treatment, etc. Guar gum is well known for its gelling, binding, strengthening, moisture binder, and ice crystal inhibitor properties. (Barth; 2016). India is the world's largest producer of guar, contributing about 80% of world production annually. The term guar arises from the word "Gowahaar" Gow means Cow and Ahaar means to feed. Guar is a multi-purpose Kharif season leguminous crop (Prem et al. 2005). Guar seed consists of three major parts seed coat or hull, endosperm, and hull. Hull consists of (14-20%) of guar seed by weight, endosperm (35-45%), and germ (43-47%). Guar gum is an excellent raw material in the cosmetic industry. The unique cosmetic properties of guar gum include cold solubility, viscosity enhancement, solvent resistance film forming, protective colloid, wide pH range resistance, stability, non-toxic nature, safe and cheap (McKiernan 2016). Guar gum colour varies from white to cream and yellowish-white, it is odourless in nature. Phenolics and flavonoids play important role in the bioavailability and bio accessibility of Guar seeds. Various phenolics such as chlorogenic acid, gallotannins and gallic acids compounds in leguminous based plants food has large diversity in chemical, physical and biological formation, can be extracted and isolated by high performance liquid chromatography

(Ercelebi and Ibanoglu, 2019). Phenols and flavonoids present in guar seeds play an important role in treatment of various cardiovascular and nervous system related diseases (Hartemink, et al., 2014). Anti-nutrients tannins, phytates and oxalates negatively effects the minerals and vitamins availability. Major volatiles observed from Guar seed oils are furfuraldehyde, ethyl benzoate etc. *Cyamopsis tetragonoloba* is well known for medicinal plant useful in lowering low density lipoproteins improving heart health (Keshin S. et al., 2007). The endosperm contains the Galactomannan (gum) and guar gum or guar. Refined splits is derived from this part of the seed. Guar gum powder is obtained from processing the guar gum or guar refined splits. There are several grades of guar gum powder, depending upon colour of guar gum powder white to creamy coloured, free flowing odourless powder, free from foreign matter, there are several grades of powder vary in different viscosities and granule size (Rakesh Pathak; 2015). Its ability to suspend solids, bind water by hydrogen bonding, control the viscosity of aqueous solutions, and form strong tough films are the major reasons for its use in various industries (Sumnu, et al., 2010). The remaining two parts, hull and germ, are enriched in protein. Various forms and derivatives according to the availability for different industries petroleum, paper, food and pharmaceuticals (Ercelebi and Ibanoglu, 2019). It is rich in folic acid and iron content which helps to increase haemoglobin production and oxygen binding to blood. Cluster beans contains good amount of calcium and phosphorous, which improves bone health. Anticancer, antimycoplasmal activities are found in Guar seeds. Leaves of Guar plant are used to cure night blindness. Seeds are used as chemotherapeutic agent against smallpox. Boiled guar seeds are used in treatment of plague, head swellings and swellings due to bone breakage. (Patel J.J, et al., 2014)

| Part of seed | Protein (%) | Fibre (%) | Ash (%) | Moisture (%) | Sugars | References |
|---|---|---|---|---|---|---|
| Hull | 5.0 | 36.0 | 4.0 | 10.0 | D-Glucose | (Hartemink et al. 2014) |
| Endosperm | 5.0 | 1.50 | 0.6 | 10.0 | Galactomannan | (Keshin S. et al. 2007) |
| Germ | 55.5 | 18.0 | 4.6 | 10.0 | Glucose | (Miller J.N 2014) |

Table 1. Nutritional composition of Guar seed (per 100 gm)

Extraction process of Guar gum from guar seed:



