



(51) International Patent Classification:

A23L 1/0524 (2006.01) A23L 1/308 (2006.01)
A23L 1/0534 (2006.01) C12C 5/02 (2006.01)
A23L 1/054 (2006.01) C12G 3/00 (2006.01)
A23L 1/29 (2006.01) C12G 3/04 (2006.01)
A23L 1/30 (2006.01)

(21) International Application Number:

PCT/GB2012/050570

(22) International Filing Date:

15 March 2012 (15.03.2012)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

1104447.6 16 March 2011 (16.03.2011) GB

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: COMESTIBLE PRODUCT

(57) Abstract: The invention provides alcoholic comestible products comprising acid gellable hydrocolloids, such as gellan gum. Methods of suppressing alcohol consumption by consuming the product are also provided.



WO 2012/123748 A1

Comestible Product

The invention relates to appetite suppressing comestible products and to their use in suppressing alcohol consumption in subjects.

Increasing levels of alcohol consumption, especially through so called “binge drinking” associated with the social behaviour of many young people is an increasing cause of concern as it is associated with social harm, economic cost and increased disease burden. Heavy regular binge drinking is associated with adverse effects on neurological, cardiac, gastrointestinal, haematological, immune, musculoskeletal organ systems as well as increasing the risk of psychiatric disorders. Binge drinking during adolescence is associated with injuries resulting from traffic and other accidents and violent behaviour as well as suicide.

Research into appetite suppression to reduce energy intake for weight control has shown that one potential way of reducing appetite is to have liquid foods that respond to the environment that they find themselves in and reduce people’s consumption. Hoad *et al* (J. Nutrition (2004), 134, pages 2293-2300), investigated a food that is structured by a hydrocolloid. Alginate gel was investigated and shown that such a gel self-assembles in the stomach to form a gel within the stomach.

Norton *et al* (Food Hydrocolloids (2006) 20, pages 229-239), show that the onset of hunger can be delayed by several hours using alginate gels.

These papers and a paper by Pelkman *et al* (J. Clin. Nutrition (2007) 86, 1595-1602), have shown that the desire to re-eat can be effected by gelling the stomach contents. However, observation showed that only a limited gelation rate occurred. The alginate gels utilised were relatively weak, producing reduced satiety effects.

A number of problems have been identified by the current inventors, including that the prior art gels were not controllably or manipulated, resulting in incomplete gelation of the stomach contents. Alginate is calcium-sensitive, thus producing potential problems with calcium-containing foods such as milk. Alternatives to alginate were not investigated and the micro

structure control of mixtures of hydrocolloids was not explored. Neither was the rate of availability of the alginate for acid gelation as it was released as a calcium fluid gel.

The inventors have recognised that products that suppress appetite can be modified and used to suppress the consumption of alcohol. Preferably the modified appetite suppressing product is an alcoholic beverage.

The inventors identified that hydrocolloids could be used in appetite suppressing products and products to suppress alcohol consumption. Hydrocolloids are normally precipitated by ethanol so low ionic forms of hydrocolloid are preferred such as, for example, gellan gums.

Gellan gums are polymers of a tetrasaccharide which consists of two residues of D-glucose and one of each residue of L-rhamnose and D-glucuronic acid. The gum is a naturally occurring capsular polysaccharide produced by a bacterium, Sphingomonas elodea. It is available in two forms: the native or high acyl (HA) form which comprises two acyl substituents, acetate and glycerate. Both substituents are located on the same glucose residue and, on average, there is one glycerate per repeat unit and one acetate per every two repeat units. A second, low acyl (LA) form is commercially available. The acyl groups have been removed to produce a linear repeat unit substantially lacking in both groups. Deacylation of the gum is usually carried out by treating a fermentation broth with alkali

The inventors recognise that low acyl gellan gums are particularly advantageous because they are gellable in the presence of an acid. The stomach contents of the typical person are highly acidic (typically a pH of 2 or below). Accordingly, the acidic content of the stomach can be used to gel the gellan gum. This means that products containing the gum can be provided as, for example, liquid or soft food form, which is more palatable to consumers, and then will gel *in situ* within the stomach.

The invention provides an appetite suppressing comestible product, preferably comprising alcohol, that will suppress the consumption of alcohol comprising an acid gellable hydrocolloid, preferably a carbohydrate based hydrocolloid such as gellan gum, alginate, pectin or mixtures of these hydrocolloids. Preferably the hydrocolloid is a low acyl gellan gum.

The product is typically substantially homogenous. That is substantially without separation of the liquid ingredients and the gel.

The gel that is formed within the stomach preferably gives a feeling of fullness in the stomach for a period of time suitable for suppressing the consumption of alcohol during a drinking session with the gel being broken down in the stomach so that it does not suppress the consumption of food or affect eating habits in any adverse way. It is expected that the consumption of alcohol can be suppressed to reduce binge drinking if the gel is broken down in the stomach after a period of between 10 minutes and 3 hours.

The concentration of alcohol in the final product is typically 0.1 to 40% by volume, more typically at least 0.5%, 1% or 2% and less than 30%, or 20% by volume. Preferably the concentration is 2% to 15% or 2% to 10% or 2% to 8% by volume.

The inventors have found that using a concentration of 0.05%-5% by weight, 0.06-5%, above 0.15% or 0.05%-0.4% 0.1-3% or 0.1-2% by weight of hydrocolloid, such as gellan gum, produces a particularly advantageous gel within the stomach. That gel may have a sponge-like texture.

Typically the viscosity of the product is between 1 and 30 times the viscosity of water and preferably between 1 and 20 times or 1 and 10 times the viscosity of water.

Where the product is a fluid gel exhibiting a slight structuring during manufacturing this structuring is can broken up with the application of modest or gentle shearing forces, commonly known as a sheared gel. The product is preferably a sheared gel. The shearing forces may be produced during the manufacturing operation, for example during bottling of the product.

The invention is suitable for products that do not contain gas and for products containing gas as a result of fermentation or carbonation.

The texture of the comestible product may be varied by adding one or more additional hydrocolloids. Such hydrocolloids are typically food-grade hydrocolloids and are edible. One example of such a hydrocolloid is alginate. Alginate is a readily available hydrocolloid

food product. Suitable acid sensitive hydrocolloid systems include alginates and pectins. High acyl gellan may also be used.

Non-acid sensitive hydrocolloids can be added to the acid sensitive hydrocolloid to slow the gelation kinetics. Such non-acid sensitive hydrocolloids include but are not limited to guar, agar, locust bean gum (LBG, also known as carob gum or carobin) and carrageenan.

Additionally, the product may comprise one or more flavourings or colourings or any combination of these. Such flavourings or colouring will normally be food-grade and may include, for example, sweeteners such as aspartame or colourings to improve the taste and appearance of the product.

Macro-nutrients can be incorporated with these flavouring and colouring materials.

The additional flavourings, colourings or macro-nutrients may be encapsulated in a hydrocolloid shell. The shell structure will be broken down slowly over a period of time by gastric fluids after ingestion to release the material. The hydrocolloid shells can be single, double or triple shells or preferably a mixture of these to provide structures that breakdown at different rates for release over a period of hours. Such shells are generally known in the art.

Shells can also include starch such as a Guar or xanthan gum modified starch or ion resistant material such as alginates or carrageenan.

Typically the product is provided in the form of an alcoholic beverage, such as a beer, lager, cider, wine or flavoured drink commonly known as an “alcopop”. The alcohol may be provided as base produced by techniques generally well known in the art to which the gellan gum is added.

Although it has been shown that the natural pH of beers, lagers, ciders and wine need no buffering for the invention to work, the product may be buffered to a predetermined pH optimised for gel formation in the stomach or to limit gel formation prior to being consumed. Buffering is not required for sheared gels.

The invention also provides a method of producing a product according to the invention comprising dissolving the acid gellable hydrocolloid in water and mixing the dissolved hydrocolloid with an alcohol base. Preferably the dissolved hydrocolloid is mixed with the alcohol base at 60:40 to 40:60 vol:vol, preferably 50:50 vol:vol.

The acid gellable hydrocolloid may alternatively be dissolved directly into the alcohol base.

In a further embodiment of the invention the acid gellable hydrocolloid can be added before the fermentation process. Hydrocolloids, and gellan gum in particular, are not fermentable and will not be degraded or adversely affected by fermentation processes.

The water or alcohol base may be heated to assist in dissolving the acid gellable hydrocolloid, for example to a temperature in the range 50 to 80°C.

The inventors have also identified that it may be desirable to produce lower viscosity drinks that gel in the stomach. One way of carrying this out is to subject the alcohol base comprising the hydrocolloid to shearing to break the matrix of cross linked hydrocolloid polymers in the product, resulting in a sheared gel.

