



ISSN NO. 2320-5407

Journal homepage: <http://www.journalijar.com>

INTERNATIONAL JOURNAL
OF ADVANCED RESEARCH

RESEARCH ARTICLE

GUAR GUM AND THEIR DERIVATIVES: A RESEARCH PROFILE

Anek Pal Gupta¹ and Devendra Kumar Verma^{1*}

¹Department of Applied Chemistry and Polymer Technology, Delhi Technological University (Formerly Delhi College of Engineering), Shahabad, Daulatpur, Bawana road, Delhi-110042, India.

*Corresponding author email: vermadev148@gmail.com

Manuscript Info**Manuscript History:**

Received: 10 November 2013

Final Accepted: 25 December 2013

Published Online: January 2014

Key words:

Guar gum, Research profile,
Guar gum derivatives.

Abstract

It is fact that Polymers and their products have changed the face of the world in all the field of the technology. They are the future of the coming up generation of the research of the world. But this is also fact that these synthetic non biodegradable polymers have created a tough situation for the living being for a healthy life. So now this is our priority to change the flow of our research from non-biodegradable polymeric product to the biodegradable polymeric products. Guar gum and their derivatives are fully biodegradable natural polymers. In this review we have described the huge research on guar gum and their derivatives and their application in different areas in last ten years. The aim of this review is also to find out the new area of research where guar gum and their derivatives can be used.

Copy Right, IJAR, 2014,. All rights reserved.

Introduction

Guar gum also called Guaran, Clusterbean, Calcutta lucern, Gum cyamopsis, Cyamopsis gum, Guarina, Glucotard and Guyan is a natural non-ionic, water soluble polysaccharide exhausted from the refined endosperm of cluster bean seeds. Guar gum is a galactomannan [7, 8] similar to locust bean gum consisting of α (1, 4)-linked β -D-mannopyranose backbone with branch points from their 6- positions linked to α -D-galactose (i.e. 1, 6-linked- α -D-galactopyranose) (Dodi, 2011; Singh, 2011).

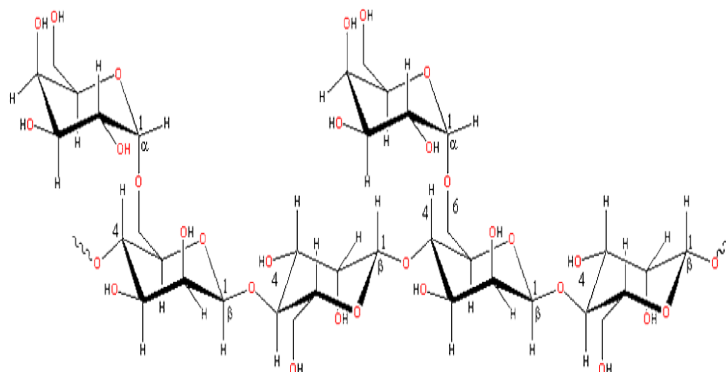


Fig.1. Chemical structure of guar gum

This polysaccharide has been extensively used in a wide range of applications because of its unique ability to alter the rheological properties [4, 15], the thickening and the viscosity of aqueous solution.

Qualities and Properties of Guar Gum

1. Guar gum has excellent property of high viscosity i.e. the result of its large hydrodynamic volume in solution and the nature of its specific intermolecular interactions (entanglements).
2. Guar gum products show a pronounced temperature thinning effect when their solutions are heated [5]. This is caused by loss of water of hydration around the polymer molecule which makes the guar gum most applicable natural polymer.

Application of Guar Gum and Its Derivatives: Guar gum and its derivatives have a long chain [6] of applications in all fields of sciences. Some of them are as:

1. Guar Gum as Dietary Fibers [1]

High viscosity of guar gum decreases the protein efficacy and lipid utilization during interfering with the digestion and absorption of nutrient (when it dissolved into water), results in slower, gastric problems. To solve this problem, PHGG (Partially Hydrolysed Guar Gum) named as Sun fibre is now being used in various beverages, food products and medicinal foods as a safe, natural and functional dietary fibre in all over the world.

2. Guar Gum as Sensor and Semiconductor

Recently J. I. Kadowaka [2] from Kagoshima University has developed a Semiconducting Guar Gum film and Temperature Sensing film [12] from an ionic liquid, 1-butyl-3-methyl-imidazolium chloride. D. B. Kestwal [3] have developed dip- strip sucrose sensor by the help of guar gum, chitosan and polyacrylamide hydrogels.

3. Guar Gum as in Drug Delivery [9, 10]

Guar gum is used for colon delivery [11] because it can be degraded by specific enzymes. The gum protects the drug during passing through the stomach and in small intestine environment and delivers the drug to the colon where it undergoes assimilation by specific microorganism

4. Guar Gum in Pharmaceutical and Pharmacological Profile.[14]

Guar gum has wide applications in pharmaceutical like cosmetic, food, textile, paper, explosive and toiletries industries etc. Therapeutically it is used as hypoglycaemic, hypolipidemic, antimicrobial, antiproliferative, bulk forming etc. Guar gum c-glycosylated derivative obtained by chemical modification of guar gum were found to have anti-inflammatory and anti-proliferative activity. The metabolic profile suggests that guar gum consumption contributes to better long term control in several diabetic, non –insulin dependent.

