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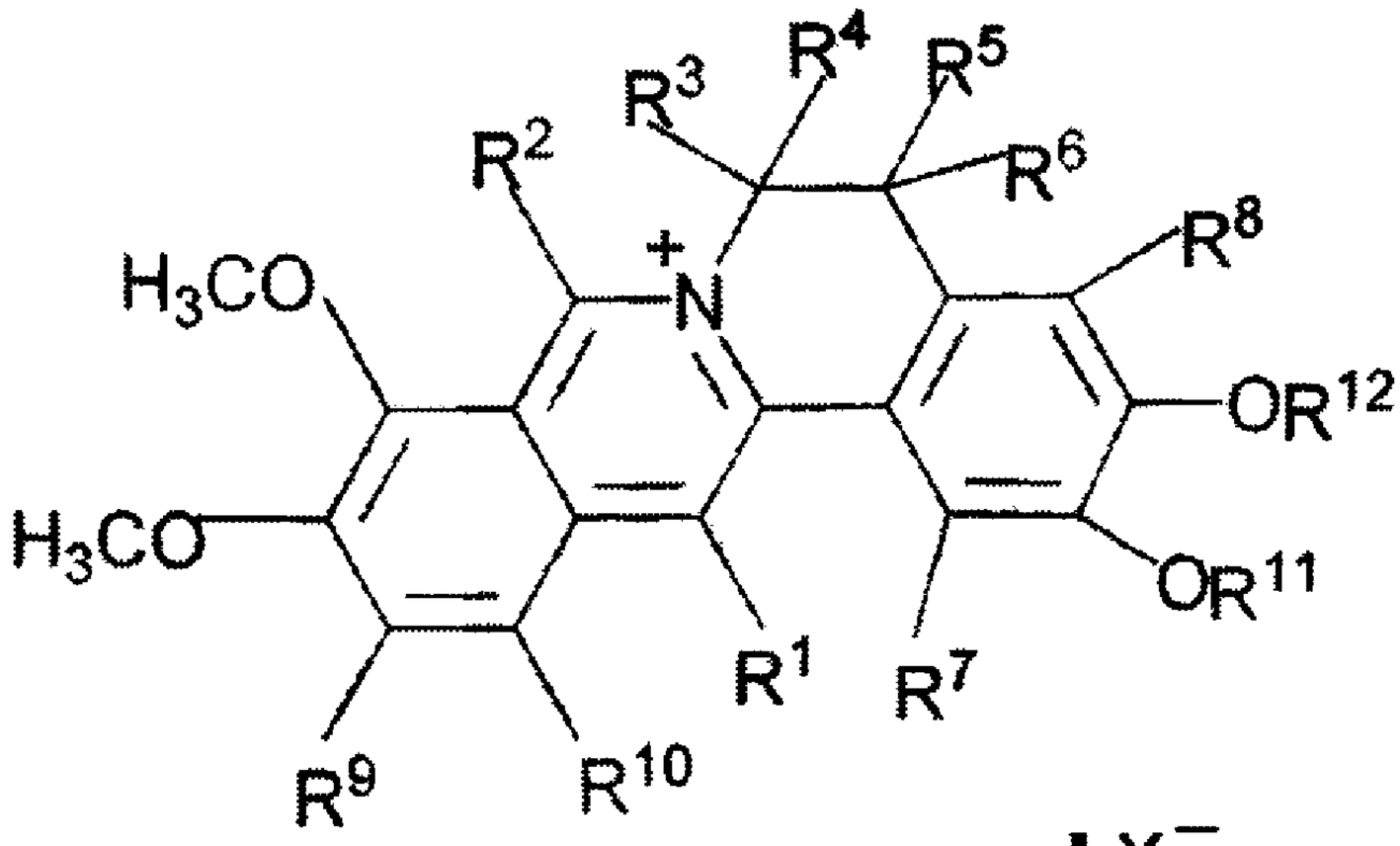

Formula (1)

(57) Abrégé/Abstract:
The present invention related to compositions including berberine or derivatives thereof of formula (1) (where R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12 and X are as defined in claim 1) and/or polymeric dialdehyde chosen from compounds such as dialdehyde polysaccharides (such as oxidised cellulose (oxycellulose) or oxidized starch (oxystarch) or poly(acrolein/acrylic acid) for the treatment of gastrointestinal functional disorders and related conditions, including Irritable Bowel Syndrome; Inflammatory Bowel Disease; Colitis,Crohn's disease and/or for promoting weight gainin animals including humans.

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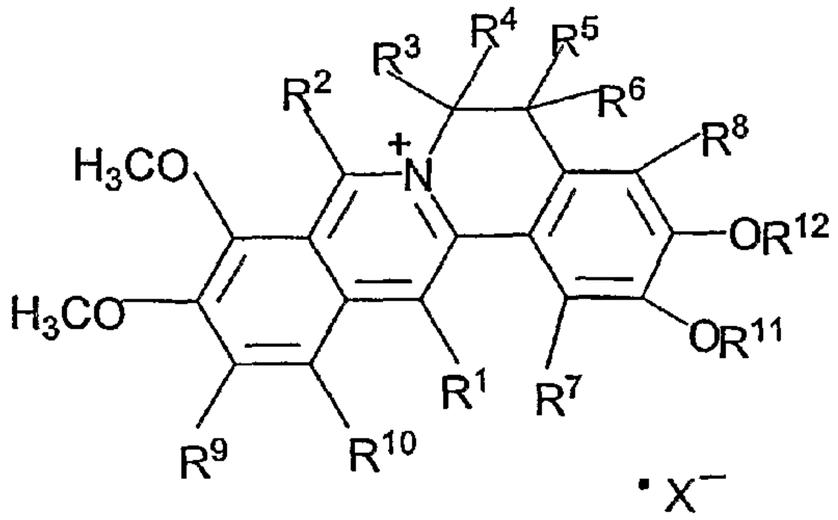
(54) Title: COMPOSITIONS FOR VETERINARY AND MEDICAL APPLICATIONS



(1)

(57) Abstract: The present invention related to compositions including berberine or derivatives thereof of formula (1) (where R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12 and X are as defined in claim 1) and/or polymeric dialdehyde chosen from compounds such as dialdehyde polysaccharides (such as oxidised cellulose (oxycellulose) or oxidized starch (oxystarch) or poly(acrolein/acrylic acid) for the treatment of gastrointestinal functional disorders and related conditions, including Irritable Bowel Syndrome; Inflammatory Bowel Disease; Colitis,Crohn's disease and/or for promoting weight gainin animals including humans.

WO 2005/020997 A1

Compositions of Isoquinolines and Polymeric dialdehydes for Veterinary and Medical Applications

Background to the Invention

Gastrointestinal ("GI") function disorders are caused by the invasion of pathogens, post treatment of broad-spectrum antibiotics, improper diet, stressful lifestyle and other causative factors. They are very common diseases, with conditions such as Irritable Bowel Syndrome (IBS) presenting in as much as 20% of the adult population in the USA. In Canada, IBS is second only to the common cold as the leading cause of time absent from school and work. So far, there is no effective medicine for the treatment IBS and Inflammatory Bowel Disease (IBD). Desirably, compositions for therapeutic purposes should meet the following criteria:

- Non-toxic, safe to use.
- Not inhibiting or adversely affecting probiotic bacteria in the gut.
- Preferably very poor oral bioavailability (no systemic effects).
- Not causing bacterial resistance.
- Anti-inflammatory.
- Anti-diarrhoea, antisecretory.
- Anti-motility.
- Strengthening immunity.
- Neutralizing toxins.