The sheared gel may be produced by shaking or using a pin stirrer or by the manufacturing processes. The alcohol base comprising the dissolved acid gellable hydrocolloid may be passed through, for example, through a scraped-surface heat exchanger ("A unit"), and a pin stirrer ("C unit"). This may be cooled, for example to 5°C.

In such a method, the final concentration of hydrocolloid in the product may be 0.05 to 1% by weight.

The shearing forces for producing a sheared gel of the invention are generally very low and not expected to result in any loss of gas from products containing carbonation. If higher shear forces are required it may be desirable to add a gas to replace the gasses removed by shearing. The method therefore includes dissolving a gas, preferably carbon dioxide or nitrogen gas, into the alcoholic base comprising the dissolved hydrocolloid. If the shearing process to produce the sheared gel is found to have a detrimental effect on the gas content the

shearing can alternatively be carried out under pressure of, for example 2 Bar to retain the carbonation.

The water and/or alcohol base may have the pH adjusted to optimise the pH of the product for gel production or to inhibit gel formation prior to being consumed, so that the gel forms in the stomach.

After formation of the gel structure in the stomach the gel is slowly broken down by the digestion processes in the stomach and by the shear forces exerted by the stomach wall. The gel structure formation and break down are determined by the gel composition.

The invention also provides a method of suppressing alcohol consumption comprising consuming a product according to the invention. The amount of alcohol consumed compared to alcoholic drinks without the gel is reduced because of the increased sensation of fullness.

The product may be utilised, for example, as part of a therapy in the treatment of disorders such as alcoholism.

A further aspect of the invention provides a product according to the invention for use to suppress alcohol consumption.

The invention will now be described by way of example only with reference to the following Figures:

Fig.1. (Norton, 2010) Schematic of a typical true stress/true strain curve obtained during uniaxial compression of gellan gum acid gels. Also shown is how the data in the plot are interpreted to give the Young's modulus, bulk modulus and total work of failure for the acid gel structures.

Fig. 2. True stress/true strain curves for the 50:50 LA Gellan:cider mixed gels (2-4 wt%) stored at RT (a) and at 5 °C (b) respectively. Each curve is the mean of at least four repeats; error bounds are plus/minus a single standard deviation.

Fig. 3. Young's and bulk moduli and total work of failure for the 2-4 wt% 50:50 LA Gellan:cider gels stored at RT (a) and at 5 °C (b) respectively. Data points are averages of four repeats.

Fig. 4. True stress/true strain curves for the 50:50 LA Gellan:lager mixed gels (2-4 wt%) stored at RT (a) and at 5 °C (b) respectively. Each curve is the mean of at least four repeats; error bounds are plus/minus a single standard deviation.

Fig. 5. Young's and bulk moduli and total work of failure for the 2-4 wt% 50:50 LA Gellan:lager gels stored at RT (a) and at 5 °C (b) respectively.

Fig. 6. True stress/true strain curves for the 50:50 LA Gellan:lager mixed gels (2-4 wt%) (a) and 50:50 LA Gellan:cider mixed gel (2-4 wt%) (b) after they were exposed to a 0.5% HCl acid bath soak (24 hours). Each curve is the mean of at least four repeats; error bounds are plus/minus a single standard deviation.

Fig. 7. Young's and bulk moduli and total work of failure for the 50:50 LA Gellan:lager mixed gels (2-4 wt%) (a) and 50:50 LA Gellan:cider mixed gel (2-4 wt%) (b) after they were exposed to a 0.5% HCl acid bath soak (24 hours).

Fig. 8. True stress/true strain curve for the 5 wt% LA Gellan lager solution gel (a). The curve is the mean of four repeats and error bounds are plus/minus a single standard deviation. Fig. 8 (b) shows the Young's and bulk modulus and total work of failure for the sample.

Fig. 9. True stress/true strain curves for the 4 wt% LA Gellan cider solution gel (a) and after the former was exposed to a 0.5% HCl acid bath soak (24 hours) immediately after production (b) . Each curve is the mean of at least four repeats; error bounds are plus/minus a single standard deviation.

Fig. 10. Young's and bulk moduli and total work of failure for the 4 wt% LA Gellan cider solution gel (a) and after the former was exposed to a 0.5% HCl acid bath soak (24 hours) immediately after production (b).

Experimental

Materials

Low acyl gellan gum (Kelcogel F, CPKelco, UK) was used as the model “acid-sensitive” hydrocolloid in this study. The water used for all the prepared hydrocolloid solutions was passed through a reverse osmosis unit and then a Milli-Q water system. CarlsbergTM lager and StrongbowTM cider were used to produce the low acyl gellan gum:cider and low acyl gellan gum:lager mixed gel structures. HCl acid was purchased from Fisher Scientific (Loughborough, UK) and was used for the acid baths in which the produced gels were exposed to post-production. Visking dialysis tubing (25.4mm internal diameter, 14000 Da

pore size) was purchased from Medicell International Ltd (London, UK) and was used to hold the mixed gel solutions when they were placed within the acid bath. All materials were used with no further purification or modification of their properties.

Methods

Preparation of mixed gels

Initially, aqueous solutions of gellan with concentrations between 2 wt% and 4 wt% were prepared by dissolving the required amounts of the hydrocolloid in distilled water at 80 °C to avoid gelation. The natural pH of the gellan solutions was measured as below and it was not dependent upon the gellan concentrations used. 50:50 low acyl gellan:cider mixed solutions were then made by adding equal volumes of the low acyl gellan aqueous solution and the cider together. The solutions were poured into cylindrical moulds (22.5 mm internal diameter and 50 mm height), which were stored at room temperature and at 5 °C for at least 24 h to allow for gel formation. 50:50 low acyl gellan:lager mixed solutions (concentrations 2 – 4 wt%) were then prepared following the same procedure for the 50:50 low acyl gellan:cider mixed solutions and were stored again both at room temperature and at 5 °C for at least 24 h to allow for gel formation. 2 wt% and 5 wt% low acyl gellan lager solutions were then prepared by dissolving the required amounts of the hydrocolloid directly into the lager solution at room temperature initially (agitation applied using a magnetic stirrer bead and stirrer plate) and then at 80 °C to avoid gelation. The solutions were then poured into cylindrical moulds (22.5 mm internal diameter and 50 mm height), which were stored at 5 °C for at least 24 h to allow for gel formation. 3 wt% and 4 wt% low acyl gellan cider solutions were then prepared following the same procedure for the low acyl gellan lager solutions.

Texture analysis (see following section for details) of all samples that had fully gelled was carried out immediately after the 24 hr setting period.

The pH of the Carlsberg lager was pH 4.12 and the pH of the Strongbow cider was pH 3.01.

Texture Analysis

The structure of the prepared gels was assessed by performing a series of compression tests using a TA.XT.plus texture analyser (Stable Micro Systems Ltd., UK), fitted with a 40-mm diameter cylindrical aluminium probe. All samples had a diameter of 22.5 mm and their length was kept at ~ 10 mm; thus sample diameter was always a factor of approximately 2 smaller than the diameter of the probe. All measurements were carried out four times with a compression rate of 1 mm/s.

The force/distance (of compression) data, as obtained directly from the texture analyser, were converted into “true strain” ϵ_H and “true stress” σ_T data using the following equations (for example see: Moresi & Bruno, 2007):

$$\epsilon_E = (H_o - h)/H_o \quad (1)$$

$$\epsilon_H = \ln(1 + \epsilon_E) \quad (2)$$

$$\sigma_E = F/A_o \quad (3)$$

$$\sigma_T = \sigma_E(1 + \epsilon_E) \quad (4)$$

where ϵ_E and ϵ_H are the engineering and true (Hencky) strain, σ_E and σ_T are the engineering and true stress, H_o and A_o are the initial height and cross-sectional area of each sample and F and h are the compression force applied and height of each sample as recorded during the compression tests.

