Journal of Textiles, Coloration and Polymer Science

https://jtcps.journals.ekb.eg/

Natural Thickener in Textile Printing

Sara. A. Ebrahim [a], Ahmed G. Hassabo [b]* and Hanan A. Osman [a]

[a] *Textile Printing, Dyeing and Finishing Department, Faculty of Applied Arts, Benha University, Benha, Egypt.*

[b] *National Research Centre (Scopus affiliation ID 60014618), Textile Industries Research Division, Pre-treatment, and Finishing of Cellulose-based Textiles Department, 33 El-Behouth St. (former El-Tahrir str.), Dokki, P.O. 12622, Giza, Egypt.*

THE USE of synthetic thickeners in the printing industry has several negative environmental consequences. As a result, in this study, we emphasized the use of various eco-friendly natural gums as thickeners to reduce the environmental impact. Fundamentally, printing is a type of colorings in which the colors are applied to specific areas of the fabric instead of the entire fabric. The resulting multicolored patterns have beautiful and artistic effects, increasing the value of the cloth above that of plain dyed cloth. The coloring matter is pasted with the help of a thickening agent to relegate it to the design area. Correct color, sharpness of mark, levelness, good hand, and efficient use of dye are all required for a successful print.

Keywords: Textile printing, Natural thickener, Gums.

Introduction

Textile printing is a branch of the textile wet processing industry that is quickly becoming a popular technique for all fibers, fabrics, and garments. Fundamentally, printing is a type of colorings in which the colors are applied to specific areas of the fabric instead of the entire fabric. The resulting multicolored patterns have beautiful and artistic effects, increasing the value of the cloth above that of plain dyed cloth. The coloring matter is pasted with the help of a thickening agent to relegate it to the design area. Correct color, sharpness of mark, levelness, good hand, and efficient use of dye are all required for a successful print. All of these variables are affected by the type of thickener used [1]. Thickeners have long been the main ingredient in textile printing pastes. They have a high molecular weight, a high viscosity in an aqueous medium, good storage, a long hydration time comparable to other printing paste materials, and are colorless. They offer print paste plasticity and stickiness, as well as the ability to add designs without bleeding. Printing pastes' primary purpose is to catch, adhere, and move dyestuff to the appropriate cloth. Various well-known synthetic and natural thickeners have been used. There are four important approaches to produce thickeners: to provide the requisite viscosity to the print paste, to bring the printing ingredients into the fabric surface, and to avoid premature contact between the printing ingredients. Low concentration of polymers with a high molecular weight. Materials with a high concentration but low molecular weight. Two immiscible fluids are emulsified.[2]

Attractive properties of thickeners affect the consistency of printing paste: Stability of printing paste in terms of storage, strain, and temperature The properties of the dry film that has been made, Impact on the yield of color, Simplicity of preparation removing the fabric from the surface Low cost and easy to obtain It's simple to get rid of by washing it after it's dried. The distribution of printing paste is homogeneous, Effects on the climate Printing styles and techniques, the fabric that was used Compatibility and stability with a variety of printing ingredients, such as dyes and auxiliaries Develop sharp outlines that don't bleed or spread, to keep the dry film from dusting, it should have good mechanical properties, to get the most out of your paint, make sure you have strong diffusion, Condensed water absorbs well, Condensed water absorption is good to ensure that dye and water molecules can penetrate the fibers, It's not sup-

Corresponding author: Ahmed G. Hassabo, Email: aga.hassabo@hotmail.com, Tel.: +20 110 22 555 13
(Received 25/03/2021, accepted 18/04/2021)
DOI: 10.21608/jtcps.2021.69482.1051

posed to retain the colorants or keep it away from the fabric. To avoid spreading and wetting, allow plenty of time to dry. To avoid "fish-eyes," clarity and good solubility are needed. [1]

Definition

Thickeners are thick materials that give printing pastes gumminess and plasticity, allowing them to be applied to cloth surfaces with precise design outlines and without bleeding or scattering. [1] Thickeners are viscous pastes used in textile printing that are made up of either high molecular weight polymer solutions or liquid phase emulsions. Chemicals used to come from several chemical groups. At low concentrations, unbranched polymers create viscous solutions, but as tensile increases, the viscosity decreases. [2]

Classification of thickener

Emulsions

Emulsions are created by dispersing oil in water and water in oil. As water-in-oil emulsions with a high Dissolved solid, their use pollutes wastewater with badly biodegradable or non-biodegradable hydrocarbons. Mineral oils are deposited in water treatment plants' wastewater and degraded in very small amounts by microbes. Because both phases of the thickener are volatile and have no effect on handle or fastness, the use of emulsified thickeners (o/w type) results in excellent fastness properties, a high degree of cleverness, sharp outlines, and a smooth handle in the printed fabric. The presence of large amounts of white spirit has three major drawbacks that limit its use in many countries: the risk of explosion during fabric drying if the airflow is inadequate, environmental pollution, and increased costs due to rising oil prices and a declining availability of oil products. [3]

Synthetic thickeners

Synthetic thickeners are long-chain polymers with partly cross-linked carboxylic groups. The compounds have the potential to swell dramatically in water and form high viscosity gels when neutralizing [2]. Synthetic polymers such as polyvinyl alcohol, polyvinyl pyrrolidine, polyacrylic acid, and polyacrylamide are used to make them. They are the products of the polymerization of their respective monomers. In comparison to natural and semi-synthetic goods, they are typically very costly. The main benefit of synthetic thickening agents is that they can be tailored to a specific situation. [1]

Natural thickeners

Natural thickeners are polysaccharides obtained from natural sources such as plant exudates, seaweeds, seeds, and roots are widely used. Some of them are suitable for prints using a specific dye category, but they must be chemically customized to meet the printing requirements.