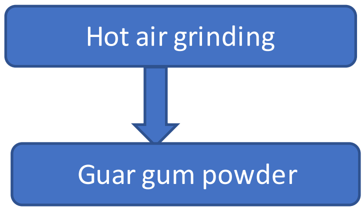



**Fig 1. Extraction process of Guar gum from guar seed:**

**Flowsheet of oil extraction by solvent method:**

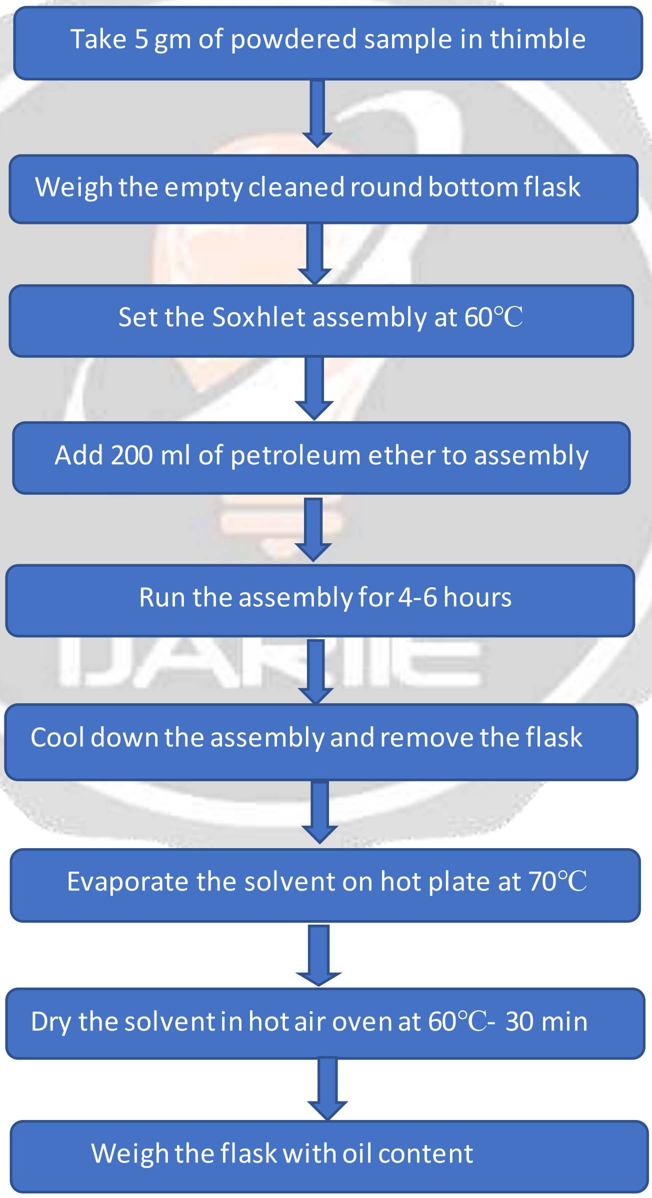



**Fig 2. Oil extraction of guar seed by solvent method**

**Pretreatment of Guar seeds prior to oil extraction:**

Seeds were stored in an air light chamber to maintain the moisture level and temperature constant. Seeds were cleaned by winnowed or sieving was done to remove dirt, sand and metal particles. Seeds were grinded finely powder was separated by sieving. 5g of grinded sample was taken in a thimble. Sample was fixed in soxhlet assembly with water inlet and water outlet. Note down the empty weight of flask. Petroleum ether was poured in the soxhlet assembly and heater was switched on and temperature was set at 60°C. When extraction of oil cycle started note down the time and complete the same cycle for 6-8 hrs. Assembly was cooled down and take out the flat bottom flask. Excess of solvent was dried by placing flask on water bath at 60°-70°C, after complete removal of solvent, keep flask in hot air oven for half an hour at temperature of 80°C. Note down the weight after solvent removal. Oil efficiency is calculated by $\frac{(final\ weight\ of\ flask - empty\ weight\ of\ flask)}{sample\ weight} \times 100.$

Crushing and pressing of oilseeds are traditional methods of oils extraction, due to advancement and innovative technology using artificial intelligence oils and fats industries are growing more with help of automation in plants and industries. Crude oil is refined and processed in three main steps: neutralization, bleaching and deodorizing, which remove off- flavors, improve colors and free fatty acids formed due to hydrolytic or oxidative rancidity in oils and fats. Rancidity leads to cause degradation of chemical and nutritional properties of oils and fats. Heating of oil at various time temperature is necessary in each step of processing of oils and fats. Refining process can be batch process or with the help of equipment's it may be continuous. Different oils and fats have different fatty acids composition, which can be analyzed by using gas- liquids chromatography. Oils and fats are neutralized by using caustic soda in various concentration. On saponification of oils with caustic soda sodium and potassium salts are formed also known as soaps which can be washed from oils by using water. Oils and fats are bleached by using activated carbon or bleaching earth at atmospheric pressure. Bleaching results in lowering down the color pigments like chlorophyll, pheophytins & carotenoids and helps to get oils of light color. After heating and mixing the oil clay is removed by filtration process; oil obtained after bleaching results in more stable and more flavorful.