Need of derivatives of guar gum?

Although guar gum is abundantly available at low cost but its uncontrolled rate of hydration decreases its viscosity upon storage and further microbial contamination limits its long term applications. So guar gum has been chemically derived to modify into various properties for broaden its industrial applications such as in food, paint and pigments, oil field, mining, paper, water treatment, personal care, pharmaceutical and new types of superabsorbent. Some of the derivatives of the guar gum are listed below:

1. Carboxymethyl guar gum [13].
2. Hydroxymethyl guar gum[28].
3. Hydroxypropyl guar gum [29].
4. O- carboxymethyl- O-hydroxypropyl guar gum (CMHPG) [30].
5. O-2hydroxy-3- (trimethylammonia propyl) guar gum (HTPG).
6. O-carboxymethyl-O-2 hydroxy-3-(trimethylammonia propyl) guar gum (CMHTPG) [34].
7. Ammonium hydroxyl propyl trimethyl chloride of guar gum [33].
8. Acryloyloxy guar gum [31].
9. Methacryloyl guar gum.[32].
10. Methylated guar gum.
11. Sulfated guar gum.[55]
12. Guar gum esters.[54]

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.

Grafting:

Graft copolymerization of methyl methacrylate onto guar gum was carried out by Brij Raj Sharma et al [16] in an aqueous medium using a Ceric ammonium nitrate–nitric acid initiation system. The percent grafting (%G) and percent grafting efficiency (%GE) were determined as functions of the concentrations of Ceric ammonium nitrate, nitric acid, methyl methacrylate, guar gum, polymerization temperature and time. The optimum reaction conditions obtained for grafting of MMA onto GG were: amount of GG = 0:1g/L, CAN= 0:02 mol/L, MMA= 0:35 mol/L, HNO₃=0:2M, reaction time =3 h and temperature of reaction = 308°C

As a natural biopolymer, guar gum (GG) was covalently grafted [17] on the surfaces of multiwall carbon nanotube (MWCNT) to obtain GG–MWCNT composite. Then iron oxide nanoparticles were synthesized on the GG–MWCNT to prepare the magnetic GG–MWCNT–Fe₃O₄. GG–MWCNT was composed of about 21.6 wt% GG components, which enhanced the dispersion of GG–MWCNT in aqueous solution and also acted as a template for growth of iron oxide nanoparticles. GG–MWCNT–Fe₃O₄ exhibited superparamagnetic with a saturation magnetization (13.3 emu g⁻¹), and good adsorption on neutral red and methylene blue. GG–MWCNT–Fe₃O₄ could be easily separated from the aqueous solution in a magnetic field.

A novel polymeric flocculant based on polyacrylamide grafted carboxymethyl guar gum (CMG-g-PAM) [18] had been synthesised by grafting polyacrylamide chains onto CMG backbone using conventional redox grafting and microwave assisted grafting methods. The flocculation characteristics of grafted and ungrafted polysaccharides had been evaluated in kaolin suspension, municipal sewage wastewater and decolourization efficiency of a dye solution (methylene blue). It was evident from results that CMG-g-PAM synthesised by microwave assisted grafting method was showing best flocculation characteristics.

Guaran was transformed into Guaran Grafted Polystyrene (G-G-Ps) Copolymer using vinyl monomer [19]. The grafting was initiated through the formation of free radical centres on the polymer backbone by oxidation of guaran with cerium (IV) in nitric acid medium. It was concluded that the guaran offers a very regular linear matrix suitable for incorporating the desired physical and chemical properties through appropriate grafting and crosslinkage. The viscosity, hydrophilic-hydrophobic nature of the graft, degree of grafting and chain length of the graft was found of great significance in mineral processing and petroleum industries.

A new sorbent material[20] based on guar gum (GG) was prepared by the polymerization grafting of acrylamide (Aam) onto guar gum, using potassium bromate/thiourea dioxide redox system for initiating the polymerization reaction. The so prepared polyacrylamide/guar gum graft copolymer (PAamGG) was further crosslinked with glutaraldehyde (GA) to obtain the sorbent material in the form of hydrogel. The so-obtained hydrogel was used for removal of hexavalent chromium ion (Cr (VI)) from its aqueous solution. It was found from the study that the sorption of Cr (VI) by the hydrogel was pH-dependent and maximum sorption was obtained at pH 3. The sorption data obeyed Langmuir and Freundlich sorption isotherms. The Langmuir sorption capacity (Q_{max}) was found to be 588.24 mg/g. Freundlich constants, KF and n, were found to be 55.03 and 2.835, respectively.

Modification [21] of either guar gum or hydroxypropyl guar was achieved in a three-step process: carboxymethylation with sodium chloroacetate, esterification with dimethyl sulfate (DMS) and amidation with a series of polyalkoxyalkylamines by Ahmad Bahamdan. It was concluded that the solutions of the new derivatives possessed viscosities of approximately ten times less than the viscosities of the parent materials.

The graft copolymerization of 4-vinyl pyridine [22] onto guar gum initiated by potassium peroxymonosulphate/ascorbic acid redox pair in an aqueous medium was studied gravimetrically under a nitrogen atmosphere. The thermal analysis data showed that the synthesized graft-copolymer was more thermally stable than the un-grafted guar gum by considering the value of FDT and char yield. It was concluded that the synthesized graft-copolymer can be used as a coating material when protection from excessive heat is needed.

p-toluenesulfonate esters hydroxypropyl guar gum[23]- A new guar gum derivative containing amino group was synthesized through nucleophilic substitution of p-toluenesulfonate activated hydroxypropyl guar gum with ethanolamine.