The following are the most effective natural thickeners

a) Starch and its derivatives
b) Soluble Cellulose derivatives
c) Gums

are formed from seeds or roots of plants such as guar gum [1] (Guar gum is an organic gum that is obtained from the Guar seeds and is an organic thickening agent. Guar beans have a thick endosperm that contains galactomannan gum, which gels in water. Guar gum, as it is popularly called, is widely used in food and industrial applications). [2]

Extracts of seaweeds such as Alginate (Sodium alginate thickeners, unlike starches and gums, do not chemically bind with the fabric's structure or interfere with the fiber reactive dye. Many benefits of sodium alginate include good permeability, uniform color, ease of washing, lack of sticking to the cylinder and scraper, soft hand feel, good plasticity. [2]

Modified natural thickeners

Semi-synthetic thickening agents are natural thickeners that have been modified. These are created by using chemical, physical, and thermal methods to alter cellulosic materials, starch, and gums. Recently, modified polylactic acid was used as a thickening agent. Biodegradable materials are regarded as one of the most important areas of materials science. Polylactic acid, polyglycolic acid, and polycaprolactone are only a few examples of biodegradable polymers. This is due to their intrinsic and important renewable properties, such as transparency, good film-forming properties, high-quality thermal stability, and good mechanical and processing properties, as well as other significant properties such as biocompatibility and biodegradability. [1]

A natural or synthetic polymer can be used as a thickener. The use of man-made thickeners in the printing industry has several negative environmental consequences. However, this effect can be mitigated by substituting eco-friendly natural thickeners for synthetic ones. The sources of natural thickeners are widely distributed across the plant kingdom and are widely available. Natural thickener constituents are non-allergic and non-toxic to humans, posing no health risk. The most important requirement for thickeners in textile printing is that they be either soluble in water or absorb water to form viscous solutions. [1]

Extraction of endosperm from seeds

The hull and cotyledons are removed mechanically, physically, or chemically to obtain endosperm. Extracting gum from P juliflora seeds in water overnight at room temperature, removing the hull and germ by filtration Gum was extracted from the filtrate by precipitating it in ethanol, then drying it at 45 degrees Celsius and milling it. In the case of a chemical method, whole seed treatment with acid at high temperatures to carbonize the hull, which was then washed off. Sodium hydroxide treatment of P chilensis seeds manually separating the hull, endosperm, and cotyledons at high temperatures. [4]

Polysaccharides are monosaccharide polymers. It is derived from a variety of natural sources, including plant sources (like pectin and guar gum), microbial sources (such as alginate, dextran, and xanthan gum), and animal sources (chitosan and chondroitin). Polysaccharides have a wide range of molecular weight and a complex chemical composition which contribute to diversity in their property. Polysaccharides can be effectively chemically and biochemically modified due to the presence of distinct derivable groups on molecular chains, resulting in a wide range of polysaccharide derivatives. [5-8]

Polysaccharides are a type of carbohydrate that is highly complicated. They have excellent mechanical strength and can be used to make fibers, films, adhesives, rheology modifiers, hydrogels, emulsifiers, and drug delivery agents. Some polysaccharides, for example, have been shown to improve drug-human mucosa contact due to their high mucoadhesive properties. Seed endosperm is a hydrogel composed of polymers, primarily polysaccharides that are released by seed coat epidermis upon imbibition. Myxospermy is a feature found in several plant species, such as Arabidopsis thaliana (Arabidopsis), where the paste is composed of two layers. [4]

Natural gums

Natural gums are hydrophobic compounds that are primarily obtained from natural or microorganisms. Because the gum molecules are biological in origin, there is a significant difference in the linear chain length, branching features, and molecular weight. Natural gums hydrolyze to form a mixture of xylose, arabinose, galactose, mannose, and ironic acids, among others. Gums are classified into two types based on their origin: (a) plant exudate gum (including gum karaya, salai gum, and Arabic gum), and (b) seed gum (including guar gum, locust bean gum, and tamarind gum) (c) microbial gum (xanthan gum, gallant gum, and dextran gum) and (d) marine gums (e.g., Alginic acids).[9-12]

Galactomannan gum in textile printing

Important sources of galactomannan

Leguminous plants provide the majority of the seeds of gum. Water solubility is primarily determined by the endosperms of seeds. Galactomannan polysaccharides are extracted from the endosperm of plant seeds or microbial sources, specifically yeast and fungi Galactomannan has been found in non-leguminous seeds of few other species, including coffee arabica, Cocos Nucifera, phoenix dactylifera, Elaeis guinensis, phytelephas macrocarpa, and others. in a few exceptional cases, specifically glycine max, coat, and kernel. [13-16]

