is a starch-rich grain similar to maize \textit{(Zea mays Linn.)}, but sorghum has been underutilized for biobased products and bioenergy. Researchers in USA conducted studies to investigate the effects of supercritical-fluid-extrusion (SCFX) of sorghum on ethanol production. Morphology, chemical composition, and thermal properties of extruded sorghum were characterized. Analysis of extruded sorghum showed increased measurable starch content, free sugar content, and high levels of gelatinized starch. SCFX cooked and non-extruded sorghum were further liquefied, saccharified and fermented to ethanol by using \textit{Saccharomyces cervisiae}. The ethanol yield increased as sorghum concentration increased from 20 to 40\% for both extruded and non-extruded sorghum. Ethanol yields from SCFX cooked sorghum were significantly greater than that from non-extruded sorghum (>5\%).

Extrusion cooking increased ethanol yield and fermentation efficiency of sorghum. Improvements in the bioconversion of sorghum starch probably were from the release of starch from the protein matrix and enhancing the availability of starch for conversion to fermentable sugar. SCFX cooked sorghum showed greater fermentation efficiency than non-extrusion cooked sorghum and could be partly explained by an increased fermentable starch, decreased measurable fibre content and fine porous structures produced by SCFX cooking. Both ethanol yield and fermentation efficiency were affected by sorghum concentration. Ethanol yield increased as substrate concentration increased, whereas greater fermentation efficiency was generally observed at a low substrate concentration. Finally, SCFX cooking is an effective pretreatment method that could improve the bioconversion rate of sorghum starch into ethanol [Zhan X, Wang D, Bean SR, Mo X, Sun XS and Boyle D, Ethanol production from supercritical-fluid-extrusion cooked sorghum, \textit{Ind Crops Prod}, 2006, 23(3), 304-310].

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**Fuel**

The major methods of textile wastewater treatment involve physical and/or chemical processes. Chemical treatment being a costly process and non-ecofriendly limits its applications at times. Herbal coagulants have several advantages compared to chemical, as they are biodegradable, safe to human health and have a wider effective dosage range for flocculation of various colloidal suspensions. Also, since they can be locally grown, harvested and processed, they have the potential to be cost effective when compared to imported chemicals. The scientists at Southern Laboratories, Indian Institute of Technology, Kanpur, India and Department of Chemistry, University of Allahabad, Allahabad, India investigated dye decolorization from synthetic dye solutions using the non-ionic, water-soluble, high molecular weight seed gums of \textit{Ipomoea dasysperma Jacq. f.} and guar \textit{Cyamopsis tetragonoloba (Linn.) Taub.} as coagulants. The use of galactomannans derived from plants in this system presents a sustainable method of textile effluent treatment. These natural coagulants extracted from plants proved to be workable alternatives to conventional coagulants like polyaluminum chloride (PAC). Coagulant dose and coagulation $p$H are important factors influencing the mechanism of coagulation. Also the type and chemical structure of the dye plays an important role in the coagulation process. The seed gums alone were found to be effective for decolorization of direct dye and in combination with PAC their coagulation efficiency was well extended even for reactive and acid dyes [Sanghi Rashmi, Bhattacharya Bani, Dixit Awantika and Singh Vandana, \textit{Ipomoea dasysperma} seed gum: An effective natural coagulant for the decolorization of textile dye solutions, \textit{J Environ Manag}, 2006 81(1), 36-41].