Guar gum/polyacrylamide graft copolymer [24] was prepared in the presence of potassium bromate/thiourea dioxide as initiation system. The so-prepared and separated guar gum/polyacrylamide graft copolymer was used for preparation of silver nanoparticles through reduction of silver nitrate under certain conditions. For comparison, guar gum, polyacrylamide and guar gum/polyacrylamide composite were used individually for the preparation of silver nanoparticles under the same conditions. It was concluded that TEM images showed that 85% of silver nanoparticles prepared using the separated graft copolymer fall within the narrow range of 15–20 nm, while in case of using the composite for silver nanoparticles preparation, the histogram showed wide range of particle size distribution.

Graft copolymers of carboxymethyl guar gum (CMGG) and polyacrylamide (PAM) had been synthesized by grafting polyacrylamide [25] chains onto carboxymethyl guar gum backbone using a ceric-ion-induced solution polymerization technique. It was found that flocculation efficiency of CMGG graft copolymer shows better flocculation performance.

Guar gum (GG) was chemically modified with polyaniline (PANI) using ammonium persulfate (APS) as oxidant/initiator in acidic condition [57]. The solubility of copolymer in water was not obtained up to 230 %G. The maximum bulk electrical conductivity of the copolymer was 1.63×10^{-2} S/cm at pH 1. The grafted materials had hybrid properties of GG biopolymer and PANI both. It was concluded that *Cyanopsis tetragonolobus* could be usefully exploited for making environmental-friendly semiconductor devices by grafting with PANI, and would be novel materials for the fabrication of various electronic sensors.

S. no.	Guar gum graft copolymer	Initiated by	Applications	References
1.	Methyl methacrylate onto guar gum	Ceric ammonium nitrate–nitric acid	---	Brij Raj Sharma et al. 2003 [16]
2.	Polyacrylamide grafted carboxymethyl guar gum	Potassium persulphate solution	Treatment of wastewater.	Sagar Pala, et al.2011. [18]
3.	Guaran Grafted Polystyrene (G-G-Ps) Copolymer	Cerium (IV) in nitric acid medium	In mineral processing and petroleum industries.	A.V. Singh et al.2010. [19]
4.	Acrylamide (Aam) onto guar gum	Potassium bromate/thiourea dioxide redox system	Removal of hexavalent chromium ion (Cr (VI)) from its aqueous solution.	E.S. Abdel-Halim, 2011. [20].
5.	copolymerization of 4-vinyl pyridine onto guar gum	Potassium peroxy monosulphate/ascorbic acid redox pair	As a coating material, when protection from excessive heat is needed.	Abhishek Srivastava et al. 2007.[22]
6.	p-toluenesulfonate esters hydroxypropyl guar gum	Tosyl chloride in pyridine,	----	Yongchao Zhao, et al. 2012 [23]
7.	Guar gum/polyacrylamide graft copolymer	Potassium bromate/thiourea dioxide	Used for synthesis of silver nanoparticles.	E.S. Abdel-Halima et al,2011. [24]
8.	carboxymethyl guar gum (CMGG) and polyacrylamide (PAM)	Ceric-ion-induced solution	polymeric flocculant material	P. Adhikary et al. 2011. [25]
9.	Magnetic guar gum grafted carbon nanotube.	-----	For removal of dye from the water	Li Yana et al.2012. [17].
10.	Guar gum graft polyaniline	APS (ammonium persulphate) in acidic medium	For making environmental-friendly	Tiwari,A., et al.2008. [57]

		semiconductor devices	
--	--	-----------------------	--

Blends:

Cationic guar gum (GG) and sodium carboxymethylcellulose (NaCMC) blend film [26] was synthesised by casting method. Differential scanning calorimetry (DSC), FTIR, X-ray diffraction (XRD), and viscosity methods were used to examine the miscibility, interaction, and degradability of cationic guar gum (GG) and sodium carboxymethylcellulose (NaCMC) in their blend films. Blend films was **degradable quicker** than pure GG or NaCMC film. It was concluded that GG/NaCMC blend films have good sustained release performance.

Polymer dispersions of Ethylcellulose (EC)/ inulin (IN), Ethylcellulose (EC)/Guar Gum (GG) or Ethylcellulose (EC)/ levan (LEV) blends[27], containing up to 30% of the oligo-polysaccharide, were used for film casting on a Teflon® plate. All the films were tested for the thermal analysis. It was observed that Tmax1 (temperature at which a thermal degradation rate goes up to a maximum) and (OH (wavenumber at which the OH absorption band are centralised) show similar trends in the composition range of the studied blends.

Films from waterborne polyurethane (WPU) and carboxymethylated guar gum (CMGG) [35] with different contents (20–80 wt %) were prepared through solution casting method, and then were crosslinked with calcium chloride. The effect of CMGG content on the miscibility, morphology and physical properties of the blend films was investigated. The results revealed that the blend film had higher thermal stability and tensile strength than that of the WPU film, suggesting good miscibility between WPU and CMGG.