Natural function

The endosperm, the reserve source of plant polysaccharides, serves two physiological functions: on the one hand, it serves as a food reserve for seed germination, and on the other, it maintains H_2O by solution and thus inhibits complete drying of seeds, while also avoiding protein denaturation, particularly denaturation of enzymes essential for seed germination. [13, 14]

Galactomannan is neutral polysaccharides consisting of a linear mannan backbone with single galactose residue side chains. They are normally extracted from Leguminosae seed endosperm, which is protected by the seed coat. [4] Galactomannan is water-soluble polysaccharides found in a variety of endospermic leguminous seeds. Galactomannan is a polysaccharide that is non-toxic and biodegradable. The endosperm of leguminous seeds is made up of galactomannan, but it also contains proteins, crude fiber, and fat, which must be separated through an extraction process. Galactomannan is typically produced by extracting endosperm powder. [3, 17, 18]

Extraction

Galactomannan can be extracted using one of two methods: alcohol precipitation. The former entails extracting water and then precipitating it with ethanol and the latter involves complexation with Cu^{2+} and Ba^{2+} salts followed by ethanol precipitation. The endosperm, hull, and embryo make up the majority of the oval seeds. With a light microscope, galactomannan growth in leguminous plants has been split into 4 widely spaced stages: embryo growth, galactomannan deformation, late galactomannan deposition, and galactomannan maturation. And the specific time for each phase of development varies greatly depending on the species and growth environment of leguminous plants. [17, 19-21]

Polysaccharides were extracted in duplicate from Astragalus gombos seeds. Dry seed powder was dispersed in deionized water (1/75 (w/w)) for 2 hours with reflux and agitation. The water extract was then centrifuged and the supernatant was filtered through the following filters: (i) a fine mesh strainer for removing macroscopic insoluble, and (ii) a sintered glass filter with a porosity of 3 (16-40 m).

Using a rotary evaporator, the filtrate was concentrated by ten times under reduced pressure. The solution was cooled in an ice bath to 4°C before adding the trichloroacetic acid solution to precipitate and collect proteins.

Finally, polysaccharides were recovered from the supernatant after alcoholic precipitation using 3 volumes of cold ethanol (96 %). After centrifugation, the pellet was washed with acetone and filtered under vacuum on a sintered glass filter with porosity 2. This crude polysaccharide fraction was dried overnight, crushed into a fine white powder, and labeled PSG. [22-26]

Structure and property of plant galactomannan gums

Polysaccharide's basic element is a simple monosaccharide. In particular, the physical and mechanical characteristics, modifying approaches, and applications of plant galactomannan gums can be evaluated by degrading polysaccharides into monosaccharides. Together with the advancement of inspection and analysis technology, the new technology will be applied to polysaccharide structure analysis.

Figure 1 shows typical structures of locust bean gum and tara gum with the linear main chain of β-(1→4)-linked mannose units and side chains of α-(1→6)-linked galactose unit. [26]

Polysaccharide gums have rheological properties as well. Guar gum is pseudoplastic in an aqueous solution. As the shearing action increases, the viscosity decreases, which becomes more apparent as the polymer concentration and molecular

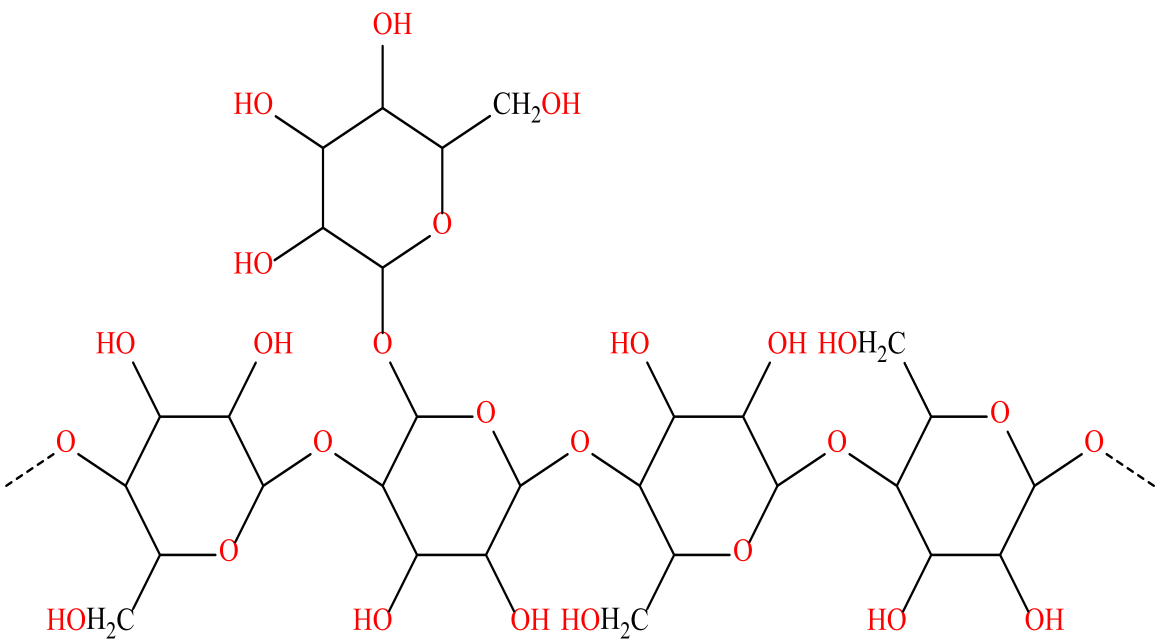

Fig. 1. structures of locust bean gum and tara gum

weight increase. Aqueous solutions of guar gum at 1% concentration exhibit typical macromolecular biopolymer behavior. [19]

