GUAR GUM: A VERSATILE MATERIAL FOR PHARMACEUTICAL INDUSTRIES

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ABSTRACT

Guar gum (GG) is galactomannan, derived from guar (cyamopsis tetragonolobus) kernels which belong to family Leguminosae. The solution of guar gum in water has the highest viscosity amongst all the natural polysaccharide discovered till the date. Further it has better bio-degradability and bio-compatibility. Due to these properties, guar gum finds application in various industries like, Textile, Food, Petrochemical, Mining, Paper, Explosive etc. But due to uncontrollable rate of viscosity, uncontrollable rate of hydration, instability of its solution for a long time and susceptibility to microbial contamination restricts its use in pharmaceutical industries. To overcome these drawback guar gum should be chemically modified. Modified guar gum is widely used in pharmaceutical application due to its viscosity enhancing properties. Guar gum and derivatives are used as binders and disintegrate in tablet and also used as a control-released agent for the drug. In this review article we summarized different pharmaceutical applications of native guar gum and its derivatives.

Keywords: Guar gum, Extraction method, Guar gum derivatives, Pharmaceutical applications, Control-release.

INTRODUCTION

Guar gum (GG) is galactomannan, derived from guar (cyamopsis tetragonolobus) kernels which belong to family Leguminosae. Guar gum is also known as cluster bean, Guaran, Cyamopsis, Guarina, Clusterbean, Calcutta lucern.

The guar plant is about 0.6m high and pods are 5-12.5cm long and contain an average 5-6 light brown seeds. Guar gum is insoluble in hydrocarbons, fats, alcohols, esters, ketones- in fact with a very few exceptions (e.g. formamide) in organic solvents in general. The only important solvent for guar gum is water [1]. The general structure of guar gum is shown in below figure.

Guar gum has the ability to produce highly viscous, pseudo plastic aqueous solutions even at low concentrations due to the high molecular weight (up to 200,000 to 300,000 Daltons) and to the presence of the extended repeating unit formed by hydrogen bonding. This feature allows guar gum to be soluble and gel even in cold water.

Chemically guar gum has a linear chain of (1→4)-linked β-D-mannopyranosyl units with (1→6)-linked α-D-galactopyranosyl residues as side chains with mannose: galactose ratio is approximately 2:1. As it is non-ionic it is not affected by any pH. It is stable between pH ranges 5-7 and degrades on extreme pH and temperature [2, 3, 4, 5, 6].

Extraction of guar gum

Guar gum is extracted from guar kernels. Global demand for guar seed has increased over the year with a sudden rise in demand in the recent time on account of its increasing use in the petroleum industry and pharmaceutical industries. Exports of Indian guar gum have increased from mere 85,000 tons in 1995-96 to 205,000 tons in 2006-07. In the current year too, the exports are expected to inch higher to 210,000 tones as per trade estimates.

The extraction process of guar gum from guar seed is shown in below figure.

Fig. 1: It shows the structure of guar gum

Fig. 2: It shows the extraction of guar gum from guar seed
Guar galactomannan has the unique property of imbibing large quantities of water, resulting in dispersions of extremely high viscosity. High viscosity coupled with the branched character of the polymer is responsible for adhesion of guar gum to hydrophilic surfaces. Guar gum products show a pronounced temperature thinning effect when their solutions are heated. This is caused by loss of water of hydration around the polymer molecule which makes the guar gum most applicable natural polymer [7]. Because of these properties, guar gum is used for a large number of industries viz. Textile, Petroleum, Paper, Explosive, Pharmaceutical and Food applications [8].

Guar gum is used to deliver drug to colon due to its drug release retarding property and susceptibility to microbial degradation in the large intestine. The gel-forming property retards the release of the drug from the dosage form as well as it is susceptible to degradation in the colonic environment [9-11].