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**Gum/Rubber**

**Seed gums for decolorization of textile dye solutions**

The major methods of textile wastewater treatment involve physical and/or chemical processes. Chemical treatment being a costly process and non-ecofriendly limits its applications at times. Herbal coagulants have several advantages compared to chemical, as they are biodegradable, safe to human health and have a wider effective dosage range for flocculation of various colloidal suspensions. Also, since they can be locally grown, harvested and processed, they have the potential to be cost effective when compared to imported chemicals. The scientists at Southern Laboratories, Indian Institute of Technology, Kanpur, India and Department of Chemistry, University of Allahabad, Allahabad, India investigated dye decolorization from synthetic dye solutions using the non-ionic, water-soluble, high molecular weight seed gums of \textit{Ipomoea dasysperma Jacq. f.} and guar \textit{Cyamopsis tetragonoloba (Linn.) Taub.} as coagulants. The use of galactomannans derived from plants in this system presents a sustainable method of textile effluent treatment. These natural coagulants extracted from plants proved to be workable alternatives to conventional coagulants like polyaluminum chloride (PAC). Coagulant dose and coagulation $p$H are important factors influencing the mechanism of coagulation. Also the type and chemical structure of the dye plays an important role in the coagulation process. The seed gums alone were found to be effective for decolorization of direct dye and in combination with PAC their coagulation efficiency was well extended even for reactive and acid dyes [Sanghi Rashmi, Bhattacharya Bani, Dixit Awantika and Singh Vandana, \textit{Ipomoea dasysperma} seed gum: An effective natural coagulant for the decolorization of textile dye solutions, \textit{J Environ Manag}, 2006 81(1), 36-41].
Deep-fat frying is a widely used method for food processing. Batter application prior to frying forms a continuous and uniform layer over the food surface. In addition, it enhances the texture, flavour and appearance of foods. Gums can be used in batter formulations to provide adequate viscosity. They have the ability to bind water which is an important property to obtain products containing less oil since there is a strong relation between oil uptake and moisture loss during frying. Xanthan gum is completely soluble in cold or hot water and shows high viscosities at low concentrations. It is used in many low fat food systems due to its water binding capacity. Carrot is one of the most popular vegetable consumed in the world whatever the season is and its consumption has been increasing regularly, either in raw or cooked form. Frying may be an alternative cooking method for consumption of carrot which is a vegetable rich in fibres and carotenoids. The scientists at Department of Food Engineering, Middle East Technical University, Ankara, Turkey evaluated the effects of addition of different hydrocolloids such as hydroxypropyl methylcellulose (HPMC), guar gum, xanthan gum and guar-xanthan gum combination to the batter formulations on quality of deep-fat fried carrot slices. Coating pick up of batter formulations and moisture content, oil content, texture, porosity and colour of samples were determined during frying at 170°C for 2, 3 and 4 minutes. Gums were effective in controlling moisture loss and oil uptake, producing crisp and porous product in deep-fat fried carrot slices. A guar-xanthan gum combination gave a maximum of 53% reduction in oil content as compared to control after 4 minutes of frying. Increase in coating pick up and fracturability were about 66.5% and 6%, respectively at this condition. The porosity of the fried carrot slices coated with batter containing guar and xanthan gums which is a good indicator of volume was about 3.6 times higher than the product coated with control batter [Akdeniz Neslihan, Sahin Serpil and Sumnu Gulum, Functionality of batters containing different gums for deep-fat frying of carrot slices, *J Food Eng*, 2006, 75(4), 522-526].

**Thickening of sweet and sour sauces with various polysaccharide combinations**

Thickening of sweet and sour sauces with modified starches is reported in the literature. In continuation to these reports scientists in Poland investigated possibilities of thickening of sweet and sour sauces with various polysaccharide combinations. Influence of a type and concentration of oat starch and various polysaccharide-based thickening combinations (oat starch-xanthan gum, oat starch-oat hydrolysate, oat hydrolysate-xanthan gum and potato starch-xanthan gum) upon rheological, textural, and sensory properties of sweet and sour (S&S) sauces were studied. Either oat starch or combinations of oat starch with xanthan gum and oat hydrolysate with xanthan gum provided superior adhesiveness and stringiness of S&S sauces. Every tested thickener offered statistically equally good penetration force and sensory properties of S&S sauces. In sauces thickened with potato starch xanthan gum blends, penetration force, adhesiveness and stringiness increased, and the same trends could be observed in sauces thickened with blends of oat starch with oat hydrolysates. In sauces containing either the blends of oat starch with xanthan gum or three component blend of oat starch with oat hydrolysate and xanthan gum, these textural parameters decreased on storage, although in the latter blends changes in stringiness were negligible [Gibinski Marek, Kowalski Stanislaw, Sady Marek, Krawomika Jan, Tomaski Piotr and Sikora Marek, Thickening of sweet and sour sauces with various polysaccharide combinations, *J Food Eng*, 2006, 75(3), 407-414].
Waste natural gum as a multifunctional additive in rubber

