IJLSR (2018), Vol. 4, Issue 9 **Review Article**

IJLSR INTERNATIONAL JOURNAL OF LIFE SCIENCES AND REVIEW

Received on 08 July 2018; received in revised form, 18 August 2018; accepted, 28 August 2018; published 01 September 2018

GUAR GUM: PHARMACEUTICAL AND THERAPEUTIC APPLICATIONS

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ABSTRACT: Guar gum is a non-ionic polysaccharide that is found abundantly in nature. It is extracted from the endosperm of seeds of guar plant (*Cyamopsis tetragonaloba*). It has many advantageous applications in industries due to their various properties. Guar gum is widely used in cosmetics, food, paper, textile, explosive, and pharmaceutical industry. In pharmaceuticals, the use of guar gum as delivery carriers as drugs has gained great attention due to its high swelling characteristics in aqueous solution. Guar gum can be modified by derivatization, grafting, and network formation to improve its property profile for a wide spectrum of biomedical applications. Guar gum and its derivatives in the various forms such as coatings, matrix tablets, hydrogels, and nano/microparticles are exploited as potential carriers for targeted drug delivery, colon-specific, protein, transdermal drug delivery systems. Guar gum is also used for healthy bowel activity, weight loss, and diabetes control. Partially hydrolyzed guar gum (PHGG) is produced by a controlled process of partial hydrolysis. PHGG affects the prevention and treatment of constipation, diarrhea, diabetes, and iron deficiency anemia. It has beneficial effects on irritable bowel syndrome, reduction of post-prandial glucose and insulin levels, and plasmatic levels of cholesterol.

Keywords: Guar gum, *Cyamopsis tetragonaloba*, Transdermal drug delivery systems

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INTRODUCTION: Guar gum is a free-flowing, off-white powder. It is also known as gum cyamposis, Cyamopsis gum, guarina, glucotard, and guyan. Guar gum is a naturally occurring galactomannan polysaccharide. It is obtained from leguminous crop guar or cluster bean *Cyamopsis tetragonaloba* (L.) Taub. (syn. *C. psoraloides*) seeds.

QUICK RESPONSE CODE

DOI: 10.13040/IJPSR.0975-8232.IJLSR.4(9).131-39

The article can be accessed online on www.ijlsr.com

DOI link: http://dx.doi.org/10.13040/IJPSR.0975-8232.IJLSR.4(9).131-39

Guar, a legume crop, grows best in sandy soils and needs moderate, intermittent rainfall with lots of sunshine. It is a native to the Indian subcontinent, grown mainly in India, Pakistan and the United States, and also in some parts of Brazil, Africa, and Australia. The guar kernel is composed of several layers, namely the husk (14-17%), the germ (43-47%) and the endosperm (34-42%) which is mainly composed of guar gum [4].

Guar gum is extracted from the endosperm of guar seeds. **Fig. 1** shows the different part of guar seed and **Fig. 2** shows the flowchart of the gum extraction. Guar gum is a galactomannan polysaccharide, chiefly consisting of high molecular weight hydrocolloidal polysaccharide,

composed of galactan and mannan units linked through glycosidic linkagesm [3]. In nature, these poly-saccharides have various ingenuity from the algal origin (*e.g.*, alginate), plant origin (*e.g.*, pectin and guar gum), microbial origin (*e.g.*, dextran and xanthan gum), and animal origin (chitosan and chondroitin). The gum gives a high viscosity in solution, which is due to its high molecular weight and long chain structure.

