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A REVIEW ON NATURAL BINDERS

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ABSTRACT

Natural binders have emerged as promising alternatives to synthetic polymers in pharmaceutical formulations due to their safety, biodegradability, and cost-effectiveness. This review focuses on various natural binders derived from plant, animal, and microbial sources that are used in tablet formulation and drug delivery systems. Common examples include starch, guar gum, acacia, tragacanth, pectin, mucilage, and cellulose derivatives. The review discusses their sources, extraction methods, physicochemical characteristics, and binding mechanisms that influence tablet hardness, disintegration time, and drug release profile. Comparative studies indicate that several natural binders provide binding efficiency comparable to or better than conventional synthetic binders while minimising toxicity and environmental hazards. Moreover, recent advancements in the modification and characterisation of natural binders have expanded their application in novel drug delivery systems. Overall, natural binders represent a sustainable and effective option for modern pharmaceutical formulation, aligning with the current trend toward green and biocompatible excipients.

KEYWORDS: Natural binders, Gum, Mucilage, Pharmaceutical.

1. INTRODUCTION

Pharmaceuticals such as tablets, capsules, and syrups are administered to people to treat a variety of illnesses. However, a single medication component cannot effectively cure those conditions and demonstrate its therapeutic efficacy. For this reason, excipients should be used in pharmaceutical compositions. To hold the powder together and create granules, a binder is added to the tablet formulation. Tablet formulation uses natural polymers and binders due to their

low cost, low toxicity, biocompatibility, and ecologically benign production.[1] Binders are used in tablet formulations to increase the strength of the inter-particle bonding within the tablet by adding plasticity. New excipients for usage as binding agents in tablet formulations are continually being researched and produced. This is because different binding agents can be utilised to achieve varying drug release properties and tablet mechanical strengths for different pharmaceutical purposes.[2] Natural binders (polymers), mostly gum and mucilage, are hydrocolloids found in plants that are created when a plant is injured or when unfavourable circumstances cause the cell wall to break down.[3] Binders are liquid or dough-like materials that solidify chemically or physically and hold together fibre, filler powder, and other particles that are affixed to natural gum- based binders. In cooking, a variety of edible thickening agents are used as binders in a mixture of tablets compared to those that are typically composed of distinct ingredients. They frequently serve several purposes in contemporary pharmaceutical dosage forms, including modifying release, enhancing the stability and bioavailability of the active ingredient, and modernising the formulation to ensure patient acceptability and ease of manufacture. Because natural polymers can create a wide range of materials depending on their molecular weight and characteristics, they have been the subject of research in drug delivery systems.[4] Several excipients are utilised in the manufacture of solid dosage forms. In addition to many other categories, they comprise dyes, flavours, binders, emollients, fillers, lubricants, and preservatives. Excipients were traditionally used in drug formulations as inert vehicles to provide the weight, consistency, and volume required for the proper administration of the active ingredient. However, in contemporary pharmaceutical dosage forms, they frequently serve a variety of purposes, including modifying release, enhancing patient acceptability, improving the stability and bioavailability of the active ingredient, and ensuring ease of manufacture.[5] The most crucial binders are hydrophilic and frequently soluble in water. The binder is added to a dry mix, mixed during granulation, or added to a granulating liquid. The binder forms a matrix with fillers and drugs embedded within it, and when it dries solid, it forms glue that holds the particles together. Additionally crucial are the mechanical characteristics of the binder film; a quality tablet binder should provide flexibility and yield to bear the impact of elastic recovery without breaking.[6]