The rheological behavior and synergistic character of mixed polysaccharide systems were examined for blends of xanthan with enzymatically modified guar [36]. Blends of xanthan with enzymatically modified guar gum samples were examined in terms of their dynamic rheological properties and compared to those of xanthan locust bean gum blends. It was found that at constant ionic strength the enzymatically modified guar gum - xanthan blend was more elastic as the temperature of mixing was increased.

A new polymeric film based on blends of cellulose acetate and guar gum [37] blend was synthesized for **coating for colon targeting**. It was found that the blend had good film forming properties. It was resulted that guar gum cellulose acetate blends were highly promising film coating material for targeting the colonic site.

Aqueous polysaccharide blends, formed from 2.5% (w/v) solution of hydroxypropyl guar gum (HPG) and 2.5% (w/v) solution of carboxymethyl cellulose (CMC) [38] according to different blending ratios, were investigated at 20 °C in terms of their shear-dependent viscosity and thixotropic properties. It was found that aqueous HPG/CMC blends behaved as non-Newtonian shear-thinning fluids. Their shear-dependent viscosity behavior could be described using Cross viscosity model with reasonable accuracy.

Novel blends from quaternized polysulfone (QPSF) and benzoyl guar gum (BGG) [39] coded as QB with different contents (10-80 wt %) were prepared through solution casting method. Simultaneously, other kinds of blends were prepared from chloromethylated polysulfone (CIPSF) and BGG coded as CIB to compare the effects of the substituted groups on the miscibility and properties of the composite materials. The results revealed that QB blends had good or certain miscibility over the entire composition ratio of BGG to QPSF under study. It was found that the composite properties changed considerably with moisture content, which attributed that water molecules had a great effect on the hydrogen bonding between the two polymers.

Guar gum, a polymeric galactomannan, was intrinsically modified to a new guar gum benzamide [40]. Benzoylation was carried out by benzoyl chloride reaction in water medium and a propyl amine spacer was used to impart a high degree of hydrophobicity. The ability of GGBA film to **limit bacterial growth** was assessed in qualitative and quantitative experiments. Large inhibitory halo was observed against both gram positive and gram negative organisms.

A comparative study of the rheological properties of guar [GG], methyl guar [MG], hydroxypropyl guar [HPG] and hydroxypropyl-methyl guar [MHPG] [41] polymers aqueous solutions in semidilute (both unentangled and entangled) and concentrated regimes, using oscillatory and steady shear techniques was reported by Daniela Risica et al. The storage and loss moduli of guar and guar derivatives aqueous solutions had been measured using angular frequencies in the range between 10^{-3} and 10 rad/s. The data had been analyzed using the “blob” model for semidilute solutions and the scaling approach proposed by Rubinstein, Dobrynin and Colby for concentrated solutions.

Blend films of chitosan (CH) and hydroxypropyl guar gum (HGG) [42] were prepared using a conventional solvent-casting technique and were dried at room temperature. A good intermolecular interaction was found because of hydrogen bonding between CH and HGG occurred in the blend films. The blend film containing 60% HGG had greater thermal stability than did the other blend and pure CH films. In addition, **the best optical transparency** was observed from 500 to 800 nm in the blend film containing 60% HGG.

Films were prepared by the casting method using sodium alginate (SA) and methacryloyl guar gum (MAG) [43] in different ratios. Water vapor transmission rate and oxygen permeability of the films were investigated. Films were evaluated for mechanical and antibacterial properties. The film prepared with the blend containing 85% MAG and 15% SA (v/v) was found to be the best as it had lower oxygen permeability, better mechanical properties while retaining the similar **antibacterial properties of MAG**, when compared with MAG film not containing SA.

A study on The swelling/degradation behavior of Ba²⁺ ions-crosslinked sodium alginate/carboxymethyl guar gum [44] bipolymeric beads which were intended to exhibit greater stability in the environment of changing pH along the gastrointestinal (GI) tract were reported by S.K. Bajpai. Finally, it was concluded that barium ion-crosslinked bipolymeric beads demonstrate **pH-sensitive swelling** and are quite stable in the environment of changing pH, thus offering their strong candidature for possible use in oral delivery of drugs along the GI tract.

The synergistic interaction between the cationic guar gum (the ammonium hydroxyl propyl trimethyl chloride of guar gum) [45] and sodium alginate was studied. The effect of the mass ratio, mixed temperature, barks salt ion concentration, incubation time and pH value on gelation were investigated. It was concluded that the gel strength was maximum at mass ratio 0.6, temperature 70°, barks salt ion concentration 1.0 mol/L, incubation time 30 min and pH 8.

Composites/ nanocomposites:

A guar gum- silver nanocomposite was synthesised for **optical sensor for ammonia detection**. Aqueous ammonia sensing study of polymer/silver nanoparticles nanocomposite (GG/AgNPs NC) [46] was performed by optical method based on surface plasmon resonance (SPR). It was concluded that in the near future we could use our room temperature optical ammonia sensor for clinical and medical diagnosis for detecting low ammonia level in human.

