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Cassia Tora Hydrocolloid: Exploring its Potential as a Key Material for Diverse Applications- A Review

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Abstract
Cassia Tora hydrocolloid, a versatile natural polysaccharide gum, is a valuable resource with diverse applications in various industries. The composition and structure of Cassia Tora Gum is characterized by galactomannans, offering excellent thickening, stabilizing, and emulsifying properties. The production of Cassia Tora Gum involves extraction from the seeds through a series of processing steps to obtain a high-quality gum product. Its applications range from being a suspending agent in pharmaceutical formulations to a thickening and stabilizing agent in food products. Overall, Cassia Tora Gum stands out as a promising natural hydrocolloid with a wide array of uses, its unique composition, versatile chemistry, and beneficial properties that cater to the evolving needs of different sectors**.** The market for Cassia Tora gum will also be boosted by an increase in customers who are becoming more conscious of their health and by the growing desire for clean label products.

Keyword: Hydrocolloid, Galactomannan, Cassia Tora Seeds, Cassia Tora Gum, Thickening Agent, Stabilizer, Applications

1. Introduction:

Polysaccharides are complex carbohydrates consisting of monosaccharide groups linked by glycosidic linkages, forming the macromolecules found in nature (Mohammed *et al*., 2021). They are widely distributed in the natural world and can be found in a wide range of organisms, including bacteria, plants, animals, and algae. Numerous qualities of polysaccharides make them useful for applications in the culinary, pharmaceutical, cosmetic, biotechnological, and other industries. Benefits from these bio macromolecules include improved solubility, stability, non-immunogenicity, biodegradability, and biocompatibility (Liu *et al*., 2015). Polysaccharides can be chemically and physically modified to enhance their properties for specific applications. They play role in biomedical applications due to safety, low cost, stability, water stability, biocompatibility and compatibility for various purposes (Liu *et al*., 2015; Seidi *et al*., 2022).

The food industry often utilizes natural polysaccharide gum because of its distinctive characteristics. Natural gums are non-hazardous, budget-friendly, readily accessible, and have diverse uses in both food and pharmaceutical sectors (Munir *et al*., 2021). Gums are natural ingredients commonly found in food formulations. They provide numerous benefits including stabilizing, thickening, emulsifying, and surface-active properties. Plant gums are widely employed in all kinds of processed food products, encapsulation of flavors and colors, emulsions, fiber enrichment, thickening and foaming agents, and functional food formulations. They enhance the textural qualities of food and extend shelf life (Eghbaljoo *et al*., 2022; Da *et al*., 2020). Some commonly used gums include xanthan gum, guar seed gum, carrageenan gum, locust bean gum, and cellulose gum, each offering specific functional qualities that contribute to the desired textural characteristics and longevity of food products (Cui *et al*., 2005; Milani and Maleki, 2012).

The use of leguminous seeds as a source for hydrocolloids in industries like food and pharmaceutical is being explored due to their abundance of proteins, fibers, and bioactive components (Ibanez and Ferrero, 2003). Galactomannans, found primarily in leguminous plant seeds like guar, locust bean, and fenugreek, are polysaccharides with a mannose backbone and galactose side groups. They possess unique properties making them useful in diverse industries. Galactomannans serve as viscous solutions, stabilizers, emulsifiers, and thickeners, contributing to the texture, stability and shelf-life extension of various food products (Phillips and Williams, 2009; Nussinovitch, 1997).

Cassia Tora Linn. belongs to family – Leguminosae is annual shrub all over the tropical areas (Kumar *et al*., 2022). Cassia tora Linn, a leguminous plant, is widely distributed. (Murty and Iyer, 1956). Cassia tora seeds come from a plant with the same name, Cassia tora. These seeds have unique galactomannan structures that make them useful in various industries. Cassia tora gum (CTG) is a natural biopolymer extracted from the seeds of the Cassia tora plant, which is part of the Leguminosae family. The main components of CTG are galactose and mannose units. It consists of a galactomannan backbone made of (1→4)-β-d-mannopyranose (M) units and (1→6)-α-d-galactopyranose (G) side chains. Unlike other commercial galactomannans, CTG contains fewer galactose units, typically maintaining a ratio of 5:1 (mannose to galactose units) (Mahungu and Meyland, 2021; Sarwa *et al*., 2022).