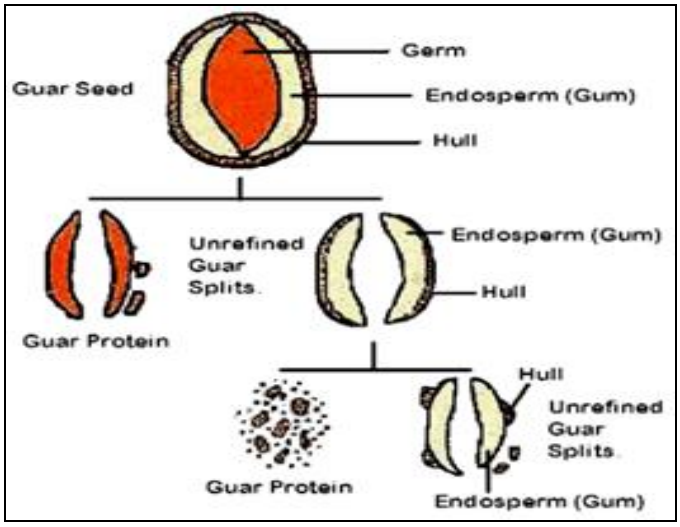

FIG. 1: SCHEMATIC DIAGRAM SHOWING IN THE DIFFERENT PART OF SUGAR SEED

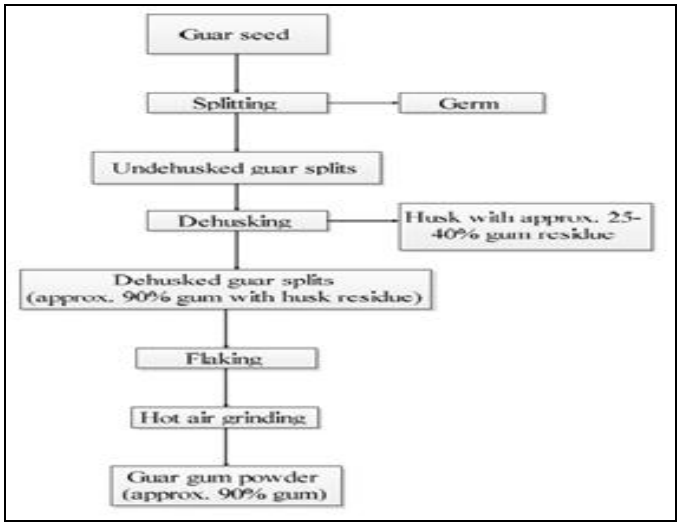

FIG. 2: IT SHOW EXTRACTION OF GUAR GUM FROM GUAR SEED

General Properties of Guar Gum: The general properties of Guar gum is high molecular weight, nonionic nature [38], and mainly white to yellowish-white in color, nearly inodorous, free-flowing powder-like substance. The guar gum has very advantageous properties. It has the capability to quick hydration in cold water to get uniform and very high viscosity at comparatively low concentrations. Guar gum is stable in solutions over an extensive range of pH values from 4-10, solubilize in warm and cold water and insoluble in most organic solvents.

Instead of it, guar gum is the most cost-effective stabilizer and emulsifier, it gives the texture improvement and water retention property, and enhances mouthfeel and controls crystal formation. It also has strong hydrogen bonding, excellent thickening, emulsion, stabilizing, and film forming properties. It has many hydroxyl groups which can be modified to form many different derivatives [22]. It is well-suited with many other hydrocolloids which are used in the food industry. Guar gum, an important natural food supplement with high nutritional value, plays a crucial role in human blood lowering serum cholesterol and glucose levels and also considered helpful in weight loss programs [19]. Guar gum and its derivatives are widely used in many applications including food, textile, cosmetics, paper, and pharmaceutical industry and also in health care products because of their natural abundance, low cost and other desirable properties [23].

Chemical Properties of Guar Gum: Guar gum consists of α (1, 4)-linked β- D-mannopyranose backbone and branch points form through their 6-positions linked to α-D-galactose (*i.e.*, 1, 6-linked-α-D-galactopyranose). **Fig. 3** shows the chemical structure of guar gum. The physicochemical properties of galactomannans are determined by galactose to mannose ratio [23]. The ratio of mannose to galactose units diversities from 1.6 to 1.8. [1]

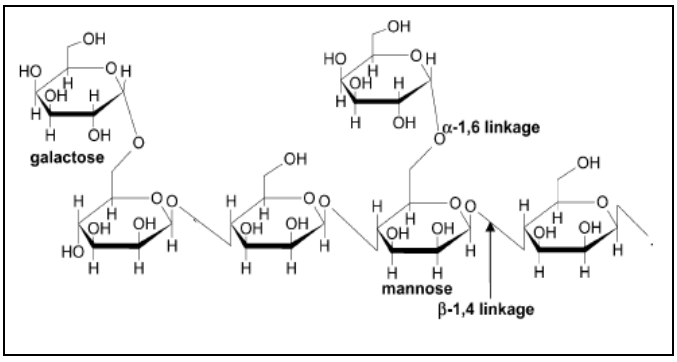

FIG. 3: CHEMICAL STRUCTURE OF GUAR GUM

This polysaccharide has been broadly used in a wide range of applications because of its unique ability to alter the rheological properties, the

thickening, and the viscosity of the aqueous solution. While a single molecular weight of GG cannot be given due to trouble in resolve, it is predictable in the range of 200,000 to 300,000 daltons [25]. It chiefly contains high molecular weight hydrocolloidal polysaccharide, self-possessed of galactan and mannan units linked through glycosidic linkages.

Derivatives of Guar Gum: Guar gum is available at low cost, highly abundant but its viscosity gets decreased due to the uncontrolled rate of hydration and further microbial contamination limits its long term applications. The occurrence of hydroxyl groups is the most precise property of the guar gum and their derivatives, which makes them suitable for making changes in their structure formula and functionalization. So guar gum has been chemically modified to get various desired properties for extending its industrial applications, such as in food, paint and pigments, oil field, mining, paper, water treatment, personal care, pharmaceutical, and new types of superabsorbent. A lot of studies has been done on guar gum for altering their physical and chemical properties by grafting, combination, and compositing with artificial and natural polymers [31].

Some of the derivatives of the guar gum are mentioned here:

1. Carboxymethyl guar gum. **2.** Hydroxymethyl guar gum. **3.** Hydroxypropyl guar gum. **4.** O-carboxymethyl- O-hydroxypropyl guar gum (CMHPG). **5.** O-2hydroxy-3- (trimethylammonia propyl) guar gum (HTPG). **6.** O-carboxymethyl-O-2 hydroxy-3-(trimethylammonia propyl) guar gum (CMHTPG). **7.** Ammonium hydroxyl propyl trimethyl chloride of guar gum. **8.** Acryloyloxy guar gum. **9.** Methacryloyl guar gum. **10.** Methylated guar gum. **11.** Sulfated guar gum. **12.** Guar gum esters.