A low cost eco-friendly method for the synthesis of gold nanoparticles (AuNPs) using guar gum (GG) as a reducing agent was reported. GG/AuNPs nanocomposite (GG/AuNPs NC) [47] was exploited **for optical sensor for detection of aqueous ammonia** based on surface plasmon resonance (SPR). It was found to have good reproducibility, response times of ~10 s and excellent sensitivity with a detection limit of 1 ppb (parts-per-billion). It was concluded that, this system could be used for the rapid production of an ultra-low-cost GG/AuNPs NC-based aqueous ammonia sensor.

GG/Ag nanocomposite [48] was synthesized for making a **ammonia gas sensor for chemical reaction** studies. It was concluded that the nanocomposite could detect ammonia as low as 500 parts-per-trillion at room temperature in a minute time. It was demonstrated by results that such made nanocomposite can be used in several applications including homeland security, environmental pollution and leak detection in research laboratories and many others.

Novel montmorillonite nanocomposites were prepared using neutral guar gum and cationic guar gum [49]. It was observed that morphology and structure of the guar-montmorillonite nanocomposites was dependence on the relative amounts of guar and montmorillonite used for their preparation. This was responsible for necessary flexibility for the potential applications of such nanocomposites.

Guar gum-nano zinc oxide (GG/nZnO) biocomposite [50] was used as **an adsorbent for enhanced removal of Cr(VI) from aqueous solution**. The maximum adsorption was achieved at 50 min contact time, 25 mg/L Cr(VI) conc., 1.0 g/L adsorbent dose and 7.0 pH. Langmuir, Freundlich, Dubinin-Kaganer-Radushkevich and Temkin isotherm models were used to interpret the experimental data. It was found that GG/nZnO biocomposite adsorbent showed an improved adsorption capacity for Cr (VI) ($q_m = 55.56$ mg/g) as compared to other adsorbents reported in the literature. The results suggested that GG/nZnO biocomposite is **economical, eco-friendly** and capable to remove Cr(VI) from natural water resources.

AgNPs were synthesized using a thermo-associating polymer namely, carboxymethyl guar grafted poly(ethylene oxide-co-propylene oxide) [CMG-g-PEPO][51]. It was found that the polymer was acting as both reducing agent as well as **stabilizing/capping agent**. The use of these nanoparticles in the controlled release of Doxorubicin hydrochloride (Dox), an anticancer drug was also demonstrated. The binding of Dox onto the polymer and AgNPs was investigated by XPS and Raman spectroscopy which indicated that a charge-transfer mechanism was operative between the Dox and polymer holding both the entities together.

The effect of acetylation of guar gum [52] on its properties as a filler in an unsaturated polyester matrix was studied. The rheology of the uncured composition indicated increased polymer-filler interaction with increased ester content. It was found that the tensile and flexural properties increased with the acetylation degree of guar gum; however the impact resistance of the composites was reduced. it was concluded that the treatment of GG particles was not restricted to the particle surface as in the case of natural fibres and changed the nature of the filler itself. Polysaccharides could thus be **used as fillers in unsaturated polyester** composites as a replacement to mineral fillers making the composites **more eco-friendly**.

Silver (Ag) nanoparticles were synthesized in aqueous GG solution by using gamma radiation [53]. The nanoparticles in solution were prepared by exposing aqueous solution of GG containing AgNO₃ and isopropyl alcohol to 60 Co gamma radiation. The aim of this study was to investigate the optical and structural properties of silver nanoparticles as well as the influence of capping agent concentration, precursor concentration along with effect of other parameters on nanoparticle size and size distribution.

Silver nanocomposite of carboxymethyl guar grafted poly (ethylene oxide-co-propylene oxide) [CMG-g-PEPO] was synthesized by Nivika R Gupta, et al 2013.[56]. It was found that the polymer acts as both **reducing agent** as well as **stabilizing/capping agent**. The binding of Dox onto the polymer and AgNPs was investigated by XPS and Raman spectroscopy which indicated that a charge-transfer mechanism was operative between the Dox and polymer holding both the entities together.

New cationic biopolymer guar gum alkylamine (GGAA) Silver Nanocomposites [58] was synthesized for Wound healing Applications. In wound healing experiments, faster healing and improved cosmetic appearance were observed in the new nanobiomaterial treated group compared to commercially available silver alginate cream. The nanobiomaterial was observed to promote wound closure by inducing proliferation and migration of the keratinocytes at the wound site.

Gamma ray induced synthesis of Ag clusters in the aqueous medium had been carried out using natural polysaccharide guar gum as a stabilizer.[59] The results showed that guar gum was very effective in binding the Ag clusters and restrict their size in the nano region. From thermogravimetric analysis it had been demonstrated that incorporation of nano sized Ag clusters within guar gum improved the thermal properties of irradiated guar gum.

Guar-gum stabilized copper Nanoparticles catalyst for cycloaddition reaction were synthesised by Ajeet kumar et al.2012. [60] To confirm the morphology of the synthesized nanoparticles, selected area electron diffraction (SAED) analysis of the samples was carried out and it was found that the particles were crystalline in nature which was further confirmed by X-ray diffraction study.

