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A REVIEW ON GUMS AND MUCILAGES USED IN PHARMACEUTICAL INDUSTRY

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Abstract

The term mucilage is used as ordinary name for liquid material Collected from plants, minerals, or animals, as well as semisynthetic Material prepared through modifying the chemical structure or herbal Ingredients. Consequently, mucilages can contain gums and hydrogels Which includes xanthan gum, gum arabic, or the Carbopol 940(1) Mucilages from Vegetable assets are a natural fabricated from their metabolism (secondary Metabolites), as compared to gums, for which the plant should suffer a few Damage or physiological alternate to result in their manufacturing.Plant components together with leaf Cells, seed coats, roots, barks and center lamella are Rich in plant mucilage. It's miles a semitransparent amorphous substance and polymer of monosaccharides,And majority is determined in attachment with uronicacids.Gum and mucilage have comparable materials and on Chemical reaction, they yield a mixture of sugar And uronicacid. natural mucilage hence has a extensive Range of recognition because of low price, smooth availability, Biocompatibility, non-toxicity and least irritancy and For this reason preferred primarily than synthetic excipients .It also has a big position in plant host-pathogen Interaction and ionic balance of plant cells. Waterbinding ability of the plant mucilage is excessive due to To the presence of large number of hydroxyl companies found in it.

Keywords gum, mucilage, herbal material, synthetic excipients

Introduction

On this growing international, there is a tremendous demand forNovel drug shipping structures, and there may be a noteworthyIncrease inside the approvals of comparable systems. HerbalExcipients and their utility in the pharmaceuticalEnterprise are exquisite imposed with the aid of the presence of syntheticExcipients. Herbal excipients are desired over theArtificial as they are inert, secure, non-poisonous, biocompatible,Biodegradable, low value, f6ba901c5019ebe39975adc2eb223bef and abundantlyTo be had in nature.1-three Conventionally, excipients were Integrated in dosage forms as inert cars however inContemporary pharmaceutical dosage bureaucracy they oftenAccomplish multitask roles together with improvement ofSolubility of poorly soluble

tablets decorate bioavailability,Preferred drug release, goal precise inside the form ofMicroparticles, and nanoparticles.4In current years, polymers those are derived from plant originHave evoked exquisite interest due to their variousPharmaceutical programs together with diluent, binder, disinte-Provide in capsules, thickeners in oral liquids, protective colloidsIn suspensions, gelling marketers in gels, and bases in suppository[1]. They may be extensively utilized in cosmetics, paints, textiles, and paperMaking[2]. Those herbal gums and mucilages are desiredOver the artificial ones because they're biocompatible, Reasonably-priced, and effortlessly to be had than the synthetic ones. AlsoThe natural excipients are desired at the artificial andSemisynthetic ones due to their lack of toxicity, low cost,Soothing motion, availability, and nonirritant nature of theExcipients[3−6].

Some Recently Investigated Natural GumsAnd

1. **Albizia Gum**. Albizia gum is acquired from the incisedTrunk of the tree Albiziazygia (circle of relatives Leguminosae). IConsists of β-1-three-linked D galactose devices with a few ß1-6-Connected D-galactose units. Albania gum has been investigated As a likely alternative for gum Arabic as a herbal emulsifier For meals and pharmaceuticals[7−8]. These gums had been triedAs coating substances in compression-covered tablets, whichDegraded, by the colonic microflora, thereby releasing theDrug[9].

2. Fenugreek Mucilage. Mucilage is obtained from seeds of Trigonellafoenum-graceum (own family: Leguminosae). Its seedsComprise a high percent of mucilage and do no longer dissolveIn water however form viscous cheesy mass and swell up whileUncovered to fluids[10]. Gum contains mannose, galactose, And xylose. The mucilage obtained from fenugreek turned into found To be better launch retardant in comparison to hypromellose atEqual content[11]

3. **Hibiscus Mucilage. M**ucilage is acquired from cleanLeaves of Hibiscus rosa-sinensis (circle of relatives: Malvaceae). MucilageOf Hibiscus rosa-sinensis incorporates L-rhamnose, D-galactose,D-galacturonic acid, and D-glucuronic acid[12]. The usage ofIts mucilage for the development of sustained launch tabletHas been stated[13].