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Cassia Gum, extracted from Tora seeds, is gaining attention in the food industry for its valuable functional properties and alignment with consumer demands for natural ingredients. This versatile hydrocolloid offers several advantages, including enhancing texture, retaining moisture, and mimicking fat, making it a favorable substitute for synthetic additives. With the growing shift towards healthier and sustainable products, Cassia Tora Gum stands to play a significant role in various food applications. This review offers a detailed overview of the significance, characteristics, and possible versatile uses of this naturally occurring hydrocolloid. The market for hydrocolloids is expanding due in large part to the growing need for food to feed a growing population, the expanding economies of developing countries and their adaptable use in manufacturing, the rise in consumers who are more conscious of nutrition, and the growing desire for clean label products (Manzoor *et al*., 2020).

2. Phytobiology of Cassia Tora

Cassia Tora is a plant commonly found in different countries like India, Sri Lanka, West China, and tropical regions. In India, it is typically found as a weed in wastelands and rainy season areas. It can grow in dry soil in tropical regions and high hills up to 1,800 meters, as well as in plains. Cassia Tora is believed to have originated from India to Polynesia. This plant is typically an annual herb with a pungent odor, and it can reach a height of 30-90 cm. It has pinnate leaves with three pairs of opposite leaflets that are obovate or oblong with an oblique base and can be up to 10 cm long. The flowers of Cassia Tora have five petals and are pale yellow in color. In India, flowering occurs after the monsoon season (Shukla *et al*., 2013). Pods are usually flat or have four sides and grow to 4-6 inches in length. They resemble a sickle, hence the name "sickle-pod." Each pod contains 30-50 rhombohedral seeds **(Figure 1)**. The seeds are dried in the sun during harvest, which happens in the autumn. Traditional medicine uses these seeds for various ailments, including leprosy, heart problems, gas, and bronchitis. Modern research indicates that these seeds have potential preclinical benefits against diseases like aging. This potential stems from their anti-bacterial, anti-hyperlipidemia, and anti-obesity properties resulting from their anti-inflammatory and antioxidant activities (Pawar and D'mello, 2011; Jain and Patil, 2010).

3. Composition and Structure of Cassia Tora Seed

The approximate composition analysis of Cassia Tora seeds shows varied value for different nutritional components. Proximate composition analysis values such as moisture content ranged from 10.82% to 11.50%, ash content from 4.44% to 4.69%, while protein content showed wide variation from 13.79% to 23.44% and similarly lipids or fat content showed very wide variation of 9.25% to 16.01% and crude fiber content from 7.78% to 28.13% and carbohydrate content also show wide range from 25.68% to 58.33%. On the other hand, every 100 grams of presence of calcium content in Cassia Tora seeds were 630 mg, iron 37.1 mg and phosphorus 240 mg which is about the presence of various valuable minerals. Carbohydrate polymers called galactomannans are mostly present in the seeds of plants belonging to the Leguminosae family. Galactomannans are composed of β-l,4-d-mannopyranoside units arranged in a linear chain, while α-d-galactopyranosides branch as a single unit through l,6 connections. A key component in defining the nature of galactomannans is the substitution of galactose in the mannan backbone. The insertion of galactose onto the mannan backbone has a substantial effect on its characteristics. Galactomannans make up the primary chain of Cassia Tora gum. Its structure is made up of side chains of (1→6)-α-d-galactopyranose units and (1→4)-β-d-mannopyranose units with a 5:1 (Man/Gal) ratio **(Figure 2).** Cassia tora galactomannan has special qualities due to its unique Man/Gal ratio (5:1), which makes it a useful raw material for a variety of industrial uses ((Srivastava & Kapoor, 2005; Sharma *et al*., 2020).

4. Production of Cassia Tora Gum

Process flowsheet for preparation Cassia Tora Gum by slight modification in method suggested by (Nemade and Sawarkar, 2015) is shown in **Figure 3.** To extract Cassia Tora Gum, the seeds first undergo cleaning, then grinding and sieving operations to separate the endosperm from the hull and embryo, based upon differences in their hardness. When these procedures are coupled with further physical treatments, the seed breaks and its components separated. The endosperm, which is rich in galactomannan, is separated from the protein-rich germ part. Next, the Cassia Tora Split endosperm is ground into a powder. After fat is removed from the prepared powder, Native (Natural) Cassia Tora gum is added. Extracted Cassia Tora gum is utilised in a variety of industries.