Conclusion

Guar gum and their derivatives have a hues research profile. They have a lot of applications in all fields of sciences. The main reason of easy derivatization of guar gum is the presence of hydroxyl groups which are capable of easy functionalization. Grafting of the guar gum is good technique for getting different materials which can be used in different applications as in treatment of waste water, in mineral processing and petroleum industry, in removal of heavy metals, in coating material for heat and chemicals, in removal of dye from water, synthesis of different nanoparticles and hydrogels. Blending of guar gum with different synthetic and natural polymers has given an extensive uses of guar gum. Good adsorbents, quick biodegradable films, coating material for colon targeting, optically transparent and antimicrobial film (MAG) with pH sensing(with respect to swelling) properties are some of the properties of guar gum blends, which can be obtained by very easy methods. The composite of the guar gum with different nanoparticles have also added a series of application. Guar gum based nanocomposite Gas sensor (quick response in 10 sec.) can be used for homeland security, gases leak detection in research lab and heavy metals removal from waste water.

But even of being such hues research in guar gum, there has been done a little work for nanocomposite. Even now very little work has been done for the affect of guar gum on conducting polymers and their blends, grafting and composite. If we use such natural polymer with conducting polymers, then we can also improve their processing problems and biodegradability. We can synthesize biomaterial based conductive, antimicrobial, pH sensitive nanocomposites and blends which can be used in bare paints, nanopaints, coating material, and sensing devices. A new field for researcher is the use of guar gum and their derivatives as filler in unsaturated polymers composites as a replacement to mineral fillers making the composites more eco-friendly.

So guar gum and their derivatives are even now a big interest of research. New areas are also there where researchers have a great space for research.

References

1. **Yoon, S.J., Chu, D. C., Juneja, L.R. (2008):** Chemical and physical properties, Safety and Application of Partially Hydrolyzed Guar Gum as Dietary Fiber. *J. Clin. Biochem. Nutr.*, 42:1–7.
2. **Kadowaka, J. I. (2009):** 101 uses for guar gum. *CSHCBM / www.rsc.org/chemicalscience Chemical Science*. 6(7).

3. **Bagal-Kestwala, D., Kestwala, R. M., Chianga, B.M., Karveb M.S.(2011):** Development of dip-strip sucrose sensors: Application of plant invertase immobilized in chitosan–guar gum, gelatin and polyacrylamide films. *Sensors and Actuators B* 160:1026–1033.
4. **Venugopal, K.N., Abhilash M.(2010):** Study of Hydration Kinetics and Rheological Behaviour of Guar Gum. *International Journal of Pharma Sciences and Research (IJPSR)*, 1(1):28-39.
5. **Reddy,T.T., Tammishetti,S.(2004):** Free radical degradation of guar gum. *Polymer Degradation and Stability* 86:455-459.
6. **Chudzikowski.R.J.(1971):** Guar gum and its applications. *J Soc. ½ osmt., Gh•m.* 22:43-60.
7. **Abdallah, M.(2004.):** Guar Gum as Corrosion Inhibitor for Carbon Steel in Sulfuric Acid Solutions *Portugaliae Electrochimica Acta* 22: 161-175.
8. **Silveira, J.L.M., Bresolin, T.M.B. (2011):** Pharmaceutical Use of Galactomannans. *Quim. Nova*, 34(2), 292-299.
9. **Badmapriya D, Rajalakshmi A.N. (2011):** Guar Gum Based Colon Targeted Drug Delivery System: *In-Vitro* Release Investigation. *Research Journal of Pharmaceutical, Biological and Chemical Sciences.* 2(3): 899.
10. **Mohaptra, Santosh K, Kshirsagar Sanjay J, Bhalekar Magesh R, Shukla Gajendra N, Patil Amol V.(2011):**Development and Evaluation of enzymatically triggered multiparticulate colon targeted drug delivery system. *International Journal of Research in Ayurveda and Pharmacy.* 2(1):211-215.
11. **Abhishek Kumar Jain, C. P. Jain.(2011):**Naturally occurring biodegradable polymers for controlled release of ciprofloxacin for treatment of inflammatory bowel disease. *Asian Journal of Pharmaceutical and Clinical Research*, 4(2):16-22.
12. **Prasad. K., Izawa,H., Kaneko,Y., Kadokawa, J-I.(2009).** Preparation of temperature-induced shapeable film material from guar gum-based gel with an ionic liquid. *Journal of Materials Chemistry*,19: 4088-4090.
13. **Dodi, G., Hritcu, D., Popa, M.I. (2011):** Carboxymethylation of Guar Gum: Synthesis and Characterization. *Cellulose Chem. Technol.*, 45 (3-4), 171-176.
14. **Shaikh,T., Kumar, S.S.(2011):** PHARMACEUTICAL AND PHARMACOLOGICAL PROFILE OF GUAR GUM AN OVERVIEW. *International Journal of Pharmacy and Pharmaceutical Sciences*, 3(5):38-40.
15. **Oblonsěk, M., .Sonja Šostar-Turk, Lapasin, R. (2003):** Rheological studies of concentrated guar gum. *Rheol Acta.*, 42: 491–499.
16. **Sharma,B.R., Kumar,V., Soni, P.L.(2003):** Ce(IV)-Ion Initiated Graft Copolymerization of Methyl Methacrylate onto Guar Gum. *Journal of Macromolecular Science Part A—Pure and Applied Chemistry*, 40(1):49–60.
17. **Li Y., Peter R.C., Pengwu Z, Xiaofei M.(2012):** Characterization of magnetic guar gum-grafted carbon nanotubes and the adsorption of the dyes. *Carbohydrate Polymers*, 87:1919– 1924.
18. **Pala,S., Ghoraiya,S., Dasha,M.K., Ghoshb, S., Udayabhanu, G.(2011):** Flocculation properties of polyacrylamide grafted carboxymethyl guar gum (CMG-g-PAM) synthesised by conventional and microwave assisted method. *Journal of Hazardous Materials*, 192:1580– 1588.
19. **Singh, A.V., Singh, R.(2010):** Synthesis, Characterization and Rheological Properties of Guar Grafted Polystyrene (G-G-Ps) Copolymer. *Journal of Engineering, Science and Management Education*, 3:47-51.