Guar gum and its derivatives are used as a binder and disintegrate in tablets to add cohesiveness to drug powder. Guar gum is also used as a controlled release agent for the drug due to high hydration rate (swelling in aqueous media)[12]. As discussed earlier due to uncontrollable rate of viscosity, uncontrollable rate of hydration, guar gum finds limited use in virgin forms. There so it has been chemically modified into various properties to expand its industrial applications such as in food, paint and pigments, oil field, mining, paper, water treatment, personal care, pharmaceuticals and new types of superabsorbers. Natural polysaccharides like starch, cellulose, chitosan etc. are modified to carboxymethyl derivatives is the wide scope of research [13-15]. The most specific property of the guar gum and their derivatives is that they have hydroxyl groups, which makes them suitable for making changes in their structure formula and functionalization. A lot of research has been done on guar gum for the changing their physical and chemical properties by grafting, blending and compositing with synthetic and natural polymers. [16-19].

Some of the reported derivatives of guar gum are Carboxymethyl guar gum [16], Hydroxyethyl guar gum[20], Hydroxypropyl guar gum [21], O- Carboxymethyl- O-hydroxypropyl guar gum (CMHPG) [22], O-2-hydroxy-3- (trimethylammonia propyl) guar gum (HTPG), O-Carboxymethyl-O-2-hydroxy-3-(trimethylammonia propyl) guar gum (CMHTPG) [23], Acrylloxylu guar gum [24], Methacryloyl guar gum[25], Sulphated guar gum[26], Guar gum esters [27].

Guar gum in pharmaceutical industries

Guar gum in control drug release system

Guar gum used as thickener and stabilizer in pharmaceutical formulation. When mixed with different ingredients in the formulation of tablets it form protective layer and consequently, drug releases out from the guar gum tablet in a sustained manner, as a controlled release agent for the drug due to high hydration rate (swelling in aqueous media) [12]. To achieve the desired kinetics effect, and masked unpleasant taste and odor of drugs and improve its stability and drug release properties.