From the obtained true stress/true strain curves, the slope of the initial linear region (up to strain values of 0.05) can be used to calculate the Young's modulus (Smidsrød, Haug, & Lian, 1972) while the slope of the second linear region (for strain values over ~0.1), leading to the subsequent structure failure can be used to calculate the bulk modulus (Nussinovitch, 2004). The calculated moduli provide information regarding the two deformation mechanisms associated with each of the two linear regions. When the samples are initially loaded the "connections" between the hydrocolloid molecules within the gel network are bent, as a result of the applied stress. During this compression stage the gel matrix exhibits an elastic behaviour a measure of which is given by the calculated Young's modulus. When a critical stress is reached the connections between the hydrocolloids eventually collapse and the process of deformation enters a second much steeper linear region during which packing of the hydrocolloid chain takes place. During this compression stage the exhibited behaviour is non-elastic and the slope of the linear region in the true stress/true strain curve, thus the calculated bulk modulus, relates to the stiffness/deformability of the gel matrix, until structure failure occurs. Finally the total work of failure (for example see: Kaletunc, Normand, Nussinovitch, & Peleg, 1991) is the total work (given as work per unit area in this study) that is required in order for the structure to fail and is represented by the area, up to the point of failure, under the true stress/true strain curve. Fig. 1 schematically shows a typical

true stress/true strain curve and also how the data in the plot are interpreted to give the Young's modulus, bulk modulus and total work of failure for the acid gel structures.

Exposure to acidic environment

The response of all 50:50 LA gellan/cider solutions (2-4 wt%); 50:50 LA gellan/lager solutions (2-4 wt%); and the 4 wt% LA gellan powder in cider solution, to exposure to an acidic environment was investigated by placing them in visking dialysis tubing before submerging them into an acid solution (0.5 wt% HCl corresponding to ~ pH 1) for 24 hrs. Texture analysis of these systems took place immediately after the 24 hr exposure period and tests were performed upon replicate samples.

Results and Discussion

Initially, 50:50 LA Gellan:cider mixed gels were produced at varying weight percentage concentrations without the addition of acid to investigate how this affected their gelation properties. The mixed gel solutions were then stored at room temperature and at 5 °C to investigate whether the storage temperature has any effect on the textural properties of the produced gel structures. The data obtained for 2-4 wt% 50:50 LA Gellan:cider mixed gels stored at room temperature and at 5 °C is shown in Figs. 2 (a) and (b) respectively. All of the solutions formed gels strong enough to display purely brittle behaviour, with a rapid decrease in the applied stress once the gels fail at strains between 0.2 and 0.35. The error bars for all measurements until failure are relatively small which further supports the fact that the performed tests give a genuine representation of the behaviour of these systems. Error bars on the data recorded after the structures have failed are larger due to the random nature of fracture propagation through the gel matrix. Fig. 2 confirms that the physical properties of the formed gellan:cider mixed gels are dependent on the hydrocolloid concentration in the systems, with the strength of the gels increasing with increasing weight percentage. The storage temperature of the samples had very little effect on the textural properties of the

produced gels structures. Minimal variations in the true stress/true strain curves were observed with the 4 wt % and 2 wt % fracture peaks being marginally higher and lower respectively, in the samples stored at 5 °C compared to those stored at room temperature. However, these variations are small enough to confidently state that the storage temperature does not affect the physical properties of these systems.

The data from Fig. 2 were used to calculate the Young's modulus, bulk modulus and total work to failure for the tested gel structures, which are plotted in Fig. 3. The data suggests that increasing the total weight percentage concentration of the gellan hydrocolloid mixed system increases the elasticity (Young's modulus) of the structures, their stiffness (bulk modulus) and also their overall strength (total work of failure). The 50:50 LA Gellan:cider samples stored at room temperature and at 5 °C are both of similar stiffness as demonstrated by their bulk modulus trends in Fig. 3, however slight variations with the Young's modulus and total work of failure values are observed for the samples stored at 5 °C. The samples stored at 5 °C are observed to be roughly two thirds more elastic, and in addition have a slightly higher overall strength than the samples stored at room temperature. The work of fracture for the room temperature stored samples increases with increasing total weight percentage concentration however, although the same is observed for those samples stored at 5 °C between 3 – 4 wt%, the value calculated for 2 wt% is too high to fit the same trend. Presumably, this is due to some sort of experimental error or simply that the overall strengths of the 3 wt% and 4 wt% gels are very similar. It is important to note that the differences between the two total work of fracture points in J/m^2 are very small.

We have shown from the moduli data in Fig. 3 that the elasticity and strength of the overall mixed gellan:cider gels increase with increasing hydrocolloid concentration and these in turn

are a reflectance on the extent of cross-linking between the polymer chains i.e. the extent of interactions between the hydrocolloid chains also increase as a result of increasing hydrocolloid concentration

Next, 50:50 LA Gellan:lager mixed gels were produced in exactly the same way as the 50:50 LA Gellan:cider mixed gels and likewise were stored at room temperature and at 5 °C to investigate whether the storage temperature has any effect on the textural properties of the produced gel structures. The data obtained for 2-4 wt% 50:50 LA Gellan:lager mixed gels stored at room temperature and at 5 °C is shown in Figs. 4 (a) and (b) respectively. Once again, all the solutions formed gels strong enough to display purely brittle behaviour, with a rapid decrease in the applied stress once the gels fail at strains between 0.3 and 0.4. The error bars for all measurements until failure remain to be relatively small, and those after the structures have failed are again larger due to the random nature of fracture propagation through the gel matrix. Fig. 4 confirms that the physical properties of the formed gellan:lager mixed gels are dependent on the hydrocolloid concentration in the systems, with the strength of the gels increasing with increasing weight percentage. The storage temperature of the samples also had very little effect on the textural properties of the produced gels structures. Minimal variations in the true stress/true strain curves were observed with the 2 wt % and 3 wt % fracture peaks being marginally lower in the samples stored at 5 °C compared to those stored at room temperature. However, once again these variations are small enough to confidently state that the storage temperature does not affect the physical properties of these systems.

The data from Fig. 4 were then used to calculate the Young's modulus, bulk modulus and total work to failure for the tested gel structures, which are plotted in Fig. 5. The data

suggests that increasing the total weight percentage concentration from 3 wt% to 4 wt% of the gellan hydrocolloid mixed system increases the elasticity (Young's modulus) of the structures, their stiffness (bulk modulus) and also their overall strength (total work of failure). This trend is not fully reflected between 2wt% and 3 wt%, since the properties of the produced gels for the systems seem to vary slightly with storage temperature. For the 50:50 LA Gellan:lager samples stored at room temperature, an increase in the stiffness and overall strength of the gels are observed with increasing total weight concentration from 2 wt% - 3 wt%, with the elasticity displaying a decrease. For the 50:50 LA Gellan:lager samples stored at 5 °C, the opposite is observed with only the elasticity increasing with increasing total weight concentration from 2 wt% - 3 wt% and the stiffness and overall strength of the gels displaying a decrease. It is also worth noting that the total work of failure (overall strength) for the 5 °C stored samples is slightly higher compared to the room temperature samples (3 wt% at 5 °C is roughly equal to 4 wt% at RT). Despite all these differences however, the variations in scales between them are very small and are not of significant importance.

The response of the 50:50 LA Gellan:cider solutions (2-4 wt%) and the 50:50 LA Gellan:lager solutions (2-4 wt%) to exposure to an acidic environment was next investigated by placing them in visking dialysis tubing before submerging them into an acid solution (0.5 wt% HCl corresponding to ~ pH 1) for 24 hrs to study the effect on the textural properties of the subsequent acid gels produced. The reason behind these tests is that once the alcoholic beverages are consumed they remain within the stomach's acidic environment for much longer after the initial gelation is completed. The data obtained for the 50:50 LA Gellan:lager solutions (2-4 wt%) and the 50:50 LA Gellan:cider solutions (2-4 wt%) after they were exposed to a 0.5 wt% HCl acid solution (24 hours) is shown in Figs. 6 (a) and (b) respectively. As with the previous tests, the solutions formed gels displaying purely brittle behaviour, with a rapid decrease in the applied stress once the gels fail at strains between 0.3

and 0.4. The error bars for all measurements until failure remain to be relatively small, and those after the structures have failed are again larger due to the random nature of fracture propagation through the gel matrix.

Fig. 6 confirms that the physical properties of the formed gellan:lager and gellan:cider mixed gels are still dependent on the hydrocolloid concentration in the systems, despite the exposure to the acidic environment, with the strength of the gels increasing with increasing weight percentage. Exposing the two mixed solution types to an acidic environment caused the produced gels to have a greater strength than those gels produced by leaving the solutions to set at room temperature or at 5 ° C. For the 50:50 LA Gellan:lager solution gels, the strength increased by roughly two times and four times for the 2-3 wt% and 4 wt% gels respectively, compared to the non-acid gels in Fig. 4. For the 50:50 LA Gellan:cider solution gels, the strength increased by roughly two and three-quarter times and two times for the 2 wt% and 3-4 wt% gels respectively, compared to the non-acid gels in Fig. 2.