Partially Hydrolyzed Guar Gum (PHGG): Partially hydrolyzed guar gum (PHGG) is the form of natural guar gum which retains more advantageous properties concerning GG. It was formed through a well-ordered process of partial hydrolysis, reducing its sticky aspect and its retaining water capacity, without a detectable reduction in the amount of dietary fiber. PHGG is also marketed as a dietary fiber supplement. PHGG has mostly used in the pharmaceutical industry because of its effective properties on different diseases such as for the prevention and treatment of constipation, treatment of diarrhea, and beneficial effects on irritable bowel syndrome, on the reduction of post-prandial glucose and insulin levels.

Applications of Guar Gum: Guar is generally treated as a vegetable for human consumption in India. Guar gum and its products are extensively used in various industries like food, cosmetics, pharmaceuticals, *etc.* as per its requirement [20].

Cosmetic Industry: In the cosmetic industry, guar gum is used as a gelling, thickener, defensive colloid in skin care products, creams, and ointments. It is also used in toothpaste, and shaving cream for easy extruding from the container tube.

Food Industry: In the food industry, guar gum is utilized 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, and concentrates, chocolate milk, flavored milk, jams, jellies, fruit spreads, bread, biscuit and other baked foods, soft cheese and cheese spreads, sauce and dressings, noodles and pasta.

Textile Industry: Guar gum provides brilliant film forming and thickening properties when used for textile sizing, dying, finishing, and printing. It reduces warp cracking, brushing while sizing, and provides better proficiency in production.

Paper Industry: Guar gum provides better properties compared to other substitutes. It gives thicker and dancer external surface to the paper used for printing. Guar gum expresses improved erasive and writing properties, better bonding strength, and increased hardness. Due to the improved association, it gives well breaking, mullen, and bending strengths.

Explosives Industry: Guar gum is used as gelling agents for gel sausage type explosives and pumpable slurry explosives. It is also used as cross-linking agents for gel and slurry explosives systems.

Pharmaceutical and Therapeutic Applications of Guar Gum: Guar gum is a broadly used polysaccharide in the pharmaceutical industry as drug delivery and itself as a medicine. Guar gum powder is utilized as gelling, viscosifying, thickening, suspension, stabilization, emulsification, preservation, water holding/water phase regulator, etc. In tablet manufacturing, it is used as a binder and disintegrating agent and in microencapsulation of drugs for controlled drug delivery systems [21].

Drug Delivery:

Colon-specific Drug Delivery: The target of many vigorous and infected disease of the colon by using GG mediated site-specific drug delivery has fascinated considerable attention for past few years to improve drug delivery systems that can release drugs specifically in the colon in a liable and reproducible way. The site-specific drug delivery to the colon is essential for the cure of diseases related to the colon, sinking the side effects of the drug and sinking the ordered dose. GG could potentially be used as biodegradable material for the preparation of colon particular delivery systems of drugs by either condensing native guar into matrix tablets or chemically modified gum to reduce its swelling properties.

Matrix tablets of dexamethasone and budesonide were prepared by using 60.5% (w/w) of GG in the tablet. The amount of drug dissolution depended on the concentration of galactomannanase. The study confirmed that the galactomannanase (~0.1%) enhanced dissolution of dexamethasone and budesonide from GG matrix tablet. A lot of research has been carried out to evaluate the capability of GG as a transporter in colonic drug delivery [7].

Matrix tablet of indomethacin with GG has been prepared and tested. These tablets were prepared to hold their integrity in 0.1M HCl for 2 h and in Sorensen's phosphate buffer (pH 7.4) for 3 h, releasing only 21% of the drug in this 5 h. However, in the presence of 2% rat cecal contents, the drug release increased and further increased with 4% concentration of cecal contents. The drug release after the enzyme induction in rat enhanced to about 91% in 4% cecal content medium.

This research emphasizes the specificity of these matrices for enzyme activation in the colon to release the drug. In the lack of enzyme system, the GG swells to form a viscous layer that decelerates down the seeping of dissolution fluid into the core. The initial 21% release can be credited to the dissolution of indomethacin existing on the surface of the tablet [41].

Recently poly (acrylamide)-graft-GG was prepared by microwave initiated free radical grafting process as a matrix for precise release of 5-aminosalicylic acid **Fig. 4**. The investigators of United States Pharmacopeia (USP) approved the applicability of this matrix for sustained drug release by dissolution method, under different pH environments [10].

