The aim of the study conducted by researchers at Germany and Turkey was to investigate the long-term anaerobic fermentation of an extremely sour substrate, an energy crop, for continuous production of methane (CH\(_4\)) as a source of renewable energy. The sugar beet silage was used as the mono-substrate, which had a low pH of around 3.3-3.4, without the addition of manure. The mesophilic biogas digester was operated in a hydraulic retention time (HRT) range between 15 and 9.5 days, and an organic loading rate (OLR) range of between 6.33 and 10 g VS l\(^{-1}\) d\(^{-1}\). The highest specific gas production rate (spec. GPR) and CH\(_4\) content were 0.67 l g VS\(^{-1}\) d\(^{-1}\) and 74\%, respectively, obtained at an HRT of 9.5 days and OLR of 6.35 g VS l\(^{-1}\) d\(^{-1}\). The digester worked within the neutral pH range as well. Since this substrate lacked the availability of macro and micro nutrients, and the buffering capacity as well, external supplementation was definitely required to provide a stable and efficient operation, as provided using NH\(_4\)Cl and KHCO\(_3\) in this case. The findings of this ongoing long-term fermentation of an extremely acidic biomass substrate without manure addition have reflected crucial information about how to appropriately maintain the operational and particularly the environmental parameters in an agricultural biogas plant [Demirel Burak and Scherer Paul, Bio-methanization of energy crops through mono-digestion for continuous production of renewable biogas, Renew Energy, 2009, 34 (12), 2940-2945].

**Development of a stable hydrogel network based on agar-kappa-carrageenan blend cross-linked with genipin**

Blend of food hydrocolloids, viz. agar and kappa-carrageenan (agar/kC), was treated with the natural cross-linker genipin in aqueous medium to impart functional stability by scientists at Central Salt and Marine Chemicals Research Institute, Bhavnagar, Gujarat, India. The genipin-fixed blend exhibited remarkable stability in the wide range of pH 1-12, as well as in Ringer’s solution. Ratios of the hydrocolloids and genipin in the blend as well as in the cross-linked product were optimized (agar/kC 25:75 and agar/kC/genipin 25:75:0.8, w/w) on the basis of swelling properties. Compatibilities of unmodified blend (agar/kC) and the cross-linked blend product in aqueous solution were studied by measuring apparent and intrinsic viscosities and UV absorptions. Properties of agar/kC blend and the genipin cross-linked blend in solid state were evaluated by bulk and true density, pore volume, porosity, thermogravimetric analysis (TGA), swelling ability, X-ray diffraction, degradation rate in vitro, optical microscopy, scanning electron microscopy (SEM) and rheological measurements. The cross-linked blend exhibited higher viscosity, thermal stability and swelling ability as well as low weight loss ratio compared to those of the unmodified blend. The presence of genipin in the cross-linked polymer network was confirmed by MS/MS analysis. This genipin cross-linked blend presents an immense potential for food applications and in other pH-specific applications as well. The seaweed hydrocolloids blend of agar and kappa-carrageenan generated a cross-linked hydrogel network assembly on reaction with genipin, showing remarkable swelling capacity and solution stability in a wide range of pH. This hydrogel can be utilized in specific food applications as well as other applications that demand pH resistance. This report is yet another example of value addition of these hydrocolloids with emerging new applications, obtainable from a renewable bioresource [Meena Ramavatar, Prasad Kamalesh and Siddhanta AK, Development of a stable hydrogel network based on agar-kappa-carrageenan blend cross-linked with genipin, Food Hydrocol, 2009, 23 (2), 497-509].
Gum/Rubber

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Purification and partial physicochemical characteristics of protein free fenugreek gums

Fenugreek (Trigonella foenum-graecum Linn.) is an annual herb, widely grown in India, Egypt, Middle Eastern countries as well as in Canada. The seeds are used as a spice and the leaves are consumed as a green vegetable. Fenugreek gum is derived from the endosperm of the seeds. Fenugreek gum, like guar gum and locust bean gum, is composed of galactose and mannose, and gives a high viscosity in aqueous solutions. The galactomannans are neutral water-soluble polysaccharides, widely used as thickening, water holding, stabilizing and emulsifying agents in food products. The objective of the study done by scientists at Canada was to obtain a protein free galactomannan fraction and evaluate the effect of protein content on the physicochemical characteristics of fenugreek gum.

