Guar Gum Products, Its Research & Uses in Chemical Industries

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Abstract- *India is the world leader for production of guar, which is grown in the northwestern parts of country. Guar gum, it is a white to yellowish white, nearly odorless, free-flowing powder with a bland taste. Guar gum along with many products and co-products requires detailed technical, environmental, economic and institutional analysis. Guar gum mainly functions as a thickener, emulsifier, stabilizer, binding agent, gelling agent, natural fiber, flocculent, and fracturing agent.*

Keywords- Guar gum, Guar gum derivatives, Extraction method

I. INTRODUCTION

Guar is an annual plant, which can grow in extremely drought resistant conditions and can thrive in semiarid regions where most plants perish. The guar bean has a large endosperm, which contains significant amounts of guar gum, which is the primary marketable product of the plant. Guar is used as cattle feed and green manure and can be eaten as a green bean. Guar Gum, which is a very important product of guar seed processing, is used as an emulsifier, thicker and stabilizer in food, cosmetics and pharmaceuticals, explosives, textiles and carpets, oil well drilling, mining, construction and paper industry. The by-products of guar processing, 'Churi' and 'Korma' are used as cattle feed. Guar gum recovery normally comes around 31% of total guar seed processed, whereas Churi and Korma accounts for 29% and 37% respectively.

Guar gum, also known as Gum cyamopsis or guar flour, is derived from the ground endosperm of the seed of the guar plant, Cyamopsis tetragonaloba (L) Taub. (syn. Cyamopsis psoraloides). This plant has been cultivated in India and Pakistan for centuries. It can also be cultivated in the southern hemisphere in semi-arid zones in Brazil, Australia and South Africa or in the Southern part of the USA, like Texas or Arizona. The guar kernel is composed of several layers, namely the husk (16-18%) on the outside, the germ (43-46%) and the endosperm (34-40%), which is composed of guar gum.1-4.Guar splits are obtained after separation of the husk and the germ. After heat treatment, the hull is easy to separate by either attrition milling or various types of impact mills. The endosperm is recovered by sieving from the finer germ and hull fractions, and then milled to obtain powdered guar gum. The guar gum may be further purified clarified by dissolution in water, precipitation and recovery with ethanol or isopropanol. It is called as clarified (purified, extracted) guar gum. Clarified guar gum in the market is normally standardized with sugars. Guar gum is mainly consisting of the high molecular weight polysaccharides composed of galactomannans which are consisting of a linear chain of (1→4)-linked β-D-mannopyranosyl units with (1→6)-linked α-D-galactopyranosyl residues as side chains. The mannose: galactose ratio isapproximately 2:1. The molecular weight range is 50,000-8,000,000.

The clarified guar gum has higher galactomannans content and no longer contains the cell structure. The gum is a white to yellowish white, nearly odorless, free-flowing powder with a bland taste. Guar gum is insoluble in organic solvents. The gum is soluble in cold water without heating to form a highly viscous so1ution. Guar gum solutions have buffering capacity and are very stable in the pH 4.0-10.5 range. Addition of a small amount of sodium borate to a water solution of guar gum will result in formation of a gel. 1-4

Fig. 1 Guar gum Seeds

II. MATERIALS AND METHODS

The processing technologies and purification technique to meet commercial samples of guar gum should contain approximately 4-12% moisture, 2-5% acid-soluble ash,0.4-1.2% ash, and 2-6% protein. The samples of clarified guar gum should contain approximately 5-10% moisture, 0.2-0.8% acid-soluble matter, 0.1-0.5% ash, and 0.1-0.6% protein. Apart from the gum content, the guar gum should contain:

- husk residues represented by the acid-insoluble-matter criterion (not more than 7.0%)
- proteins from the germ represented by the protein criteria (not more than 10.0%)
- ethanol / isopropanol residues for washing or extraction solvent(not more than 1% singly or in combination).

The endosperms are recovered after separation of the husk and the germ and milled. The clarified gum is obtained by dissolution in hot water and then recovery by precipitation in ethanol or isopropanol solutions.

Manufacturing process of guar gum is as the flow chart. Guar splits are obtained after separation of the husk and the germ. After heat treatment, the hull is easy to separate by either attrition milling or various types of impact mills. The endosperm is recovered by sieving from the finer germ and hull fractions, and then milled to obtain powdered guar gum. The guar gum may be further clarified (purified) by dissolution in water, precipitation and recovery with ethanol or isopropanol.[5-9]