Polymers, both natural and manmade, have been studied in great detail. Some drawbacks of synthetic polymers include their high cost, toxicity, environmental contamination during synthesis, reliance on non-renewable resources, adverse consequences, and low patient compliance. However, as natural polymers are affordable, easily accessible, inexpensive, nontoxic, chemically modifiable, potentially biodegradable, and with rare exceptions, biocompatible, their usage in medicinal applications is appealing.[7] In the creation of pharmaceutical dosage forms, gums—which are often polysaccharides with a polymeric nature—are a common natural component derived from both woody and nonwoody plant Parts, including bark, seeds, sap, roots, rhizomes, fruit, and leaves. These compounds are amorphous and transparent, and they dissolve or partially dissolve in water. Alcohol and the majority of organic solvents do not dissolve them. Through swelling or absorption, they combine with water to generate viscous sticky solutions. Guar gum, tragacanth, gum acacia, gum karaya, and gum ghatti are significant gums in the pharmaceutical industry. Certain natural orders, such as the Leguminosae, Rosaceae, Combretaceae, and Sterculiaceae, are characterised by gums. Gums are generally employed in the printing, textile, paper, paint, confectionery, culinary, and pharmaceutical sectors, mainly as thickening agents or adhesives.[8] Plant gums, which are frequently polysaccharides with a polymeric character, are a popular natural element used in the production of pharmaceutical dosage forms. They are obtained from both woody and non-woody plant parts, such as bark, seed, sap, roots, rhizomes, fruit, and leaves. These compounds are amorphous and transparent, and they dissolve or partially dissolve in water. They are insoluble in most organic solvents and alcohol. Through swelling or absorption, they combine with water to generate viscous and sticky solutions.[9]

2. ADVANTAGES OF NATURAL BINDERS

a. They can modify drug release, which in turn affects the integrated medicines' absorption and bioavailability.
b. Natural binders are widely used as excipients and additives in the food and pharmaceutical sectors due to their low toxicity, affordability, accessibility, and biodegradability.
c. They act as vehicles that transport the combined drug to the absorption site, guarantee exact and accurate dosing, and improve the organoleptic properties of the drug. When necessary to increase patient loyalty.
d. Dosage forms should be tested during both the manufacturing process and patient administration.[9]
e. It has the capacity to alter drug release and affect drug absorption and bioavailability.[10]
f. They should maximise the dosage form's performance both during production and during patient ingestion.
g. All living things naturally make these polymers. They don't have any negative effects on people or the environment.[11]
h. All of those plant elements are naturally occurring carbohydrates made up of repeating monosaccharide units.
i. Compared to synthetic materials, they are less expensive and require less manufacturing.[12]

3. DISADVANTAGES OF NATURAL BINDERS

a. The inclusion of incorrect disintegrates is usually necessary when choosing polymer binders, but these are highly costly and have an adverse influence on the stability of the final product.
b. It can occasionally result in processing issues such as quick over-granulation, increases in tablet hardness, etc.
c. Natural polymers are dependent on the environment and other physical conditions, whereas synthetic polymers are manufactured using a controlled process with defined quantities.
d. The synthesis rate of natural polymers is slow because it depends on the environment and other factors.[9]
e. Strong disintegrants are usually needed when polymer binders are chosen; however, these are quite costly and have an adverse influence on product stability.
f. It can occasionally result in processing issues such as quick over-granulation, increases in tablet hardness, etc.[13]
g. Natural polymers are dependent on the environment and several physical parameters, whereas synthetic polymers are manufactured using a controlled process with defined quantities.
h. As the production rate depends on the environment and other factors, so natural polymers have a slow rate of production.[14]

4. CHARACTERISTICS OF AN IDEAL NATURAL EXCIPIENT

a. Non-irritating and non-toxic.
b. Simple to handle.
c. No adverse effects on medications or other ingredients in the formulation and packing.
d. Active in pharmaceuticals.[15]

5. SOURCES OF NATURAL BINDERS

Natural binders come from sources such as minerals, plants, animals, and even microorganisms.[16]

a. Plant sources: alginate, cellulose, sugar, and starch
b. Animal sources include stearic acid, lactose, and gelatin.
c. Sources of minerals: silica, phosphate, and calcium.

6. BINDERS USED IN PHARMACEUTICALS

a. Pharmaceutical excipients are typically used in the production of tablets, which are solid dosage forms. They can vary in size, shape, weight, hardness, thickness, dissolution and disintegration properties, and other factors based on their intended purpose and oral medication administration.

b. Binder excipients are designed to serve as an adhesive, essentially "binding together" powders, granules, and other dry ingredients to give the product the mechanical strength it needs. They can also add volume to tablets with a low active dose. Binders are commonly used in wet granulation to make granule formation more effective and predictable.

c. Binders are categorised based on their intended use. Gelatin, cellulose, cellulose derivatives, polyvinyl pyrrolidone, starch, sucrose, and polyethylene glycol are examples of solution binders that dissolve in a solvent. Binders are the substances that give the granules cohesion or adherence. This guarantees that the pill will not break when crushed, in addition to the flow characteristics provided by the formation of granules of derived hardness and size.