This invention seeks to provide compositions and treatments for GI functional disorders which meet one or more of the above criteria.

In humans, the gastrointestinal (GI) tract with an area of 300-400m^2 is the second largest surface connecting the body with the outside world. With consumption of 1 ~ 2kg of food every day, the GI immune system is presented with the threat of ingested poisons and pathogens together with an enormous variety of harmless antigens. The GI tract digests food and absorbs the nutrients that are beneficial to the body, while eliminating components that pose a potential risk to health. A large portion of the body's immune system is located in the GI wall and the mesenteric lymph nodes, called gut-associated lymphoid

tissue (GALT) system. GI secretions are rich in antimicrobial factors such as lactoferrin and lysozyme and other factors, like important growth and mucosa healing factors such as epidermal growth factor (EGF). The mucosa of the gut is normally covered by a unique protective layer of mucus and is colonized by microflora, which perform a key function in the regulation of the GALT system.

The mucus serves to a large extent as a matrix for the indigenous protective flora. The intestines contain about 1kg probiotic bacteria. The roles of these bacteria are to maintain the healthy ecology in the GI tract, synthesizing vitamins, hormones, and other important factors, and to help to break down complex proteins and fiber into smaller molecules that can be absorbed by the mucosal cells.[1]

Pathogenic bacteria in the intestinal tract are an important aspect in the GI functional disorders both as a causative factor and as a symptom. Other disorders can actually cause the GI tract to lose probiotic bacteria and allow pathogenic bacteria growth, eventually, resulting in changes to the intestinal ecology and further exacerbation of the GI functional disorders.

For the treatment of GI functional disorders it is important to restore healthy ecology. This invention relates to the treatment of GI functional disorders and related conditions including IBS and IBD including colitis, Crohn's disease and coeliac disease. The treatment is expected to improve intestinal health and reduce symptoms including constipation, flatulence and diarrhoea. It acts as a GI cleanser, strengthening the immune system, inhibiting and removing the pathogenic bacteria, and helping to restore a healthy ecology in the intestinal tract. The resulting healthy digestion system will support the healthy state of the body and healthy weight gain in animals including humans.

Berberine is an isoquinoline quaternary alkaloid derived from a number of species of the barberry plant including Berberis aristata and Coptis chinensis.[2] Structural analogues of berberine have been isolated from extracts of the Chinese medicinal plant, Acangelisia gusanlung.[3] which has been used for over 2000 years in traditional Eastern medicine to treat gastro-enteritis and

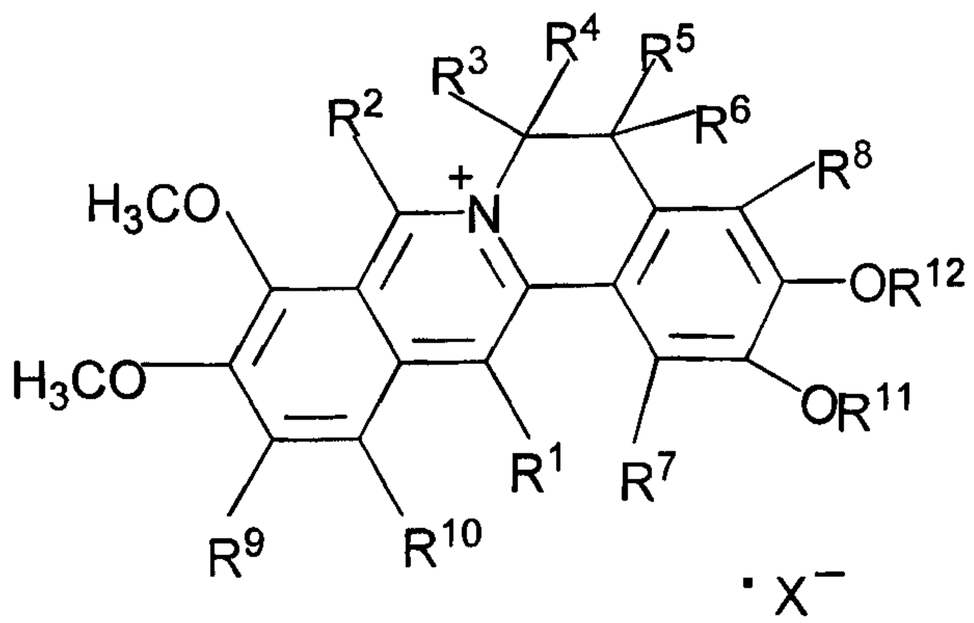
secretory diarrhoea[4] and is also effective in the prevention and the treatment of animal models of diarrhoea.[5-7] Berberine possesses antimicrobial[4], anti-motility[8] and anti-secretory properties.[9~11] Thus, several mechanisms may contribute to the therapeutic usefulness of berberine. Berberine has been used as an anti-diarrhoea drug at dose range of 100mg~300mg t.i.d. in adult (6mg~18mg/kg/day) in China.[12] Finally the apparent permeability coefficient (Papp) of berberine across the intestinal tissue was of the order of 10^{-7} cm/s[13], typical of the values of poorly absorbed compounds, and reflected by poor bioavailability in vivo. This poor oral bioavailability causing poor systemic absorptions should offer the benefit of safe use of the oral administration of berberine.

Certain saturated lower dialdehydes also possess antibacterial activity toward sulfate-reducing bacteria.[14] Furthermore, alcoholic sporicidal compositions containing similar saturated lower dialdehydes were taught.[15] Also it is known that water-soluble dialdehyde starch can be incorporated into chewing gum compositions as a cariostatic agent[16], a water insoluble dialdehyde polysaccharide being applied in medium at a concentration of at least about 0.1 weight per cent to inhibit the bacterial growth.[17] Synthetic polymeric dialdehydes such as poly-(2-propenal, 2-propenoic acid) have been used in the treatment of gastrointestinal diseases. However, since the antimicrobial activities of these compounds are very weak, very high doses for treatment, such as 500~2500mg/kg body weight/day are required. [18]

After searching and screening it has been found that compositions including compounds of Formula (1) below, (particularly berberine chloride), and compounds of Formula (2) below, (particularly oxidized cellulose), are each useful for the treatment of the GI functional disorders and related conditions as well as for a method of promoting weight gain in animals including humans. One of the most important findings of the invention is the existence of a synergic effect obtained by using combination of the compounds of Formula (1) and compounds of Formula (2) (see Example 4 and Example 8, below). This synergic effect provides the possibility of using lower dosage of the compounds, thereby achieving higher safety and economy.