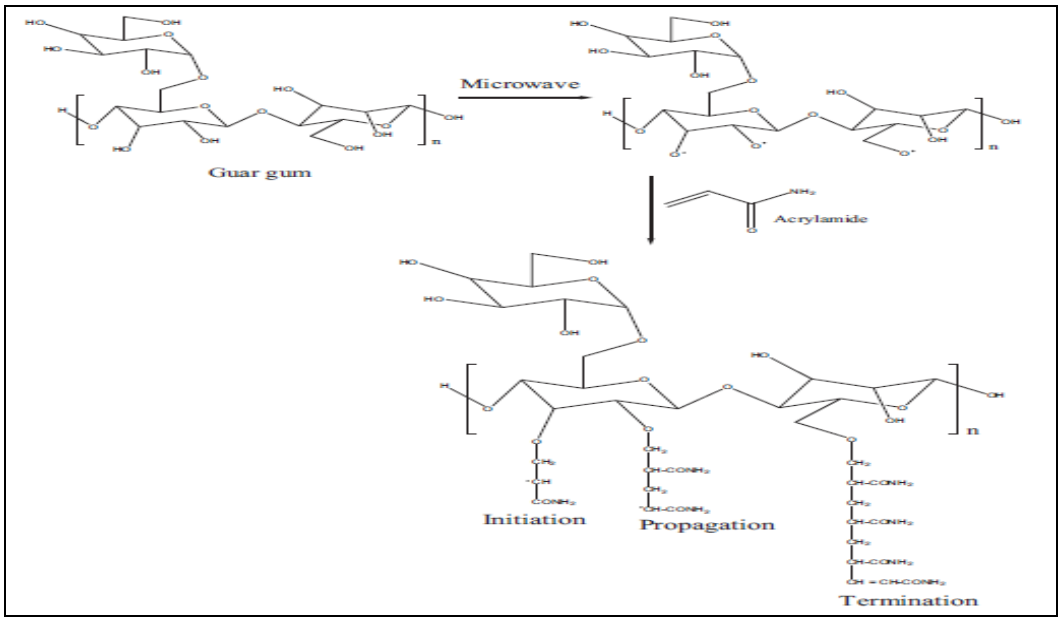

FIG. 4: SCHEMATIC REPRESENTATION FOR THE SYNTHESIS OF GG-GRAFT-POLY (ACRYLAMIDE)

The evaluation of mebendazole sustaining GG matrix tablets through pharmacokinetics has been carried out. This study showed that the mebendazole sustaining tablet did not release the drug inside the stomach and small intestine resulting in the slow absorption of the drug, so this drug only available for local action in the colon [40]. The administration of 5-fluorouracil for colon cancer therapy through intravenous route could produce critical systemic side-effects due to its cytotoxic effect on normal cells. To reduces such harm, recently GG tablet developed for site-specific delivery of 5- fluorouracil to the colon without the drug being released in the stomach or small intestine.

In this study, fast decaying of 5-fluorouracil core tablets was compression coated with 60%, 70% and 80% of GG, and was evaluated for *in-vitro* drug release. Though the HPLC method, the amount of 5-fluorouracil released from the compression-coated tablets in the dissolution medium at different time intervals was estimated. The releasing amount of 5-fluorouracil is only 2.5-4% from the guar gum compression-coated tablet, and then the stimulation of gastrointestinal fluids is applied. In the simulated colonic fluids (4%, w/v, rat caecal content medium) the compression-coated with 60%, 70% and 80% GG tablets released 70, 55 and 41% of the 5-fluorouracil, respectively. This study concludes that the targeting of 5-fluorouracil for local action in the colon if compression-coated tablets containing 80% of GG in the physiological environment of the stomach and small intestine then they released only 2.38% of the drug [35].

Antihypertensive Drug Delivery: The potential advantages of GG in antihypertensive drug release are only due to its characteristics like high viscosity, low cost, and commercial availability. In many studies, it has been reported that GG has potential in the release of antihypertensive water-soluble drugs. The antihypertensive drugs are delivered through a controlled release matrix by the utilization of GG. These drugs such as ketoprofen, nifedipine, and diltiazem hydrochloride have been demonstrated for the matrix tablets. The diltiazem hydrochloride, using several viscosity grades of GG, is used in two proportions through the wet granulation method for oral controlled release [6]. The matrix tablets of diltiazem hydrochloride containing 30% (w/w) low viscosity, 40% (w/w) medium viscosity or 50% (w/w) high viscosity GG showed controlled release [26].

Recently, microspheres of glutaraldehyde cross-linked poly(acrylamide)-graft-GG hydrogel were formulated for the controlled release of calcium channel blockers like verapamil hydrochloride and nifedipine [14]. These microspheres containing calcium channel blockers are spherical shaped and cross-linked. Microgels of poly(acrylamide)- graft-GG were prepared by the emulsification method having weakly anionic [15]. The microgels formed were found to be sensitive to pH and ionic strength of the external media due to the occurrence of ionizable carboxylic functional groups. The release of both diltiazem hydrochloride and nifedipine under the relaxation controlled method was found to be closely related to pH changes resulted in the swelling of the microgels. The GG poly (acrylamide)-graft-GG was also prepared by taking three different ratios to acrylamide (1:2, 1:3.5, and 1:5).