| Sl. No. | Industry | Uses | Expected Function | References |
|---|---|---|---|---|
| 1. | Textile printing | Cotton, rayon, wool sizing, carpet printing | Reduce wrap breakage & dusting film | (Heyne and Whistler; 2017) |
| 2. | Paper | Wrapping, paper, craft, photographic paper, filter | Replaces hemi-cellulose, increase strength | (Mudgil et al. 2019) |
| 3. | Oil well drilling | Drilling fluids hydraulic fracturing | Control of water loss, viscosity, suspension, mobility | (Goldstein and Alter; 2019) |
| 4. | Explosives | Stick explosives, blasting slurries | Water proofing, gelling agent | (Chudzikowski; 2017) |
| 5. | Fire fighting | Water for fighting fire | Friction reduction, dispersion and direction control | (Barth; 2018) |
| 6. | Coal mining | Coal suspension, stock | Friction reducing suspending agent | (Mark H.F et al. 1963) |
| 7. | Tobacco | Reconstitution of tobacco | Binding & strengthening agent | (Kesin S.O et al. 2007) |
| 8. | Water treatment | Industrial & drinking water | Coagulant aid | (Grasdalen and Painter; 2019) |
| 9. | Photography | Emulsions, gelatin solutions | Gelling, hardening agent | (Tripp et al. 2018) |
| 10. | Pharmaceuticals | Medicines, diabetic treatment, laxative slimming aids, gastric hyper acidity, vitamin formation | Cholesterol treatment appetite depressant, Reduction of urinary glucose loss, appetite depressant, stable water suspension | (Ercelebi and Ibanoglu; 2019) |
| 11. | Cosmetic uses | Hair shampoos, hair | Detergent, compatible | (Presto et al. 2016) |

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|---|---|---|---|---|
| | | conditioner, lotions, ointments, tablets | thickener, granulating | |
| 12. | Bakery | Bread, cake, pastry, icing | Moisture retention, prolong shelf life | (Sumnu et al. 2010) |
| 13. | Frozen foods | Ice-cream, soft serves | Water retention, ice crystal inhibitor | (Shaikh et al. 2020) |
| 14. | Dairy products | Yoghurts, molasses, desserts | Inhibits when separates keep texture after sterilization | (Ghodke S.K 2009) |
| 15. | Instant mixes | Pudding sauces, desserts, beverages | Fast cold dispersible, thickening & text rising agents | (Mehta et al. 2019) |
| 16. | Processed cheese | Cottage cheese, cream, cheese | Increase the yields of curd solids | (Klis & Micheal 2016) |

Table 2: Industrial application of guar gum

**Phytochemical properties of guar gum:**

Guar plants leaves and pods contains carbohydrates, proteins, fibres, ascorbic acid and tannins like gallic acid, caffeic acid, vanillic, gentistic acid (Khare; 2007). Wang et al 2007 has reported various flavonoids by HPLC technique and reported 1.114 mg daidzein, 0.700 mg genistein, 0.553 mg quercetin and 14.460 mg kempherol per 100g sample. High concentration of kampherol in guar seeds increase the nutraceuticals and pharmaceuticals applications. Polyphenol includes chlorogenic acid, ellagic acid, gallotannins etc. (Daniel et al. 2016). Depending upon the stage of maturity of guar plant this concentration varies. Concentration of polyphenol ranges in 0.69-1.26%, 0.12-0.49% for gallic acid, 0.21-0.51% for gallotannins, 0.13-0.23% for flavanols. Total lipids content in guar seeds was reported as 7% by weight of guar seed meal which includes triacylglycerol, hydrocarbon sterol ester, free fatty acids and polar lipids. (Satya et al. 2018).