d. The Dioscorea rotundata genus has compressional qualities and is used as a binder and disintegrant in pill production. The impact of plantain and columbiform bird pea starches on the mechanical, disintegration, and compressional characteristics of paracetamol tablets is investigated.

e. It has been demonstrated that Starch 1500 works well as a binder and produces compressible granulation. To promote granules or cohesive compactness during direct compression, dry powders or liquids are added to wet granulation. It provides mechanical power to the tablet. There are two types of binders: liquid and powder.

f. Cellulose, methyl cellulose, polyvinyl pyrrolidine, and PEG are examples of powder binders; gelatin, PVP, HPMC, PEG, sucrose, and starch are examples of solution binders. The following methods can be used to add binder to the formulation: powdering the binder before wet agglomeration to guarantee uniform dispersion. It functions as an agglomeration solvent in solution form during wet granulation. We call it a liquid binder. Until it is compacted into a dry powder and combined with additional components (either tabletting or slugging). We call it a dry binder.

g. For wet granulation, natural binders like acacia and tragacanth are added as powder for direct compression, or they can be employed alone (or in combination) in solution at a
concentration of 10– 25%. In direct compaction, polymers like MC and HPMC are utilised as dry powders, and in solution, they function as potent binding and adhesive agents. HPMC and ethyl cellulose are both suitable anhydrous adhesives for use in alcoholic solutions.

h. The substance required to maintain the tablet preparations' strong structure during the production process before packaging is known as the binding agent, or binder. The tablet's ability to form interparticle bonds can be strengthened by the binding agent. By enhancing the granule flow characteristics, the binding agent makes it possible to formulate granules with the appropriate hardness and scale. These binding agents include things like starch paste, polyvinyl pyrrolidone, gelatin, acacia, carboxymethyl cellulose, and povidone.

i. In the production of novel pharmaceutical products, paste formulations that contain the original maize starch have long been employed as binding and dissolving agents. Different binding agents may result in tablets with varying mechanical strengths and drug release characteristics, depending on the intended usage. The pharmaceutical industry frequently uses natural polysaccharides as excipients because of their low toxicity, cost, biodegradability, and safety.When gelatin is mixed with acacia or used by itself, it produces a more potent binding agent than the two natural polymers previously discussed. In direct compaction, polymers like MC and HPMC are utilised as dry powders, and in solution, they function as potent adhesives and binding agents. In alcoholic solutions, ethyl

cellulose and HPMC can be employed as anhydrous adhesives.

j. The pharmaceutical industry frequently uses natural polysaccharides as excipients because of their low toxicity, cost, biodegradability, and safety. In addition to serving as binding agents, starch, mucilage, gum, and dried fruits have a variety of other uses, including disintegrants, fillers, and sustained release. They are also used to modify drug release to influence the bioavailability and absorption of the additional drug, serving as a medium for delivering the medication integrated into the absorption site, as well as guaranteeing dosage accuracy and precision, stability, and improving the drug's organoleptic qualities, all of which increase patient compliance.[4]

Table 1: Natural binding agents and their uses.[17]

Product	Type	Use
Accroides	Resin	Binder in fireworks and flares.
Candelilla	Wax	Binder in chewing gum.
Guar	Gums	Binder in baking, meat and tablets.
Gum Arabica	Gums	Binder in baking, cosmetics, incense, photography, Water colour paints, ceramic glazes and fireworks.
Karaya	Gums	Binder in baking and paper manufacturing.
Shellac	Shellac	Binder in mascara, eyeliners, fireworks and pyrotechnics.
Tragacanth	Gums	Binder in icing, tablets, incense and pastel paints.
Xanthan	Gums	Binder in baking, laxatives and toothpaste.