*Bahera* gum, extracted from the bark of *Terminalia bellirica* Roxb., is a waste material. The scientists at Indian Institute of Technology, Kharagpur, West Bengal, India carried out studies on the use of this natural gum as a multifunctional additive in natural rubber (NR) and brominated isobutylene-co-paramethyl styrene (BIMS). Fourier transform infrared (FTIR) analysis was employed to study the functional groups present in the gum. It was found that fatty acids/esters in the gum act as accelerator activator and can replace stearic acid in rubber formulations. Polyphenols in the gum act as antioxidant and the action is comparable with the commercial antioxidant 2, 2, 4-trimethyl-1, 2-dihydroquinoline (TQ) in natural rubber. The gum improves the tack strength of the rubbers (21% at 2.5/hr loading for NR and 54% at 10/hr loading for BIMS). The gum imparts plasticization effect which is reflected in the reduction in k and enhancement in n values, the exponents in the power law equation, with increasing gum concentration. The activation energy of flow is also reduced with the addition of the gum. Moreover, it decreases the elastic memory of the system which causes reduction in die swell [Guhathakurta S, Anandhan S, Singha Nikhil K, Chattopadhyay RN and Bhowmick Anil K, Waste natural gum as a multifunctional additive in rubber, *J Appl Polym Sci*, 2006, 102(5), 4897-4907].

Pineapple leaf fibre and natural rubber composites

The scientists at Department of Rubber Technology and Polymer Science, Prince of Songkla University, Pattani, Thailand and Department of Engineering Materials, University of Sheffield, United Kingdom carried out studies on the performance of short pineapple leaf fibre (PALF)-natural rubber (NR) composites on a laboratory two-roll mill. The influences of untreated fibre content and orientation on the processing and mechanical properties of the composites were investigated. The dependence of extent of orientation on fibre concentration was also established. Sodium hydroxide (NaOH) solutions (1, 3, 5 and 7% w/v) and benzoyl peroxide (BPO) (1, 3 and 5 wt % of fibre) were used to treat the surfaces of PALFs. FTIR and scanning electron microscope (SEM) observations were made of the treatments in terms of chemical composition and surface structure. The tensile strength and elongation at break of the composites were later studied. The fibre-matrix adhesion was also investigated using SEM technique. It was found that all surface modifications enhanced adhesion and tensile properties. The treatments with 5% NaOH and 1% BPO provided the best improvement of composite strength (28 and 57%, respectively) when compared with that of untreated fibre. The PALF-NR composites also exhibited better resistance to ageing than its gum vulcanizate, especially when combined with the treated fibres [Lopattananon Natinee, Panawarangkul Kuljanee, Sahakaro Kannika and Ellis Bryan, Performance of pineapple leaf fiber-natural rubber composites: The effect of fiber surface treatments, *J Appl Polym Sci*, 2006, 102(2), 1974-1984].