**Extraction of active metabolites from cluster beans:**

Active metabolites were extracted and optimized by using six solvents (crude methanol, n-hexane, chloroform, ethyl acetate, butanol and aqueous alcohol) from guar seeds to check the antioxidants such as total phenol contents (TPC), free radical scavenging activity (FRSA) by DPPH (2,2- diphenyl-1 picrylhydrazyl) assay. Antidiabetic and anticancer study was conducted by α-amylase inhibition and MTT (3-(4,5-dimethyl-2-thiazolyl)-2,5-diphenyl-tetrazolium bromide) assay. Ethyl acetate and methanol extract have more antioxidants potential with highest TPC (16.38 mg GAE/g) and TFC (8.15 mg/CE/g). Methanol extract presented the highest free radical scavenging activity (46.31) (Saima Riaz et al 2017).

**Application of Guar Gum in food industries:**

**Beverages:** Guar gum is used in beverages for thickening and viscosity control to increase the shelf life. Guar gum is easily soluble in cold water and due to its several inherent properties which makes it easy to use in beverage processing plants. (Tripp, et al., 2018)

**Processed Cheese:** Weeping or syneresis is a serious problem in cheese processing. Guar gum controls syneresis by water phase management due to which texture and body of cheese products improves. (Kliss;1996) 3% of guar gum was added to the total weight of products and found that guar gum helps to soft the cheese by enhances the total yield of total curd solids and provides softer curve with separated whey. Low- fat cheese was produced by addition of guar gum at (concentration of 0.0025-0.01%) without changing rheology and texture as compared with full-fat cheese. (McKiernan; 2016)

**Processed meat products:** Guar gum has strong capacity to hold hot as well as cold water, therefore syneresis control, prevention of fat migration during storage, viscosity control of liquid phase during processing and control of accumulation of the water in the during storage to use as binder and lubricant in the production of sausage products and stuffed meat products (Mehta, et al., 2019).

**Bakery products**: Addition of 1% guar gum in cake and biscuit dough results in improve machinability of the dough to desirable binding and film- forming properties that decrease the penetration of oils and fats. Guar gum in addition with 3% starch was found to be effective in prevention shrinking, cracking and dehydration of frozen- pie fillings. (Sumnu et al. 2010) Guar gum helps to increase the loaf volume of wheat bread dough on baking. Guar gum also retards staling in chapati at room temperature as well as refrigerated temperature by controlling retrogradation of starch. (Brennan and Tudorica; 2008)

**Salad dressing and sauces:** Guar gum in salad dressings, acts as an emulsifier and stabilizer by enhancing the viscosity of water phase and decrease the separation rate of water and oil phase. 0.2-0.8% of guar gum was added in salad dressing mixture to show its dispersibility and compatibility with high acidic emulsions (Greenberg, 2003). As compared to other hydrocolloids like carboxy methyl cellulose, sodium alginate, gum acacia and pectin; addition of guar gum shows better results for consistency of tomato ketchup ( Gianniniet al 2006). Serum loss and flow value of tomato ketchup was decreased by addition of guar gum which makes it a novel thickener (Gujral et al. 2002).

**Effect of antioxidant and antibacterial properties of guar gum coating containing spices extracts and its application on tomatoes:**

Guar gum based edible coatings have been found to increase the shelf life and storage conditions of fruits and vegetables. Guar gum coating to tomatoes were successful to preserve the quality parameters of tomatoes throughout storage. The rate of change in titratable acidity, pH and total soluble acids were found to be more of guar gum extract with ethanol as compared to guar gum mixed with methanol. The percent rate of antioxidants, bioactive compounds are found to be more in fresh tomatoes as compared to tomatoes coated with guar gum. (Ayeza Naeem et al 2018)

**Physicochemical properties of bread using hull less barley & guar gum:**

Bread was made with hull less barley (0%, 10% and 20%) and guar gum (0%, 1%, 1.5% and 2%) in different concentration, to evaluate the physicochemical properties like extensibility, hardness and colour parameters. Mixed bread with 20% hull less barley and 1% guar gum was analysed as the best for physicochemical properties. 200 ppm of ascorbic acid was added to improve the nutritional and sensory values of the bread mixed quality. (Zahra Sheikholeslami et al 2017).