7. EXTRACTION OF DIFFERENT BINDING AGENTS

a. Extraction Of Pectin From Citrus Fruit Peel

Distilled water was used to dissolve the necessary amount of powdered dried citrus fruit peel.[18] Since the extraction water should be acidic by nature, it should be acidified using any acidic medium, such as citric acid, with a pH of 1.2. After that, the resulting acidified mixture was added to the peel combination, and the mixture was heated for a total of 60 minutes and 120 minutes. Following the heating phase, the resultant mixture is either treated with ethanol or ethyl alcohol while being continuously stirred for up to 15 minutes. After two hours, the mixture is set aside, and the precipitation is filtered off. Once the precipitate has dried out, it is ready.[19]

b. Starch 1500 As A Binding Agent

Starch 1500 works well as a binding agent in a variety of medicinal formulations. It functions as a powerful disintegrant for tablets that dissolve in the mouth or that are disposable and release their active ingredient quickly. The hardness and friability of tablets are enhanced by the starch 1500 in contrast to povidone, which is also a super disintegrant.[20] The disintegration and dissolution performance of the povidone formulation, which uses a super disintegrant, was surpassed by the formulation of Lamivudine tablets with starch 1500.[21]

c. Extraction Of Tapioca Starch As A Binding Agent

This natural binder is mostly utilised in the manufacturing of Diclofenac tablets. Starch, which is frequently utilised in extraction, makes up 25% to 32% of fresh tapioca roots. During the extraction procedure using a tapioca starch manufacturing machine, the raw cassava tubers were first uprooted and cleaned. Next, the rasper, which mostly grinds cassava into pulp, received the fresh cassava. The pulp is then sent to a screening machine to separate the fibers and starch. The screening machine is equipped with a device to gather the pulp's extracted starch. The dewatering machine is used to dry the slurry. Starch that satisfies commercial needs is produced when the moisture content is reduced.[22,23]

d. Extraction Of Gum Okra Fruit As A Natural Binder

It functions as a naturally occurring binder and contains gum that forms a viscous mucilage. It primarily comes from the okra plant's pods. The potential of okra gum derived from conventional extraction as a tablet for film coating. Okra pod powder was mixed with demineralised water and heated to 80 degrees for 30 minutes while sodium chloride was present. The mixture was then freeze-dried after being filtered in a centrifuge set at 4000 rpm for 30, 60, and 120 minutes. After that, the gum was vacuum-filtered and desiccator- dried.[24]

e. A Potential Natural Tablet Binders From Grewia Optiva

The mucilage was isolated from the bark of Grewia Optiva. The gum mucilage obtained from the Grewia Optiva has superior rheological properties.[25] The dissolution, disintegration and hardness of the tablet increase with an increase in the concentration of gum mucilage. The Grewia Optiva is cheap, economical, and easily available and also suitable for use as pharmaceutical tablet binders.[26]

8. NATURAL GUM AND MUCILAGE AS A BINDER

High molecular weight carbohydrates that are biodegradable, non-hazardous, and biocompatible make up natural polymers.[27] They have environmentally friendly qualities. Natural gums are plant hydrocolloids that are created when a plant is injured or when unfavourable circumstances, such as drought, cause the cell walls to break down.[28] Higher plants develop these translucent, amorphous compounds as a post-injury defence.[29] Their makeup varies widely. They produce a thick, sticky solution when dissolved in water. A combination of sugars and uric acids can be obtained by hydrolysing gums for an extended period of time with diluted acids.[45-49] Trees and shrubs belonging to many families, particularly the Rutaceae, contain them. Mucilages are naturally occurring byproducts of metabolism that are created inside plant cells and could indicate.[30]

Table 2: Application of Gum and Mucilages as Binders.

Common name	Botanical name	Family	Pharmaceutical application	Reference
Neem gum	Azadirachta indica	Meliaceae	It is used as a binder, suspending agent and Transdermal film- forming agent.	31
Guar gum	Cyamopsis tetragonoloba	Leguminosae	It is used as an emulsifier, binder and disintegrant.	32-33
Gum ghatti	Anogeissus latifolia	Combretaceae	It is used as a binder, emulsifier and suspending agent.	33
Albizia gum	Albizia gummifera	Fabaceae	It is used as a tablet binder.	34-35
Mango gum	Mangifera Indica	Anacardiaceae	It is used as a tablet binder.	36
Fenugree mucilage	Trigonella foenum-graecum	Fabaceae	It is used as a gelling agent. It can also be used as a disintegrant, table binder, sustaining agent, emollient and	37-38
Cassiator mucilage	Senna tora	Fabaceae	It is used as a granulating agent, binding agent, and suspending agent.	39-40
Phoenix mucilage	Phoenix dactylifera L.	Arecaceae	It is used as a binder.	41
Dendrophthoe Mucilage	Dendrophthoe falcata	Loranthaceae	It is used as a binder.	42
Cordia mucilage	Assyrian plum	Boraginaceae	It is used as a tablet binder and emulsifier.	43-44