The data from Fig. 6 were then used to calculate the Young's modulus, bulk modulus and total work to failure for the tested gel structures, which are plotted in Fig. 7. The data once again suggests that increasing the total weight percentage concentration of the gellan hydrocolloid mixed system increases the elasticity (Young's modulus) of the structures, their stiffness (bulk modulus) and also their overall strength (total work of failure). The 50:50 LA Gellan:lager and LA Gellan:cider mixed solutions are both of similar stiffness and share overall strengths, however the latter mixed solution (cider) has an increased elasticity than the former (lager) mixed solution. Presumably, this is due to expected variations in the calculations between the samples when fitting the linear regression curves to give the Young's modulus values. Regardless of these variations, it is clear from comparing Fig. 7

with that of Figs. 3 and 5 that the exposure to the acid causes the subsequent acid gels produced to strengthen, thus indicating that a greater number of hydrocolloid chains are being cross-linked and that any initial gel formation cross-linking likely to be present has been reinforced.

2 wt% and 5 wt% LA Gellan lager solutions were next prepared by dissolving the required amounts of the hydrocolloid directly into the lager solution before storing them at 5 °C for at least 24 h to allow for gel formation. The 2 wt% solution did not form a solid gel after this setting period and so subsequent compression tests could not be performed to assess the textural properties. The 5 wt% LA Gellan lager solution formed a very thick paste-like gel, which could not be poured into the visking tubing to subject to a 0.5 wt% HCl acid bath soak however, compression tests were able to be performed on the sample. The obtained results from these tests are shown in the true stress/true strain curve in Fig. 8 (a). The gel displays purely brittle behaviour, with a rapid decrease in the applied stress once the gel fails at a strain of roughly 0.25. The error bars up to the point of failure are relatively small, and those after the structure has failed are again larger due to the random nature of fracture propagation through the gel matrix. The data from Fig. 8 (a) were then used to calculate the Young's modulus, bulk modulus and total work to failure for the tested gel structure, which are plotted in Fig. 8 (b). The produced gel via this alternative method is stronger than the 50:50 LA Gellan:lager mixed gels also stored at 5 °C and this is demonstrated by the bulk modulus data in Figs. 8 (b) and 5 (b) (the 5 wt% Gellan lager solution gel is roughly three times stiffer than the 4 wt% 50:50 LA Gellan:lager solution gel).

3 wt% and 4 wt% LA Gellan cider solutions were then prepared by dissolving the required amounts of the hydrocolloid directly into the cider solution before storing them at 5 °C for at least 24 h to allow for gel formation. Each of the samples were also exposed to a 0.5 wt% HCl acid bath soak (24 hours) to investigate whether exposure to an acidic environment affected their textural properties. The 3 wt% solution did not form a solid gel after either the refrigerated setting period or after the 24 hour acid solution exposure. However, the 4 wt% LA Gellan cider solution did form a gel in each of these two conditions. The obtained results from these tests are shown in the true stress/true strain curves in Fig. 8.

The gels display purely brittle behaviour, with a rapid decrease in the applied stress once the gels fail at strains between roughly 0.2 and 0.25. The error bars up to the point of failure are relatively small, and those after the structure has failed are again larger due to the random nature of fracture propagation through the gel matrix. The 4 wt% LA Gellan cider solution gel (no exposure to acid) is approximately twice as strong as the 4 wt% 50:50 LA Gellan:cider solution gel (no exposure to acid) (Figs. 9 (a) and 2 (b)). Exposure to an acidic environment further increases the strength of the 4 wt% LA Gellan cider solution gel by roughly 50 %. This increased strength once again indicates a greater number of hydrocolloid chains are being cross-linked as a result of the acid exposure, and that any initial gel formation cross-linking likely to be present has also been reinforced.

The data from Fig. 9 were used to calculate the Young's modulus, bulk modulus and total work to failure for the 4 wt% LA Gellan cider solution gel structures with and without acid exposure, which are plotted in Figs 10 (a) and (b) respectively. This data further confirms that the gel becomes stiffer and more resistant to fracture as a result of exposure to an acidic environment. Comparing the bulk modulus data of the 4 wt% LA Gellan cider solution gel

(after 24 hour acid soak) with the 4 wt% 50:50 LA Gellan:cider solution gel (after 24 hour acid soak) the former is roughly a quarter times stiffer than the latter.

Conclusions

The gelation properties of a variety of different low acyl gellan/cider and low acyl gellan/lager mixed solutions has been investigated. The structure of these gels were found to be dependent on the concentration of the hydrocolloid used during their formation. Exposing the same solutions to an acidic environment for 24 hours immediately after their production was found to affect gel structure. These initial findings are promising as they demonstrate that the structuring of gellan/cider or lager mixed solution gels can be controlled by both the process used for their production and by exposure to an acidic environment. Ideally, one would not want the mixed gel solutions to form solid gels until they reach the stomach's acidic conditions, so total percentage weight concentrations of 2 – 5 wt% are too high. It is preferable to use concentrations of e.g. 0.1 wt% - 2 wt%, so that the gel 'breaks' upon the application of a shearing force. Another, proposal related to this concept is the production of fluid gels. Aqueous mixed solutions can be made as already described before pumping them through a surface heat exchanger and pin stirrer ('a and c-units') controlled at high shear rates, in addition to adjusting the temperature jackets so that the solution released is a gel that remains fluid.

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Claims

1. An appetite suppressing alcoholic comestible product comprising an acid gellable hydrocolloid.
2. A product according to claim 1 which is homogenous.
3. A product according to an preceding claim having a viscosity of 1 to 10 times that of water and/or which is a sheared gel.
4. A product according to claim 1, wherein the hydrocolloid is a carbohydrate based hydrocolloid, preferably gellan gum, alginate, pectin or mixtures thereof.
5. A product according to any preceding claim, wherein the hydrocolloid is gellan gum.
6. A product according to claim 1 comprising 0.1 to 40% by volume ethanol.
7. A product according to claims 1 to 6 comprising beer, cider or lager.
8. A product according to claims 1 to 7, wherein the acid gellable hydrocolloid is a low acyl gellan gum.
9. A product according to claim 8, comprising 0.05% to 5% by weight, preferably 0.1-2% by weight of gellan gum.
10. A product according to any preceding claim, comprising one or more additional hydrocolloids.
11. A product according to claim 10, wherein the additional hydrocolloid is a non-acid sensitive hydrocolloid.

12. A product according to claim 11, wherein the additional hydrocolloid is guar, agar, carrageenan or locust bean gum.
13. A product according to any preceding claim comprising one or more nutrients, such as vitamins or minerals.
14. A product according to any preceding claim additionally comprising one or more flavourings or colourings.
15. A method of suppressing alcohol consumption comprising consuming a product according to any preceding claim.
16. A product according to claims 1 to 14 for use to suppress alcohol consumption.
17. A method of producing a product according to claims 1 to 14 comprising dissolving the acid gellable hydrocolloid in water and mixing the dissolved hydrocolloid with an alcohol base.
18. A method according to claim 17, wherein the dissolved hydrocolloid is mixed with the alcohol base at 60:40 to 40:60 vol:vol, preferably 50:50 vol:vol.
19. A method of producing a product according to claims 1 to 14, comprising dissolving the acid gellable hydrocolloid in an alcohol base
20. A method according to claims 17 to 19 comprising subjecting the alcoholic base comprising the dissolved hydrocolloid to shearing.
21. A method according to claim 20, wherein the shearing is produced by shaking or using a pin stirrer.
22. A method according to claims 20 or 21, wherein the final concentration of acid sensitive hydrocolloid in the product is 0.05 to 1% by weight.

23. A method according to claims 17 to 22, comprising dissolving a gas, preferably carbon dioxide or nitrogen gas, into the alcoholic base comprising the dissolved hydrocolloid.