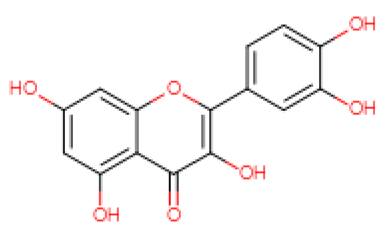
**Guar gum in pharmaceutical industries:** Guar gum has potential applications in pharmaceutical industries as formulation and agents for many drugs due to its ability to form viscous dispersion or gel formation (Yoon et al. 2008). Guar gum is getting more importance because of their eco-friendly, biodegradable, non-toxic, easily available nature. Guar gum plays an important role in solid, liquid or semi-solid forms as film forming, viscosity enhancer, emulsifier and stabilising agent. Guar gum and is derivatives are used in drugs coating material, nano-emulsions, hydrogels and nanoparticles formulations. (Butt et al. 2007) It is used to promoting regular bowel movements, relieving constipation and reduces post-prandial blood glucose absorption in small intestine. (Rideout et al. 2008)

**Guar gum in treatment of diabetes:** Guar gum used as thickener and stabilizer in pharmaceutical industries. David J.A, et al. reported gum and its derivatives to control blood sugar. Studies showed that guar gum is helpful to reduced postprandial rise in blood glucose and insulin concentration. They reported that total cholesterol level and triglyceride concentration in blood was lowered by consuming guar gum. Biesenbach G et al reported that combination of pectin with guar gum helps in treatment of hyperlipidaemia, results indicate in the reduction in blood glucose level and plasma insulin.

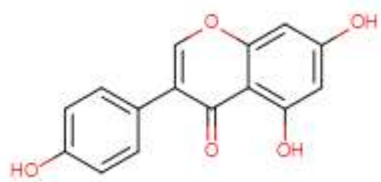
**Guar gum in treatment of Cancer:** Cancer due to intestinal disorders and colorectal cancer is cured by guar gum and its derivatives. Chourasia M. et al reported by making guar gum microsphere crosslinked by emulsification with glutaraldehyde and other drugs which are released in colon for the treatment of colorectal cancer.

**Guar Gum in Cosmetic Industry:** Guar gum plays an important role in cosmetic industry due to its non-toxic, wide pH range stability, viscosity enhancing, cold water solubility. (Sobha and Tharanathan 2009). In tooth paste formulation guar gum is used to impart flowing nature, so paste can be extruded from collapsible tubes with small force (Mathur and Allen 2005). In creams and gels guar gum helps to prevent phase separation by preventing weeping, increase emulsion stability, prevents water loss and reduced the migration of fog. Guar gum in concentration of 0.02-0.08% is added in hair colourants as thickener. (Garti and Lesser 2001)

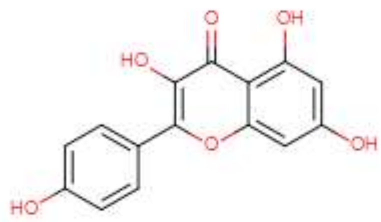
**Phenolics of *Cyamopsis tetragonoloba*:**




Quercetin – CSSB00015191104




Genistein – CSSB00000023541

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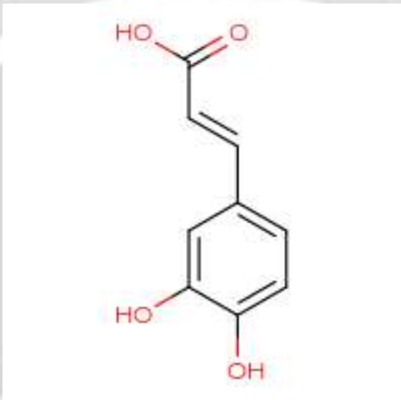
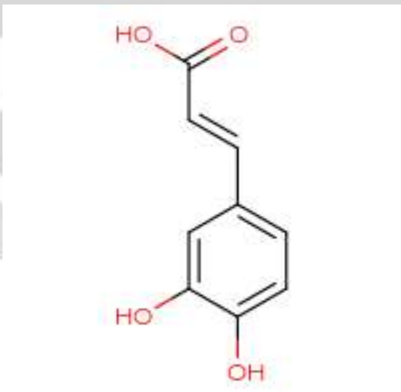
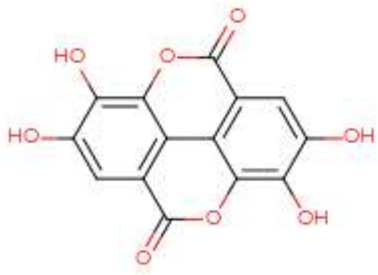