Extraction and characterization of Malva nut gum

Malva nut is the seed of *Scaphium scaphigerum* (G. Don) Guib. & Planch containing a large amount of mucilaginous substance and have been used as a traditional medicine in South-East Asia. The jelly made from Malva nuts is consumed, when sweetened, as dessert, but its principal use is for relief of canker sores and cough. However, Malva nut mucilage is not commonly used as a stabilizer or thickening agent in food products due to lack of information on the physicochemical properties of the mucilage and the extraction process. Researchers from Thailand and Canada...
conducted studies to extract and characterize gums from Malva nut seed. Malva nut gum can be effectively extracted by a dilute alkaline solution. The extracted gum contains high levels of carbohydrates (62.0%). The major constituent monosaccharides were arabinose, galactose and rhamnose together with small amounts of uronic acid, glucose and xylose. The polysaccharides contained terminal L-Araf, 1,3-linked L-Araf, 1,4-linked D-Galp, 1,4-linked D-GalAp with small amounts of branching units: 1,2,4-linked D-Galp and 1,2,3,4-linked RhamP. The molecular weight (6.65×10^6 Da) of Malva nut gum was very high, which was significantly reduced by the purification processing (dialysis and decoloring). FTIR spectroscopy and methylation analysis revealed that Malva nut gum had a fairly similar structure to gum arabic, yet much higher molecular weight [Somboonpanyakul P, Wang Q, Cui W, Barbut S and Jantawat P, Malva nut gum. (Part I): Extraction and physicochemical characterization, Carbohydr Polym, 2006, 64(2), 247-253].

**Konjac glucomannan/chitosan blend films**

A study conducted by researchers in China and UK was aimed at modifying chitosan by blending it with konjac glucomannan (from Amorphophallus tuber) to improve the mechanical properties and water solubility and the biocompatibility of chitosan as a konjac glucomannan/chitosan blend film. Specialised blend films have been prepared by blending 1% w/v konjac glucomannan aqueous with 1% w/v chitosan solution in acetate solution and drying at room temperature for 24 hours. The condensed state structure and miscibility of the blend films were studied by Fourier transform infrared spectroscopy, scanning electron microscopy, differential scanning calorimetry, and wide-angle X-ray diffraction. The results indicated that the blend film obtained from an 80/20 mixing ratio of konjac glucomannan and chitosan derivate showed the highest miscibility and blend homogeneity and that strong intermolecular hydrogen bonds took place between the amino groups of chitosan and the hydroxyl groups of konjac glucomannan; thus the tensile strength also achieved its maximum in this ratio. The cell morphologies on the pure and blend films were examined by light microscopy and cell viability was studied by using MTT assay. The results showed that the particular blend film was more suitable for the cell culture than the pure konjac glucomannan film and that the cells cultured on this blend film had greater spreading coefficients than that of the pure konjac glucomannan film. As a result of the good mechanical properties, miscibility and biocompatibility, the blend film is a promising biomaterial matrix [Ye X, Kennedy JF, Li B and Xie BJ, Condensed state structure and biocompatibility of the konjac glucomannan/chitosan blend films, Carbohydr Polym, 2006, 64(4), 532-538].

**Cassia javahikai seed as potential source of commercial gum for the textile wastewater treatment**

Investigations were carried out by researchers at Indian Institute of Technology, Kanpur, India and University of Allahabad, India for possible exploitation of Cassia javahikai seeds as potential source of commercial gum for the textile wastewater treatment. Graft copolymerization with acrylamide was done to modify the seed gum for the favourable properties. C. javahikai seed gum, and its copolymer grafted with acrylamide were synthesized in the presence of oxygen using potassium persulphate/ascorbic acid redox system. Both C. javahikai seed gum (CJ) and its grafted-polyacrylamide (CJG), were found to be good working substitutes as coagulant aids in conjunction with PAC, for the decolorization of all the dyes in varying ratios. CJ and CJG alone could effectively decolorize direct dyes (DBR and DO) and in conjunction with a very low dose of PAC could decolorize all the dyes (DBR, DO, ASR and PBB) to more than 70%. Grafting also increased the decolorizing ability of CJ gum. Being biodegradable and safe to human health,
Hydrocolloids (gums) are used in starch-based products to improve stability, modify texture, facilitate processing, reduce costs, control moisture and show a variety of gelatinization and rheological properties. The gelatinization of cationic tapioca (*Manihot esculenta* Crantz.) starch embedded in gum matrices was investigated by researchers at Department of Biotechnology, Faculty of Science, Mahidol University, Bangkok, Thailand using a Rapid Visco-Analyzer (RVA), differential scanning calorimeter (DSC), scanning electron microscope (SEM) and rheometer. In addition, swelling power and solubility indices were measured. Xanthan and guar gum increased the RVA peak viscosity of cationic tapioca starch during pasting synergistically in different ways. Guar gum was more effective than xanthan gum in terms of increasing peak viscosity due to its ability to increase the swelling power and solubility index. Both xanthan gum and guar gum induced association between the gelatinized granules probably due to bridging. Association was much more extensive with xanthan. DSC studies showed that the presence of gums influenced the gelatinization characteristics of starch significantly by increasing the onset gelatinization temperature and decreasing the gelatinization enthalpy. Dynamic rheological measurement showed a strong interaction occurred in the cationic tapioca starch-xanthan gum mixture resulting in a decrease in the loss tangent (tan δ) as compared with guar gum addition or starch alone. The ionic interaction of gums and starch was found to play an important role in the gelatinization characteristics of the mixtures and also rheological properties of the pastes [Chaisawang Montri and Suphantharika Manop, Effects of guar gum and xanthan gum additions on physical and rheological properties of cationic tapioca starch, *Carbohydr Polym*, 2005, 61(3), 288-295].