4. **Neem Gum.**Neem gum is acquired from the treesOf Azadirachtaindica (own family: Meliaceae). Gum includesMannose, glucosamine, arabinose, galactose, fucose, xylose, And glucose[14]. Studies have been finished on neem gum For its binding belongings[15] and sustained release property.Consequences show that as the percentage of Azadirachtaindica Fruit mucilage increases, the general time of launch of the drug From the matrix tablet additionally increases[16].

5. **Gum Copal.**
   Gum copal is a natural resinous material of plant Bursera bipinnata (family: Burseraceae). Copal resin contains agathic acid along with ciscommunic acid, transcommunic acid, polycommunic acid, sandaracopimaric acid, agathalic acid, monomethyl ester of agathalic acid, agatholic acid, and acetoxy agatholic acid[27]. Copal gum has been evaluated as matrix-forming material for sustaining the drug delivery. In an independent study copal resin was used as a film forming agent. Films showed good swelling property. It was concluded that it can be used as a coating material for sustained release and colon targeted drug delivery. Film was prepared using gum copal and its swelling studies were performed in different phosphate buffer (pH 4.5, pH 6.0, and pH 7.4); significant swelling was found in pH 7.4 so colon can be targeted[28]

6. **Moi Gum.**
   Moi gum is obtained from leaves, stems, fruits, and bark of the stem Lannea coromandelica (family: Anacardiaceae). This gum is yellowish white colour in fresh and on drying becomes dark. Gum ducts are present in leaves, stems, and fruits and are most abundant in the bark of the stem[29]. The roots contain cluytyl ferulate; heartwood gives lanosterol; bark, dlepi-catechin, and (+)-leucocyanidin; flowers and leaves, ellagic acid, quercetin, and quercetin-3 arabinoside. Flowers also contain isoquercetin and morin. Leaves in addition contain beta-sitosterol, leucocyanidin, and leucodelphinidin. Moi gum was evaluated as

microencapsulating agent and release rate controlling material. Microspheres were prepared by solvent evaporation technique. Moi gum produced microspheres having acceptable size and morphology. Microspheres formulated using moi gum showed sustained release beyond 10 hours in comparison to guar gum but when used in 1 : 1 ratio microspheres showed more sustained release[30]

7. **Kondagogu Gum.**

Kondagogu gum or hupu gum is a naturally occurring polysaccharide derived as an exudate from the tree Cochlospermum religiosum (family: Bixaceae). Gum contains rhamnose, galacturonic acid, glucuronic acid, b-D galactopyranose, a-D-glucose, b-D-glucose, galactose, arabinose, mannose, and fructose[31]. Studies were performed on kondagogu gum for its gastric floating property. The polymer concentration, concentration of sodium bicarbonate, and that of pharmatose to the weight of drug and polymer were selected as independent variables. Cumulative percent drug released at 12 hrs was selected as dependent variable. The release rate decreased as the proportion of hupu gum increased[32]. Hupu gum was also evaluated for its mucoadhesive microcapsule forming property. All microspheres showed good mucoadhesive property in in vitro wash of test. In vitro drug release studies showed that the guar gum had more potentiality to retard the drug release compared to other gums and concentrations. Drug release from the microspheres was found to be slow and following zero order release kinetics with non-Fickian release mechanism, stating that release is depended on the coat : core ratio and the method employed[33].

8. **Phoenix Mucilage.**

Phoenix mucilage is obtained from the dried fruit of Phoenix dactylifera (family: Palmaceae). Carbohydrates make up to 44–88% of the fruit which include mainly reducing sugars such as fructose, sucrose, mannose, glucose, and maltose in addition to small amounts of polysaccharides such as pectin (0.5–3.9%), starch, and cellulose. Binding properties of date palm mucilage were successfully evaluated. The tablets manufactured using phoenix mucilage were found to be less friable than tablets manufactured using acacia and tragacanth. As the concentration of the gum increased the binding ability improved, producing good uniformity in weight and hardness of the tablets[34].