Disclosure of the Invention

In one aspect, the present invention relates to a composition including a compound of Formula (1) and/or a polymeric dialdehyde, for the treatment of gastrointestinal (GI) functional disorders and related conditions, including Irritable Bowel Syndrome (IBS); Inflammatory Bowel Disease (IBD), Colitis, Crohn's disease and coeliac disease; and/or for promoting weight gain in animals, where Formula (1) comprises:



Formula (1)

where R^1, R^2, R^7, R^8, R^9, and R^{10} may be the same or different and are selected from H, CH_3, OH, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl;

R^3, R^4, R^5, R^6 may be the same or different and are selected from H, CH_3, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl, or

R^5 and R^6 are the same or different and are selected from H, CH_3, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl and R^3 and R^4 together are =O, or

R^4 and R^6 are the same or different and are selected from H, CH_3, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl and R^3 and R^5 together form a double bond or are =O, or

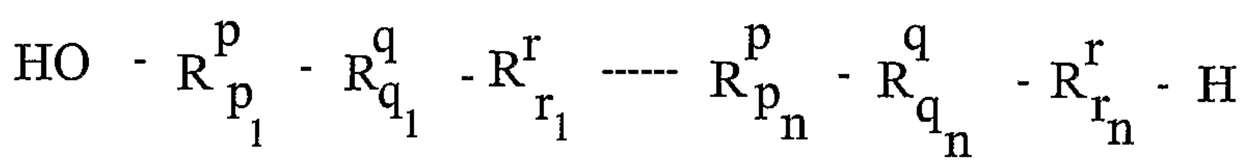
R^3 and R^4, are the same or different and are selected from H, CH_3, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl and R^5 and R^6 together are =O;

R^{11} and R^{12} together form $=CH_2$, or R^{11} and R^{12} may be the same or different and are independently selected from the group consisting of H, CH_3, CH_2CH_3 and $CH_2CH_2CH_3$; and

X^- is selected from the group consisting of Cl, Br, SO_4, I and $R^{13}COO$, where R^{13} is CH_3 or poly acids.

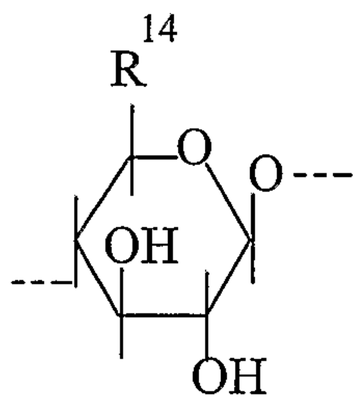
Preferably, R^1, R^2, R^3, R^4, R^5, R^6,R^7, R^8, R^9 and R^{10}, are hydrogen, R^{11} and R^{12} together form $H_2C=$ and X^- is Cl so that Formula (1) is berberine chloride.

The polymeric dialdehyde may be chosen from a wide range of suitable compounds. For example poly-(2-propenal, 2-propenoic acid) may be combined with a compound of Formula (1) to form the compositions of this invention. Preferably, the polymeric aldehyde is a dialdehyde polysaccharide. Particularly preferred dialdehyde polysaccharides have a formula in accordance with Formula (2):



Formula (2)

wherein each of the monomers R^p and R^r, are independently selected from the group consisting of:



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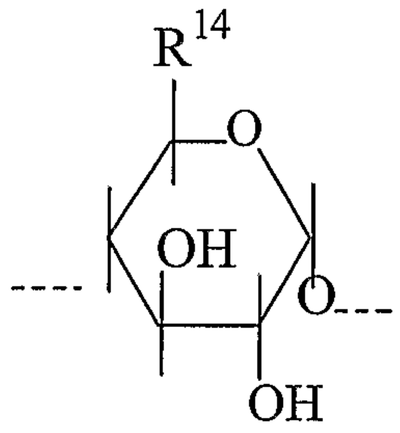
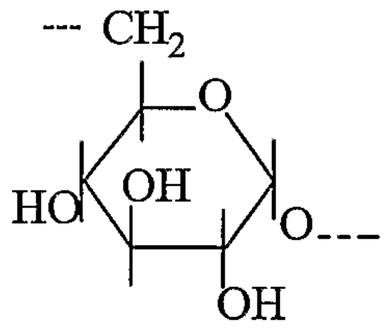
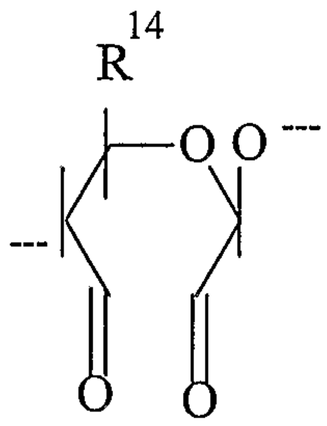


and (B)



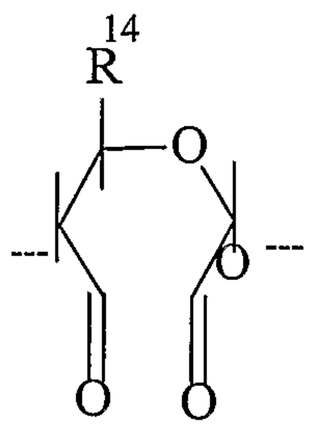
and (C)

and each monomer R^q is independently selected from the group consisting of:



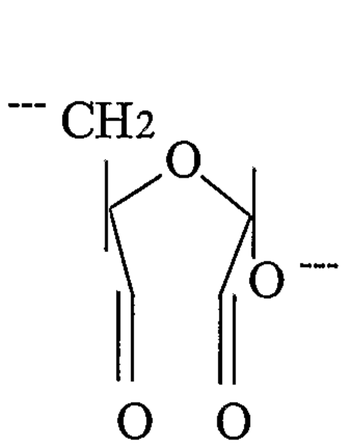
(D)

and



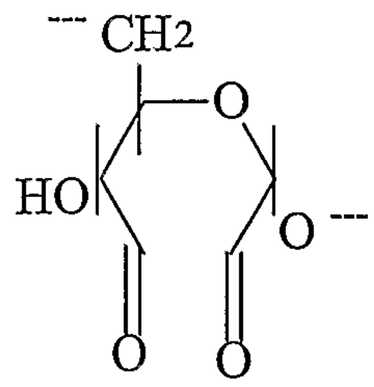
(E)

and



(F)

and



(G)

wherein each R^{14} may be the same or different and is independently selected from the group consisting of CH_2OH, COOH, CH_2OCH_2COOH and CH_2OR^{15}, where R^{15} is selected from the group consisting of $CH_2C_6H_4COOH$, C_6H_4COOH and $CH_2(CH_2)_yCOOH$ where y=1 to 20;

wherein p_1 --- p_n may be the same or different and are each independently selected from the range 0 to n; q_1 --- q_n may be the same or different and are each independently selected from the range 1 to m, preferably from the range 2 to m; r_1 --- r_n may be the same or different and are each independently selected from the range of 0 to n, n is an integer greater than 0 and m is an integer greater than 1; and wherein

$$\frac{q_1+---+q_n}{p_1+---+p_n+q_1+---+q_n+r_1+---+r_n} \times 100\% \geq 30\%$$

In one preferred embodiment, each R^p and R^r are (A) and R^q is (D), so that the polymeric dialdehyde is oxidised cellulose. In this case, it is also preferred that R^{14} is CH_2 OH or CH_2OCH_2COOH.

In another preferred embodiment, each R^p and R^r are (B) and R^q is (E), so that the polymeric dialdehyde is oxidised starch or dextrin.

In another preferred embodiment, each R^p and R^r are (C) and each R^q is (F) or (G) so that the polymeric dialdehyde is oxidised dextran.

In each case, it is preferred that:

$$\frac{q_1+---+q_n}{p_1+---+p_n+q_1+---+q_n+r_1+---+r_n} \times 100\% \geq 40\%$$

and particularly preferred that:

$$40\% \leq \frac{q_1+---+q_n}{p_1+---+p_n+q_1+---+q_n+r_1+---+r_n} \times 100\% \leq 60\%$$

that is, the oxidised cellulose, starch, dextrin or dextran is from 40% to 60 % oxidised.