A non-ionic glucomannan from the seeds of *Bryonia lacinosa*

*Bryonia lacinosa* Linn. syn. *Bryonopsis lacinosa* (Linn.) Naud. (Family — Cucurbitaceae) plant locally known as *Shivlingi* and *Gargumaru* in Allahabad is distributed throughout India. It is an annual climber with bright red fruits and reported to be highly medicinal. Locally in India its seeds are being used for promoting conception in women. Plant as a whole is bitter, tonic and mild laxative. Its leaves are used on inflammations. Due to tremendous medicinal importance of the seeds, the seed mucilage of the plant was subjected to phytochemical investigation by researchers at Department of Chemistry, University of Allahabad, Allahabad, India. Extraction of defatted and decolorized seeds with 1% aqueous acetic acid yielded a polysaccharide material, having D-glucose and D-mannose in the molar ratio of 1.00:1.01. Hydrolysis of the fully methylated seed gum furnished 2,3,4,6-tetra-O-methyl-d-glucose and 2,3-di-O-methyl-D-
Guar galactomannan is the material of choice in various industries such as food, oil recovery, cosmetics, pharmaceuticals, textile, etc. owing to its easy availability at low cost and excellent viscosity properties. However, modification (including debranching/depolymerization) of guar galactomannan is beneficial for its diversified applications. Depolymerized guar galactomannan with relatively low $M_w$ and low viscosity is of use as a source of soluble dietary fibre in nutraceutical products and functional foods. In comparison with the conspicuous thixotropic property of native guar gum solutions, the partially hydrolyzed guar gums with lower $M_w$ are easily soluble in water with better clarity of solution. Researchers at Department of Biochemistry and Nutrition, Central Food Technological Research Institute, Mysore, India and Kraft Foods, Inc., IL, USA made use of commercially available-inexpensive pectinase from Aspergillus niger in partial depolymerization of guar galactomannan. A kinetic study of optimum depolymerization of guar gum by pectinase has been determined, which is of use in the partial depolymerization process so as to get products with water solubility and enhanced G:M ratio. In addition, the gelling properties of both native and modified guar galactomannans were determined.

Use of gum arabic in microencapsulation of flavours

Solvent extracted oleoresins exhibit a flavour profile, close to the freshly ground spice in a wide spectrum of foods. In spite of their many advantages over ground spices, their sensitivity to light, heat and oxygen is a disadvantage. Microencapsulation protects the oleoresin against destructive changes and also converts it into a free-flowing powder. Besides, it also protects the flavours from undesirable interaction with food and minimizes flavour/flavour interaction.