9. **Cassia tora Mucilage.**

Cassia tora mucilage derived from the seeds of Cassia tora (family: Caesalpiniaceae). The primary chemical constituents of Cassia include cinnamaldehyde, gum, tannins, mannitol, coumarins, and essential oils (aldehydes, eugenol, and pinene); it also contains sugars, resins, and mucilage among other constituents[35]. Studies were performed on Cassia tora mucilage for its binding property. It was observed that increasing the concentration of mucilage increases hardness and decreases the disintegration time of the tablets which were formulated with different concentrations ofcassia tora gum[36].This mucilage was also evaluated for its suspending agent. The suspending ability of Cassia tora mucilage was compared with that of tragacanth, acacia, and gelatin. The suspending ability of all the materials was found to be in the order: Cassia tora > tragacanth gum > acacia gum. Gelatin results suggest that suspending action of the mucilage is due to high viscosity of the gum[37]

10. **Bhara Gum.**

Bhara gum is a yellowish natural gum extracted from the bark of Terminalia bellerica (family: Combretaceae). Main chemical constituents are tannins which mainly include ß-sitosterol, gallic acid, ellagic acid, ethyl gallate, galloyl glucose, and chebulaginic acid. A new sustained release microencapsulated drug delivery system employing bhara gum has been proposed. The microcapsules were formulated by ionic gelation technique using famotidine as the model drug. The effect of different drug: bhara gum ratio drug release profile was examined and compared with guar gum. Microcapsules employing bhara gum exhibited slow release of famotidine over 10 hour[38]

11. **Mimosa Mucilage.**

Gum is obtained from seeds of Mimosa pudica (family: Mimosaceae). Seed mucilage is composed of D-xylose and D-glucuronic acid. Mimosa seed mucilage hydrates and swells rapidly on coming in contact with water. A controlled delivery system for diclofenac sodium using Mimosa seed mucilage was studied. In this

study different batches of tablets were formulated and their drug releases were checked. It was observed that as the proportion of the Mimosa pudica seed mucilage increases, there is a decrease in release of drug, the mechanism of release being diffusion for tablets containing higher proportion of mucilage, and a combination of matrix erosion and diffusion for tablets containing smaller proportion of mucilage. Studies showed that as the proportion of the mucilage increased, there was a corresponding increase in increase in percent swelling and decrease in percent erosion of the tablets[39].

12. **Grewia Gum.**
Grewia gum is a polysaccharide derived from the inner bark of the edible plant Grewia mollis (family: Tiliaceae). The gum consists of glucose and rhamnose as the main monosaccharide components and galacturonic acid as the main sugar acid[40] . Studies were performed on grewia gum for its binding property, compressional property. In this study it was found that formulations containing grewia gum exhibited higher degree of packing than those containing PVP. Grewia gum was also found to improve fluidity granules than PVP. [41]. Studies were also carried out on matrix forming property of this gum. In this study tablets containing different concentrations of grewia gum were compressed by direct compression technique and were evaluated. In vitro drug release studies reveal that grewia gum can control the release of cimetidine from tablets for up to 12 hours. There was synergy between grewia gum and HPMC in delaying the release of cimetidine from tablets[42] and film forming property[43].

13. Olibanum Gum. Olibanum gum is a dried, gummy exudation obtained from Boswellia serrate (family: Burseraceae). Gum olibanum is used as an anti-inflammatory remedy and recent studies have found positive influence of olibanum on rheumatism. Its composition and chemical characteristics depend on its three principal origins: Aden/Somalia, Eritrea, and India which contains approximately 5–9% oil content, 13–17% resin acids, 20–30% polysaccharides, 40–60% boswellic acid. Studies were performed on olibanum gum for its sustained release matrix forming[44], binding[45]. Olibanum resin coated microcapsules were formulated by emulsification solvent evaporation method. It was observed that drug release from the resin-coated microcapsules was slow over 24 hours and depended on core : coat ratio, wall thickness, and size of the microcapsules[46].