20. **Abdel-Halim,E.S., Al-Deyab,S.S.(2011):** Hydrogel from crosslinked polyacrylamide/guar gum graft copolymer for sorption of hexavalent chromium ion. *Carbohydrate Polymers* 86:1306– 1312.
21. **Bahamdan.A., William H. D.(2007):** Hydrophobic guar gum derivatives prepared by controlled grafting processes. *Polymers for Advanced Technologies*.18: 652–659.
22. **Srivastava,A., Tripathy,J., Mishra, M.M., Behari, K.(2007):** Modification of Guar Gum through Grafting of 4-Vinyl Pyridine using Potassium Peroxymonosulphate/Ascorbic Acid Redox Pair. *Journal of Applied Polymer Science*.106:1353–1358.
23. **Zhao,Y., He, J., Hana,X., Tian, X., Deng, M., Chen, W., Jiang, B.(2012):** Modification of hydroxypropyl guar gum with ethanolamine. *Carbohydrate Polymers*, 90:988– 992.
24. **Abdel-Halima,E.S., El-Rafieb, Al-Deyab, S.S.(2011):** Polyacrylamide/guar gum graft copolymer for preparation of silver nanoparticles. *Carbohydrate Polymers* 85:692–697.
25. **Adhikary, P., Krishnamoorthi, S., Singh, R.P. (2011):** Synthesis and Characterization of Grafted Carboxymethyl Guar Gum. *Journal of Applied Polymer Science*, 120:2621–2626.
26. **Yi, J.Z., Zhang, L.M.(2007):** Biodegradable Blend Films Based on Two Polysaccharide Derivatives and Their Use as Ibuprofen-Releasing Matrices. *Journal of Applied Polymer Science*, 103:3553–3559.
27. **Osvaldo A. C., Bruno P.I., Alessander C.B., Edgardo Alfonso G.P., Ana Adelina W.H.(2004):** Characterisation of Ethylcellulose Films containing Natural Polysaccharides by Thermal Analysis and FTIR Spectroscopy. *Acta Farm. Bonaerense*, 23(1): 53-7.
28. **Lapasin, R., Pric, S., Tracanelli, P. (1991):** Rheology of hydroxyethyl guar gum derivatives. *Carbohydrate Polymers* .14(4):411–427.
29. **Lapasin, R., Lorenzi, L.D., Pricl, S., Torriani, G.(1995):** Flow properties of hydroxypropyl guar gum and its long-chain hydrophobic derivatives. *Carbohydrate polymers*, 28(3):195-202.
30. **Shi,H-Y., Li, M.Z.(2007):** New grafted polysaccharide based on O-carboxymethyl- O-hydroxypropyl guar gum and N- isopropylacrylamide: synthesis and phase transition behaviour in aqueous media. *Carbohydrate polymer*,. 67:337-342.
31. **Shenoy,M. A., Dawid J. D’Melo.(2010):** Synthesis and Characterization of Acryloyloxy Guar Gum. *Journal of Applied Polymer Science*, 117:148–154.
32. **Xiao, W., Dong, L.(2011):** Novel excellent property film Prepared from Methacryloyl chloride -graft-Guar Gum Matrixes. Conference Location: XianNing, Date of Conference: 16-18 April, 1442 – 1445.
33. **Wilma F. Bergfeld.(2012):** On the Safety Assessment of Galactomannans As Used in Cosmetics-The 2012 Cosmetic Ingredient Review. <http://www.cir-safety.org/sites/default/files/Galact032012FR.pdf>.
34. **Li-Ming Z., Jian-Fang Z. and Peter S. H.(2005):** A comparative study on viscosity behavior of water-soluble chemically modified guar gum derivatives with different functional lateral groups. *Journal of the Science of Food and Agriculture*, 85:2638–2644.
35. **Huang,Y., Yu,H., Xiao,C.(2006):** Effects of Ca²⁺ crosslinking on structure and properties of waterborne polyurethane-carboxymethylated guar gum films. *Carbohydrate Polymers*, 66:500–513.
36. **Pai, V. B., Khan, S.A.(2002):** Gelation and rheology of xanthan enzyme modified guar blends. *Carbohydrate polymers*, 49:207-216.