Modification of plant galactomannan gums

Several methods for modifying plant galactomannan gums have been investigated. Plant galactomannan gums contain a large number of active hydroxyl groups in their galactomannan molecules. Chemical and enzymatic methods are the two most common methods of modification. The hydroxyl groups could be changed by etherification, esterification, or oxidation reactions using certain chemicals. Galactose side chains or fracturing the mannose main chain could be removed using an enzymatic method. [19]

Chemical modification

We can introduce hydrophilic groups into galactomannan molecules and decrease the hydrogen bond between both the molecules through chemical modification, increasing galactomannan gums' solubility, hydrophobicity, and swelling speed. Simultaneously, the amount of water-insoluble substance is reduced, and the clarity of the gums is improved. Chemical modification improves the properties of galactomannan gums, and application fields can expand. In particular, the grafted guar polysaccharide gum was more water-soluble. It can flocculate impurities in solutions and absorb metal ions.

Tripathy et al. grafted a 4-vinyl pyridine copolymer with partially carboxymethylated guar gum. [27] Its metal ion absorption and flocculation properties were investigated. The graft copolymer that resulted outperformed the control in these properties. Singh et al reported a poly (methyl acrylate) graft with guar gum that used a persulfate / ascorbic acid redox pair. The efficacy of the grafted product in removing Cr (VI) from local industrial wastewater was tested. The experiments revealed that the guar-graft-poly (methyl acrylate) could be reused five times. To establish a new hydrogel, polysaccharide guar gum (GG) was cross-linked with polyethylene glycol diglycidyl ether in an alkaline solution. [19]

Galactomannan from fenugreek

Fenugreek is a leguminous herb that is widely grown throughout the world. Egypt, Iran, France, Turkey, Spain, Afghanistan, India, and North African countries are among those represented. The two largest producing countries are India and North Africa. Each 100 g of fenugreek leaves contains 89 percent H_2O, 6% carbohydrates, 40% calcium, 4% protein, and less than 1% fat. Guar gum has a galactose-to-mannose ratio of 1:2, whereas locust bean gum has a ratio of 1:4. This is in contrast to the 1:1 ratio of fenugreek. As a result of the extra galactose in the fenugreek gum powder, it has excellent solubility and dispersive-ness, resulting in the formation of a stable colloid over a long period. Mannan, on the other hand, is hydrophobic, meaning it is completely insoluble in water.

However, because fenugreek gum is a combination of hydrophilic (galactose) and hydrophobic (mannan), it has surface-active, which means it is an emulsifier and can mix with both water and oil. Galactomannan gum was obtained from fenugreek seeds by grinding and sifting the seeds, washing and filtering them, precipitating them with ethyl alcohol, and drying them. Thus, obtained products were subjected to novel oxidation under a variety of conditions using microwave irradiation and sodium perborate (SPB) oxidant the oxidation process of galactomannan fenugreek gum was carried out using microwave synthesis systems. [19, 28]

Screen printing was used to apply the pastes to the fabric. The color was fixed in an automatic thermostatic oven. Following by washing was performed following the dye manufacturer's recommendations, thoroughly rinsing with cold water, Treatment with hot water, soaping near-boiling water, washing with hot water, Finally, rinsing with cold water. Color strength values and overall color fastness properties for goods printed with the formulated thickener using microwave irradiation and the formulated thickener using standard heating are either greater or equal to the corresponding samples printed.[9]

Tamarind seeds gum in textile printing

Tamarind seed gum, also known as tamarind kernel powder (TKP), is one such material that has the potential to be investigated for commercial applications as a thickening agent in textile printing. Tamarind seed gum is classified as a galactoxyloglucan which is a highly branched carbohydrate polymer high in the polysaccharide xyloglucan (~65-72%) and contains glucose, xylose, and galactose units in a 3:2:1 molecular ratio. It is environmentally friendly and has natural thickening properties, as well as the advantages of being environmentally friendly and having a low production cost. It is a plentiful and inexpensive by-product of the commercial or non-commercial tamarind fruit and pulp industry, and it can serve as a good source of tamarind seed, which can be used as a textile thickener. [26]

Methods of Isolation and Extraction of TSP Large scale

Tamarind seed gum is a galactoxyloglucan, a branched-chain carbohydrate polymer rich in polysaccharide xyloglucan (65-72%) and containing glucose, xylose, and galactose units in a molecular ratio of 3:2:1. It is biodegradable and has natural thickening properties, as well as the advantages of being environmentally friendly and having a low production cost. [26]

Method 1

The coat of tamarind seeds is removed, revealing the white part of the seeds. Grinded tamarind seed into a coarse powder, then soak in distilled water for 24 hours. TSG launch gum, TSG isolation with muslin cloth the marc is removed from the gum, and an equal amount of absolute ethyl alcohol is added to the gum, forming a precipitate that is separated by filtration. The isolation process is repeated until the material is free of gum. The separated gum is dried in a hot air oven at 40°C. The dried gum was then powdered and kept at room temperature in airtight containers.