(A) Neem Gum

(B) Guar Gum

(C) Gum Ghatti

(D) Albizia Gum

(E) Mango Gum

(F) Fenugreek Mucilage

Fig 1: (A) NeemGum, (B) Guar Gum, (C) Gum Ghatti, (D)Albizia Gum, (E) Mango Gum, (F) Fenugreek Mucilage.

(A) Cassia Tora Mucilage

(B) Pheonix Mucilage

(C) Dendropthoe Mucilage

(D) Cordia Mucilage

Fig 2: (A) Cassia Tora Mucilage, (B) Pheonix Mucilage, (C) Dendropthoe Mucilage, (D) Cordia Mucilage.

CONCLUSION

Natural binders play a vital role in pharmaceutical formulation by enhancing the mechanical strength, stability, and performance of tablets while ensuring safety and biocompatibility. Their renewable nature, non-toxicity, and low cost make them suitable substitutes for synthetic binders, which often pose issues related to toxicity and environmental impact. Research indicates that natural binders such as starch, gum acacia, pectin, mucilage, and cellulose derivatives can provide comparable or superior binding properties when properly processed and characterised. However, variability in source, composition, and performance remains a key challenge that requires standardisation and optimisation. Continued research into modification techniques and formulation compatibility can further enhance their functional properties and broaden their application in advanced drug delivery systems. Overall, natural binders represent a sustainable, efficient, and eco-friendly approach for the future of pharmaceutical development. The growing demand for sustainable and biocompatible excipients opens vast opportunities for the development of natural binders in pharmaceutical formulations. Future research should focus on standardising extraction and purification methods to minimise variability in natural materials. Advanced modification techniques such as cross-linking, grafting, and nano-formulation can be explored to enhance the binding efficiency, stability, and controlled release properties of these binders. Additionally, interdisciplinary studies integrating pharmaceutical sciences with biotechnology and materials engineering can help design novel hybrid binders with tailored functionalities. The establishment of comprehensive

regulatory guidelines for natural excipients will further promote their acceptance in the global pharmaceutical industry. Overall, the future of natural binders lies in innovation, standardisation, and sustainable utilisation, paving the way for eco- friendly and patient-safe drug delivery systems.