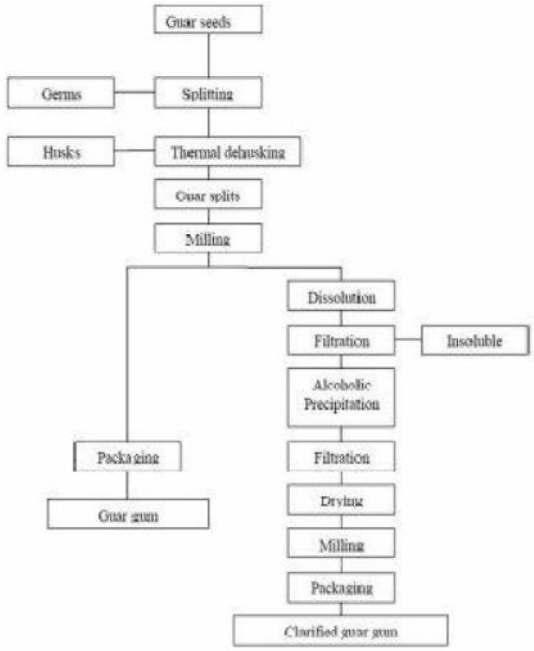

Fig.2 Manufacturing process of guar gum[18]

Research used in different industrial uses:

Guar gum and its derivatives are widely used in various industries as per its needs. It is used in industries such as food, textile, pharmaceuticals, personal care, health care, nutrition, cosmetics, paper, explosives, mining and oil well drilling. Guar gum mainly functions as a thickener, emulsifier, stabilizer, binding agent, gelling agent, natural fiber, flocculent, fracturing agent etc. in the above-mentioned industries.

Food Industry:

In food Industry guar gum derivatives is used as gelling, viscosifying, thickening, clouding and binding agent as well as used for stabilization, emulsification, preservation, water retention, enhancement of water soluble fiber content etc. Some food products in which guar gum powder is used are:

- Ice cream, soft drinks & concentrates, puddings
- Chocolate milk, flavored milk
- Pet Foods
- Bread, biscuit and other baked foods
- Ham and sausages
- Soft cheese and cheese spreads
- Canned or retorted food of fish and meat
- Myonnaise, ketchup, sauce and dressings
- Noodles and pasta

In frozen food products guar gum reduces crystal formation; act as a binder & stabilizer to extend shelf life of ice cream.

In baked food products guar gum provides unparallel moisture preservation to the dough and retards fat penetration in baked foods.

In dairy products guar gum improves texture, maintains uniform viscosity and color. In sauces & salad preparations- guar gum acts as a water binder in sauces and salad dressings and reduces water and oil separation. In confectionary guar gum controls viscosity, bloom, gel creation, glazing and moisture retention to produce the highest-grade confectionary. In beverages guar gum provides outstanding viscosity control and reduces calories value in low calories beverages. In pet food guar gum forms gels and retains moisture, acts as a thickening, stabilizer and suspending agent for veterinary preparations.[10-17]

Pharmaceutical Industry:

With a view that hydroxypropyl guar (HPG) may replace hydroxyethyl cellulose (HEC) from water based paints, chemical modification of guar gum via hydroxypropylation was carried out at lab/commercial level. The comparative study reveals that HPG is a perfect choice of rheological agent, which governs excellent properties for aqueous paints. This product has similar/ better properties of HEC. Graft copolymerization of methacrylic acid (MAA) onto guar gum was carried using potassium persulfate (PPS) as free radical initiator. Using PPS, the maximum percent grafting was ascertained to be 241 at the optimum conditions of 60°C

reaction temperature, 3 h of reaction time, 1.1 mmol of PPS and 0.058 mol of MAA. The prepared graft copolymer could find applications in drug delivery systems. A mild method for microencapsulation of sensitive drugs, such as proteins, employing a suitably derivatized carboxymethyl guar gum (CMGG) and multivalent metal ions like Ca2+ and Ba2+ was reported. The swelling data of Ca2+ and Ba2+ crosslinked beads suggest that Ba2+ crosslinks CMGG much more efficiently than Ca2+. The drug loading efficiency of these Ba2+/CMGG beads, as a function of concentration of both metal ion as well as drug, was then determined using Bovine Serum Albumin as a model drug. Results indicated that Ba2+ crosslinked carboxymethyl guar gum beads could be used for gastrointestinal drug delivery.

Guar gum was chemically modified by sulphonation using chlorosulphonic acid (ClSO3H) as a reagent. Activated partial thromboplastin time (APTT) assay showed that the guar gum sulphate could inhibit the intrinsic coagulant pathway. The anticoagulant activity strongly depended on the degree of substitution (DS) and molecular weight (Mw) of polysaccharides. DS>0.56 was essential for anticoagulant activity. The guar gum sulphate with the DS of 0.85 and the Mw of 3.40×104 had thebest blood anticoagulant activity.
Guar gum or its derivatives are used in pharmaceutical industries as gelling /viscosifying/thickening,suspension, stabilization, emulsification, preservation, water retention / water phase control, binding, clouding/bodying, process aid, pour control for suspensions, anti-acid formulations, tablet binding & disintegration agent, controlled drug delivery systems, slimming aids, nutritional foods etc.Guar gum is an important non-caloric source of soluble dietary fiber. Guar gum powder is widely used in capsules as dietary fiber. Fiber is a very important element of any healthy diet. It is useful in clear the intestinal system since fiber cannot be digested. This keeps the intestines functioning properly and also improves certain disorders and ailments. All natural fiber diet works with body to achieve a feeling of fullness and to reduce hunger. Its synergistic mix of guar gum and fiber mixture when taken with water expands in stomach to produce a feeling of fullness.