Method 2

Take tamarind kernel powder and mix it with cold distilled water to make a slurry. The slurry is then poured into a pot of boiling distilled water. In a water bath, the solution is boiled with constant stirring. The resulting thin clear solution is kept overnight to allow the majority of the proteins and fibers to settle out. After that, the solution is centrifuged. By continuously stirring, the supernatant is separated and poured into double the volume of absolute ethanol. The product was sandwiched between two layers of felt. The precipitate is washed with absolute ethanol, diethyl ether, and petroleum ether before being dried under a vacuum.

Method 3

Tamarind kernel powder (TKP) was defatted, and the powder is further ground using a hammer mill or a Pin mill to reduce the size of the powder to less than 100 mm. Initially, only a multi-technique approach is used to characterize and standardize gums and mucilage. Standard preparations must be developed to improve quality, efficacy, and safety. [6]

Method 4

The tamarind seeds were dried and the seeds' coats were manually removed. The coatless seeds were then ground in a ball mill and sieved through a 355 nm mesh sieve. [29-31] Tamarind kernel thickener is used for printing polyester fabric giving a sharp outline and the color was observed to be uniform. [26]

Natural thickener from plants

Guar gum

Guar gum is a novel agrochemical derived from the endosperm of the cluster bean. It is commonly used as an ingredient in food, medical, paper, textile, explosive, oil well drilling, and cosmetic products throughout the form of guar gum powder. Because of its capacity to establish hydrogen bonds with water molecules, guar gum has industrial applications. [32]

Guar gum, derived from the endosperm of Cyamopsis tetragonolobus or Cyamopsis psoraloides, is one of the cheapest sources of galactomannan. It is a member of the Leguminosae family. Guar gum is a high molecular weight polysaccharide obtained from the guar plant that has a white to yellowish-white appearance and is colorless. The guar plant grows to a height of about 0.6 m, with pods ranging in length from 5 to 12.5 cm. Guar gums are an example of a hydrophilic polysaccharide. They have a rod-like polymeric structure with galactose side chains linked on the mannose backbone at a molecular ratio of 1:2 on average. Straight chains of D-mannose units are linked together by β (1-4) glycoside linkage, and D-galactose units are linked together alternately by (1-6) glycoside linkage. Guar gum has distinctive and intriguing physical properties. In most cases, it is insoluble in hydrocarbons, fats, alcohols, esters, and ketones. Guar gum is only soluble in water. In the presence of water, galactose units on mannose units interact with water molecules, resulting in inter-molecular chain entanglement, which aids in the thickening and increasing viscosity of the solution. [12]

Production

Guar gum is a gel-forming galactomannan procured by grinding the endosperm portion of Cyamopsis tetragonolobus, a leguminous plant grown for decades primarily in India and Pakistan, where it is a major crop that has long been used as food for humans and animals. The guar plant is primarily a sun-loving plant that is tolerant of high ambient conditions but extremely vulnerable to frost. The plant requires a soil temperature of 25–30°C and, ideally, a dry climate with sparse but consistent rainfall for fast growth. Rain is required for optimal growth of the guar plant planting time, as well as to induce seed growth and development. Extra moisture during the early growth stages but after seed maturation leads to lower quality guar beans.

The monsoon rain pattern in northeastern India and Pakistan usually provides optimal growing conditions for guar. India and Pakistan produce nearly 90 percent of the world's guar. Because of the crop's distinctive requirement for the right amount of rain at the right time of growth and maturation, this crop is heavily reliant on yearly rainfall patterns, causing occasional large swings in guar supply and prices. Guar is also grown in the southern hemisphere in semi-arid zones such as Brazil, Australia, South Africa, and the southern states of the United States such as Texas and Arizona. [32]

Guar gum manufacturing

The ground endosperm of Cyamopsis tetragonolobus is used to make guar gum (see Figure 2). [33] There are a variety of mechanical processes used in the commercial extraction of guar gum from seeds, including sieving, polishing, attrition, and roasting. Due to differences in the hardness of the constituents, endosperm can be removed easily from its constituents. Guar splits are gained after the separation of the hull and germ. After heat treatment, the hull is very easy to isolate using either attrition milling or different kinds of affect mills. Smelting easily recovers the finer germ and hull fractions from the endosperm. The powdered guar gum is then obtained through a milling process. The obtained guar gum is purified further by dissolving it in water, precipitating it, and recovering it with ethanol or isopropanol. [12]