Researchers at Food and Fermentation Technology Department, Institute of Chemical Technology, University of Mumbai, Matunga, Mumbai, India conducted investigations on microencapsulation of cardamom oleoresin by spray drying using gum arabic, maltodextrin and a commercially available modified starch as wall materials. The microcapsules were evaluated for the content and stability of volatiles, non-volatiles, entrapped 1,8-cineole and entrapped $\alpha$-terpinyl acetate for 6 weeks. Gum arabic was found to be better wall material for encapsulation of cardamom oleoresin as compared to maltodextrins and modified starch. The free flowing nature of all these microcapsules is of advantage to the food processing industry [Krishnan Savitha, Kshirsagar Amol C and Singhal Rekha S, The use of gum arabic and modified starch in the microencapsulation of a food flavoring agent, Carbohydr Polym, 2005, 62(4), 309-315].
Gum/Rubber

Pectinase from *A. niger* associated with polygalacturonase activity, caused considerable debranching-depolymerization of guar galactomannan. Zymogram analysis further confirmed the action of pectinase on the latter. Optimum activity occurred at pH 5.0 and 50°C and the reaction obeyed Michaelis-Menten kinetics with $K_m$ and $V_{max}$ values of 3.72 mg/ml and 1.852 mmoles/min/mg. In conclusion, partial depolymerization of guar gum could be achieved by *A. niger* pectinase, which being inexpensive and food grade is of commercial importance and utility. The partially hydrolyzed guar galactomannans, in addition to decrease in $M_w$/viscosity underwent modification in the G:M ratio. Because of its easy solubility in aqueous medium and its soft gelling property, the depolymerized products may be of value as functional food ingredients [Shobha MS, Vishu Kumar AB, Tharanathan RN, Koka Rathna and Gaonkar Anil Kumar, Modification of guar galactomannan with the aid of *Aspergillus niger* pectinase, *Carbohydr Polym*, 2005, 62(3), 267-273].

Insecticides/Pesticides/Larvicides

Larvicidal activity of *Balanites aegyptiaca* (Linn.) Del. fruit mesocarp

There is no vaccine to prevent infection of dengue caused by *Aedes aegypti* mosquito nor there are drugs to combat the disease in infected persons so vector control is the most opted solution available so far for reducing the morbidity. A considerable number of plant derivatives have shown to be effective against mosquito with a safe manner, however, due to the dramatic increase in resistance of mosquitoes to familiar chemicals better alternative means of control are sought. Chloroform, ethyl acetate, butanol and methanol extracts of fruit mesocarp of *Balanites aegyptiaca* (Linn.) Del. and five fractions from the methanol extract were tested against the *A. aegypti* mosquito larvae by researchers of Israel. All extracts showed larvicidal effects, however, the highest larval mortality was found in methanol extract. One fraction obtained from the silica gel column chromatography of the latter was found most effective for larval mortality. This fraction also interfered with adult emergence. A concentration of 0.0014% (w/v) of this active fraction showed inhibition of the 50% of the test larval population from emerging adults ($EC_{50}$). The analysis of total saponin content of these tested extracts and fractions revealed a strong correlation between saponin content and larval mortality.

The results of this study clearly show that extract and fraction of *B. aegyptiaca* fruit mesocarp that contain high total saponins demonstrate a high larval mortality. As adult mosquitoes transmit diseases, the critical concentrations of the materials which inhibit 50% of the treated larval population from emerging adults ($EC_{50}$) are more meaningful. Since, the use of the active fraction (0.0014% w/v) was shown to be sufficient to inhibit the emergence of 50% of the larvae population, this will certainly help reduce the mosquito population drastically. The discovery of plant-derived compounds that could control the mosquito population would be of great value. In this context, the highly bioactive compounds of *B. aegyptiaca*, which is being grown widely in most areas where *A. aegypti* is a serious problem, offer an opportunity for developing alternatives to rather expensive and environmentally hazardous organic insecticides. Furthermore, the findings of the high correlation between saponins content and larval mortality would also open the door for using saponins as natural larvicidal agents [Wiesman Zeev and Chapagain Bishnu P, Larvicidal activity of saponin containing extracts and fractions of fruit mesocarp of *Balanites aegyptiaca*, *Fitoterapia*, 2006, 77(6), 420-424].