5. Properties of Cassia Tora Gum

Cassia Tora Gum powder is a fine, off-white to yellowish powder with a neutral odor and taste. It has a bulk density of 0.6 kg/l and a particle size less than 250 microns. This fine particle size makes it suitable for dispersion in various food applications. The gum is insoluble in ethanol but disperses effectively in cold water, forming a colloidal solution that acts as a thickening agent. The pH range for Cassia Tora Gum is 5.5 to 8.0, and its viscosity exceeds 260 mPas at a 1% concentration, which are essential parameters affecting its performance as a stabilizer and thickener in food products. Its break strength, quantified by measuring the force needed to break the gel or structure it forms, ranges from 1,200 to 1,800 g/cm². This measurable parameter reflects how the gum contributes to the textural properties of food products (Mahungu and Meyland, 2008).

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6. Applications of Cassia Tora Gum

Cassia Tora gum has lots of industrial application (**Table 1).** Cassia Tora gum is applied majorly in all manners of food industries; as a thickener, stabilizer, or gelling agent. In medicine, cassia gum is used for binding and coating of tablets. One such important property of Cassia gum is its use as a coagulant in the effluent treatment of wastewater, particularly textile and paper industry effluents, which gives the possibility of removal of contaminants from water. It is also used for development of disposable packaging material. It is this multifunctional nature of Cassia gum that makes it suitable as an ingredient in diverse industrial processes.

6.1 Application in Food Industry:

The invention made by Bayerlein *et al*. in 1988 deals with new alkyl ethers and phosphoric acid esters of Cassia gum polygalactomannans having the properties of improved thickening without the disadvantages of conventional agents, for example, such as LBG or LBG ethers. Because of this, they are good for textile and paper printing, well drilling fluids, mining, explosives, and so forth. All these derivatives, particularly with good thermal stability, find enormous application in petroleum recovery and well drilling for their property to maintain viscosity even under severe conditions. They may work alone or could be mixed with other polysaccharide derivatives such as guar gum, sodium alginate, or xanthan gum. Synthesis involves the reaction of Cassia gum polygalactomannans with alkyl halides or alkylene oxides to produce alkyl ethers whereas phosphating is derived by esterifying with phosphoric acid or its salts. This makes possible the versatile solutions of the derivatives for various industrial needs while ensuring stable performance and enhanced functionality.

Hallaganf *et al*., had earlier reported that the applications of cassia gum included it as a thickening agent, emulsifying agent, foam stabilizing agent, and moisture retention agent and texture improvement in various food products meant for human beings and pets.

The system of gelling and thickening agent is patented from cassia galactomannan-based (Kuhn, 1989). In this sense, it is a really synergistic combination: cassia galactomannan with carrageenan, agar, and/or xanthan gum. The new preparation from cassia seeds shows excellent synergism with extracts from red algae and biopolymers of this kind. This potassium, calcium, and/or ammonium ions, are added together with agents of gelling and thickening to enhance the properties of forming. High improvements were noted in the gelling and thickening capacity of these agent products across a wide range of industrial applications with high usage in many fields like food, pharmaceuticals, cosmetics, paper manufacturing, explosives formulations, water treatment, etc., as reported in this patent. This patent, in general, represents another condition which is favourable in some respects: cassia galactomannans-based novel class of gelling and thickening agent types manifesting high synergistic effects in combination with other polysaccharides and biopolymers and thus useful for enhanced gel formation properties across broad range industrial applications.

Veen and Budemann, 2013 reported that Fat substitute compositions comprising inulin and cassia gum (CTG). Cassia gum (CTG) is basically used in a number of applications owing to its property to hydrate and build up a colloid in hot water. It has associated impacts of thickener, emulsifier, and binder of food products. It is further utilized as a fat substitute combined with inulin which will incorporate a composition of fat substitutes that give attributes similar to those of fats based on food products; will offer a mouthfeel, body, and texture akin to those of fat-based products and yet appear to have an identity alike traditional fat-based product.