K.L.K. Paramjothy et al prepared transdermal patches of verapamil HCl by using sodium carboxymethyl guar as a polymer matrix. A comparison of various polymers and plasticizers were also made. In vitro release studied through the mouse skin has shown that sodium carboxymethyl guar as a suitable polymer [28]. Y.V. Rama Prasad et al studied in vitro drug release of guar gum in the form of compression coat applied over indomethacin core tablets protects the drug from being released under conditions mimicking mouth to colon transit. The study clearly established that guar gum, in the form of compression coat, is a potential carrier for drug targeting to colon [29]. Ishihara N et al investigated the effect of partially hydrolyzed guar gum (PHGG) for treatment of the colonization of Salmonella enteritidis (SE) in young and laying. They concluded that ingestion of different rat dose of PHGG decreases the Salmonella enteritidis (SE) due to improvement in the balance of intestinal microflora. Feed supplemented with 0.025% PHGG was found the most effective [30]. Kumares S. Soppimath et al prepared Poly (vinyl alcohol)-guar gum interpenetrating network microspheres by cross-linking with glutaraldehyde. Nifedipine, an antihypertensive drug, was loaded into these matrices before and after cross-linking to study its release patterns. The in vitro release study indicated that the release from these microspheres is not only dependent upon the extent of cross-linking, but also on the amount of the drug loaded as well as the method of drug loading [31]. Suppimath K. et al modified guar gum micelles by functionalization with trimetazidinehydrochloride by compressing on either side of guar gum matrix tablet granules of trimetazidinehydrochloride. The three-layer matrix tablets were evaluated for hardness, thickness, drug content uniformity, and were subjected to in vitro drug release studies. The results clearly indicate that guar gum in the form of three-layer matrix system is a potential hydrophilic carrier in the design of oral controlled drug delivery systems for highly soluble drugs [33]. Y.S.R. Krishnaiah et al studied site-specific delivery of 5-fluorouracil to the colon without the drug being released in the stomach or small intestine using guar gum as a carrier. The study shows the guar gum composite-coated tablets released shows 25-4% of the 5-fluorouracil in simulated GI fluids [34]. Toti U S et al prepared guar gum-polyacrylamideideopolymer. In vitro drug release of diltiazem hydrochloride was studied. The effect of drug loading 0-25% on release kinetics was evaluated. The nature of drug transport through the polymer matrices was studied by comparing with Higuchi, Hixon-Crosswell and Korsmeyer equations [35]. Muniraj S et al investigated the role of carboxymethyl guar gum for drug delivery systems. For this terbutaline sulfate (TS) was taken as model drug and the drug loading capacity of carboxymethyl guar gum films was studied at different pH range [36]. Muniraj S et al prepared microfiber containing various proportions of guar gum by wet spinning technique using starch paste and sodium alginate as model drug. The results of study indicate that microfiber containing 50% guar gum and coated with 10% hydroxy propyl methylcellulose phthalate are most suitable for drug like sennosides which are mainly active in the lower GIT [37]. M.K. Chaourasia et al studied colon-targeting delivery of metronidazole using guar gum microspheres. In vitro drug release studies were performed in simulated gastric fluid and study shows 15.27±0.56% of the drug was released in 5 hrs. [38]. Pabiyana L.R. Cunhaa et al prepared gel by cross-linking guar gum with glutaraldehyde. The reaction condition utilized leads to a guar gel with viscosity 40 times higher than the guar gum composite-coated tablets released. 95.6% of drug is released from 100% drug loaded matrix tablet containing 50% guar gum and coated with 10% hydroxy propyl methylcellulose phthalate. The drug loading capacity of modified guar gum was investigated with in vivo studies [39]. MohiniChaourasia et al prepared guar gum microspheres containing methotrexate (MTX). MTX-loaded microspheres demonstrated high entrapment efficiency (75.7%). The in vitro drug release was investigated using a US Pharmacopeia paddle type (type II) dissolution rate test apparatus in different media. Guar gum microspheres showed adequate potential in achieving local release of drug in in vitro release studies, and this finding was further validated with in vivo studies [40]. SmithLane et al. prepared chemically modified guar gum for improving its film forming properties. The derivatives were evaluated as film coating material by coating dummy tablets. The coated tablets were studied for various tablet parameters such as hardness, friability loss, film adhesion and disintegration. Accelerated stability studies were carried out at 40% and at 75% relative humidity at a temperature of 40°F for 6 months [41]. Tiwari A et al prepared guar gum grafted with poly(epision-caproloctone) (GG-g-PCL). This derivative studied for drug-delivery carrier using microwave irradiation. The drug-release profile showed that the GG-g-PCL micelles provided an initial burst release followed by a sustained release of the entrapped hydrophobic model drug, ketoprofen, over a period of 10-68 hrs. These results suggest that the GG-g-PCL micelles could be used as a nano carrier for in vitro controlled drug delivery [42]. GauthamSena et al synthesized polyacrylamide grafted guar gum (GG-g-PAM) as matrix for controlled release of 5-amino salicylic acid. In vitro release of this drug from various grades of GG-g-PAM has been
studied by USP dissolution method (paddle type). The effect of percentage grafting on the rate of drug release has been investigated [43]. Amit. S. Yadav et al formulated the oral controlled release zidovudine matrix tablets by using guar gum as rate controlling polymer and to evaluate drug release parameters as per various regulatory guidelines. The in vitro dissolution study was carried out for 12 hrs using paddle (USP type II) method in phosphate buffer (pH 6.8) as dissolution media. Selected formulation was subjected to stability studies for 3 months, which showed stability with respect to release pattern [44]. Richaba Malviya et al developed sustained release matrix tablets of diclofenac sodium using guar gum as rate controlling polymer. The tablets were subjected to various hardness, friability, weight variation, and an in vitro release of drug was performed in phosphate buffer saline pH 7.4 for 24 hrs. Dissolution studies show the release profile of diclofenac sodium from matrix tablets prepared using guar gum was retarded approximately 24 hrs. Thus guargum stands as a good candidate for sustained release formulation [45]. H. V. Chavda et al prepared oral controlled drug delivery system for sparingly soluble diclofenac sodium (DCLS) using guar gum as triple-layer matrix tablets. Matrix tablets of diclofenac sodium were prepared by compressing three layers one by one. The results clearly indicate that guar gum could be a potential hydrophilic carrier in the development of oral controlled drug delivery systems [46]. P. J. Subrahmanyan developed an oral colon targeted drug delivery system, which consists of theophylline matrix tablets prepared using guar gum and borax cross linked guar gum as rate controlling polymers in different concentrations. These tablets were evaluated for weight variation, friability, hardness uniformity of content and in vitro drug release under specified conditions. The dissolution data revealed that the tablets containing guar gum and borax cross linked guar gum in higher concentrations each (120mg) showed 87.56±0.42% and 76.18±0.17% of drug release respectively. Selected tablets of borax cross linked guar gum were subjected to in vitro drug release study in presence of rat caecal content medium. Results clearly indicate that there is an increase in the release of the drug to 98.93±0.38% [47]. Vipul V. Jambukia et al studied the effect of Guar gum (GG) and Modified guar gum (MGG) on the oral bioavailability of a poorly water-soluble drug, Ibuprofen (IBU). Prepared mixtures were evaluated for solubility study and in vitro dissolution studies using USP XXIII Dissolution apparatus. From the results, it was concluded that the co-grinding mixture with modified guar gum could be useful in developing a dosage form with improved dissolution rate and oral bioavailability of poorly water-soluble drugs [48].