Advantages of herbal gums and mucilage[17]

The following are a number of the blessings of herbal plant

Based materials:

1.local availability

2. Biocompatible and non-poisonous

3. Environmental friendly processing

4.Low value

5. Biodegradable

Disadvantage

Reduced rheology on storage: In popular, the Viscosity of mucilage increases on touch with Water due to its complex nature. On storage, the viscosity of mucilage decreases because of the Conversion from monosaccharide to polysaccharide-Rides and their derivatives[18−26] Microbial boom: The water content inside the Mucilage is commonly excessive, and structurally they are Carbohydrates. Therefore, the threat of microbial Increase is better during the processing and production because it receives exposed to the outside atmospheres. But, via careful managing and use ofAntimicrobial marketers as preservatives, this may be Prevented.

Applications in the food enterprise

Gums and mucilage's have a spread of programs within the foodEnterprise[20]. Different gums have different uses like water Retention and stabilization (guar and locust bean gum), Stabilizers for ice-cream, meat products and instantaneous pudding (carrageenanas), dairy, confectionary and meat products (agar),Confectionary, drinks, sponsored product, and sauces (gum Arabic, tragacanth, pectins , alginates and xanthan gum) Mucilages Packages of natural Gums and Mucilages: Gums and Mucilages of various assets and their derivatives Constitute a group of polymers widely used inPharmaceutical dosage bureaucracy. Numerous types of gums are Used within the food enterprise and are appeared as secure for Human intake. However, there is developing challengeApproximately the protection of pharmaceutical excipients derived fromHerbal resources. Plant gums and exudates are actually screened

For their use as pharmaceutical adjuvants.

Mucilage's of Different origins also are used in conventional dosage Varieties of numerous drugs for his or her binding, thickening, Stabilizing and humidifying houses in medicine.

packages inside the food industry-

Gums and mucilages Have an expansion of programs inside the meals industry. Different gums have different uses like water retention And stabilization (guar and locust bean gum), stabilizers For ice-cream, meat merchandise and immediately pudding (carrageenanas), dairy, confectionary and meat merchandise (agar), confectionary, drinks, sponsored product, and Sauces (gum arabic, tragacanth , pectins, alginates and Xanthan gum)

Reference

1) J. L. Zatz and G. P. Kushla, "Oral aqueous suspensions and Gels," in Pharmaceutical Dosage Forms: Disperse Systems, M. M. Reiger and G. S. Banker, Eds., vol. 2, pp. 164–405, Marcel Dekker, New York, NY, USA, 1989.
2) G. K. Jani, D. P. Shah, V. D. Prajapatia, and V. C. Jain, "Gums and mucilages: versatile excipients for pharmaceutical Formulations," Asian Journal of Pharmaceutical Sciences, vol. 4, No. 5, pp. 309–323, 2009.
3) R. L. Whistler, "Drug-release retarding polymers are the key Performers," in Industrial Gums, Academic Press, London, UK, 2nd edition, 1996.
4) H. K. Kakrani and N. K. Jain, "A study on investigated as drug Retarding agents, each presenting a binding properties of guggal Gum," Indian Journal Hospital Different Approach to the Matrix System, vol. 18, Based on the Pharmacist, no. 3, pp. 100–102, 1981.
5) N. S. Bhunvara and M. L. Khorana, "Studies on usually classified Into three main groups: hydrophilic, suspending properties Of Hyprophilaspinosa. Hydrophobic and plastic," Hydrophilic Polymers are the Indian Drugs, vol. 22, pp. 500–502, 1985.
6) G. T. Kulkarni, K. Gowthamarajan, R. R. Dhobe, F. Yohanan, And B. Suresh, "Development of controlled release spheroids Using natural polysaccharide as release modifier," Drug Delivery, Vol. 12, no. 4, pp. 201–206, 2005.
7) Guo J, Skinner GW and Harcum WW: Pharmaceutical Application of naturally occurring water soluble Polymers. Pharmaceutical Science and Technology Today 1998; 1: 254-261.
8) The joint IPEC-PQG good manufacturing practice Guide for pharmaceutical excipients, Europe, 2006.
9) Tommasina C and Matricardi P: Polysaccharide Hydrogels for modified release formulations. Journal Of Controlled Release 2007; 119: 5-24.
10) Hamman JH and Tarirai C: Functional excipients. Chem Today 2006; 24: 57-62.