Crude fenugreek gum (3.74% protein) was purified by dissolving in aqueous solvent and centrifugation to remove impurities which yielded a purified gum fraction containing 1.10% protein residue. Further, purification of the gum was achieved by treating the gum solution with phenol to obtain protein free fenugreek gum (0.16% protein residue). The three types of fenugreek gums were evaluated for: molecular weight, surface activity and rheological performance. Surface and interfacial tension, measured by a Du Nouy ring, indicated that the removal of protein in the gum significantly reduced its surface activity. However, the crude fenugreek gum exhibited lower intrinsic viscosity and radius of gyration compared to the purified and protein free fenugreek gums. It was found that both protein residue and gum concentration affected the elastic modulus ($G'$), viscous modulus ($G''$) and complex viscosity ($\eta'$).

The study demonstrated that the protein content in fenugreek gums played an important role in reducing surface activity. The viscosity of fenugreek gum rose with increasing gum concentration or with reduction of the residual protein attached. The molecular weight of fenugreek gum increased with removing the attached proteins [Youssef MK, Wang Q, Cui SW and Barbut S, Purification and partial physicochemical characteristics of protein free fenugreek gums, Food Hydrocol, 2009, 23 (8), 2049-2053].

Effects of gums on macro and micro-structure of breads baked in different ovens

The Researchers at Scientific and Technological Research Council of Turkey, Kocaeli, Turkey and Department of Food Engineering, Middle East Technical University, Ankara, Turkey aimed their study to investigate the effects of gums on macro and micro-structure of breads baked in different ovens [infrared (IR)-microwave combination and conventional] by the help of image and SEM analysis, respectively. The gums used were xanthan, guar, κ-carrageenan and xanthan-guar blend. The gums were added to the formulation at 0.5% concentration. As a control, no gum added formulations were used. Results of Image analysis demonstrated that xanthan-guar gum blend addition improved bread quality with increasing pore area fractions. It was seen that about 75% of the pores of control breads baked in infrared-microwave combination oven and about 63% of the pores of control breads baked in conventional oven had diameters of above 1000 µm. According to SEM analysis, pores in control breads baked in conventional oven were found to be smaller, and had spherical, oval-like shape as compared to the ones baked in IR-microwave combination oven. Moreover, more homogeneous closed-cell structure was observed for conventionally baked control breads. The pores of breads baked in IR-microwave combination oven were so close to each other which resulted in coalescence of the gas cells to form channels, then the pores were no longer spherical. The starch granules in conventionally baked breads were more distorted and seen as a continuous sheet of gelatinized starch. On the other hand, granular residues and continuous starch structure was observed together in IR-microwave combination heating [Ozkoc Semin Oğe, Sumnu Gulum and Sahin Serpil, The effects of gums on macro and micro-structure of breads baked in different ovens, Food Hydrocol, 2009, 23 (8), 2182-2189].
Edible films and coatings can provide additional protection for food, while being a fully biodegradable, environmentally friendly packaging system. Preliminary works have shown that the presence of a moderate electric field during the preparation of chitosan coating solutions may influence e.g. their transport properties. If such effect is confirmed, moderate electric fields could be used to tailor edible films and coatings for specific applications. Thus, the aim of the work done by scientists at Portugal, Cuba and Brazil was to determine the effect of field strength on functional properties of chitosan coatings (obtained from lobster from the Cuban coasts). Four different field strengths were tested (50, 100, 150, 200 V/cm) and, for each electric field treatment, the water vapour, oxygen and carbon dioxide permeabilities of the films formed were determined, together with their colour, opacity and solubility in water. The surface microstructure of the films was analyzed using atomic force microscopy (AFM).

The results showed that ohmic heating had statistically significant effects on film’s physical properties and structure. In general, the most pronounced effect of the field strength was observed for treatments made at 100 V/cm or higher, a positive correlation being found between the water vapour, oxygen and carbon dioxide permeability coefficients and field strength. The AFM results show that the surface of chitosan films is much more uniform when an electric field is applied, which may be related with a more uniform gel structure leading to the differences observed in terms of transport properties. In practice, the changes in the film properties induced by the application of the electrical field may translate in an improved shelf life of the products due to reduced water loss and reduced O₂ and CO₂ exchanges, which will mean a slower metabolism e.g. in fruits and vegetables.