In this work, the grafted copolymers amide groups become converted into carboxylic functional groups. For the controlled release of diltiazem hydrochloride, these modified polymers were used as the matrix tablet. The release was found to be continued up to 8 h by poly(acrylamide)-graft-GG matrix. The release time increased in case of hydrolyzed poly(acrylamide)-graft-GG matrix and released increased with the grafting ratio of the grafted copolymer, which continued up to 12 h.

In another research work, GG nanoparticles with lipase functionalized in the size range 19-32 nm were prepared by nanoprecipitation and cross-linking method for the applications in drug delivery. In this work, the efficiency of the drug release through the GG nanocarrier was confirmed indirectly by the release of crystal violet. The release kinetics showed that the release was faster till 24 h and after that release was very slow. This suggests that GG based nano-sized materials could be potentially used as a drug delivery carrier [34].

Protein Delivery: The physical and chemical instabilities of proteins are the most difficult obstruction in the development of protein pharmaceuticals. In the pharmaceuticals, protein

instability is one of the major reasons because of which the protein is administered through the injection rather than taken orally like most small chemical drugs [37]. The peptide and protein drugs are readily degraded by the low pH of the gastric medium in the stomach and hence become denatured. So the successful oral delivery of the protein drug, protection of the protein, and peptide from the harsh environment in the stomach is needed. Then designing oral dosage forms, the natural pH environment of GI tract varies from acidic (pH~1.2) in the stomach to slightly alkaline in the intestine (pH~7.4) all things are must be considered by formulator [16]. pH-sensitive hydrogels have attracted increasing attention in the design of oral delivery of peptide or protein drugs. The formulation for pH-sensitive hydrogels for getting the desired controlled release of protein drugs, a variety of synthetic or natural polymers was prepared with acidic or basic pendant groups [39].

Recently, designed an alginate GG hydrogel cross-linked with glutaraldehyde, which is pH sensitive for the controlled delivery of protein drugs. Alginate is a non-toxic polysaccharide also with favorable pH sensitive qualities for intestinal delivery of protein drugs. To check the release profiles of a model protein drug (BSA) from alginate-GG hydrogels were studied under simulated gastric and intestinal media. The ratio of beads having alginate to GG combination is 3:1, which showed desirable characters like better encapsulation efficiency and bead forming properties.

In the presence of glutaraldehyde concentration giving maximum (100%) encapsulation efficiency and the most appropriate swelling characteristics was found to be 0.5% (w/v). Minimal protein release from alginate-GG hydrogels at pH 1.2 (~20%), and it was established to be significantly higher (~90%) at pH 7.4. The results of this study clearly showed that the presence of crosslinking of the GG and glutaraldehyde increases entrapment efficiency and prevents the rapid dissolution of alginate in higher pH of the intestine, which ensures a controlled release of the entrapped drug [18].

Transdermal Drug Delivery: Transdermal drug delivery device, may be of an active or a passive both type of design, is a device which provides administering of medication with an alternative route. The pharmaceuticals allow. These devices to be delivered across the skin barrier [11]. To the inside of a patch, a drug is applied in a relatively high dosage, which is worn on the skin surface for an extended period. The drug arrives the bloodstream directly through the skin through a diffusion process. For a long period of time, the drug will keep diffusing into the blood, sustaining the constant concentration of drug in the blood flow. Recently, carboxymethyl GG was used and tested for transdermal drug delivery systems. In this study, terbutaline sulfate was used as a model drug.

The final effects of this study showed that the diffusion of terbutaline sulfate relatively slower at pH 5 than at pH 10 in the presence of carboxymethyl GG solution. This is only because of the static interaction between carboxymethyl GG and terbutaline sulfate at pH 5 [27]. The hydrogels of various types of acryloyl GG were prepared by the reaction of GG in the presence of acrylic acid, methacrylic acid, 2-hydroxyethyl methacrylate, and 2-hydroxypropyl methacrylate. These hydrogels were used as transdermal drug delivery devices for l-tyrosine and 3,4-dihydroxy phenylalanine (l-DOPA) as the model prodrugs for the synthesis of neurotransmitters in the brain involved L-Tyrosine. L-Tyrosine is a precursor to L-DOPA, nor-epinephrine, and epinephrine. These hydrogel materials were used for the high loading of l-tyrosine and L-DOPA.

Release studies of these hydrogels showed slow release pattern, especially in the medium of pH 7.4. The structure-property relationship in the release of both L-tyrosine and L-DOPA exhibited with the hydrogel materials. The percentage accumulative release of L-tyrosine was found to be maximum from the acryloyl GG holding poly (methacrylic acid), while the maximum discharge of L-DOPA was detected from acryloyl GG holding poly (acrylic acid) in both the [28].

Diabetes Treatment: Guar gum and its derivatives are very useful in the control of blood sugar. Research showed that guar gum reduced the postprandial rise in blood glucose and insulin concentrations. In the antidiabetic therapy gel-forming, unabsorbable carbohydrate may be a useful adjunct, irrespective of the type of treatment

or insulin dosage used [5]. The effects of guar gum on streptozotocin-induced diabetes were studied by evaluating the anti-hyperglycemic and anti hyperlipidemic effects in male rats. The research studies result in shows that significantly decreased the serum concentration of cholesterol, triacylglycerols and LDL-C and atherogenic index through the guar gum diet. The most significant result in this study was treated with the guar gum diet after 28 days *vs.* non and glibenclamide treated rats significance reduction of blood glucose in diabetic rats. The gum encouraged a general upgrading in the condition of the diabetic rats in body weight and food intake in comparison with non-treated rats [30].