Guar gum in treatment of diabetes

The role of guar gum and its derivatives to control blood sugar is well known. Studies showed that guar gum reduced the postprandial rise in blood glucose and insulin concentrations.

David J. A. Jenkins et al reported that when nine diabetic patients supplemented either their normal home diets (four patients) or metabolic ward diets (five patients) with 25 gm guar gum daily for 5 or 7 days their mean urinary glucose excretion fell by 46% (P<0.05) and 54% (P<0.01), respectively. Gel-forming, unabsorbable carbohydrate may therefore be a useful adjunct to antidiabetic therapy, irrespective of the type of treatment or insulin dosage used [49]. Biesemachal et al used combination of pectin and guar gum for chemopreventive and anti-inflammatory properties. They reported that modified guar gum has potential to prevent cancer and must be taken as supplement in foods. Results conclude that derivative of guar gum diet significantly decreased the serum concentration of cholesterol, triacylglycerols and LDL-C and atherogenic index. The most significant result in this study was the reduction of blood glucose in diabetic rats treated with the guar gum diet after 28 days versus non-treated rats. The guar gum provided a general improvement in the condition of the diabetic rats in body weight and food intake in comparison with non-treated rats [50]. Valesca Dal’Alba et al studied the effect of soluble fibre from partially hydrolysed guar gum (PHGG) on the MetS and cardiovascular risk factors in patients with type 2 diabetes. In this study randomized controlled clinical trial, 44 patients with type 2 diabetes and the MetS underwent clinical, laboratory and dietary evaluations at baseline, 4 and 6 weeks. All patients followed their usual diet and the intervention group received an additional 10 gm/day of PHGG. In patients with type 2 diabetes and the MetS, the addition of PHGG to the usual diet improved cardiovascular and metabolic profiles by reducing WC, HbA1c, UAER, and trans-FA [51].

Guar gum in treatment of Cancer

Guar gum and its derivatives are also helpful in cancer therapy especially colorectal cancer most common form of cancer due to intestinal disorder.