The compounds of Formula (2) preferably have a molecular weight of from 1,000 to 1,000,000. More preferably, they have a molecular weight of from 10,000 to 750,000. Where the compounds of Formula (2) are water-insoluble, they preferably have a particle size of from 5μ to 100μ, more preferably from 5μ to 30μ. For example, the diameter of microcrystalline oxidized cellulose is about 20μ.

Generally, the oxidized rate of the Formula (2) is from 30~100%, preferably 40~100%, more preferably 40~60%. It was found that the compounds of the Formula (2) were non-toxic by oral administration. In particular, the oxidized celluloses are relatively stable in the GI tract. Their high molecular weights prevent them being absorbed by gut. Their polydialdehyde functional groups interact and neutralize toxins. The compounds of the Formula (2) possess an anti-constipation effect. The compounds also promote ulcer healing. The compounds do not adversely affect the growth of probiotic bacteria in gut.

Animals to which the composition may be administered include: primates including humans, birds including poultry, ungulates including cattle, sheep, horses, cervidae and swine, fish including crustaceans and molluscs, reptiles, rodents, canines and felines.

In another embodiment, the invention comprises using compounds of Formula (1) and compounds of Formula (2) in the manufacture of a medicament for the treatment of GI functional disorders and related conditions including Irritable Bowel Syndrome (IBS); Inflammatory Bowel Disease (IBD) including Colitis, Crohn's disease and coeliac disease; and for promoting weight gain in animals including humans.

In another embodiment, the invention comprises a method of treating gastrointestinal disorders including Irritable Bowel Syndrome (IBS); Inflammatory Bowel Disease (IBD), colitis, Crohn's disease and coeliac disease,

including administering to an animal, including a human, suffering from a gastrointestinal disorder, effective amounts of a compound of Formula (1) and/or polymeric dialdehyde. Preferably, the method of treatment comprises administering effective amounts of a compound of Formula (1) and polymeric dialdehyde in conjunction. In different embodiments of the invention treatment may comprise administering the compound of Formula (1) and the polymeric dialdehyde sequentially or simultaneously. In a preferred embodiment the compound of Formula (1) is combined with the polymeric dialdehyde to form a composition which is then administered. Preferably the polymeric dialdehyde is a compound of Formula (2), more preferably oxidised cellulose, especially oxidised cellulose having an oxidation level of from 40% to 60%.

The required dose of the composition containing Formula (1) and a polymeric dialdehyde is generally less than 50% of those separately using individual components. For example, the dose of beberine is 6mg~18mg/kg/day for adult. The use of 40% oxidized cellulose is 250mg~750mg/kg/day. However, when using combination of berberine and 40% oxidized cellulose the required dose is berberine 0.5mg~6mg/kg/day plus 40% oxidized cellulose 5mg~200mg/kg/day. Preferably, in humans, a dose of berberine 0.5mg~3mg/kg/day plus 40% oxidized cellulose 5mg~80mg/kg/day is used.

In addition, effective amounts of a compound of Formula (1) and polymeric dialdehyde may be administered in conjunction to promote weight gain in animals, including humans. In this context the compounds may be administered as feed additives. Accordingly, the invention includes modified foods containing from 0.1 to 50 ppm of a compound of Formula (1) and from 1 to 400 ppm of a polymeric dialdehyde. Preferably, the modified food contains from 2 to 10 ppm of a compound of Formula (1) and from 10 to 200 ppm of a compound of Formula (2); more preferably Formula (1) is berberine chloride and Formula (2) is oxidized cellulose.

It is envisioned that the compound of Formula (1) and the polymeric dialdehyde may be provided separately, rather than as a composition. The present invention also comprises a kit including a quantity of a compound of Formula (1)

and a quantity of a polymeric dialdehyde for the treatment of gastrointestinal (GI) functional disorders and related conditions including Irritable Bowel Syndrome (IBS); Inflammatory Bowel Disease (IBD) including colitis, Crohn's disease and coeliac disease; and for promotion of weight gain in animals including humans. Preferably the weight ratio of the quantity of compound of Formula (1) to the quantity of polymeric dialdehyde ranges from 1:1 to 1:100, more preferably from 1:10 to 1:40.

It has also been found that berberine selectively inhibits pathogenic bacteria such as Staphylococcus aureus, Streptococcus Group B, Vibrio cholerae, Clostridium perfringens, Candida albicans, but does not inhibit beneficial bacteria (probiotics) such as Lactobacillus plantarum at <500 □g/ml (see Table 1).

Table 1

Antimicrobial Activities of berberine, oxidized cellulose and Erythromycin

Microorganism	**Minimum Inhibitory Concentration (□g/ml)**		
	Berberine	**Oxidized cellulose**	**Erythromycin**
Staph. Aureus ATCC 29213	125	>1,000	<0.625
Strep. Group B MCR1 27	62.5	>1,000	<0.625
E. coli HS	>500	>1,000	>10
V. cholerae 6239	125	>1,000	>10
C. albicans ATCC 14053	62.5	>1,000	>10
Cl. perfringens ATCC 1124	125	>1,000	1.25
L. plantarum	500	>1,000	<0.625

Pathogenic bacteria like Escherichia Coli lost their filaments and were unable to attach on the wall of intestine after being treated with berberine at 5□g/ml, which is a much lower concentration than MIC (Minimum Inhibition Concentration). However, at this concentration, berberine did not affect probiotic bacteria such as Lactobacilli. This specific property of berberine offers an important aspect as a GI tract cleanser, since it can selectively remove pathogenic bacteria from the gut without affecting the inhabitations of the

probiotic bacteria in GI tract, and without exerting excessive drug pressure on the bacteria, which may lead to drug resistance.

The currently available broad spectrum antibiotics indiscriminately inhibit both pathogenic and probiotic bacteria in gut. Antibiotic treatment often causes GI function disorders. Animals and plants have coexisted with microbes throughout their evolution, sometimes to their mutual benefit, often in an antagonistic relationship. Berberines are an ancient and pervasive component of the innate defence mechanisms; they have developed to control the natural flora and combat pathogens. They do not target specific molecular receptors on the microbial surface. This characteristic may avoid the problem of inducing bacterial resistance occurred to most antibiotics. It was also found that berberine could induce the interleukine-12 (IL-12) (pro-antiinfectious) and inhibit the production of IL-8 (pro-inflammatory). This antiinflammatory property strengthening the host immunity is also very useful for the treatment of IBD and IBS.

In addition to use of the compounds of Formula (1), it has been found that compounds of Formula (2) not only possess antibacterial activity, but are also able to neutralize toxins and act as an antioxidant.

Accordingly, the research leading to the present invention also discloses the invention of treating Irritable Bowel Syndrome, Inflammatory Bowel Disorder, Colitis, Crohn's disease and ceoliac disease including administering an effective amount of a compound of Formula (1) or of Formula (2) to an animal, including a human, in need thereof.

The invention also provides a method of promoting weight gain in animals including humans including administering an effective amount of a compound of Formula (1) and/or Formula (2).