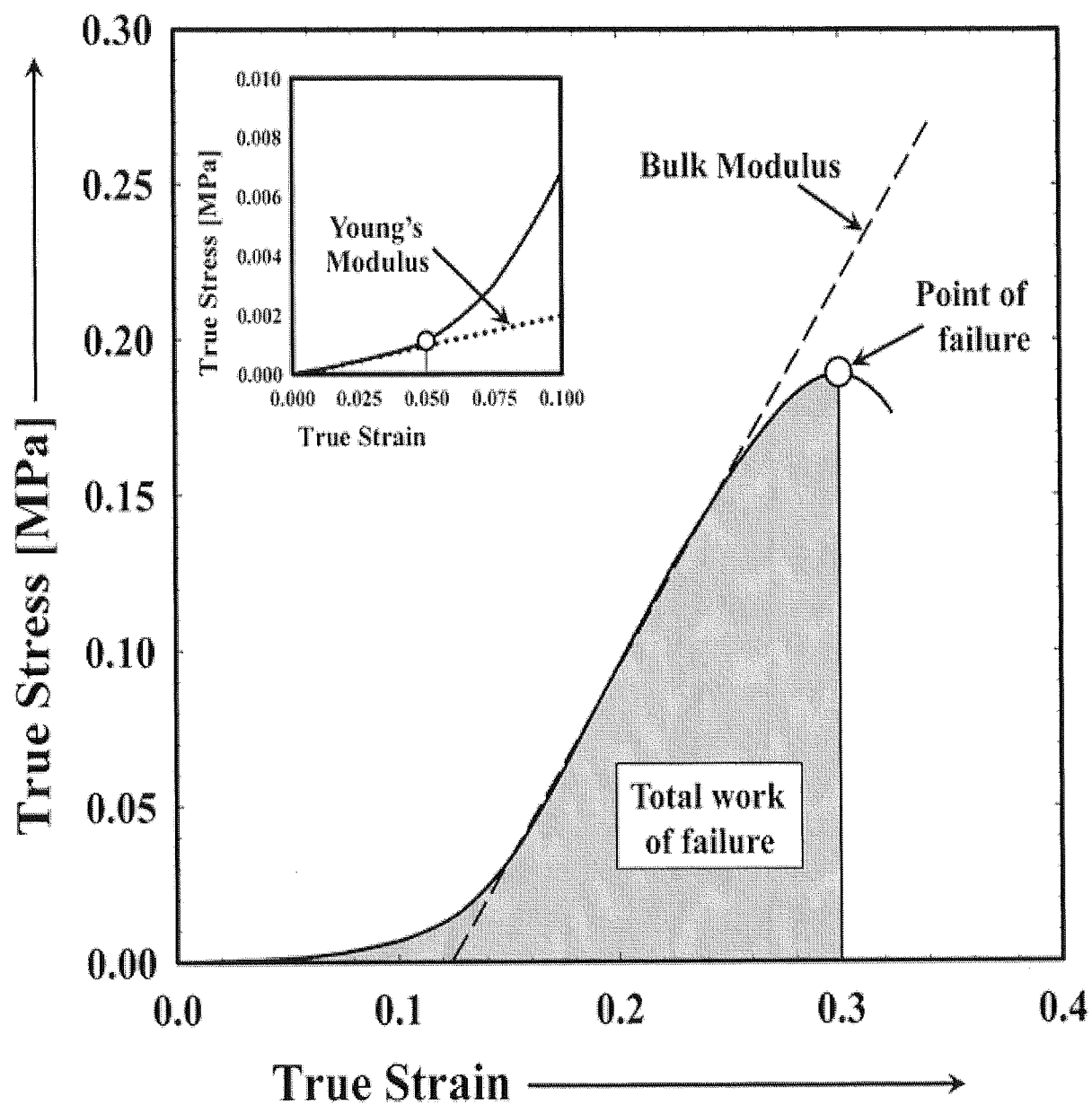
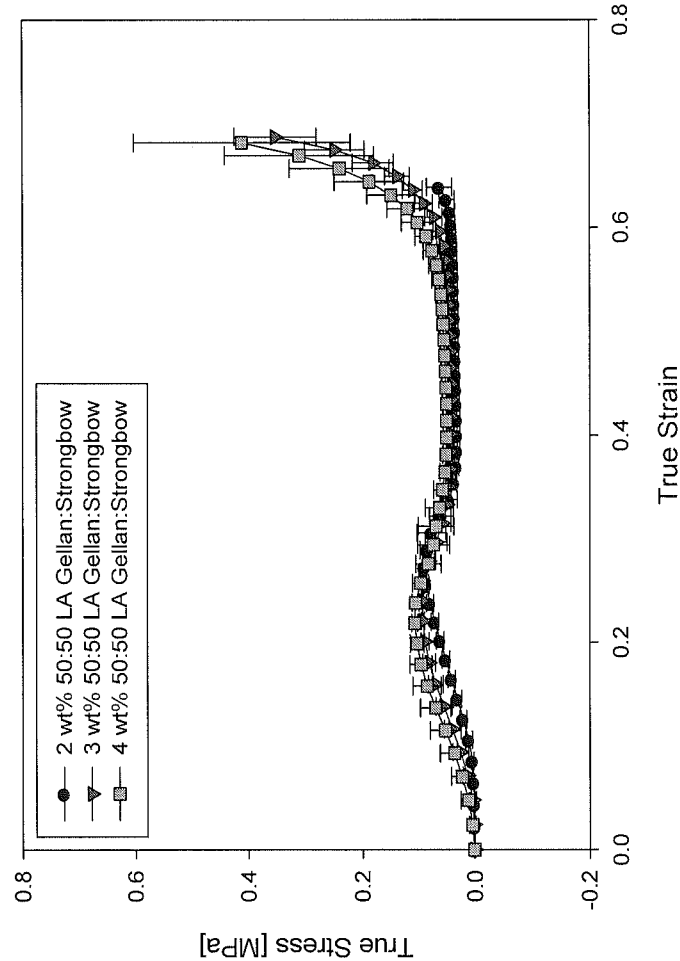


Fig. 1

Fig. 2

a



b

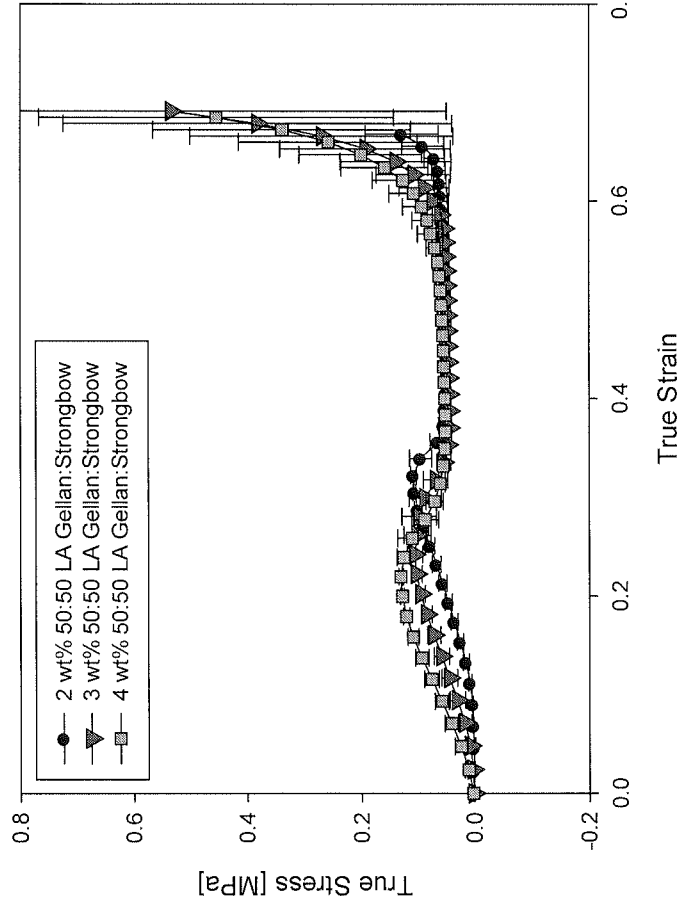
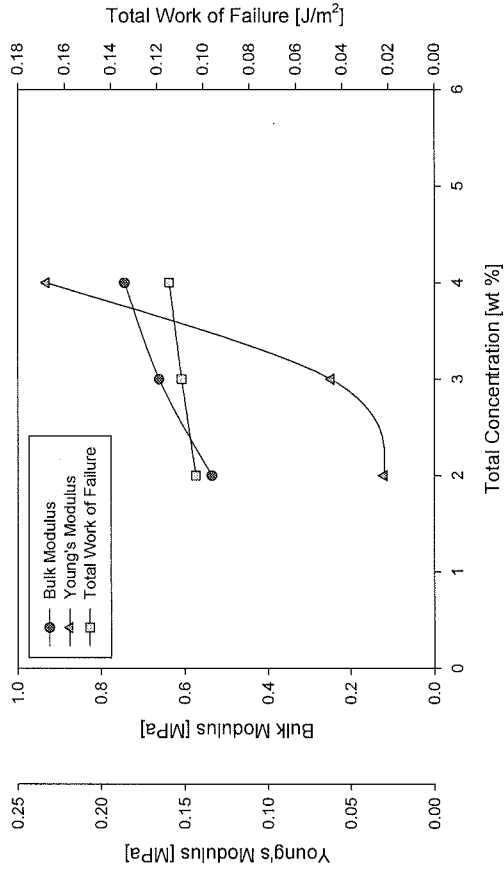