Chaurasia M et al evaluated the effect of glutaraldehyde crosslinked guar gum containing methotrexate for treatment of colorectal cancer (colon cancer). Colorectal cancer is the third most serious type of cancer having 665,000 deaths per year all around the world. They prepared guar gum microsphere crosslinked by emulsification with glutraldehyde and then characterized for local release of drug in the colon which is necessary for the treatment of colorectal cancer. The research shows that crosslinked guar has high entrapment efficiency along with methotrexate (MTX) investigation of in vitro drug release was tested by US Pharmacopeia paddle type (type-2) dissolution rate test apparatus, which shows different drug release result by changing amount of guar gum and glutraldehyde [52]. Sakata Y et al investigated that how much amount of partially hydrolyzed guar gum (PHGG) ingestion can enhances bowel movement and can stop risk of colorectal cancer. They investigated the effect of PHHg intake upon 9 healthy female students by observing weight, moisture and hardness of feces. The result shows increase in fecal moisture and texture with some variation. The benefit of bowel movements provided by the PHGG intake has variation among different female students [53]. Gamal-El-Din M et al prepared chitosan gel drug delivery system and its sulphate derivative (SGS) and observed their cancer chemopreventive and anti-inflammatory properties. They reported that modified guar gum has potential to prevent cancer and must be taken as supplement in foods. Results conclude that derivative of guar gum has ability to inhibit the carcinogen activator enzyme, cytochrome P450 IA (CYP1A), and also promote the carcinogenic detoxification enzymes glutathione-S-transferrases (GSTs) [54]. Chandra Sekhar et al prepared chitosan and guar gum-acrylamide (CH-Gg-g-AAm) semi interpenetrating microspheres (semi IPNMs) by water-in-oil (w/o) emulsion process by using glutaraldehyde as a crosslinker. 5-fluorouracil (5-FU) is an anticancer drug was absorbed and found to show promising in vitro release kinetic models. The in vitro dissolution study was carried out by changing amount of guar gum and glutraldehyde [55]. Sakata Y et al investigated that how much amount of partially hydrolyzed guar gum (PHGG) ingestion can enhances bowel movement and can stop risk of colorectal cancer. They investigated the effect of PHGG intake upon 9 healthy female students by observing weight, moisture and hardness of feces. The result shows increase in fecal moisture and texture with some variation. The benefit of bowel movements provided by the PHGG intake has variation among different female students [56]. Gamal-El-Din M et al prepared chitosan gel drug delivery system and its sulphate derivative (SGS) and observed their cancer chemopreventive and anti-inflammatory properties. They reported that modified guar gum has potential to prevent cancer and must be taken as supplement in foods. Results conclude that derivative of guar gum has ability to inhibit the carcinogen activator enzyme, cytochrome P450 IA (CYP1A), and also promote the carcinogenic detoxification enzymes glutathione-S-transferrases (GSTs) [57]. J. Chandra Sekhar et al prepared chitosan and guar gum-acrylamide (CH-Gg-g-AAm) semi interpenetrating microspheres (semi IPNMs) by water-in-oil (w/o) emulsion process by using glutraldehyde as a crosslinker. 5-fluorouracil (5-FU) in an anticancer drug was successfully loaded in these semi IPNMs. In vitro release studies were performed in basic (pH 7.4) buffer medium. The release pattern depended on grafted polymer composition, effect of cross link and drug content in the polymer matrices. In vitro release studies indicated the release of 5-FU more than 12 hrs. [58]. Elias E. J. et al studied a suitable polymer (guar gum) based matrix tablet for curcumin with sufficient mechanical strength and promising in vitro mouth-to-colon release profile. Three formulations of curcumin were prepared using varying concentrations of guar gum containing 50 mg curcumin by the wet granulation method. Tablets were subjected to evaluation by studying parameter like hardness, friability, drug content uniformity, and in-vitro drug release. In vitro
drug release was evaluated using simulated stomach, intestinal and colonic fluids. The susceptibility of guar gum to colonic bacteria was also assessed by a drug release study with rat caecal contents. The 40% guar gum containing formulation (F-1) showed better drug release (91.1%) after 24 hrs in the presence of rat caecal contents in comparison with the 50% guar gum containing formulation (F-2) (82.1%). Curcumin could, thus, be positively delivered to the colon for effective colon cancer treatment using guar gum [59].

Guar gum as hydrogel

Hydrogels are prepared by crosslinking guar gum with different monomers. These hydrogels are incorporated with different drugs to study their release pattern. Guar gum hydrogels are also useful in the control drug delivery system.