Irritable Bowel Syndrome Treatment: Irritable bowel syndrome (IBS) is a group of gastrointestinal disorders which causes irritation or pain in abdomen [36]. A fiber PHGG may play an essential role in the treatment of this disease. This fiber is water soluble, non-gelling, which provides therapeutic benefits. PHGG also play a crucial role in the treatment of diarrhea and constipation both are the predominant form of IBS. The relief in IBS patient seems after the treatment with PHGG. And PHGG also has properties of probiotics because it increases the short-chain fatty acids in the colonic content, Lactobacilli and Bifid bacteria [8].

Cancer Treatment: Guar gum has also been investigated for cancer therapy. In a recent study, guar gum *C*-glycosylated derivative (GG), and its sulfated derivative (SGG) were prepared and tested for their cancer chemopreventive, and anti-inflammatory properties. They reported that modified guar gum has the potential to prevent cancer and must be taken as a supplement in foods. Results conclude that derivative of guar gum has the ability to inhibit the carcinogen activator enzyme, cytochrome P450 1A (CYP1A), and also promote the carcinogen detoxification enzymes glutathione-S-transferases (GSTs) [2].

Evaluation of the treatment of colorectal cancer (colon cancer) through the effects of glutaraldehyde cross-linked guar gum containing methotrexate for colorectal cancer. It is the third most serious type of cancer having 665,000 deaths per year all about the world. Guar gum microspheres cross-linked by emulsification with glutaraldehyde were prepared and then characterized for the local release of drug in the colon, which is essential for the treatment of colorectal cancer [17].

Iron Deficiency Anemia Treatment: Since, several decades, it has been known that dietary fiber is an important part of the meal as it is required for preventing chronic disorders and proper intestinal function. Several studies are done analyzing the weather bioavailability of iron is effected through dietary fiber, but no conclusive results were obtained. Using rat model, to study iron deficiency anemia by evaluation hemoglobin formation showed that partially hydrolyzed guar gum dietary fiber increases the iron content in the body; thus PHGG could be used as a treatment against iron deficiency anemia [13].

Other Uses: The combination of pectin and guar gum is used for the treatment of hyperlipidemia. It is observed that the PHGG is considered as safe and good to use as a food supplement products for lowering of lipids in patients suffering from hyperlipidemia because the total cholesterol level and triglyceride concentration in blood serum is lowered, but HDL-cholesterol level continued almost the same [9]. The investigation was carried out about intake of modified partial depolymerized guar meal the blood glucose, plasma insulin, C-peptide, and gastric inhibitory polypeptide (GIP) of 14 patients of non-insulin dependent diabetes (NIDDM). The results indicate the reduction in the rise in blood glucose, plasma insulin, but no reductions in postprandial plasma C-peptide levels were observed [24]. It is concluded that increases glucose intolerance and low hypertriglyceridemia by guar gum hydrolysate (GGH) in rats fed high-fructose diets. Possible mediators of these helpful special effects of GGH are the SCFAs produced by microbial fermentation of GGH in the large Intestine [32].

Guar gum also has the most advantageous use in the treatment of dry eye disease. The understanding of dry eye disease has recently growing recognition that the etiology of the condition contains both tear loss and unsatisfactory amount of tear production, and that tear film instability and inflammation play roles in the various stages of the disease. The management of dry eye involves many strategies and therapeutic methodologies that address one or

more etiopathological mechanisms of the disease. The ocular lubricants that contain hydroxypropyl-guar and one or both of the demulcents, *i.e.*, polyethylene glycol 400 and propylene glycol. These products are safe and are indicated for the temporary relief of burning and irritation due to dryness of the eye, and both provide symptomatic relief to patients with dry eye. Dry eye disease is a multifactorial ocular condition that results from an inadequate quantity of tear film and/or a disturbance of tear film stability. Beyond the tear deficiency and evaporation, to include tear film degradation and potential damage to the ocular surface [33].

CONCLUSION: Guar gum is an important agrochemical derived from the seed endosperm of the guar plant, *i.e. Cymopsis tetragonolobus* which is cultivated in India and Pakistan from ancient times. Guar gum is a useful material to investigate. Guar gum is a non-ionic polysaccharide that is found abundantly in nature. It is extracted from the endosperm of seeds of guar plant (*Cyamopsis tetragonaloba*). It has many advantageous applications in industries due to their various properties. Guar gum is widely used in cosmetics, food, paper, textile, explosive, and pharmaceutical industry.