Hereinafter, GI tract cleansing compositions that include compounds of Formula (1) and compounds of Formula (2), and/or the pharmaceutically acceptable derivatives thereof may be referred to as GILAX cleansers. The amount of

GILAX-cleanser required for use in treatment will vary with the nature of the condition being treated and the age condition of the animal including human patients, and will ultimately be at the discretion of the attendant veterinarian or physician.

In general, a GILAX-cleanser comprises the compounds of Formula (1) and the compounds of Formula (2) at a weight ratio of 1:1~100, preferably at a weight ratio of 1:10~40. For example, for humans, the dose of GILAX-cleansers (for instance, berberine chloride and oxidized cellulose at a weight ratio of 1:10) may be 275 ~1650mg/day orally. The dose taken is according to the GI functional disorder condition. It is recommended for an adult to take 550mg once daily for IBS or post antibiotic GI functional disorder, 275mg x 2 daily for IBD, 550mg x 4 daily for acute diarrhoea or other severe conditions.

In animal farming, such as the poultry industry, GILAX-cleansers may be used as food additives to promote growth. The composition is preferably 1~20ppm of berberine plus 10~400ppm of oxidized cellulose; more preferably, 5ppm of berberine plus 50ppm of oxidized cellulose.

In swine industry, GILAX-cleansers can be used to protect piglets from diarrhoea. A composition including 0.5mg~6mg of Formula (1) (berberine)/kg/day and 50mg~200mg of Formula (2) (oxidized cellulose)/kg/day may be used.

A GILAX-cleanser composition is preferably formed by combining the compounds of Formula (1) and the compounds of Formula (2) with one or more other ingredients, for example: vitamins, antibiotics, antiseptic agents, surfactants, antidiarrheal agents, anti-constipation agents, enzymes, (especially digestive enzymes), probiotic bacteria, herbs, vaccines, ulcer healing agents (e.g. gibberellins, glucans).

In accordance with the invention, a pharmaceutical formulation including the GILAX-cleansers or pharmaceutically acceptable derivatives thereof may also contain one or more pharmaceutically acceptable carriers and, optionally, other

therapeutic and/or prophylactic ingredients. The carriers must be acceptable in the sense of being compatible with the other ingredients of the formulation and not deleterious to the recipient thereof.

Pharmaceutical formulations may be in any form suitable for administration to the gastrointestinal tract, including those suitable for oral, and rectal administration. While it is possible that for use in therapy, the GILAX-cleansers may be administered as the raw chemical(s), it is preferable to present the active ingredient(s) as a pharmaceutical formulation. The formulation may, where appropriate, be conveniently presented in discrete dosage units and may be prepared by any of the methods known in the art of pharmacy. Preferably, the methods include the step of bringing into association the active compound(s) with liquid carriers or finely divided solid carriers or both and then, if necessary, shaping the product into the desired formulations.

Pharmaceutical formulations suitable for oral administration may be presented as discrete units such as capsules, cachets, or tablets each containing a predetermined amount of the active ingredient(s); as a powder or granules; a solution, a suspension or as an emulsion. The active ingredient(s) may also be presented as a bolus, electuary or paste. Tablets and capsules for oral administration may contain conventional excipients such as binding agents, fillers, lubricants, disintegrants, or wetting agents. The tablets may be coated according to methods known in the art. Oral liquid preparations may be in the form of, for example, aqueous or oily suspensions, solutions, emulsions, syrups or elixirs, or may be presented as a dry product for constitution with water or other suitable vehicle before use. Such liquid preparations may contain conventional additives such as suspending agents, emulsifying agents, non-aqueous vehicles (which may include edible oils), or preservatives.

For administration to a gastrointestinal ulcer such as peptic ulcer, the compounds of GILAX-cleanser or pharmaceutically acceptable derivatives thereof may be administered by any of the methods and formulations employed in the art of administration to the gastrointestinal tract.

Where desired, formulations adapted to give sustained release of the active ingredient may be employed.

The compounds of the GILAX-cleansers may also be used in combination with other therapeutic agents, for example, anti-infection agents, such as antibiotics, or ulcer healing agents such as gibberellins, glucans, growth factors (EGF), and/or probiotic bacteria such as Lactobacillus plantarum.

The combinations mentioned above may conveniently be presented for use in the form of a pharmaceutical formulation and thus such formulations including a combination of compounds of Formula (1) and of Formula (2) as defined above, together with a pharmaceutically acceptable carrier therefore comprise a further aspect of the invention.

When the compounds of GILAX-cleansers are used with a second therapeutic agent active in the treatment of GI functional disorders and related conditions, the dose of each compound may either be the same as or differ from that employed when each compound is used alone. Appropriate doses will be readily appreciated by those skilled in the art.

The compounds of GILAX-cleansers and their pharmaceutically acceptable derivatives may be prepared by any methods known in the art for the preparation of compounds of analogous structure.

Examples

The invention will now be discussed with reference to examples. The examples are by way of illustration only and should not be construed as any limitation on the scope of the invention.

Example 1. Preparation of a compound of Formula (1), berberine chloride.

The root and bark of berberines vulgaris (1.5kg, grounded) was refluxed with ethanol (10L x 2). The ethanol extracts was filtered and evaporated under reduced pressure to afford a brownish oil. This residue was dissolved in a warm 0.1M HCl solution (10L x 2), filtered, and the filtrate was vacuum evaporated to

about 1L, then stirred at room temperature overnight. The yellow precipitates were collected and washed with cold water, then redissolved in boiling water (10L x 2), cooled to room temperature to afford berberine chloride (44.5g) as yellow crystalline powder after filtration, washing with water, and air-drying. Analysis of the crystals using NMR produced the following results:

^{1}H-nmr (CD_3OD) x (ppm)

3.16 (t, 2H), 4.02 (s, 3H), 4.15 (s, 3H), 4.88 (t, 2H), 6.12 (s, 2H), 7.03 (s, 1H), 7.74 (s, 1H), 7.95 (d, AB, 1H), 8.15 (d, AB, 1H), 8.89 (s, 1H), 9.83 (s, 1H).

Example 2.

Preparation of a compound of Formula (2), 40% oxidized cellulose.

To a stirring solution of periodic acid (140.7g, 0.6175 mole) in water (1.08L) at pH<0.5 was added in portions microcrystalline cellulose (particle size of ~20 in diameter) (250g, 1.54 mole) at <30°C over a period of 2 hours. The whole mixture was stirred at 30~32°C for 4 hours, then at room temperature for 16 hours. To this resulting reaction mixture was added a 5% sodium hydroxide solution (~480ml) to adjust the solution pH to 5~6. The suspension was filtered; the solid was washed with water (2L x 4) until the filtrate on KI-starch test paper showed the absence of the oxidant. The solid was then washed with acetone (0.5L) and air dried to afford 40% oxidized cellulose as a white powder (215g, 87%).

Example 3.

Preparation of a compound of Formula (2) 40% oxidized water soluble cellulose.

To a stirring solution of carboxymethyl cellulose (MW 250,000, DS=0.7) (1g, 6.17 mmole) in water (25ml) in an ice-bath, a solution of sodium periodate (532.5mg, 2.48 mmole) in water was added dropwise over a period of 2 hours. The reaction mixture was stirred at 5~10°C for 16 hours, then dialysed against water in a dialysis tube (the cut-off MW~10,000) for 48 hours. The solution was

then freeze dried to afford 40% oxidized water soluble cellulose as a white powder (813mg, 81.4%).

Example 4.

Pilot chicken experiment.