In various products, Hoover, 2015 reported the application of cassia gum. where Cassia gum is used as a principal constituent for the preparation of thickener compositions, especially when combined with highly esterified pectin. Such compositions are preferably characterized by specific weight ratios of cassia hydrocolloid to highly stable pectin from 90:10 to 10:90, more preferably 80:20 to 40:60 and even more preferably from 70:30 to 50:50. Such cassia gum is derived from the plant sources Cassia tora and Cassia obtusifolia, which find utility in the acceleration and improvement in rheology, psychosensory properties, aesthetics, and appeal of food and fodder compositions. In food compositions, the thickener composition further includes fats and proteins, especially in dairy products like yogurt, which combines the thickener composition of cassia gum and highly esterified pectin. The component of dairy can be anything from milk to yogurt.

The process for creating a gelling agent including cassia gum that melts at a temperature similar to that of carrageenan was published in a 2007 patent by Horie and Iwamoto. In addition to being easy to handle even at a lower melting temperature than a commonly known locust bean gum-containing gelling base, the present invention's mixed product of cassia gum and carrageenan can find a wide field of uses for many foods as a thickening or gelling agent, among them being the fruit jellies, Jam, puddings and desserts, soy milk puddings, etc.

Jules *et al*. (2017) reported that by mixing first and second hydrocolloids in the following way, their method enhanced the mouthfeel of beverages: The first hydrocolloids with inherent viscosity ranging from 5 to 600 ml/g were selected from a variety of sources, including low molecular weight carboxymethylcellulose, arabic gum, apple pectin, and sugar beet pectin. From the category that includes guar gum, locust bean gum, cassia gum, pectin derived from plants, high molecular weight carboxymethylcellulose, carrageenan, alginate, xanthan, and their combinations, a second hydrocolloid is chosen.

Ackerkamp *et al*., 2013, further echoed that cassia gum is a hydrocolloid and is obtained from the endosperm of the seeds belonging to the plants of either Cassia tora or Cassia obtusifolia. It forms a major constituent of the gelling agent of the packaged concentrate. Through its combination with xanthan gum, it brings the desired gel formation through which the texture and stability essentials the base concentrate gets derived. The cassia gum (CTG) as a gelling agent in this blend provides the gel with flexibility, hence it cannot be too rigidly solid and allows free run-off from packaging at a high level. In so doing, it avoids the low syneresis tendency of the concentrate and hence improves shelf stability and visual appeal. The proper amount of cassia gum in the blend of gelling agents will provide the best functionality of the gel to form a rapid dissolution in boiling water while keeping the form and flavor of the concentrate.

6.2 Application in Healthcare and Personal Care Industry:

Sarwa *et al*., 2022, reported that cassia gum is a food additive having a polycassius from the seeds of Cassia tora (CT) and is generally recognized as safe. It causes swelling with water and form a colloidal dispersion of high viscosity. In this study, from the extraction of cassia gum, it was prepared as a suspension agent in paracetamol suspension at concentrations that varied from 2-4% w/v. Comparative analyses were thereafter done with gum acacia, tragacanth, and gelatine. Results showed that suspensions prepared from Cassia gum showed the highest viscosities and the most negative zeta potential. It also had good suspending properties and redispersed well over other gums tested with the increase in concentrations. The result of storage after a period of 6 weeks showed that the Cassia gum kept the suspensions stable with minimum sedimentation and with easy redispersibility. From these results, therefore, this study further asserts that the addition of Cassia gum makes it possible to prepare flocculated suspensions that may redisperse readily post-sedimentation with little agitation.

Peffly *et al*., 2015 studied a non-guar galactomannan polymer derivative and an anionic surfactant system and its application in personal care. This is due to the fact that personal care formulations which combine anionic detersive surfactants and conditioning agents present difficult conditions in gaining effective deposition onto the surfaces of hair and skin, a scenario that jeopardizes the conditioning efficacies. As much as cationic deposition polymers, among them modified guar gum, present the answer to such problems, they require high levels for deposition requirements thus inflating the costs. This was coupled with cationic cassia gum polymer derivatives with hydroxyl propyl trimethyl ammonium chloride, taken in such a ratio that it has a greater mannose to galactose ratio (5:1), molecular weight around 200,000, and appropriately a cationic charge density of about 3 meq/g. This has better conditioning without much deposition, which gives a soft feel at the surface of hair as well. What is therefore still needed are personal cleansing compositions exhibiting improved conditioning performance but maintaining a suitably low cost.