Physical and chemical properties

Rheology

On dispersion, guar gum swells and/or dissolves in polar solvents, forming strong hydrogen bonds. It only constructs weak hydrogen bonds in nonpolar solvents. The percentage of guar gum dissolution and viscosity advancement usually increases as particle size, pH, and temperature decrease. Guar gum exhibits pseudoplastic or shear-thinning behavior in the aqueous phase. This means that viscosity decreases with increasing shear rate, as demonstrated by many high molecular weight polymers. Guar gum aqueous solution shear-thinning behavior rises with polymer concentration and molecular weight. Guar gum aqueous solutions do not exhibit yield stress properties either. [33]

Viscosity

The most important property of guar gum is

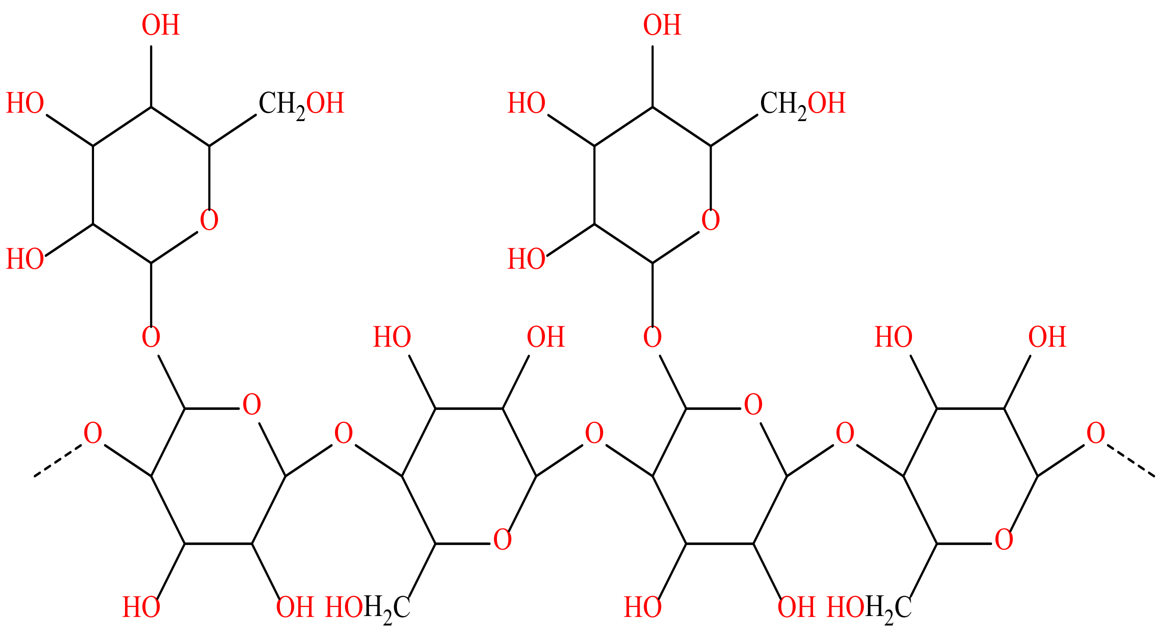

Fig. 2. Structure of guar gum molecule.

its ability to hydrate quickly in cold water systems to produce viscous fluid solutions. When fully hydrated, guar gum creates a viscous colloidal dispersion, which is a thixotropic rheological system. Diluted solutions of guar gum with a concentration of less than 1% are far less thixotropic than solutions with a concentration of 1% or higher. Guar gum's viscosity, like that of other gums, is affected by time, temperature, concentration, pH, ionic strength, and agitation type. [33]

Hydrogen bonding activity

Guar gum's hydrogen bonding action is due to the influence of a hydroxyl group in the guar gum molecule. Guar gum forms hydrogen bonds with cellulosic and hydrated minerals. The electrokinetic characteristics of any system are significantly altered by the addition of guar gum. [33]

Using natural thickeners as an alternative to industrial thickeners

Because of their biocompatibility and low toxicity, plant-based thickeners are appealing alternatives to synthetic thickeners. Natural thickeners are recommended over synthetic thickeners because they are less expensive, more readily available, and nonirritant in nature. Natural products are also typically nonrenewable sources of supply for a long time. Synthetic thickeners have several drawbacks, including high costs, toxicity, and pollution of the environment. They are derived from nonrenewable resources and may have negative side effects. [33]

Acknowledgment

The authors are gratefully grateful to acknowledge to Faculty of Applied Arts, Benha University. Thankful are also acknowledge to the National Research Centre (NRC).

References

1. Harlapur, S.F., Airani, N.R. and Gobbi, S.S., "Appliance of Natural Gums as Thickeners in the Process of Cotton Printing". *Advance Research in Textile Engineering*, **5**(2) 1048-1050 (2020).

2. Abdelrahman, M., Wahab, S., Mashaly, H., Ali, s., Maamoun, D. and Khattab, T., "Review in Textile Printing Technology". *Egyptian Journal of Chemistry*, **63**(9) 3465- 3479 (2020).

3. Kibria, G., Rahman, F., Chowdhury, D. and Uddin, N., "Effects of Printing with Different Thickeners on Cotton Fabric with Reactive Dyes". *Journal of Polymer and Textile Engineering*, **5**(1) 5-10 (2018).