Male day old chickens (white Leghorn □ New Hampshire) were fed Barastoc chicken crumbles, which contain zinc bacitracin and D.O.T. (3,5-dinitro-ortho-tuluamide) and antioxidants ethoxyquin and B.H.T. for 13 days. On day 14, they were randomly divided into six groups of five chickens each, with the average weight of chickens from each group varying from 121.4g to 124.2g (2.3% variance between all the groups). The chickens were then fed with same basic growers pellets, which did not contain any antibiotics but do contain D.O.T., with different food additives shown as follows:

Group A: feed additive is 50ppm berberine chloride.
Group B: feed additive is 10ppm berberine chloride.
Group C: feed additive is 200ppm 40% oxidized cellulose.
Group D: feed additive is 100ppm 40% oxidized cellulose.
Group E: feed additive is 5ppm berberine chloride + 50ppm 40% oxidized cellulose.
Control: no feed additive.

The chickens were fed for another 23 days. Observation was carried out on the feed intake, weight gains, colour of combs (a red coloured comb indicates a healthy state of the bird), and mortality. There were no fatalities in the experiment. There were no significant differences in the amount of feed intakes among the groups. The statistical analysis was performed two-tailed at a significance level of $p=0.05$. The results were shown in Table 2.

Table 2

Synergic effect of the composition of the compound of Formula (1) (berberine chloride) and the compound of Formula (2) (40% oxidized cellulose) on chicken growth

Experimental Group	Red Combs (Number of red comb/total number of chickens							Growth rate compared to that of the control on day 36
	Day 14	Day 17	Day 21	Day 24	Day 26	Day 32	Day 36	
A	0/5	1/5	1/5	3/5	3/5	4/5	4/5	106.36% (p=0.05)
B	0/5	0/5	2/5	2/5	3/5	4/5	5/5	101.79%
C	0/5	1/5	1/5	1/5	4/5	4/5	5/5	101.74%
D	0/5	0/5	0/5	0/5	1/5	2/5	3/5	99.82%
E	0/5	1/5	1/5	1/5	2/5	5/5	5/5	108.11% (p=0.05)
Control	0/5	0/5	0/5	0/5	0/5	1/5	1/5	100.00%

There was no residue of either berberine or oxidized cellulose found in the meat of chickens.

Example 4, demonstrates the synergic effect of the invention. From the results, it is clear that the composition of 5ppm berberine plus 50ppm oxidized cellulose gave the best growth promotion compared to 20ppm berberine or 10ppm berberine or 200ppm oxidized cellulose, or 100ppm oxidized cellulose alone. This synergic effect provides the possibility of using lower dosages of the compounds, thereby achieving higher safety and economy.

Example 5.

Preparation of GILAX-cleanser.

a) Berberine chloride 50mg mixed with 40% oxidized cellulose 500mg was packed in a capsule for oral administration for adult for the treatment of IBS or post antibiotic GI functional disorder or diarrhea.

b) Berberine chloride 25mg mixed with 40% oxidized cellulose 250mg was packed in a capsule for oral administration for the treatment of IBD.

Example 6.

Combination of GILAX-cleanser with probiotic bacteria for the treatment of IBS and IBD.

GILAX-cleanser from example 5 may be used sequentially or simultaneously with the preparation of probiotic bacteria. Probiotic bacteria capsule or tablet, protected from air, contains 0.5~1 x 10^{10} CFU/capsule or tablet. Its composition is shown as follows:

Bifidobacterium bifidum	30%
Bifidobacterium longum	20%
Lactobacillus plantarum	10%
Lactobacillus bulgaricus	10%
Lactobacillus salivarius	10%
Lactobacillus acidophilus	20%

Example 7.

Compound of Formula (2), 40% oxidized cellulose as food additive to promote chicken growth.

The chicken experiment was set up substantially as described in example 4, but with 6 chickens in each of the experimental and control groups. However, the feed additive was 1,000ppm of 40% oxidized cellulose. The growth rate of the experimental group of six chickens was 3.86% (p=0.05) higher than the six chickens in the control group.

Example 8.

Synergic effect of the compound of Formula (1) and the compound of Formula (2) on the treatment of IBD on mouse model.

hFUT1 mouse model of colitis was used. It provides insights into the pathogenesis of Inflammatory Bowel Disease (IBD). These mice do not develop disease in a germ free environment. Immune dysfunction contributing to IBD in humans includes abnormal T cell reactivity and a loss of tolerance to gut

bacteria. The compositions of Formula (1) and Formula (2) were given orally to mice to see the effectiveness on the altering the gut flora and lessening the severity of the colitis. The positive results indicated the compositions of Formula (1) and Formula (2) may have a therapeutic role in human IBD.

A total five groups with ten mice per group were used as follows.

1) Control (without treatment).

2) Treated with compound of the Formula (1) (berberine chloride), 13.5mg /kg/day (o.s.).

3) Treated with compound of the Formula (2) (40% oxidized cellulose), 114mg/kg/day (o.s.).

4) Treated with composition of the Formula (1) (berberine chloride) (6.7mg/kg/day) and the Formula (2) (40% oxidized cellulose) (57mg/kg/day) (o.s.).

5) Treated with composition of the Formula (1) (berberine chloride) (13.5mg/kg/day) and the Formula (2) (114mg/kg/day) (o.s.).

The results are shown in Table 3.

Table 3

Synergic effect of the composition of the compound of Formula (1) (berberine chloride) and the compound of Formula (2) (40% oxidized cellulose) on IBD in mice

Group No	Survival rate after 56 days treatment
1	3/10
2	5/10
3	5/10
4	9/10
5	9/10

Example 9.

Tolerance dose testing of the compound of Formula (1) (berberine chloride) and the compound of Formula (2) (40% oxidized cellulose) on Balb-C mice.

30 male and 30 femal Balb-C mice were divided into groups of 10. 10 male and 10 female mice were in each of three groups as follows;

1) Control (without compound).
2) Oral administration (gavaged) with berberine chloride 250mg/kg/day for 14 consecutive days.
3) Oral administration (gavaged) with 40% oxidized cellulose 1330mg/kg/day for 14 consecutive days.

All mice in the experiment survived and they were all healthy and no significant difference between the groups.

The histological observation on the tissue slides (liver, kidney, lung, intestine) from the tested mice showed no abnormality.

Example 10.

Evaluation of GILAX as feed additive for pig health after weaning.

Most pig farms run in a traditional continuous flow system with some co-mingling of weans, limited age group separation and routine pig flow between site areas. These factors can lead to incidents of diarrhea after weaning. It is aimed to see if GILAX cleanser could provide effective health protection on weans.

A randomized block design assigned sex-matched individual pens per treatment group at weaning. Each pen held 15 piglets (21 days old) three pens were used.

1) Positive control. The piglets received in-feed amoxicillin at 50mg/kg/day for 21 days.

2) Negative control. The piglets received no medicated feed and water for 21 days.

3) GILAX cleanser treatment. The piglets received in feed GILAX cleanser (5mg/kg/day berberine chloride+ 50mg/kg/day 40% oxidized cellulose) for 21 days.

Any sick piglets noted during the study were dosed with injectable amoxicillin (2g/day x 2). In this study the piglets in group 1 (Amoxicillin) and group3 (GILAX) were all healthy, no injectable amoxicillin was needed. Two piglets in group 2 (negative control) were sick and these were injected with antibiotic.