Cosmetic Industry

Guar gum or its derivatives being used as a thickener, protective colloid and conditioner in hair/skin care products, creams, shampoos and lotions. Beside this, these are also used in toothpaste and shaving cream for easy extruding from the container tube.

Use of Industrial Grade Guar Gum Powder:

The rheology of binary mixtures of two alginates and one carboxymethyl guar (CMG) was determined. Two reactive dyes were printed from pastes based on these mixtures. The printing and the final print (color yield, levelness and fabric stiffness) were assessed. From the results, it can be concluded that mixture of CMG with alginates can be used in reactive printing.

In industrial applications, guar gum powder/ derivatives utilized as thickening agent, sizing agent, wet-end strength additive, gelling agent and water barrier, flocculation aid for waste water treatment, as emulsifier, binder. Also used for mud formulations, enhanced oil recovery, polymer flooding, well treatment, lost circulation plugging etc. Guar gum industrial grade powder is used in industries such as textile printing &sizing, fire fighting, ceramics, pharmaceuticals, printing inks, mosquito mats, synthetic resins, paper industry, battery electrolytes, water treatment, floatation agent, water paint, carpet printing, oil well drilling, explosives, mining etc.

In paper industry, guar gum provides better properties compared to substitutes.

It gives denser surface to the paper used for printing.Guar gum imparts improved erasive and writing properties, better bonding strength and increased hardness. Due to improved adhesion, it gives better breaking, mullen and folding strengths.

In textile industry,guar gum gives excellent film forming and thickening properties when used for textile sizing, finishing and printing.

It reduces warp breakage, reduces dusting while sizing and gives better efficiency in production. In oil field industry,industrial grade guar gum powder/derivatives are use in oil well fracturing, oil well stimulation, mud drilling and industrial applications and preparations as a stabilizer, thickener and suspending agent. It is a natural, fast hydrating dispersible guar gum and is diesel slurriable. In the oil field industry, guar gum is used as a surfactant, synthetic polymer and deformer ideally suited for all rheological requirements of water-based and brine based drilling fluids. High viscosity guar gum products are used as drilling aids in oil well drilling, geological drilling and water drilling(19). These products are used as viscosifiers to maintain drilling mud viscosities that enable drilling fluids to remove drill waste from deep holes. Guar gum products also reduce friction in the holes, and so minimizing power requirements. Some guar gum derivatives act to minimize water loss should occur in broken geological formations.

In metallurgical and mining industry, chemical modification of guar gum was carried out through substitution and grafting reactions and products so obtained were tested against kaolin suspension to check their efficacy as flocculants. It was found that flocculation efficiency of the chemically modified products is better than Deftech and has potential to replace synthetic flocculants.

Flocculants were also synthesized by grafting of polyacrylamide (PAM) onto hydroxypropyl guar gum (HPG) using a ceric ion-induced solution polymerization technique. Flocculation efficiency of grafted products was determined against kaolin, iron ore and silica suspensions. Among the series of graft copolymers, the one with fewest but longest PAM chains shows the better performance. Guar gum is widely used as a flocculants to produce liquid solid separation. Guar gum is also used in flotation. It acts as a depressant for talc or insoluble gangue mined along with the valuable minerals.

In explosive industry, it is used as gelling agent for gel sausage type explosives and pump able slurry explosives, water blocking agent in nitro-glycerine, slurry explosives, ammonium nitrate and dynamite explosives- by mixing guar gum in ammonium nitrate, nitro-glycerine and oil explosives, even in wet conditions, explosive property is maintained. This is due to the better swelling, water blocking and gelling properties of guar gum. [10-17]

III. CONCLUSIONS

Guar gum, along with many products and co-products , requires detailed technical, environmental, economic and institutional analysis. For this examination of Guar gum it is clear that the economic outcomes are subject to major assumptions about the cost and availability of raw materials, processing yields, unit prices for products sold, capital investment required for commercial operations, and economies of scale and use of capacity. Finding the funds for proving a new technology adds to the complexity and challenge of the task, especially with small start-up businesses.

There is a strong relationship between price and consumption of most of the products. In order to ensure steady growth in the consumption of guar products it would be very important to contain the price of guar seed at a level which is remunerative to farmers as well as affordable for the consumers. Steps need to be taken for increasing the farmers' income by improving productivity. This can be done by the research on guar and extension activities it would be desirable for the industry to develop backward linkages. The research institutions and government agricultural departments have several priorities and certain limitations. For ensuring long term supply of raw materials at a reasonable price the industry would have to take some initiative. There are many successful examples in the country where industry has developed backward linkages i.e. Pepsi for tomatoes in Punjab, Amul and other State Dairy Federations for milk. Even sugar mills provide extension services and at a few places distribute tissue cultured plants to the sugarcane growers. In tandem with research institutions the industry could immediately start activities like adoption of 'seed villages', purchase and distribution. of guar seed besides extension activities. Lastly as a natural colloidal material and thickening agent it is preferred in developed countries like USA, Europe and Japan and hence its export demand will also grow in the coming period.

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