In pharmaceuticals, the use of guar gum as delivery carriers as drugs has gained great attention due to its high swelling characteristics in aqueous solution. Guar gum is also used for healthy bowel activity, weight loss, and diabetes control. Partially hydrolyzed guar gum (PHGG) is produced by a controlled process of partial hydrolysis. PHGG affects the prevention and treatment of constipation, diarrhea, diabetes, and iron deficiency anemia. It has beneficial effects on irritable bowel syndrome, reduction of post-prandial glucose and insulin levels, and plasmatic levels of cholesterol.

ACKNOWLEDGEMENT: The authors thankful with our deepest core of heart to Mr. Rohit Kumar Bijauliya, for his valuable guidance.

CONFLICT OF INTEREST: Nil

REFERENCES:

1. Sullad AG, Manjeshwar LS and Aminabhavi TM: Novel pH-sensitive hydrogels prepared from the blends of poly (vinyl alcohol) with acrylic acid-graft-guar gum matrixes for isoniazid delivery. Industrial & Engineering Chemistry Research 2010; 49: 7323-7329.
2. Gamal-Eldeen AM, Amer H and Helmy WA: Cancer Chemopreventive and anti-inflammatory activities of chemically modified guar gum. J Chemico-Biological Interactions 2006; 161: 229-240.
3. Sandhu APS, Randhawa GS and Dhugga KS: Plant cell wall matrix polysaccharide biosynthesis. Molecular Plant 2009; 2: 840-850.
4. Sharma BR, Chechani V, Dhuldhoya and Merchant NC: Guar gum: In Science Tech Entrepreneur. Lucid Colloids Limited, Jodhpur, India 2007; 43: 561-572.
5. Jenkins DJA, Derek T, Hockaday R, Howarth R, Apling EC, Wolever TMS, Leeds AR, Bacon S and Dilabari J: Treatment of diabetes with guar gum: Reduction of urinary glucose loss in diabetics. The Lancet 1997; 310:779-780.
6. Friend DR, Altaf SA, Yu KL and Geber MS: A novel approach for preparation of pH-sensitive hydrogels for enteric drug delivery. Proc Int Symp Control Release Bioact Mater 1997; 24: 311-312.
7. Wong D, Larrabeo S, Clifford K, Tremblay J and Friend DR: USP dissolution apparatus III (reciprocating cylinder) for the screening of guar-based colonic delivery formulations. J Control Release 1997; 47: 173-179.
8. Giannini EG, Mansi C, Dulbecco P and Savarino V: Nutrition Role of partially hydrolyzed guar gum in the treatment of irritable bowel syndrome. Nutrition 2006; 22: 334-342.
9. Biesenbach G, Grafinger P, Janko P, Kaiser W, Stuby U and Moser E: The lipid-lowering the effect of a new guar-pectin fiber mixture in type II diabetic patients with hypercholesterolemia. J Leb Mag Darm 1993; 23: 207-09.
10. Sen G, Mishra S, Jha U and Pal S: Microwave initiated synthesis of polyacrylamide grafted guar gum (GG-g-PAM)-Characterizations and application as a matrix for controlled release of 5-aminosalicylic acid. Inter Journal of Biological Macromolecules 2010; 47: 164-170.
11. Ansel HC, Loyd AV and Popovich NG: Pharmaceutical dosage forms and drug delivery systems. Lippincott, Williams & Willkins, Philadelphia, Vol. 7, 1999: 45-56.
12. Patel JJ, Karve M and Patel NK: Guar gum: a versatile material for pharmaceutical industries. Int J Pharm Pharm Sci 2014; 6: 13-19.
13. Freitas KDC, Amancio OMS, Novob NF, Neto UF and Morais MBD: Partially hydrolyzed guar gum increases intestinal absorption of iron in growing rats with iron deficiency anemia. Clinical Nutrition 2006; 25: 851-858.
14. Soppimath KS, Kulkarni AR and Aminabhavi TM: Chemically modified polyacrylamide-g-guar gum-based cross-linked anionic microgels as pH-sensitive drug delivery systems: preparation and characterization. Journal of Controlled Release 2001; 75: 331-345.
15. Soppimath KS, Kulkarni AR and Aminabhavi TM: Biodegradation, drug release mechanism and physiological activity of a protein's sustained release system by guar gum. Int Symp Control Rel Bio Mat 2001 27: 847-848.
16. Shargel L and Yu A: Applied Biopharmaceutics and Pharmacokinetics, McGraw-Hill, New York, Edition 4th, Vol. 9, 1999: 67-72.
17. Chaurasia M, Chourasia MK, Jain NK, Jain A, Soni V, Gupta Y and Jain SK: Cross-linked guar gum microspheres: A viable approach for improved delivery of anticancer drugs for the treatment of colorectal cancer. Journal AAPS Pharm Sci Tech 2006; 7: 143-51.
18. George M and Abraham TE: pH-sensitive alginate-guar gum hydrogel for the controlled delivery of protein drugs. International J of Pharmaceutics 2007; 335: 123-129.