Fig. 3

a



b

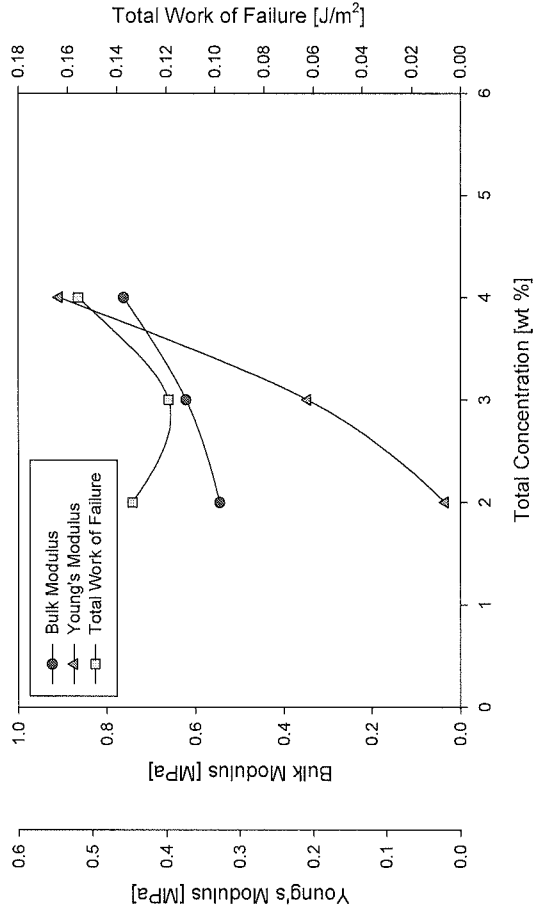


Fig. 4

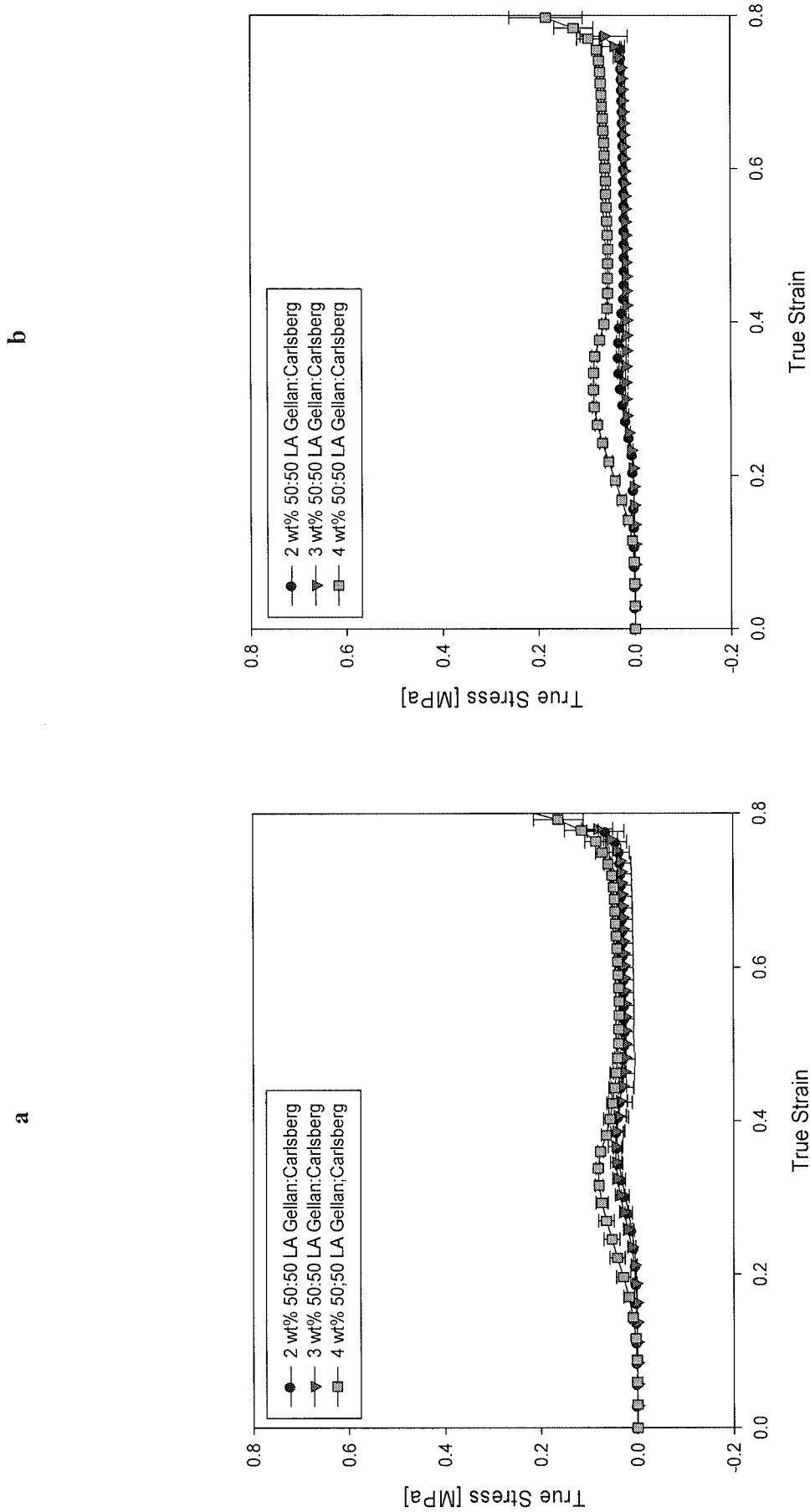
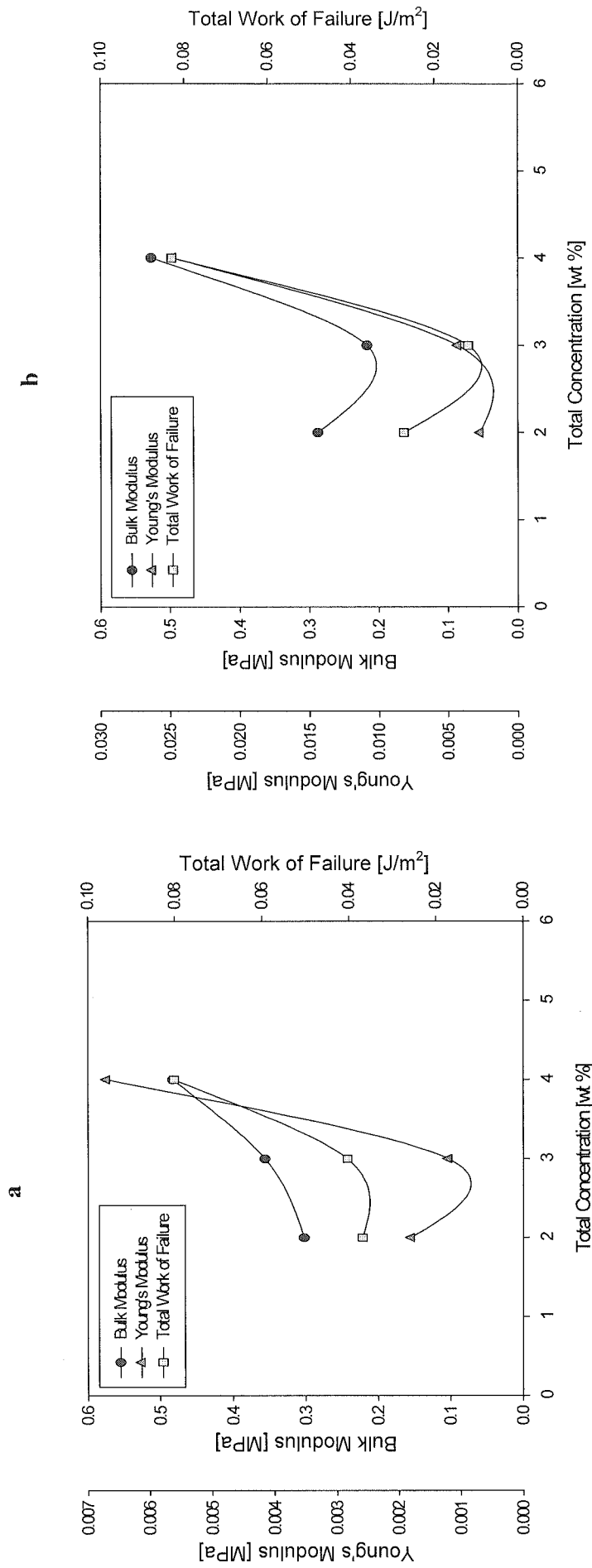