37. **Badmapriya D., Rajalakshmi A.N.(2011):** New polymeric film coating for colon targeting and its evaluation. *International Research Journal of pharmacy*, 2(7):136-140.
38. **Zhang, L-M., Kong, T.(2006):** Aqueous polysaccharide blends based on hydroxypropyl guar gum and carboxymethyl cellulose: synergistic viscosity and thixotropic properties. *Colloid Polym Sci*, 285: 145–151.
39. **Huang,Y.H., Xiao,C. (2007):** Miscibility and mechanical properties of quaternized polysulfone/benzoyl guar gum blends. *Polymer*, 48:371-381.
40. **Das,D., Ara,T., Dutta,S., Mukherjee.A.(2011):** New water resistant biomaterial biocide film based on guar gum. *Bioresource Technology* 102:5878–5883.
41. **Risica,D., Barbetta ,A., Vischetti ,L., Cametti ,C., Dentini,M.(2010):** Rheological properties of guar and its methyl, hydroxypropyl and hydroxypropyl-methyl derivatives in semi dilute and concentrated aqueous solutions. *Polymer* 51:1972-1982.
42. **Xiao,C., Zhang, J., Zhang,Z., Zhang,L.(2003):** Study of Blend Films from Chitosan and Hydroxypropyl Guar Gum. *Journal of Applied Polymer Science*, 90:1991–1995.
43. **Xiao,W., Dong,L. (2011):** Study of Blend Films from Methacryloyl Guar Gum and SodiumAlginate. *Ieeexplore*, 1639-1642.
44. **Bajpai, S.K., Saxena,S.K., Sharma,S.(2006):** Swelling behavior of barium ions-crosslinked bipolymeric sodium alginate–Carboxymethyl guar gum blend beads. *Reactive & Functional Polymers* 66:659–666.
45. **Dong, H., Li-hua L., Qing, L., Xiao-Zhen Y.(2004):** Synergistic interaction and gelation in cationic guar gum – sokium alginate system. *Wuhan university journal of natural sciences*. 9(3):371-374.
46. **Pandey,S., Goswami,G.K., Nanda, K.K.(2012):** Green synthesis of biopolymer–silver nanoparticle nanocomposite: An optical sensor for ammonia detection. *International Journal of Biological Macromolecules*, 51:583– 589.
47. **Pandey,S., Goswami,G.K., Nanda, K.K.(2013):** Green synthesis of polysaccharide/gold nanoparticle nanocomposite: An efficient ammonia sensor. *Carbohydrate Polymers*, 94:229– 234.
48. **Pandey,S., Goswami,G.K., Nanda, K.K.(2013):**Nanocomposite based flexible ultrasensitive resistive gas sensor for chemical reactions studies. *Scientific Reports*. [www.nature.com/scientific reports](http://www.nature.com/scientificreports).
49. **Mansa,R., Detellier,C.(2013):**Preparation and Characterization of Guar-Montmorillonite Nanocomposites. *Materials*, 6:5199-5216.
50. **Khan, T.A., Nazir,M., Ali,I., Kumar,A. (2013):** Removal of Chromium (VI) from aqueous solution using guar gum–nano zinc oxide biocomposite adsorbent. *Arabian Journal of Chemistry*. 1878-5352.
51. **Gupta,N.R., Bhagavatula,P., Chinnakonda, G.S., Badiger.M.V. (2013):** A Nanocomposite of Silver and Thermo-associating Polymer by Green Route: A Potential Soft-Hard Material for Controlled Drug Release. Accepted Manuscript DOI: 10.1039 /C3RA45022H.
52. **Shenoy,M., D’Melo, D.J.(2007):** Guar gum as filler in unsaturated polyester composites. *E-Polymers*, 111:1618-7229.
53. **Chapter 3:** Synthesis of spherical silver nanoparticles in guar gum by gamma irradiation. http://shodhganga.inflibnet.ac.in/bitstream/10603/11458/8/08_chapter%203.pdf.
54. **Dong, C., Tian, B.(1995):** Studies on Preparation and Emulsifying Properties of Guar Galactomannan Ester of Palmitic Acid, *J Appl Polym Sci*, 72:639–645.

55. **Mestechkina, N. M., Egorov, A. V., and Shcherbukhin, V. D.(2006):** Synthesis of Galactomannan Sulfates, *Applied Biochemistry and Microbiology*, 42:326–330.
56. **Gupta, N.R., Prasad, B., Chinnakonda, G.S., Badiger, M.V. (2013):** A Nanocomposite of Silver and Thermo-associating Polymer by Green Route: A Potential Soft-Hard Material for Controlled Drug Release. <http://pubs.rsc.org/en/content/articlelanding/2013/ra/c3ra45022h#!divAbstract>
57. **Tiwari, A., Singh, S.P.(2008):** Synthesis and Characterization of Biopolymer-Based Electrical Conducting Graft Copolymers. *Journal of Applied Polymer Science*, 108:1169–1177.
58. **Auddy, R.G., Abdullah, M.F., Das, S., Roy, P., Datta, S., Mukherjee, A.(2013):** New Guar Biopolymer Silver Nanocomposites for Wound Healing Applications. *Hindawi Publishing Corporation, BioMed Research International*, 1-9.
59. **Biswal, J., Ramnani, S.P., Shirolkar, S., Sabharwal, S.(2009):** Synthesis of Guar-Gum-Stabilized Nanosized Silver Clusters with γ Radiation. *Journal of Applied Polymer Science*, 114:2348–2355.
60. **Kumar, A., Aerry, S., Saxena, A., De, A., Mozumdar, S.(2012):** Copper nanoparticulates in guar-gum: a recyclable catalytic system for the Huisgen[3+2]-Cycloaddition of Azides and Alkynes without additives under ambient conditions. Electronic Supplementary Material (ESI) for Green Chemistry, 1-11.