Footnotes

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[14] U.S. 2,801,216.

[15] U.S. 3,016,328.

[16] U.S. 3,679,792.

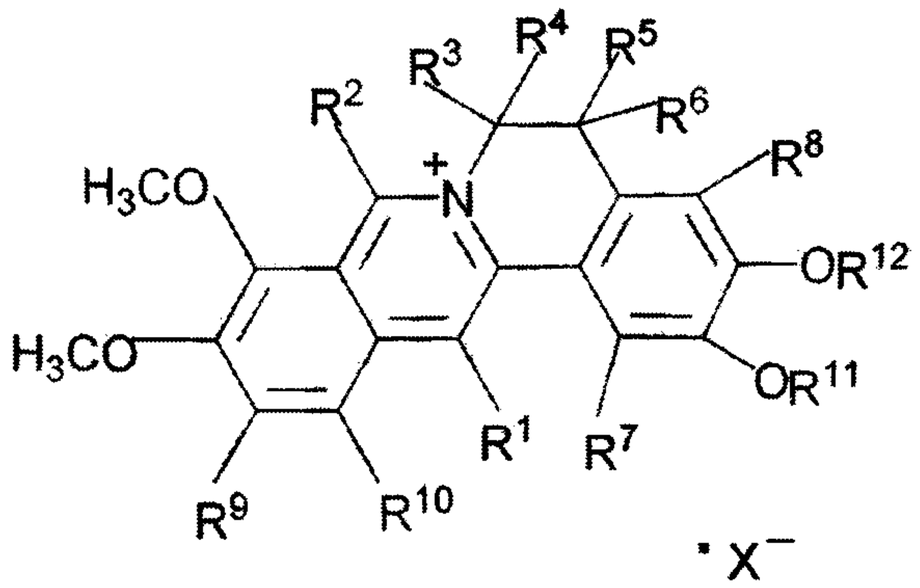
[17] U.S. 4,034,084.

[18] a) U.S. 6,410,040.

b) PCT/AU96/00328.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A composition including a compound of Formula (1) and a polysaccharide dialdehyde for the treatment of gastrointestinal (GI) functional disorders and/or for promoting weight gain in animals, where Formula (1) comprises:



Formula (1)

where R^1, R^2, R^7, R^8, R^9, and R^{10} may be the same or different and are selected from H, CH_3, OH, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl;

R^3, R^4, R^5, R^6 may be the same or different and are selected from H, CH_3, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl, or

R^5 and R^6 are the same or different and are selected from H, CH_3, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl and R^3 and R^4 together are =O, or

R^4 and R^6 are the same or different and are selected from H, CH_3, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl and R^3 and R^5 together form a double bond or are =O, or

R^3 and R^4, are the same or different and are selected from H, CH_3, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl and R^5 and R^6 together are =O;

R^{11} and R^{12} together form $=CH_2$, or R^{11} and R^{12} may be the same or different and are independently selected from the group consisting of H, CH_3, CH_2CH_3 and $CH_2CH_2CH_3$; and

X is selected from the group consisting of Cl, Br, SO_4, I and $R^{13}COO$, where R^{13} is CH_3 or poly acids.

2. The composition according to claim 1, wherein R^5 and R^6 are the same or different and are selected from H, CH_3, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl and R^3 and R^4 together are =O.

3. The composition according to claim 1, wherein R^4 and R^6 are the same or different and are selected from H, CH_3, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl and R^3 and R^5 together form a double bond or are =O.

4. The composition according to claim 1 wherein R^3 and R^4, are the same or different and are selected from H, CH_3, OCH_3, C_2H_5, OC_2H_5, OCH_2Ph, OCH_2PhNO_2, F or Cl and R^5 and R^6 together are =O.

5. The composition according to any one of claims 1 to 4 wherein the GI functional disorders or related conditions include Irritable Bowel Syndrome (IBS); Inflammatory Bowel Disease (IBD), Colitis, Crohn's disease and coeliac disease.

6. The composition according to any one of claims 1 to 4 wherein the animals are selected from the group consisting of humans, other primates, birds, ungulates, fish, crustaceans, molluscs, reptiles, rodents, canines and felines.

7. The composition of claim 6 wherein the birds are poultry and the ungulates are cattle, sheep, cervidae, or swine.

8. The composition according to any one of claims 1 to 4 wherein R^1, R^2, R^3, R^4, R^5, R^6,R^7, R^8, R^9 and R^{10} are hydrogen, R^{11} and R^{12} together form $=CH_2$ and X^- is Cl so that Formula (1) is berberine chloride.

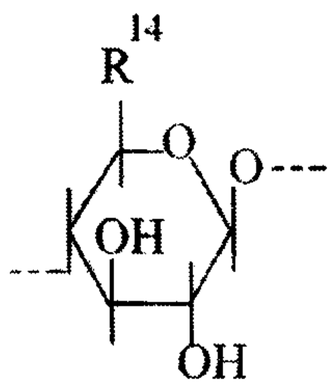
9. The composition according to any one of claims 1 to 4 wherein the polysaccharide dialdehyde is poly-(2-propenal, 2-propenoic acid).

10. The composition according to claim 1 wherein the dialdehyde polysaccharide comprises a compound of Formula (2)

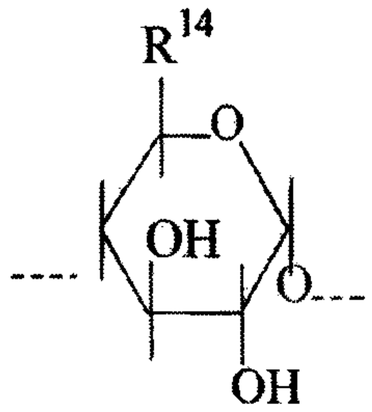
Formula (2)

$$HO - R^{p}_{p_1} - R^{q}_{q_1} - R^{r}_{r_1} \text{ ----- } R^{p}_{p_n} - R^{q}_{q_n} - R^{r}_{r_n} - H$$

wherein each of the monomers R^p and R^r, are independently selected from the group consisting of:

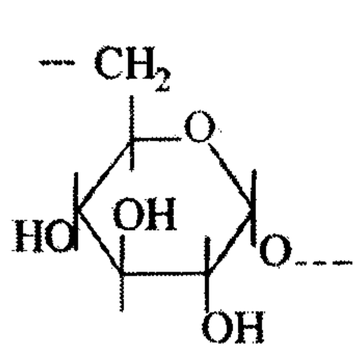


(A)



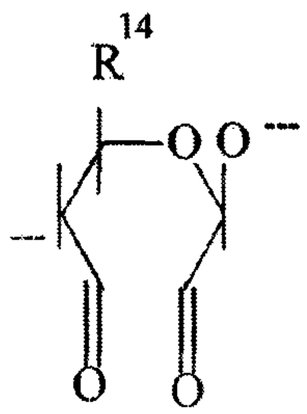
(B)

and

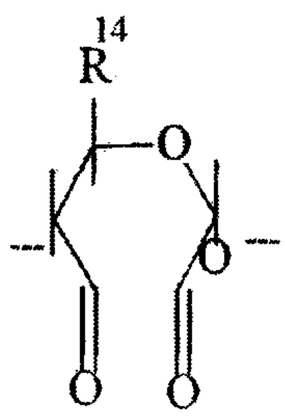


(C)