Chitosan-coated pectin beads

Pectin capsules were used as a food carrier for the delivery of folic acid. Pectin-based systems have been applied for colon-specific drug delivery via oral route. Microspheres of low degree of esterification (DE) pectin with calcium and the same sphere coated with chitosan (PCaC) were prepared by scientists at Brazil. The spheres have diameters in the range 650-680 µm. The layer of chitosan is about of 5-15 µm thick. To obtain firm and stable PCaC beads, chitosan was reacetylated. Two different degrees of acetylation, giving PCaC50 and PCaC80 were adopted. The beads were characterized by FTIR, SEM and swelling measurements. Mangiferin was loaded in PCaC reacetylated in two different ways: by addition in pectin solution (Mₚ) and by addition in CaCl₂ solution (Mₖ). The yield in producing the beads, the efficiency in encapsulation and the content of mangiferin in beads were determined. A swelling kinetics study was done in simulated gastric fluid (SGF, pH 1.2) and in simulated intestine fluid (SIF, pH 7.4). The release of mangiferin from the beads was performed in SGF followed by the release in SIF. Based on the yield and efficiency in encapsulation the best bead was found to be PCaC50-Mₚ. The highest release (7.8 mg of mangiferin/g of bead) was achieved by the PCaC50-Mₕ. For all beads more bioactive was released in SGF than in SIF.

The release percentage of mangiferin from all the beads is higher in SGF than in SIF, which means that the major fraction of the bioactive is lost in the stomach. If the release in intestine is expected, the most efficient beads are the PCaC80-Mₚ, which gives 2.1 mg of mangiferin per g of bead. The final conclusion is that it is possible to load mangiferin in matrices of pectin/calcium/chitosan reacetylated and release it in stomach and intestine. The material shows a potential application as nutraceutical to be added in functional foods, and also to improve gastroprotection, already found for mangiferin itself.

[de Souza José Roberto R, de Carvalho José Ivan X, Trevisan Maria Teresa S, de Paula Regina CM, Ricardo Nágila MPS and Feitosa Judith PA, Chitosan-coated pectin beads: Characterization and in vitro release of mangiferin, Food Hydrocol, 2009, 23(8), 2278-2286].
Rheological properties of *Lepidium sativum* Linn. seed extract

*Lepidium sativum* Linn. commonly called Garden Cress is a polymorphic species of great medicinal value. The seeds contain gum of high molecular weight and were selected as a new source of hydrocolloid and its chemical composition and molecular parameters were determined. The main rheological features were investigated by scientists at Iran and UK as a function of shear rate, concentration and temperature. The extract exhibited strong shear-thinning behaviour, which was even more pronounced than for xanthan. An increase in concentration or temperature led to an increase in pseudoplasticity. The Arrhenius model was applied to the temperature dependence of viscosity, and the activation energy ($E_a$) was found to decrease with increasing concentration. The extract solutions showed thixotropic behaviour at all the concentrations and temperatures studied, and the first-order stress decay model with a non-zero equilibrium stress fairly described the time-dependent behaviour. Based on its conformational and rheological similarities with xanthan, *L. sativum* seed extract could be used as a thickening agent in food and related industries [Karazhiyan Hojjat, Razavi Seyed MA, Phillips Glyn O, Fang Yapeng, Al-Assaf Saphwan, Nishinari Katsuyoshi and Farhoosh Reza, Rheological properties of *Lepidium sativum* seed extract as a function of concentration, temperature and time, *Food Hydrocolloids*, 2009, 23 (8), 2062-2068].

Emulsifying properties of gum kondagogu, a natural biopolymer

Natural polymers are widely used as emulsifying agents in the food and pharmaceutical industries because of their low cost, biocompatibility and non-toxic nature. Emulsifying properties of the novel natural biopolymer gum kondagogu (GKG) (*Cochlospermum gossypium* DC.), were investigated by the researchers jointly at Hyderabad and New Delhi. GKG solutions of different concentrations (0.1-0.6% w/v) were prepared in water and emulsified with liquid paraffin oil (40% v/v) in a high-speed homogenizer. Flow properties of the emulsions were measured using a rheometer. Emulsion stability and droplet size distribution were determined by visual observation, photomicrography and laser-scattering particle size distribution analysis.