Fig. 5



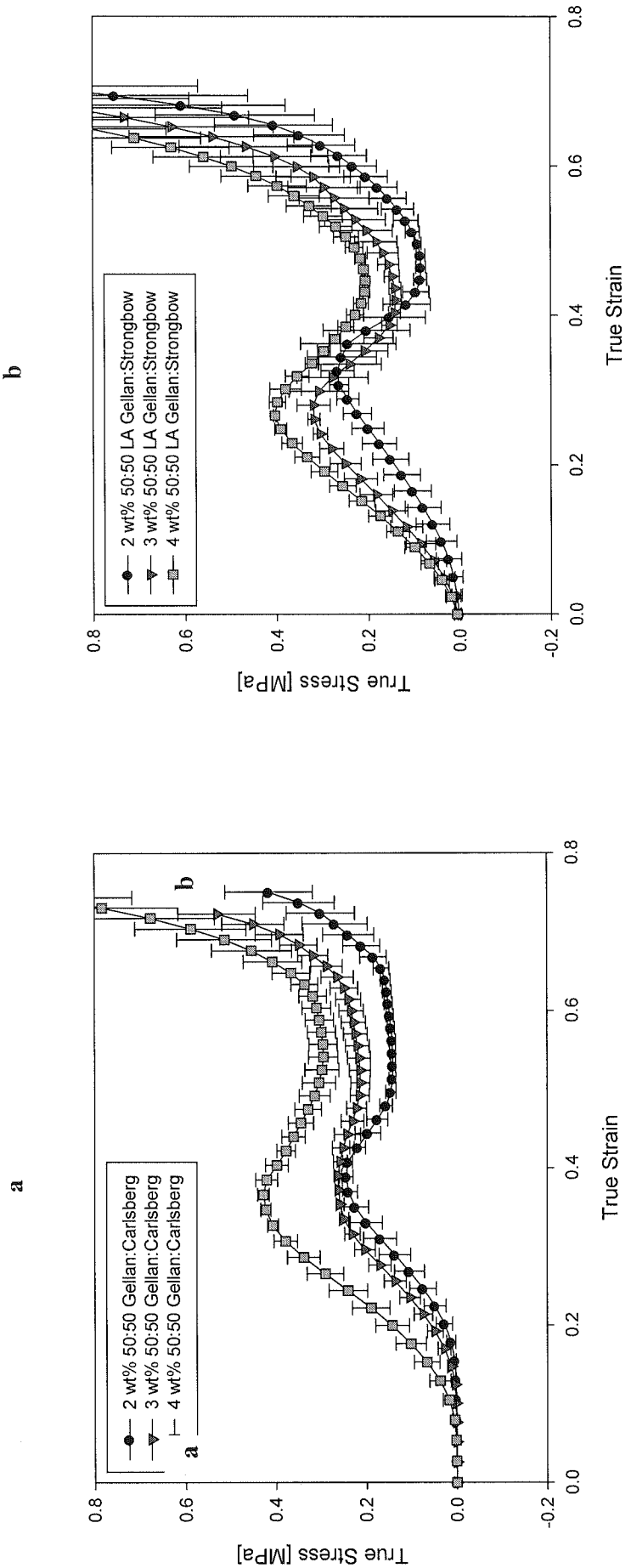
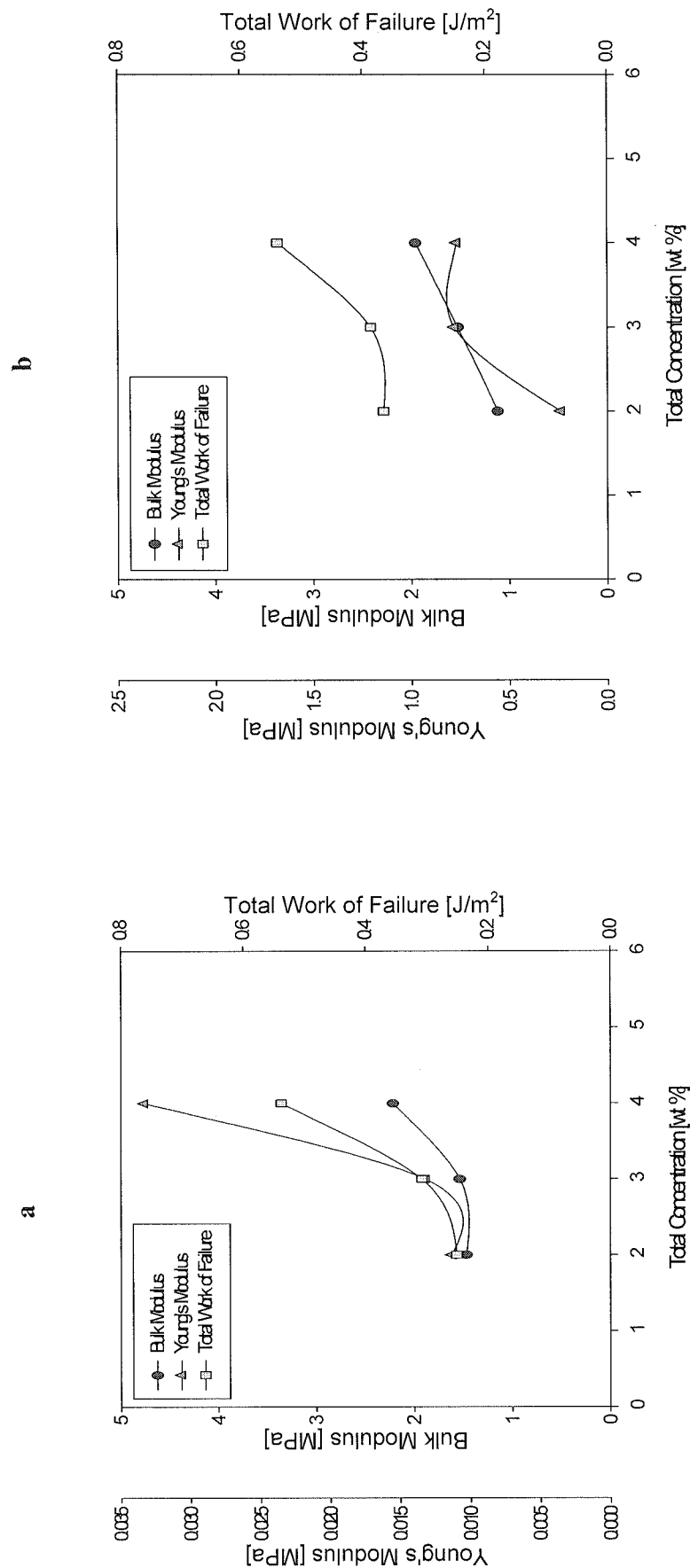