Utz *et al*., 2007 reported work on Cationic cassia derivatives and its applications, which have found wide applications, such as in the preparation of personal care articles and health care compositions like cosmetics, toiletries, cosmeceuticals, and pharmaceuticals. They act in the capacities of emulsifiers, spreading aids, carriers, thickeners, film formers, and suspension agents. These derivatives enhance the efficacy of active ingredients, their deposition, and delivery in shampoos, conditioners, lotions, creams, anti-acne products, sunscreens, oral care products, lotions, and deodorants.

6.3 Application in Packaging Industry:

Cao *et al*., 2019, have reported that carboxylated cellulose nanocrystal whiskers can enhance the barrier properties and heat sealability of edible oil packaging films with a cassia gum matrix. The packaging film obtained after the PG treatment exhibited better improvements in the barrier properties, heat sealability, and functional behaviour because OPG works in cooperation with PG due to the hydrophobic properties. On the other hand, CG provides a hydrophilic and biodegradable edible matrix for NPs reinforcement, whereas C-CNCW shows high hydrophilicity and an ability to establish a percolated network in film, further enhancing interactions with the matrix through hydrogen bonding, hence increasing mechanical strength and reducing permeability of water vapor while improving permeability to oil. In this type of film, synergy and very strong hydrogen bonding exist between the CG and the C-CNCW, making it have excellent barrier properties and heat-sealing capability for application in sustainable food packaging.

Similarly, Cao *et al*., 2018 developed edible Cassia gum film and investigated the use of glycerol and sorbitol as plasticizer ingredients. Being a hydrophilic colloid with a brownish hue, CTG is derived from the endosperm of Cassia seeds containing polysaccharides and galactomannan. The research will focus on studying the different characteristics of CG films. The emphasis is how hydrogen bonds play a role in between plasticizer and CG molecules. It also means correlating rheological properties of film-forming solutions in respect with properties that come through in the final film. Generally, the study has proved the potential for applications by the CG-based edible films in varied uses within the food industry.

Li *et al*., 2022 explained the novel development of an edible film having enhanced barrier moisture characteristics coupled with rapid dissolution features; it is made of cassia gum and ethyl cellulose for packaging dried vegetables. The research paper outlined succinctly the potential of the film in packaging convenience foods in support of environmental protection objectives, of course. Through multiple experiments and analyses conducted to test its performance, water vapor permeability was one of them, and rates of dissolution were some others.

6.4 Application in Textile Industry:
Sanghi *et al*., 2002 studied the effect of Cassia seed gum as a coagulant for decolourisation of dye solutions. Since textile wastewater is laden with colored contaminants that pose serious health and environmental hazards, the development of efficient treatment methods is paramount. Therefore, conventional methods based on synthetic coagulants, as in the case of alum or polyaluminium chloride, proved not to be effective in relation to the general resistance of textile dyes against biological degradation. The coagulant extracted from Cassia angustifolia seed gum has been experimentally explored and is an alternative to this. It was very effective against acid and direct dyed solutions; its efficacy ranges from good to medium level for reactive dye solutions. However, cassia gum shows some promising results as coagulant aid by combining it with a low dose of polyaluminium chloride for some types of dyes, and can be useful both economically and environmentally friendly management of textile dye wastewater.

6.5 Application in Wastewater Treatment:
Overall, the findings indicate that cassia gum, a naturally occurring seed gum derived from cassia, has demonstrated suitability as an alum alternative in the treatment of high-strength wastewaters, such as palm oil mill effluent (POME) (Shak and Wu, 2014). The purpose of this study was to evaluate the effectiveness of both in removing COD and TSS from POME under various settings, including temperature, settling duration, stirring speed, coagulant dose, wastewater strength, and beginning pH. Alum is generally less effective than Cassia Obtusifolia seed gum at removing TSS and COD from POME. Contrarily, the study also clearly exhibited that the treatment efficiency of wastewater temperature has little influence on Cassia Obtusifolia seed gum in comparison to alum, which was also having a greater temperature effect. This stability under high-temperature conditions would therefore be considered more beneficial for Cassia seed gum in terms of treatment effectiveness.