11) W. A. Ashton, M. Jefferies, R. G. Morley, G. Pass, G. O. Phillips, And D. M. J. Power, "Physical properties and applications of Aqueous solutions of Albiziazygia gum," Journal of the Science Of Food and Agriculture, vol. 26, pp. 697–704, 1975.
12) US National Academy of Sciences, Tropical Legumes, National
13) Academy of Sciences, Washington, DC, USA, 1979.
14) O. A. Odeku and J. T. Fell, "In-vitro evaluation of khaya and Albizia gums as compression coatings for drug targeting to the Colon," Journal of Pharmacy and Pharmacology, vol. 57, no. 2, pp. 163–168, 2005.
15) J. J. L. Jenita, K. Vijaya, R. Suma, and B. Raj, "Formulation And evaluation of compression coated tablets of mesalazine for Colon delivery," International Journal of PharmTech Research, Vol. 2, no. 1, pp. 535–541, 2010.
16) G. K. Jani and D. P. Shah, "Assessing Hibiscus rosa-sinensis Linn As an excipient in sustained-release tablets," Pharmaceutical Technology, vol. 32, no. 1, pp. 62–75, 2008.
17) A. B. Gangurde, S. S. Malode, and R. S. Bhambar, "Preliminary Evaluation of neem gum as tablet binder," Indian Journal of Pharmaceutical Education and Research, vol. 42, no. 4, pp. 344– 347, 2008.
18) A. H. Abdul, K. C. Suresh, B. A. Kumar et al., "Permeation Studies of diclofenac sodium from ficuscarica fruit mucilage Matrices for transdermal delivery," International Journal of ChemTech Research, vol. 2, no. 2, pp. 937–941, 2010.
19) M. R. Reddy, K. Manjunath. Pharmaceutical Applications Of Natural Gums, Mucilages and Pectins – A Review. International Journal of Pharmaceutical and Chemical Sciences, 2(3), 2013
20) Tommasina C and Matricardi P: Polysaccharide Hydrogels for modified release formulations. Journal Of Controlled Release 2007; 119: 5-24.
21) Koleng JJ, McGinity JW and Wiber WR: Handbook Of pharmaceutical excipients. Pharmaceutical Press, Edition 6, Edited by Raymond C Rowe, Paul J Sheskey and Marian E Quinn, 2009: 1-3
22) Girish K Jani, Dhiren P Shah, Vipul D Prajapatia, Vineet C Jain. Gums and mucilages: versatile excipients for Pharmaceutical formulations. Asian Journal of Pharmaceutical Sciences 2009, 4 (5): 308-322
23) Desai KG and Park HJ: Study of gammairradiation: Effects on chitosan micropartcles. Drug Delivery 2006; 13: 39-50.
24) Micard V, Belamri R, Morel M and Guilbert S: Properties of chemically and physically treated heat Gluten films. Journal of Agricultural Food Chemistry 2000; 48: 2948-2953.
25) Ofoefule SI and Chukwu A: Application of Abelmoschus esculents gum as a mini-matrix for Furosemide and diclofenac sodium tablets. Indian Journal of Pharmaceutical Science 2001; 63: 532-53
26) Vendruscolo CW, Andreazza IF and Ganter JL: Xanthan and galactomannan (from M. scabrella) Matrix tablets for oral controlled delivery of Theophylline. International Journal of Pharmaceutics 2005; 296: 1-11.
27) L. Osete-Cortina and M. T. Domenech-Carbo, "Analytical characterization of diterpenoid resins present in pictorial varnishes using pyrolysis-gas chromatography-mass spectrometry with on line trimethylsilylation," Journal of Chromatography A, vol. 1065, no. 2, pp. 265–278, 2005.
28) M. J. Umekar and P. G. Yeole, "Characterization and evaluation of natural copal gum-resin as film forming material," International Journal of Green Pharmacy, vol. 2, no. 1, pp. 37–42, 2008.
29) K. Venkaiah and J. J. Shah, "Distribution, development and structure of gum ducts in Lannea coromandelica (Houtt.) merril," Annals of Botany, vol. 54, no. 2, pp. 175–186, 1984.
30) B. S. Nayak, U. K. Nayak, K. B. Patro, and P. K. Rout, "Preparation and In Vitro evaluation of lamivudine entrapped MOI microspheres for oral administration," Research Journal of Pharmacy and Technology, vol. 1, no. 4, pp. 437–441, 2008.
31) B. Janaki and R. B. Sashidhar, "Subchronic (90-day) toxicity study in rats fed gum kondagogu (Cochlospermum gossypium)," Food and Chemical Toxicology, vol. 38, no. 6, pp. 523–534, 2000.