19. Butt MS, Shahzadi N, Sharif MK and Nasir M: Guar gum: A miracle therapy for hypercholesterolemia, hyperglycemia and obesity. Critical Reviews in Food Science and Nutrition 2007; 47: 389-396.
20. Shobha MS, Kumar ABV, Tharanathan RN, Koka R and Gaonkar AK: Modification of guar galactomannan with the aid of *Aspergillus niger* pectinase. Carbohydrate Polymers 2005; 62: 267-273.
21. Cunha PLR and Paula R: Purification of guar gum for biological applications. International Journal of Biological Macromolecules 2007; 41: 324-331.
22. Kotadiya R, Patel V and Patel H: Guar Gum: A better polysaccharide for colonic drug delivery. Pharmaceutical reviews. Indian J of Pharmaceutical Sci 2008; 6: 546-552.
23. Soumya RS, Ghosh S and Abraham ET: Preparation and characterization of guar gum nanoparticles. International Journal of Biological Macromolecules 2010; 46: 267-269.
24. Gatenby SJ, Ellis PR, Morgan LM and Judd PA: Effect of partially depolymerized guar gum on acute metabolic variables in patients with non-insulin-dependent diabetes. Journal of Diabetic Medicine 1996; 13: 358-64.
25. Yoon SJ, Chu DC and Juneja LR: Chemical and physical properties, safety and application of partially hydrolized guar gum as dietary fiber. Journal of Biochemistry and Nutrition 2008; 42: 1-7.
26. Al-Saidan SM, Krishnaiah YSR, Patro SS and Satya-Narayana V: *In-vitro* and *in-vivo* evaluation of guar gum matrix tablets for oral controlled release of water-soluble diltiazem hydrochloride. Journal of AAPS Pharm Sci Tech 2005; 6: 14-21.
27. Murthy SN, Hiremath SRR and Paranjothy KLK: Evaluation of carboxymethyl guar films for the formulation of transdermal therapeutic systems. International Journal of Pharmaceutics 2004; 272: 11-18.
28. Thakur S, Chauhan GS and Ahn JH: Synthesis of acryloyl guar gum and its hydrogel materials for use in the slow release of L-DOPA and l-tyrosine. Carbohydrate Polymers 2009; 76: 513-520.
29. Tripathy S and Das MK: Guar gum: Present status and applications. J of Pharma and Sci Inno 2013; 2: 24-28.
30. Saeed S, Al-Reza HM, Fatemeh AN and Saeideh D: Anti-hyperglycemic and antihyperlipidemic effects of guar gum on streptozotocin-induced diabetes in male rats. Journal of Pharmacognosy Magazine 2012; 8: 65-72.
31. Shaikh T and Kumar SS: Pharmaceutical and pharmacological profile of guar gum an overview. International J of Pharmacy and Pharmaceutical Science 2011; 3: 38-40.
32. Suzuki T and Hara H: Ingestion of guar gum hydrolysate, a soluble and fermentable non-digestible saccharide, improves glucose in tolerance and prevents hypertriglyceridemia in rats fed fructose. The Journal of Nutrition 2004; 134: 1942-1947.
33. Benelli U: Systane lubricant eye drops in the management of ocular dryness. Clin Ophthalmology 2011; 5: 783-790.
34. Toti US and Aminabhavi TM: Modified guar gum matrix tablet for controlled release of diltiazem hydrochloride. Journal of Controlled Release 2004; 95: 567-577.
35. Sinha VR, Mittal BR, Bhutani KK and Kumria R: Colonic drug delivery of 5-fluorouracil: an *in-vitro* evaluation. International J of Pharmaceutics 2004; 269: 101-108.
36. Thompson WG, Longstreth GF, Drossman DA, Heaton KW, Irvine EJ and Muller-Lissner SA: Functional bowel disorders and functional abdominal pain. Gut 1999; 45: 43-47.
37. Wang W: Instability, stabilization, and formulation of liquid protein pharmaceuticals. International Journal of Pharmaceutics 199; 185: 129-188.
38. Huang Y, Yu H and Xiao C: Carbohydrate Polymers, pH-sensitive cationic guar gum/poly (acrylic acid) poly-electrolyte hydrogels: Swelling and *in-vitro* drug release. Carbohydrate Polymers 2007; 69: 774-783.
39. Kimura Y, Tsuruta T, Hayashi T, Katsoka K, Ishihara K and Kimura Y: Biomedical Applications of Polymeric Materials, CRC Press Inc. Boca Raton, 1993; 56: 164-190.
40. Krishnaiah YSR, Raju PV, Kumar BD, Satyanarayana V, Karthikeyan RS and Bhaskar P: Pharmacokinetic evaluation of guar gum-based colon-targeted drug delivery systems of mebendazole in healthy volunteers. Journal of Controlled Release 2003; 88: 95-103.
41. Rama Prasad YV, Krishnaiah YS and Satyanarayana S: *In-vitro* evaluation of guar gum as a carrier for colon-specific drug delivery. J of Controlled Release 1998; 51: 281-28.

How to cite this article:
Kant P, Randhawa GS, Bijauliya RK and Chanchal DK: Guar gum: pharmaceutical and therapeutic applications. Int J Life Sci & Rev 2018; 4(9): 131-39. doi: 10.13040/IJPSR.0975-8232.IJLSR.4(9).131-39.