REFERENCES

1. Natural Binders: A Review Sneha Parbin, Rehan Baruah, Izaz Hussain, Abdul Hadi Umam, May-June 2023; 8(3): 1823-1829.
2. A current review on natural binders used in pharmaceuticals S Gunasekaran, Sutharsan T., 2021; 6(4): 800-806.
3. Purification and modification of Cordia myxa gum to enhance its nutraceutical attribute as a binding agent Muhammad Farrukh Tahir, Shazia Anwer Bukhari, Fozia Njum, Muhammad Qasim, Haseeb Anwar, and Syed Ali Raza Naqvi.
4. A Review on Natural Binders used in Pharmacy Anushka*, Dr Shiv Garg, Dr Piyush Sharma, Mrs Bhawana Sharma, April 2023; 10(4).
5. Varshosaz J, Tavakoli N, Eram SA. Use of natural gums and cellulose derivatives in the production of sustained release Metoprolol tablets. Drug Deliv, 2006; 13: 11319. 3
6. Panda DS, Choudhury SK, Yedukonalu SS, Guptha R. Evaluation of gum Moringa oleifera as a tablet binder and release retardant in tablet formulation. Ind. J. Pharm, 2008; 70(4): 614-618.
7. Dutta AC. Botany. 6th edition. Calcutta: Oxford University Press, 1995; 134.
8. Evans WC, Trease and Evans: Pharmacognosy. 14th Edition. Harcourt Brace & Co., Asia Pvt. Ltd: Singapore, 1996; 196, 208, 209, 213-15, 462, 555.
9. A Review on Exploring Natural Binders for Tablet Formulation in Pharmaceutical Dr Y. Venkat Veerendranadh, B. Ranjitha, K. Srivalli, K. Kalyani, K. Thriveni, B. Poojitha Int. J. of Pharm. Sci., 2025; 3(9): 1910-1916.
10. A Review on Natural Binders used in Pharmacy Subhashish Debnath, C. Navya Yadav, N. Nowjiya, M. Prabhavathi, A. SaiKumar, P. Sai Krishna, M. Niranjan Babu.
11. Extraction of pectin from citrus fruit peel and use as a natural binder in paracetamol tablets, Nilesh. R. Khule*, Nitin B. Mahale, Dipak S. Shelar, Manisha M. Rokade.
12. Isolation and Characterisation of Binding Agent from Black Gram Abhishek Soni, Ojasvi Gupta*, Hemant Kumar Verma, Dr Amit Chaudhary.
13. Studies on Ocimum gratissimum seed mucilage: Evaluation of binding properties B. Anroop a, B. Ghosh b, V. Parcha c, S. Vasanti a.
14. Formulation and Evaluation of Ibuprofen Tablets Using Gum of Anacardium occidentale as Binding Agent Suja C Jayan*, Navaneet Krishna Manoj, Neethu Chacko, and Sheena. K. K.
15. Formulation and evaluation of ibuprofen tablets using orange peel pectin as a binding agent, Sarath. S. Menon, B. V. Basavaraj*, S. Bharath, R. Deveswaran and V. Madhavan.
16. Aqueous tape casting of alumina using natural rubber latex binder Rakesh Krishnan P.P., Sujith Vijayan, Praveen Wilson, P. Arun Kumar, K. Prabhakaran
17. A Review on natural binders Subhashis Debnath*, C. Navya Yadav, N. Nowjiya, M. Prabhavathi, A. SaiKumar, P. Sai Krishna, M. Niranjan Babu
18. HK Kunjwani, AM Manikrao, Rajesh KS, Sable VP, NH Indurwade. Natural Gums as Matrix and Coating Material for Colon-Specific Drug Delivery. Research J. Pharm. And Tech, 2009; 2(4): 705-709.

19. Baldwin PM. Starch-granule associated proteins and polypeptides: a review Starch/Starke 2001; 53:475-503.
20. Bechtel DB and Wilson J. Variability in a starch isolation method and automated digital image analysis system used for the study of starch size distributions in wheat flour. Cereal Chem, 2000; 77: 401–5.
21. Poonam Yadav, Parijat Pandey, Sonia Parashar, Neeta. Pectin as Natural Polymer: An Overview. Research J. Pharm. And Tech, 2017; 10(4): 1225 1229.
22. Brocklehurst, P. A., and Evers, A. D. The size distribution of starch granules in endosperm of sized kernels of the wheat cultivar Mans Huntsman. J. Sci. Food Agric, 1977; 1084-89.
23. Olayemi O, Oremeyi J. Preliminary evaluation of Brachystegiaeurycoma seed Mucilage as tablet binder. International Journal of Pharmaceutical Research and Innovation, 2011; 3(1): 01–06.
24. Gum and mucilages: versatile excipients for pharmaceutical formulations. Asian Journal of Pharmaceutical Sciences, 2009; 4(5): 308– 322.
25. Sarojini S, Manavalan R. Effect of natural almond gum as a binder in the formulation Sarojini S, Manavalan R. Effect of natural almond gum as a binder in the formulation.
26. Choudhary PD, Pawar HA. Recently investigated natural gums and mucilage as pharmaceutical excipients: An overview. Journal of Pharmaceutics, 2014; 1(1): 01– 09.
27. Alebiowu, G. Steeping Period influence on physical, compressional and mechanical properties of tapioca starch J. Pharm. Res, 2007; 6: 139-144.
28. Alanazi FK, Ibrahim M, Bagory E, Ibrahim AA, Mohsen AB, Moustafa AA. Saudi corn starch as a tablet excipient compared with imported starch, Saudi Pharm. J., 2008; 16: 117-21.
29. Alebiowu G. Assessment of tapioca starches obtained after different steeping periods as binders in a paracetamol tablet formulation, Farmacia, 2010; 58: 341- 52.
30. Awen BZ, Chandu BR, Katakam P, Dasari V, Peraman R. Exploitation of gum olibanum as a novel natural binding agent in the designing of oral furosemide formulation, J. Chem. Pharma. Sci, 2010; 3: 71-4.
31. Prajapati VD, Jani GK, Moradiya NG, et al. Pharmaceutical applications of various natural gums, mucilages and their modified forms. CarbohydrPolym, 2013; 92(2): 1685–1699.
32. Caprita R, Adrian C, Calin J. Biochemical aspects of non–starch polysaccharides. Animal Sciences and Biotechnologies, 2010; 43(1): 368– 375.
33. Braja P. Evaluation of binder's efficiency of different natural gums in the tabletting process. Scholar Research Library, 2010; 2(4): 429–431.
34. Tadesse W, Desalegn G, Alia R. Natural gum and resin bearing species of Ethiopia. Invest Agrar: Sist Recur For, 2007; 16(3): 211–221.
35. Aditya KJ, Mousumi D, Arnab DE, et al. Determination of efficacy of a natural tablet Binder: Characterisation and in vitro release study. Asian Journal of Pharmaceutical and Clinical Research, 2014; 7(3): 164–168.
36. Bahlul. Exploitation of gum olibanum as a novel natural binding agent in the design of oral furosemide formulations. Journal of Chemical and Pharmaceutical Sciences, 2010; 3(1): 71– 74.
37. Amelia MA, Rakesh RD, Shilpa NS. Recent investigations of plant-based natural gums, Mucilages and resins in novel drug delivery systems. Indian Journal of Pharmaceutical Education and Research, 2011; 45(1): 86–99.
38. Ademoh NA. Natural honey and Nigerian gum arabic as composite binder for expendable Foundry cores. AU Journal of Technology, 2011; 15(2): 70–76.
39. Maheshwar G, Hogade. Evaluation of binding properties of aeglemarmelos fruit mucilage, Journal of