Gliko-Kabir I et al prepared a crosslinked low swelling guar gum (GG) hydrogel by reacting it with trisodium trimetaphosphate (STMP) and its function as possible colon-specific drug carriers was analyzed in the rats. They concluded that crosslinked guar (biodegraded enzymatically) is an effective vehicle for colon specific drug delivery systems [60]. Soppimuth K S et al studied drug release ability of polyacrylamide-guar gum copolymer, crosslinked with glutaraldehyde. The guar gum hydrogel microspheres were incorporated with two antihypertensive drugs, verapamil hydrochloride (water-soluble) and nifedipine (water-insoluble) to investigate their controlled drug release capacity. In vitro study showed dependence of drug release on the extent of crosslinking of guar gum copolymer. The drug release from the drug of methacrylate derivative having molecular weight range from 74-210 was studied under simulated gastric and intestinal pH conditions [67]. Lampe J W et al had given 11 healthy men three different fed enzymatically modified guar gum, maltodextrin and soy polysaccharides for 18 days trial. They demonstrated improvement in gastrointestinal function [69]. Takahashi H et al confirmed the role of partially hydrolyzed guar gum (PHGG) on fasting and postprandial hormone levels, demonstrated that PHGG did not interfere with the normal absorption of glucose, amino acid (arginine) and fat and their side effects were also investigated. 10 healthy male volunteers in a double blind trial were given to two different dietary supplements (with fibers, without fibers) for a period of two weeks. The results of the study demonstrated that PHGG did not interfere with the normal absorption of glucose, amino acid and fat and shows no side effects so its use is safe for human [71]. Heini A F et al evaluate the effects of hydrolyzed guar gum on fasting and postprandial hormone levels, respiratory quotient (RQ) and postprandial satiety during a controlled weight-loss program and found it useful for weight reduction [72]. Yamada K et al observed the role of partially hydrolyzed guar gum (PHGG), glucomannan, highly methoxylated (HM) pectin and water-insoluble cellulose on the serum lipid level and immunoglobulin (Ig) production of Sprague-Dawley. They reported decrease in serum total cholesterol, phospholipids and triglycerides and increase in immunoglobulin IgA productivity in rats fed on water soluble dietary fibers (guar gum, pectin) as compared to cellulose (water insoluble fiber) [73]. Watanabe O et al investigated the effect of phosphorylated guar gum hydrolysate (P-GGH) on intestinal calcium absorption of overeitomized (OX) rats. Rats were fed on P-GGH (50gm/Kg of diet) for six weeks. Result shows that in the condition of estrogen deficiency P-GGH may be useful for prevention of the reduction of intestinal calcium absorption and osteoporosis [74].Kowalska E M et al reported the effect of modified guar gum on appetite and body weight loss. For this purpose 28 fatty male (age 19-56) were given semisolled meal along with modified guar gum in different amount for specified time period. GG addition to a semisolid meal prevented an increase in appetite, hunger and desire to eat, which was increased in the other treatments as a result significant decrease in body weight taken place as a result of its presence half-life of 0.5-1.6 hrs. [66]. Kumares S. Soppimuth et al prepared new spherical shaped cross-linked hydrogels of polyacrylamide-grafted guar gum by the emulsion method. The derived micro gels were responsive to pH and ionic strength of pH medium. The drug release from these hydrogels was increased when pH of the medium changed from acidic to alkaline. Transport parameters, viz., solvent front velocity and diffusion coefficients were calculated from a measurement of the dimensional response of the microgels under variable pH conditions. Swelling was reversible and pulsatile with the changing environmental conditions. The pH-sensitive micro gels were loaded with diltiazem hydrochloride and nifedipine (both antihypertensive drugs) and their release studies were performed in both the simulated gastric and intestinal pH conditions [67].

Guar gum in treatment of other disease

Guar gum and its derivatives also used in treatment of other disease like, cholera, functional constipation, and diarrhea. Guar gum and its solution also used in eye-drop formulations.