7. Conclusion
In conclusion, the exploration of Cassia Tora Gum in this review paper sheds light on its significance as a natural polysaccharide with immense potential across various industries. Through an understanding of its phytochemistry, composition, and structure, it uncovers the rich galactomannan content that underpins its functional properties. This review forms a basis of establishing plant seeds as a valuable source for diverse applications and an alternative source of gum which are otherwise goes as forest waste. The detailed insights into the preparation methods highlight the intricate process of extracting and refining Cassia Tora Gum to ensure its quality and efficacy in applications. Moreover, the comprehensive overview of cassia gum's properties underscores its role as a valuable ingredient in food, pharmaceutical, cosmetic, and textile products. Its ability to act as a thickening agent, stabilizer, and emulsifier showcases its versatility and adaptability in different formulations. The applications discussed in this paper emphasize the practical relevance of cassia gum. In essence, the study of cassia gum encapsulates the intricate interplay between phytochemistry, structure, modification, and application, highlighting its significance as a versatile polysaccharide with immense potential for innovation and advancement in various industries. Rise in use of hydrocolloids in many fields in the forecast period will have definitely great future for Cassia Tora Gum.

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Conflicts of interest
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Figure 1. Cassia Tora Plant, Sickle Pod and Seeds

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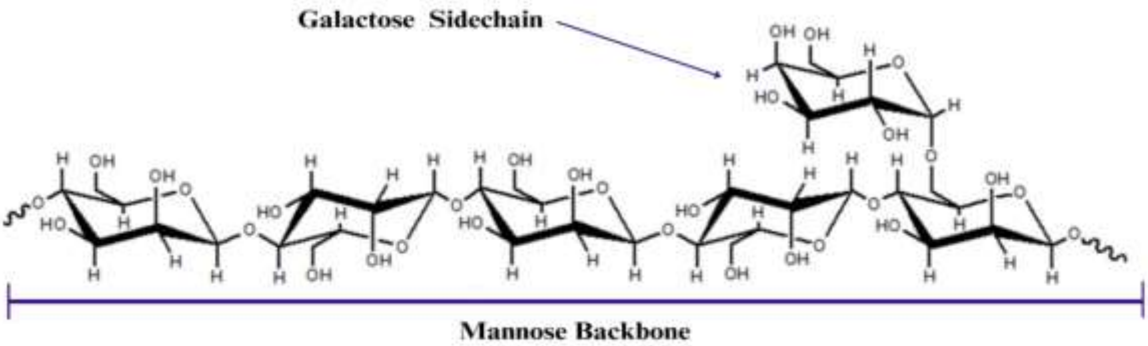