Fig. 6

Fig. 7



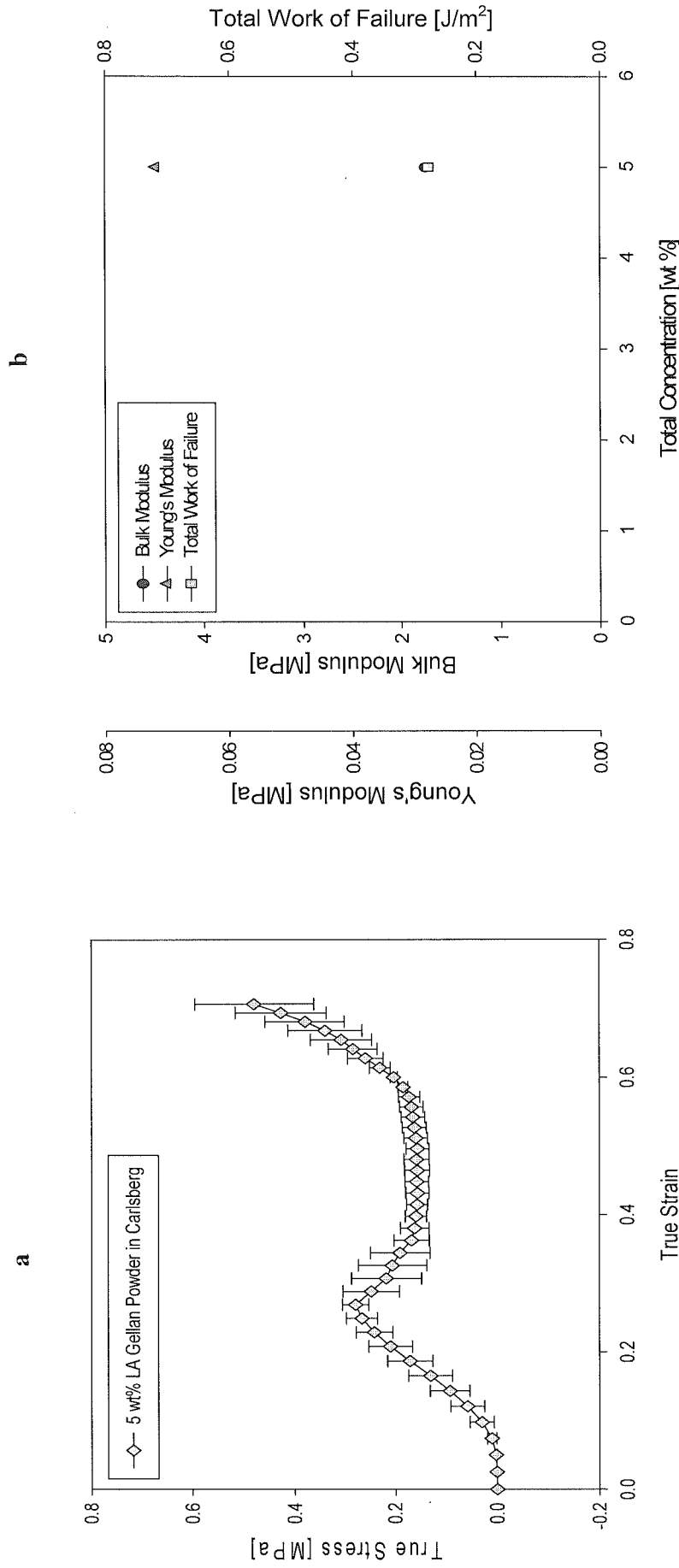
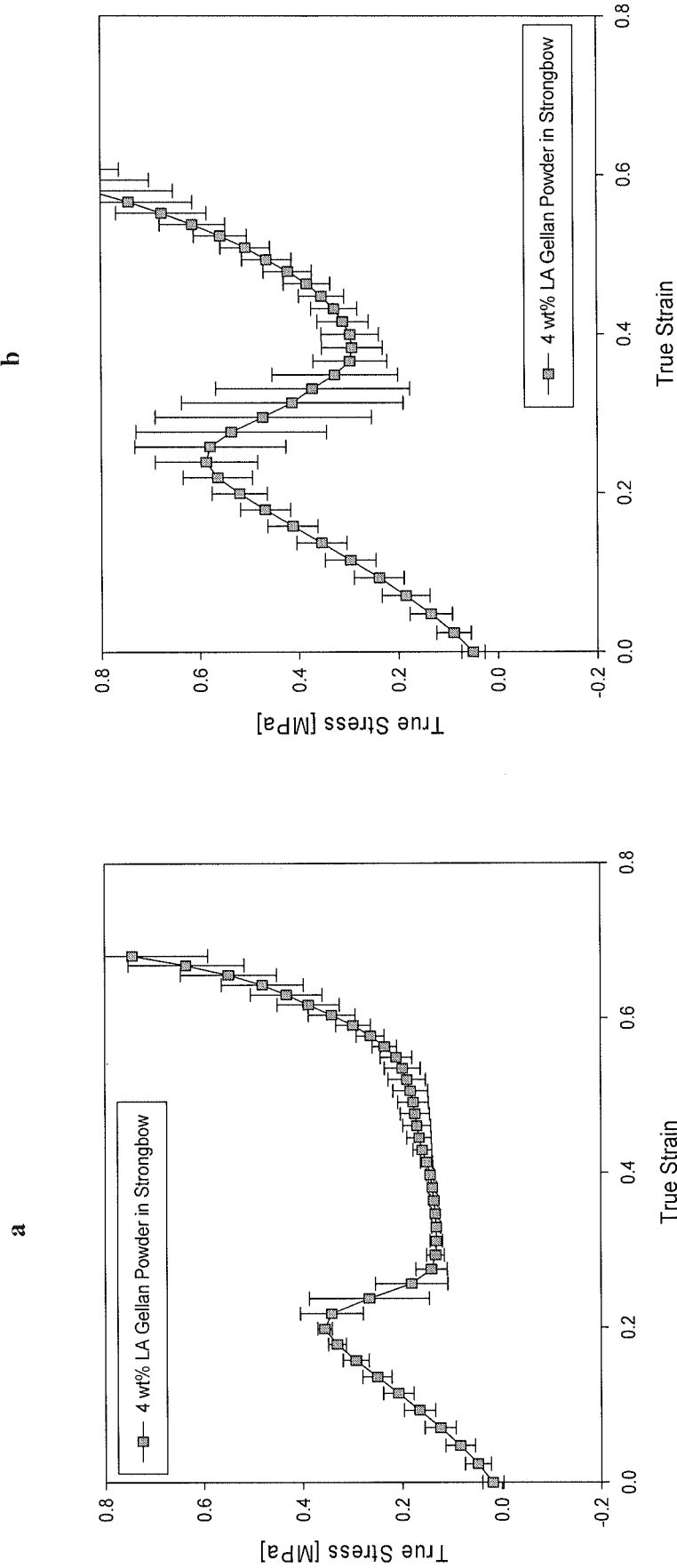


Fig. 8

Fig. 9



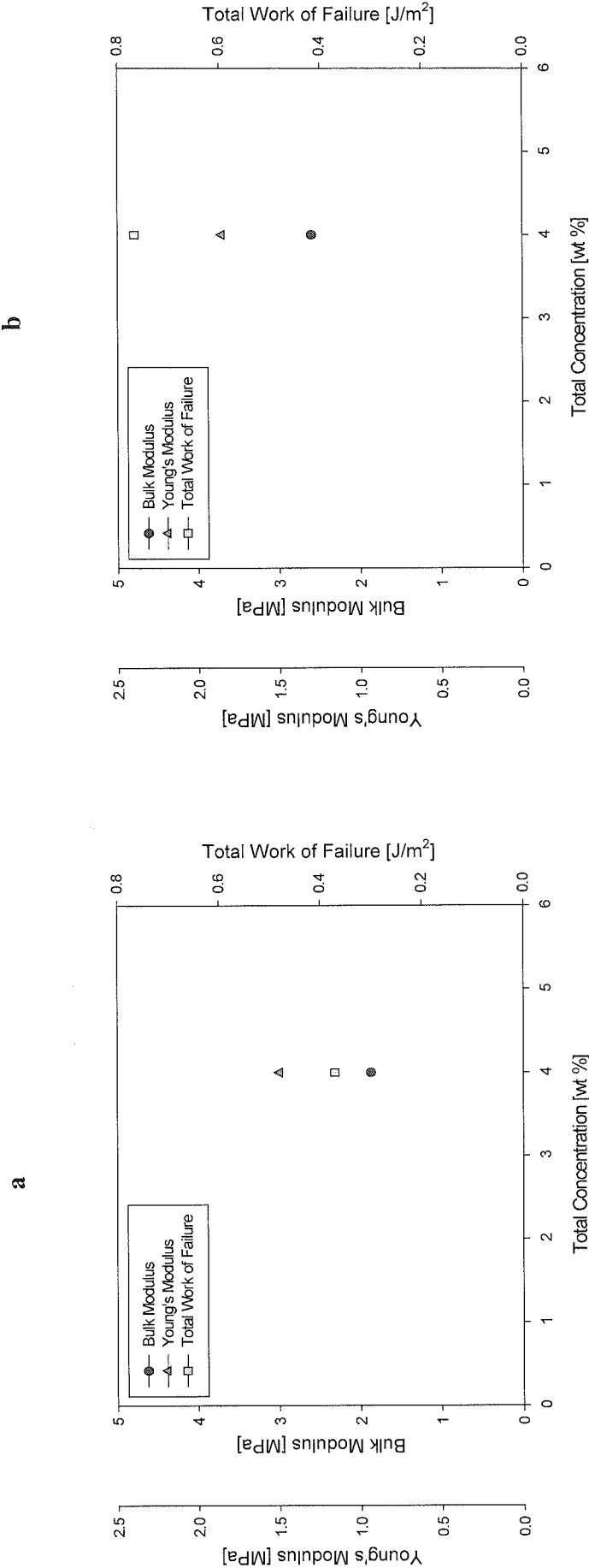


Fig. 10

INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2012/050570

A. CLASSIFICATION OF SUBJECT MATTER INV. A23L1/0524 A23L1/0534 A23L1/054 A23L1/29 A23L1/30 A23L1/308 C12C5/02 C12G3/00 C12G3/04 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) A23L C12C C12G		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPO-Internal, WPI Data, FSTA, BIOSIS		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.		
* Special categories of cited documents :		
"A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 24 May 2012		Date of mailing of the international search report 01/06/2012
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Tallgren, Antti

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International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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