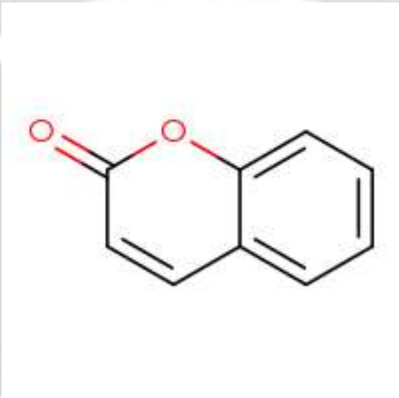

Caffeic Acid – CSSB00011195073




Gallic Acid – CSSB00000212154

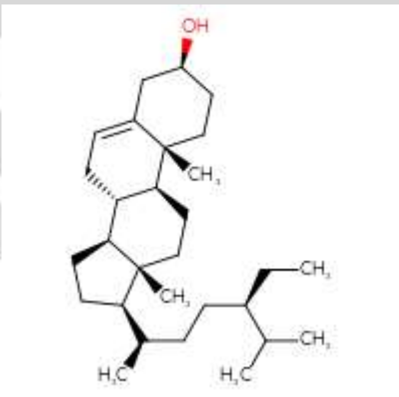


Ellagic acid - CSSB00000033518

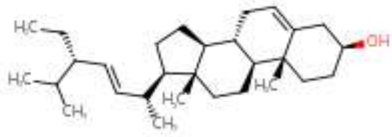


Coumarin – CSSB00000186159

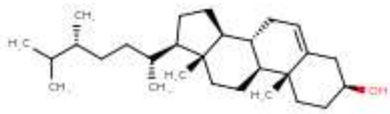
**Sterols of *Cyamopsis tetragonoloba:***



Beta-sitosterol – CSSB00020619659



Stigmasterol – CSSB00020619759



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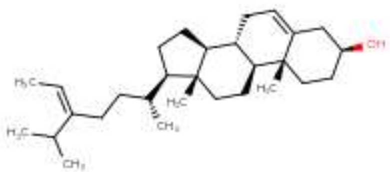

Avenasterol – CSSB00020627677

**SUMMARY and CONCLUSI ON**

Guar gum is an important agrochemical derived from the seed endosperm of guar plant i.e Cyamopsis tetragonoloba which is cultivated in India from the ancient time .Guar gum is a useful material to investigate. It has a strong hydrogen bonding forming tendency in water which makes it a novel thickner and stabilizer. Aqueous solutions of guar gum are very viscous in nature. Because of these properties it has wide applications in the industries like food, pharmaceuticals, textile, oil, paint, paper, explosive and cosmetics. This study tried within the limits of available resources, to extract, characterize the components of the oil, and analyse the phytochemical constituents of the seeds of Cyamopsis tetragonoloba. The partial characterization of mustard seed oil was undertaken by looking at its physical and chemical properties and phytochemical analysis after soxhlet extraction. The liquid state of the oil extracted makes it a good nutritional and industrial material because of ease of use. Its organoleptic properties namely, colour, odour, and taste, serve the purpose of distinguishing the genuine from adulterated oil as well as its degree of purification or refinement. It has yellow colour, penetrating odour and slightly pungent acrid taste which can be attributed to the presence of such substances as chlorophyll, carotenoids, oxidative products resins and other impurities since a pure fat and oil and their constituent fatty acids are generally colourless, odourless and tasteless. Its solubility and miscibility revealed that it is readily soluble and miscible with certain organic fats and oils are generally insoluble in water since they contain a predominance of non- polar groups, but are soluble in certain organic solvents. Phenolics and flavonoids play important role in the bioavailability and bio accessibility of Guar seeds. Various phenolics such as chlorogenic acid, gallotannins and gallic acids compounds in leguminous based plants food has large diversity in chemical, physical and biological formation, can be extracted and isolated by high performance liquid chromatography. Phenols and flavonoids present in guar seeds play an important role in treatment of various cardiovascular and nervous system related diseases. Anti-nutrients tannins, phytates and oxalates negatively effects the minerals and vitamins availability. Major volatiles observed from Guar seed oils are furfuraldehyde, ethyl benzoate etc. *Cyamopsis tetragonoloba* is well known for medicinal plant useful in lowering low density lipoproteins improving heart health.

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