Figure 2. Structure of Cassia Tora Galactomannan

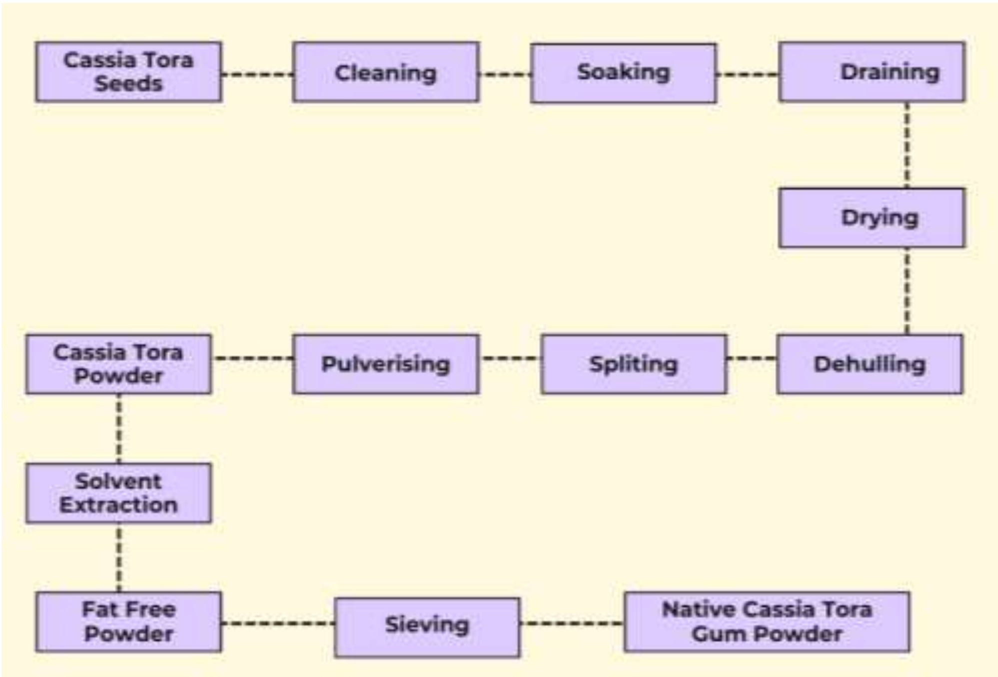

Figure 3. Process Flowsheet for Extraction of Cassia Tora Gum

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Table 1. Applications of Cassia Tora Gum in different Industries

Industry	Gum	Application	Effect	Title of patent	Patent No.	Reference
Food Industry	Cassia gum with xanthan gum	Soup, sauce, gravy or for use as a seasoning	To get desired gel formation, providing the necessary texture and stability	Packaged concentrate for preparing a bouillon, soup, sauce, gravy or for use as a seasoning, the concentrate comprising xanthan and cassia gum	CN101322538B	Ackerkamp *et al*., 2013
	Phosphoric acid esters of Cassia tora gum	Food Products	Used as thickening agents in different Products	Derivatives of cassia tora polysaccarides and their use	US4753659A	Bayerlein *et al*., 1988
	Cassia gum and Esterified Pectin	yogurt	To improve flow and stability	Improved thickener composition for food products	KR20090085072A	Hoover, 2015
	Synergistic mixture of (a) Cassia-toragalactomannan, and (b) carrageenan, agar and/or xanthan.	Animal Feed and Food	To produce a gelling and / or thickening effect.	Gelling And Thickening Agent Based on Cassia Galactomannans	DE3335593A1	Kuhn, 1989
	Cassia Gum and Inulin	processed cheese product, a yoghurt product, a processed meat product, an ice-cream product, a dessert product, a margarine product, a spreadable oil or fat, a fine food product or a dairy based beverage	To improve mouthfeel and smooth texture, and fat replacer	Fat substitute compositions comprising inulin and cassia gum	WO2013037739A1	Veen and Budemann, 2013
	Cassia gum	Improvement of the mouthfeel of drinks	To improve the mouth feel	Improvement of the mouthfeel of drinks	ES2607005T3	Jules *et al*.,2017
	Cassia gum and Carrageenan	Jelly, Jam, Pudding, Milk Dessert,	Used as thickening and gelling agent in Food Products	Method for producing cassia gum-containing gelling agent melting at temperature comparable with melting temperature of carrageenan	JP2007306900A	Horie and Iwamoto, 2007
	Cassia Gum	Canned pet foods	Used as thickening agent, emulsifier, foam stabilizer, moisture retention and texture improvement	-	-	Hallaganf *et al*., 1997
Packaging Industry	Cassia Gum and Ethyl Cellulose	Packaging Material for Dried Vegetables	To Improve Moisture Barrier for Packaging	-	-	Li *et al*., 2022
	Cassia gum, glycerol and sorbitol	Edible Film	To improve mechanical properties and low water vapor permeability.	-	-	Cao *et al*., 2018
	Cassia gum (CG)/carboxylated cellulose	Packaging Film	To enhance the heat sealability and mechanical properties.	-	-	
Healthcare and Personal Care Industry	Cassia Gum	Pharmaceutical	To form a colloidal dispersion with increasing viscosity	-	-	Sarwa *et al*., 2022
	Cassia Gum	Health and Personal Care	Acts as emulsifiers, spreading aids, carriers, thickeners, film formers, and suspension agents	Cationic cassia derivatives and applications therefor	US20050026794A1	Utz *et al*., 2007

	Cationic Cassia Gum Polymer	Personal care	To achieve desired conditioning performance	Personal care composition containing a non-guar galactomannan polymer derivative and an anionic surfactant system	US9198847 B2	Peffly *et al*., 2015
Textile Industry	Cassia Gum	Textile Industry	Used as coagulant for decolourisation of dye solutions	-	-	Sanghi *et al*., 2002
Wastewater Treatment	Cassia Gum	Waste Water Treatment	For treatment of waste water	-	-	Shak and Wu, 2014