4. Jassal, M., Acharya, B.N., Bajaj, P. and Chavan, R.B., "Acrylic-Based Thickeners for Pigment Printing—a Review". *Journal of Macromolecular Science, Part C: Polymer Reviews*, **42**(1) 1-34 (2002).

5. Peusch, M., Müller-Seitz, E., Petz, M., Müller, A. and Anklam, E., "Extraction of Capsaicinoids from Chillies (Capsicum Frutescens L.) and Paprika (Capsicum Annuum L.) Using Supercritical Fluids and Organic Solvents". *Zeitschrift für Lebensmitteluntersuchung und -Forschung A*, **204**(5) 351-355 (1997).

6. Estévez, A.M., Sáenz, C., Hurtado, M.L., Escobar, B., Espinoza, S. and Suárez, C., "Extraction Methods and Some Physical Properties of Mesquite (Prosopis Chilensis (Mol) Stuntz) Seed Gum". *Journal of the Science of Food and Agriculture*, **84**(12) 1487-1492 (2004).

7. Nasri-Nasrabadi, B., Behzad, T. and Bagheri, R., "Extraction and Characterization of Rice Straw Cellulose Nanofibers by an Optimized Chemomechanical Method". *Journal of Applied Polymer Science*, **131**(7) n/a-n/a (2014).

8. Kumar, C.S.S. and Dhinakaran, M., "Extraction and Application of Natural Dyes from Orange Peel and Lemon Peel on Cotton Fabrics". *International Research Journal of Engineering and Technology*, **4**(5) 237-238 (2017).

9. Mishra, A. and Malhotra, A.V., "Tamarind Xyloglucan: A Polysaccharide with Versatile Application Potential". *Journal of Materials Chemistry*, **19**(45) 8528-8536 (2009).

10. Nayak, A.K. and Pal, D., "Tamarind Seed Polysaccharide: An Emerging Excipient for Pharmaceutical Use". *Indian Journal of Pharmaceutical Education and Research*, **51**(2s) s136-s146 (2017).

11. Yadav, A., Vishwakarma, R.K., Mishra, S.K. and Shukla, A.K., "Isolation and Characterization of Tamarind Seed Gum as Pharmaceutical Excipient". *International Journal of Health and Clinical Research*, **3**(2) 49-57 (2020).

12. Shukla, A.K., Bishnoi, R.S., Kumar, M., Fenin, V. and Jain, C.P., "Applications of Tamarind Seeds Polysaccharide-Based Copolymers in Controlled Drug Delivery: An Overview". *Asian Journal of Pharmacy and Pharmacology*, **4**(1) 23-30 (2018).

13. Gupta, A.P. and Verma, D.K., "Guar Gum and Their Derivatives: A Research Profile". *International Journal of Advanced Research*, **2**(1) 680-690 (2014).

14. Sharma, G., Sharma, S., Kumar, A., Al-Muhtaseb, A.a.H., Naushad, M., Ghfar, A.A., Mola, G.T. and Stadler, F.J., "Guar Gum and Its Composites as Potential Materials for Diverse Applications: A Review". *Carbohydrate Polymers*, **199,** 534-545 (2018).

15. Kora, A.J., Sashidhar, R.B. and Arunachalam, J., "Gum Kondagogu (Cochlospermum Gossypium): A Template for the Green Synthesis and Stabilization of Silver Nanoparticles with Antibacterial Application". *Carbohydrate Polymers*, **82**(3) 670-679 (2010).

16. Chockalingam, A.M., Babu, H.K., Chittor, R. and Tiwari, J.P., "Gum Arabic Modified Fe3o4 Nanoparticles Cross Linked with Collagen for Isolation of Bacteria". *Journal of Nanobiotechnology*, **8,** 30 (2010).

17. Prajapati, V.D., Jani, G.K., Moradiya, N.G., Randeria, N.P., Nagar, B.J., Naikwadi, N.N. and Variya, B.C., "Galactomannan: A Versatile Biodegradable Seed Polysaccharide". *International journal of biological macromolecules*, **60,** 83-92 (2013).

18. Zerva, A., Simić, S., Topakas, E. and Nikodinovic-Runic, J., "Applications of Microbial Laccases: Patent Review of the Past Decade (2009–2019)". *Catalysts*, **9**(12) 1023 (2019).

19. Srivastava, M. and Kapoor, V.P., "Seed Galactomannans: An Overview". *Chem Biodivers*, **2**(3) 295-317 (2005).

20. Cerqueira, M., Bourbon, A., Pinheiro, A., Martins, J., Souza, B., Teixeira, J. and Vicente, A., "Galactomannans Use in the Development of Edible Films/Coatings for Food Applications". *Trends in Food Science & Technology*, **22** 662-671 (2011).

21. Zandi, P., Basu, S.K., Khatibani, L.B., Balogun, M.O., Aremu, M.O., Sharma, M., Kumar, A., Sengupta, R., Li, X., Li, Y., Tashi, S., Hedi, A. and Cetzal-Ix, W., "Fenugreek (Trigonella Foenum-Graecum L.) Seed: A Review of Physiological and Biochemical Properties and Their Genetic Improvement". *Acta Physiologiae Plantarum*, **37**(1) 1714 (2014).