Lampe J W et al had given 11 healthy men three different fed enzymatically modified guar gum, maltodextrin and soy polysaccharides for 18 days trial. They demonstrated improvement in gastrointestinal function [69]. Takahashi H et al confirmed the role of partially hydrolyzed guar gum (PHGG) for prevention of constipation on 15 constipated women for 3 weeks. Most favored reason for constipation is lack of dietary fibers in our diet. In the experiment female were taken an average diet of 9.7 +/-0.1 gm/day then weight, texture, moisture and bacterial flora ion feces were observed. Results confirmed beneficial effect of PHGG for treatment of constipation [70]. Alam N H et al evaluated the effect of partially hydrolyzed guar gum (BENEFIBER) on the rate of normal absorption of glucose, amino acid (arginine) on normal and obese rats and the side effects was also investigated. 10 healthy male volunteers in a double blind trial were given to two different dietary supplements (with fibers, without fibers) for a period of two weeks. The results of the study demonstrated that PHGG did not interfere with the normal absorption of glucose, amino acid and fat and shows no side effects so its use is safe for human [71]. Heini A F et al evaluate the effects of hydrolyzed guar gum on fasting and postprandial hormone levels, respiratory quotient (RQ) and postprandial satiety during a controlled weight-loss program and found it useful for weight reduction [72]. Yamada K et al observed the role of partially hydrolyzed guar gum (PHGG), glucomannan, highly methoxylated (HM) pectin and water-insoluble cellulose on the serum lipid level and immunoglobulin (Ig) production of Sprague-Dawley. They reported decrease in serum total cholesterol, phospholipids and triglycerides and increase in immunoglobulin IgA productivity in rats fed on water soluble dietary fibers (guar gum, pectin) as compared to cellulose (water insoluble fiber) [73]. Watanabe O et al investigated the effect of phosphorylated guar gum hydrolysate (P-GGH) on intestinal calcium absorption of overeitomized (OX) rats. Rats were fed on P-GGH (50gm/Kg of diet) for six weeks. Result shows that in the condition of estrogen deficiency P-GGH may be useful for prevention of the reduction of intestinal calcium absorption and osteoporosis [74]. Kowalska E M et al reported the effect of modified guar gum on appetite and body weight loss. For this purpose 28 fatty male (age 19-56) were given semisolled meal along with modified guar gum in different amount for specified time period. GG addition to a semisolid meal prevented an increase in appetite, hunger and desire to eat, which was increased in the other treatments as a result significant decrease in body weight taken place...
5. Of four different molecular weights (15, 20, 400, and 1,100 kDa) was changing molecular weight of modified guar gum. For trial guar gum They investigated the variation in intestinal fermentation by effects of partially hydrolyzed guar gum (PHGG) to human health. Symptoms (HADS) and quality of life (SF-36) was observed in six clinical trial different dose of PHGG was given to different patients and their gastrointestinal symptoms GSRS), physiochemical reaction of guar gum with chlorosulfonic acid under different conditions. Structure of this modified guar was confirmed by infrared spectrometry. They concluded that almost 2500mg/L concentration of sulfated guar can reduces about 60-66% cholesterol, about 76-99%LDL, and almost 100% of triglycerides [81].Bele G M et al evaluated the effect of partially hydrolyzed guar gum for treatment of functional constipation among different hospitalized patient. They found it beneficial for reduction of functional constipation [82].Kuo D C et al evaluated the role of partially hydrolyzed guar gum for prevention of FeCl3-induced arterial thrombosis and hyperlipidemia in the high-fat diet fed hamsters. Based on their results, they conclude that PHGG supplement can increase antioxidant protein expression and thus decrease oxidative stress induced arterial injury [83].

FUTURE ASPECT
All these research shows that guar gum and its derivatives finds application as drug binder, control-release agent and as dietary fiber. Guar gum and its derivatives have potential to use in many pharmaceutical applications without any side effects.

CONFLICT OF INTERESTS
Declared None

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