32) K. V. R. Murthy and G. S. V. Subramanyam, Design and Statistical Optimization of Hupu Gum Based Gastric Floating Drug Delivery Systems of Diltiazem HCl, American Association of Pharmaceutical Scientists, Atlanta, Ga, USA, 2008.
33) R. R. Krishna and T. E. G. K. Murthy, "Preparation and evaluation of mucoadhesive microcapsules of glipizide formulated with gum kondagogu: In vitro and in vivo," Acta Pharmaceutica Sciencia, vol. 52, no. 3, pp. 335–344, 2010.
34) N. C. Ngwuluka, B. A. Idiakhoa, E. I. Nep, I. Ogaji, and I. S. Okafor, "Formulation and evaluation of paracetamol tablets manufactured using the dried fruit of Phoenix dactylifera Linn as an excipient," Research in Pharmaceutical Biotechnology, vol. 2, no. 3, pp. 25–32, 2010.
35) P. L. Soni and R. Pal, "Industrial gum from. Cassia tora seeds," Trends in Carbohydrate Chemistry, vol. 2, pp. 33–44, 1996.
36) S. Singh, D. S. B. Bothara, and S. Singh, "Pharmaceutical characterization of Cassia tora of seed mucilage in tablet formulations," Scholars Research Library, vol. 2, no. 5, pp. 54– 61, 2010.
37) A. S. Mann, N. K. Jain, and M. D. Kharya, "Evaluation of the suspending properties of Cassia tora mucilage on sulphadimidine suspension," Asian Journal of Experimental Sciences, vol. 21, no. 1, pp. 63–67, 2007.
38) B. S. Nayak, U. K. Nayak, K. B. Patro, and P. K. Rout, "Design and evaluation of controlled release bhara gum microcapsules of famotidine for oral use," Research Journal of Pharmacy and Technology, vol. 1, no. 4, pp. 433–436, 2008.
39) K. Singh, A. Kumar, N. Langyan, and M. Ahuja, "Evaluation of Mimosa pudica seed mucilage as sustained-release excipient," AAPS PharmSciTech, vol. 10, no. 4, pp. 1121–1127, 2009.
40) I. S. Okafor, A. Chukwu, and K. Duala, "Somephysicochemical properties of grewia gum," Nigeria Journal of Polymer Science and Technology, vol. 2, no. 1, pp. 161–167, 2001.
41) E. Martins, I. Christiana, and K. Olobayo, "Effect of Grewia gum on the mechanical properties of Paracetamol tablet formulations," African Journal of Pharmacy and Pharmacology, vol. 2, pp. 1–6, 2008
42) E. I. Nep and B. R. Conway, "Polysaccharide gum matrix tablets for oral controlled delivery of cimetidine," Journal of Pharmaceutical Sciences and Research, vol. 2, no. 11, pp. 708–716, 2010.
43) I. Ogaji and I. S. Okafor, "Potential of Grewia gum as film coating agent: some physicochemical properties of coated praziquantel tablets," International Journal of Pharmaceutical Research, vol. 3, no. 2, pp. 16–19, 2011.
44) Y. I. Muzib and P. S. Kurri, "Formulation and evaluation of gum olibanum-based sustained release matrix tablets of ambroxol hydrochloride," International Journal of Pharmacy and Pharmaceutical Sciences, vol. 3, no. 2, pp. 195–199, 2011.
45) N. L. Prasanthi, S. S. Manikiran, and N. R. Rao, "In vitro drug release studies of ziprasidone from tablets using natural gums from biosphere," Archives of Applied Science Research, vol. 3, no. 2, pp. 513–519, 2011.
46) K. P. R. Chowdary, P. Mohapatra, and M. N. M. Krishna, "Evaluation of olibanum resin as microencapsulating agent for controlled drug delivery," Rasayan Journal of Chemistry ¯ , vol. 1, no. 1, pp. 99–104, 2008.