The emulsions prepared with GKG showed pseudoplastic behaviour. The size of oil droplets and the viscosity of emulsions at concentrations of 0.4-0.6% w/v showed little change over time (up to 30 days), indicating that the emulsions were stable. Measurements of the zeta potential of emulsions adjusted to different pH, with and without added electrolyte, showed that the stabilization of emulsions with GKG was due to mutual repulsion between electrical double layers of particles and adsorption of macromolecules on oil droplets.

The results of this experimental investigation show that GKG is a good emulsifying agent even at low concentrations, with many potential applications in the food and pharmaceutical industries [Vegi Ganga Modi Naidu, Sistla Ramakrishna, Srinivasan Palaniappan, Beedu Sashidhar Rao, Khar Roop K and Diwan Prakash V, Emulsifying properties of gum kondagogu (*Cochlospermum gossypium*), a natural biopolymer, *J Sci Food Agric*, 2009, 89(8), 1271-1276].

Composite edible films based on whey protein isolate and mesquite gum

Physical properties and microstructure of films made of mixtures of whey protein isolate (WPI) and mesquite gum (MG) were investigated by the researchers at Spain and Mexico. A photoacoustic method was used to measure water vapour diffusivity. WPI and MG were totally compatible to make solutions and films. Results showed that film structure is based on a continuous network of WPI aggregates which enlarge their size as the MG content increases.
Gum/Rubber

Neither water vapour diffusivity nor permeability was affected significantly by MG content. However, the incorporation of increasing amounts of MG in the formulation resulted in films with improved flexibility, that is, with significantly lower tensile strength and higher elongation at break. This result suggests the use of MG to improve mechanical properties of WPI films as an alternative of using larger amounts of low molecular weight plasticizers [Osés Javier, Fabregat-Vázquez Mayra, Pedroza-Islas Ruth, Tomás Sergio A, Cruz-Orea Alfredo and Maté Juan I, Development and characterization of composite edible films based on whey protein isolate and mesquite gum, *J Food Eng*, 2009, 92(1), 56-62].

Insecticides/Fungicides/Larvicides

**Antifungal activity of films and solutions based on chitosan against typical seed fungi**

The use of eco-friendy polymers as antimicrobial materials is in growth due to the need to reduce the negative impact of conventional treatments on the environment and the human health. The purpose of the study done by researchers at Department of Food Technology, Universidad Pública de Navarra, Campus Arrosadia, Pamplona, Spain was to assess the antifungal properties of films and solutions based on chitosan with different molecular weight at different concentrations. Surfactants were added to the formulation to assess their impact on treatment efficiency. The antifungal activity was conducted against three fungi, *Aspergillus niger, Alternaria alternata* and *Rhizopus oryzae*. Results indicated important and significant differences of the antifungal activity between chitosan based solutions and chitosan based films. Furthermore, the antifungal activity of the different treatment depended on the type of fungus treated. Thus, chitosan film treatments were significantly more effective on *A. niger* than solution treatments. On the other hand, solution treatments resulted in higher radial inhibition when applied against *A. alternata* or *R. oryzae*. The highest radial inhibition was observed against *A. alternata* (97%) using a chitosan solution. The influence of the other parameters (concentration, molecular weight and surfactant type) on treatment efficiency was not as important and their significance depended on treatment type and fungus nature [Ziani Khalid, Fernández-Pan Idoya, Royo Maite and Maté Juan I, Antifungal activity of films and solutions based on chitosan against typical seed fungi, *Food Hydrocol*, 2009, 23 (8), 2309-2314].

**Fumigant toxicity of essential oil from Vitex pseudo-negundo against Tribolium castaneum (Herbst) and Sitophilus oryzae (L.)**

The scientists at Iran carried out studies to determine the chemical constituents and fumigant toxicity of an essential oil that was isolated via hydrodistillation from dry leaves of *Vitex pseudo-negundo* (Hausskn.) Hand.-Mzz. The chemical composition of the essential oil was assessed via GC and GC-MS. 1, 8-Cineol (18.23%), α-Pinene (16.20%) and Sabinene (5.67%) were determined to be the major constituents of the oil. The fumigant toxicity of the essential oil was tested against 1-7day old adults of *Tribolium castaneum* (Herbst) and *Sitophilus oryzae* (Linn.) at 27±1°C and 60±5% RH in darkness. The mortality of adults was tested at different concentrations ranging from 37.0 to 925.9µl/l air and different exposure times (1-30h). The results demonstrated that the mortality increased with increases in concentration and exposure time. At concentrations higher than 185.2µl/l air, the mortality was