22. Bento, J.F., Mazzaro, I., Silva, L.M.A., Moreira, R.A., Ferreira, M.L.C., FanyReicher and Petkowicz, C.L.O., "Diverse Patterns of Cell Wall Mannan/Galactomannan Occurrence in Seeds of the Leguminosae". *Carbohydrate Polymers*, **92**(1) 192-199 (2013).

23. Thombare, N., Jha, U., Mishra, S. and Siddiqui, M.Z., "Guar Gum as a Promising Starting Material for Diverse Applications: A Review". *International Journal of Biological Macromolecules*, **88,** 361-72 (2016).

24. Geronço, M.S., Ramos, I.F.d.S., Rizzo, M.d.S., Filho, E.C.d.S., Ribeiro, A.B. and Costa, M.P.d., "Are Structurally Modified Galactomannan Derivatives Biologically Active?". *Polysaccharides*, **2**(1) 1-15 (2021).

25. Landin, M. and Echezarreta, M.M., "Galactomannans: Old and New Pharmaceutical Materials". *Polysaccharides: Development, Properties and Applications*, 477-501 (2010).

26. Ba, J., Gao, Y., Xu, Q.H. and Qin, M.H., "Research Development of Modification of Galactomannan Gums from Plant Resources". *Advanced Materials Research*, **482-484** 1628-1631 (2012).

27. Tripathy, J., Mishra, D., Srivastava, A., Mishra, M. and Behari, K., "Synthesis of Partially Carboxymethylated Guar Gum-G-4-Vinyl Pyridine and Study of Its Water Swelling, Metal Ion Sorption and Flocculation Behaviour". *Carbohydrate Polymers*, **72,** 462–472 (2008).

28. Hebeish, A., Abdelrahman, A., Nassar, S., Elsayad, H. and Elshemy, N., "Microstructural Features of Galactomannan Fenugreek Gum Newly Oxidized by Sodium Perborate under Microwave Irradiation for Reactive Printing". *Egyptian Journal of Chemistry*, **62**(11) 1971-1986 (2019).

29. Xu, W., Liu, Y., Zhang, F., Lei, F., Wang, K. and Jiang, J., "Physicochemical Characterization of Gleditsia Triacanthos Galactomannan During Deposition and Maturation". *International Journal of Biological Macromolecules*, **144,** 821-828 (2020).

30. Jian, H.-l., Cristhian, C., Zhang, W.-m. and Jiang, J.-x., "Influence of Dehulling Pretreatment on Physicochemical Properties of Gleditsia Sinensis Lam. Gum". *Food Hydrocolloids*, **25**(5) 1337-1343 (2011).

31. Mourad, L., Saoudi, A. and Hicham, G., "Characterization of Galactomannan Isolated from Algerian Gleditsia Triacanthos L. Seeds". *The Natural Products Journal*, **10**(1) 80-86 (2020).

32. Chaudhary, H. and Singh, V., "Eco-Friendly Tamarind Kernel Thickener for Printing of Polyester Using Disperse Dyes". *Fibers and Polymers*, **19**(12) 2514-2523 (2018).

33. Chouana, T., Pierre, G., Vial, C., Gardarin, C., Wadouachi, A., Cailleu, D., Le Cerf, D., Boual, Z., Ould El Hadj, M.D., Michaud, P. and Delattre, C., "Structural Characterization and Rheological Properties of a Galactomannan from Astragalus Gombo Bunge Seeds Harvested in Algerian Sahara". *Carbohydr Polym*, **175,** 387-394 (2017).

المثخنات الطبيعية في طباعة المنسوجات

سارة امين ابراهيم[1]، احمد جمعه حسبو[2]، حنان علي عثمان[1]
[1] قسم طباعة المنسوجات والصباغة والتجهيز، كلية الفنون التطبيقية، جامعة بنها، بنها، مصر.

[2] المركز القومي للبحوث، شعبة بحوث الصناعات النسيجية، قسم التحضيرات والتجهيزات للألياف السليلوزية،
٣٣ شارع البحوث (شارع التحرير سابقاً)، الدقي، ص.ب 12622، الجيزة، مصر
.

استخدام المثخنات الصناعية في طباعة المنسوجات له عواقب بيئية سلبية عديدة. نتيجة لذلك، في هذه الدراسة، أكدنا على استخدام أنواع مختلفة من المواد الطبيعية الصديقة للبيئة كمثخنات لتقليل التأثير البيئي. في الأساس، تعد الطباعة نوعًا من الألوان التي يتم فيها تطبيق الألوان على مناطق معينة من القماش بدلاً من النسيج بأكمله. الأنماط الناتجة متعددة الألوان لها تأثيرات جميلة وفنية، مما يزيد من قيمة القماش فوق القماش المصبوغ العادي. يتم لصق مادة التلوين بمساعدة عامل سماكة لإبعادها إلى منطقة التصميم. اللون الصحيح، حدة العلامة، الاستواء، اليد الجيدة، والاستخدام الفعال للصبغة كلها أمور مطلوبة من أجل طباعة ناجحة.