Pharmaceutical Sciences and Technology, 2011; 3(11): 739– 743.

40. Maheshwar G, Hogade. Evaluation of binding properties of aeglemarmelos fruit mucilage, Journal of Pharmaceutical Sciences and Technology, 2011; 3(11): 739– 743.
41. Singh. Pharmaceutical characterisation of cassia tora seed mucilage in tablet formulations, Scholar Research Library, 2010; 2(5): 54–61.
42. Vijay J Kumar, O. P. Sati and Ranjit Singh. A potential natural tablet binder from Grewia Optiva, 2011; 3(3): 120-127.
43. Tavakoli N, Ghassemi DN, Teimouri R, Hamishehkar H., Characterisation and evaluation of Okra gum as a tablet binder. Jun. J. Natural Pharm. Prod, 2008; 3: 33-8.
44. Anoop Kumar Singh, Vipul Kumar Shingala, R. Panner Selvam, T. Sivakumar. Evaluation of Mangifera indica gum as tablet binder, 2010; 2(3): 2098-2100.
45. Badhe, N., Maniyar, S., Kadale, P., Kale, R., Bhagwat, A. and Doke, R.R., Advancements in nanotechnology for glaucoma detection and treatment: A focus on biosensors, IOP monitoring, and nano-drug delivery systems.
46. Gandhi, B., Bhagwat, A., Matkar, S., Kuchik, A., Wale, T., Kokane, O. and Rode, N., 2025. Formulation and Evaluation of Bilayer Tablets of Atenolol and Amlodipine for the Treatment of Hypertension. Research Journal of Pharmacy and Technology, 18(5): 2037-2042.
47. Bhagwat A, Lokhande A, Pingat M, Doke R, Ghule S. Strategies and Mechanisms for Enhancing Drug Bioavailability through Co-Amorphous Mixtures-A Comprehensive Review. Research Journal of Pharmacy and Technology, 2025; 18(1): 409-14.
48. Bhagwat A, Tambe P, Vare P, More S, Nagare S, Shinde A, Doke R. Advances in neurotransmitter detection and modulation: Implications for neurological disorders. IP Int J Comprehensive Adv Pharmacol, 2024; 9(4): 236-47.
49. BHAGWAT, Ajay, et al. Development of Nanoparticles for the Novel Anticancer Therapeutic Agents for Acute Myeloid Leukemia. Int J Pharm Sci Nanotechnol, 2023; 16(4): 6894-906.