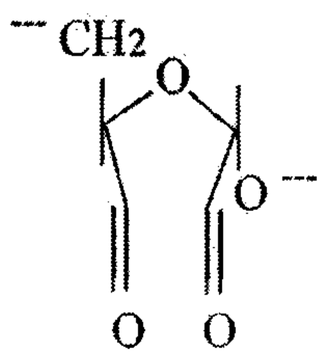
and each monomer R^q is independently selected from the group consisting of:



(D)

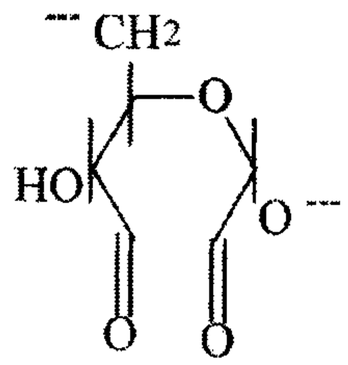


(E)



(F)

and



(G)

wherein each R^{14} may be the same or different and is independently selected from the group consisting of CH_2OH, COOH, CH_2OCH_2COOH and CH_2OR^{15}, where R^{15} is selected from the group consisting of $CH_2C_6H_4COOH$, C_6H_4COOH and $CH_2(CH_2)_yCOOH$ where y=1 to 20;

wherein p_1 --- p_n may be the same or different and are each independently selected from the range 0 to n; q_1 --- q_n may be the same or different and are each independently selected from the range 1 to m; r_1 --- r_n may be the same or different and are each independently selected from the range of 0 to n, n is an integer greater than 0 and m is an integer greater than 1; and wherein

$$\frac{q_1+---+q_n}{p_1+---+p_n+q_1+---+q_n+r_1+---+r_n} \times 100\% \geq 30\%.$$

11. The composition according to claim 10 wherein each R^p and R^r are (A) and R^q is (D), so that the polysaccharide dialdehyde is oxidised cellulose.

12. The composition according to claim 11 wherein R^{14} is CH_2OH or CH_2OCH_2COOH.

13. The composition according to claim 10 wherein each R^p and R^r are (B) and R^q is (E), so that the polysaccharide dialdehyde is oxidised starch or dextrin.

14. The composition according to claim 10 wherein each R^p and R^r are (C) and R^q is (F) and/or (G) so that the polysaccharide dialdehyde is oxidised dextran.

15. The composition according to any one of claims 11, 13 or 14, wherein:

$$\frac{q_1+---+q_n}{p_1+---+p_n+q_1+---+q_n+r_1+---+r_n} \times 100\% \geq 40\%.$$

16. The composition according to claim 15, wherein:

$$40\% \leq \frac{q_1+---+q_n}{p_1+---+p_n+q_1+---+q_n+r_1+---+r_n} \times 100\% \leq 60\%.$$

17. The composition according to claim 10 wherein the compound of Formula (2) has a molecular weight of from 1,000 to 1,000,000.

18. The composition according to claim 17 wherein the compound of Formula (2) has a molecular weight of from 10,000 to 750,000.

19. The composition according to claim 10 wherein the compound of Formula (2) is water-insoluble and has a particle size of from 5μm to 100μm.

20. The composition according to claim 19 wherein the compound of Formula (2) has a particle size of from 5μm to 30μm.

21. The composition according to claim 10, wherein the weight ratio of Formula (1) to Formula (2) ranges from 1:1 to 1:100.

22. The composition according to claim 21 wherein the weight ratio of Formula (1) to Formula (2) ranges from 1:10 to 1:40.

23. The composition according to claim 11 wherein Formula (1) is berberine chloride and the oxidised cellulose comprises from 30 to 100% oxidised monomer.

24. The composition according to claim 23 wherein the oxidised cellulose comprises from 40 to 60% oxidised monomer.

25. The composition according to claim 1 for promoting weight gain in humans and other primates, birds, ungulates, fish, reptiles, rodents, canines and felines.

26. A pharmaceutical composition including a compound of Formula (1) and a polysaccharide dialdehyde, together with one or more further active ingredients selected from vitamins, antibiotics, antiseptic agents, surfactants, antidiarrhoeal

agents, anti-constipation agents, enzymes, probiotic bacteria, herbs, vaccines, ulcer healing agents, growth factors, Gibberellins and glucans.

27. A pharmaceutical composition including a compound of Formula (1) and a compound of Formula (2), together with one or more further active ingredients selected from other polydialdehydes, vitamins, antibiotics, antiseptic agents, surfactants, antidiarrhoeal agents, anticonstipation agents, enzymes, probiotic bacteria, herbs, vaccines, ulcer healing agents, growth factors, Gibberellins and glucans.

28. A pharmaceutical composition according to claim 26 or 27, wherein the enzymes are digestive enzymes.

29. The pharmaceutical composition in accordance with claim 26, wherein the composition also contains one or more pharmaceutically acceptable excipients selected from binding agents, lubricants, fillers, disintegrants, wetting agents, suspending agents, viscosity enhancers, buffers and isotonicity-adjusting agents.

30. The pharmaceutical composition in accordance with claim 27, wherein the composition also contains one or more pharmaceutically acceptable excipients selected from binding agents, lubricants, fillers, disintegrants, wetting agents, suspending agents, viscosity enhancers, buffers and isotonicity-adjusting agents.

31. A kit including a quantity of a compound of Formula (1) and a quantity of polysaccharide dialdehyde for the treatment of gastrointestinal (GI) functional disorders or related conditions including Irritable Bowel Syndrome (IBS); Inflammatory Bowel Disease (IBD) including colitis, Crohn's disease and coeliac disease; and for promotion of weight gain in animals.

32. A kit of claim 31, wherein the animal is human.

33. The kit in accordance with claim 31 wherein the weight ratio of the quantity of compound of Formula (1) to the quantity of polysaccharide dialdehyde ranges from 1:1 to 1:100.

34. The kit in accordance with claim 33 wherein the weight ratio of the quantity of compound of Formula (1) to the quantity of polysaccharide dialdehyde ranges from 1:10 to 1:40.

35. Use of an effective amount of a compound of Formula (1) in conjunction with an effective amount of polysaccharide dialdehyde for the treatment of gastrointestinal disorders in an animal in need of such therapy.

36. Use of a compound of Formula (1) in conjunction with a polysaccharide dialdehyde in the manufacture of a medicament for the treatment of gastrointestinal disorders in an animal.

37. The use according to claim 35 or 36 wherein the gastrointestinal disorders include Irritable Bowel Syndrome (IBS); Inflammatory Bowel Disease (IBD), colitis, Crohn's disease and coeliac disease.

38. The use according to claim 35 or 36 wherein the compound of Formula (1) is berberine chloride.

39. The use according to claim 35 or 36 wherein the polysaccharide dialdehyde is poly-(2-propenal, 2-propenoic acid).

40. The use according to claim 36 wherein the dialdehyde polysaccharide comprises a compound of Formula (2).

41. The use according to claim 40 wherein the compound of Formula (2) is oxidized cellulose.

42. The use according to claim 41 wherein:

$$40\% \leq \frac{q_1+\text{---}+q_n}{p_1+\text{---}+p_n+q_1+\text{---}+q_n+r_1+\text{---}r_n} \times 100\% \leq 60\%.$$

43. The use according to claim 35 or 36 wherein the compound of Formula (1) and the polysaccharide dialdehyde are for sequential administration.

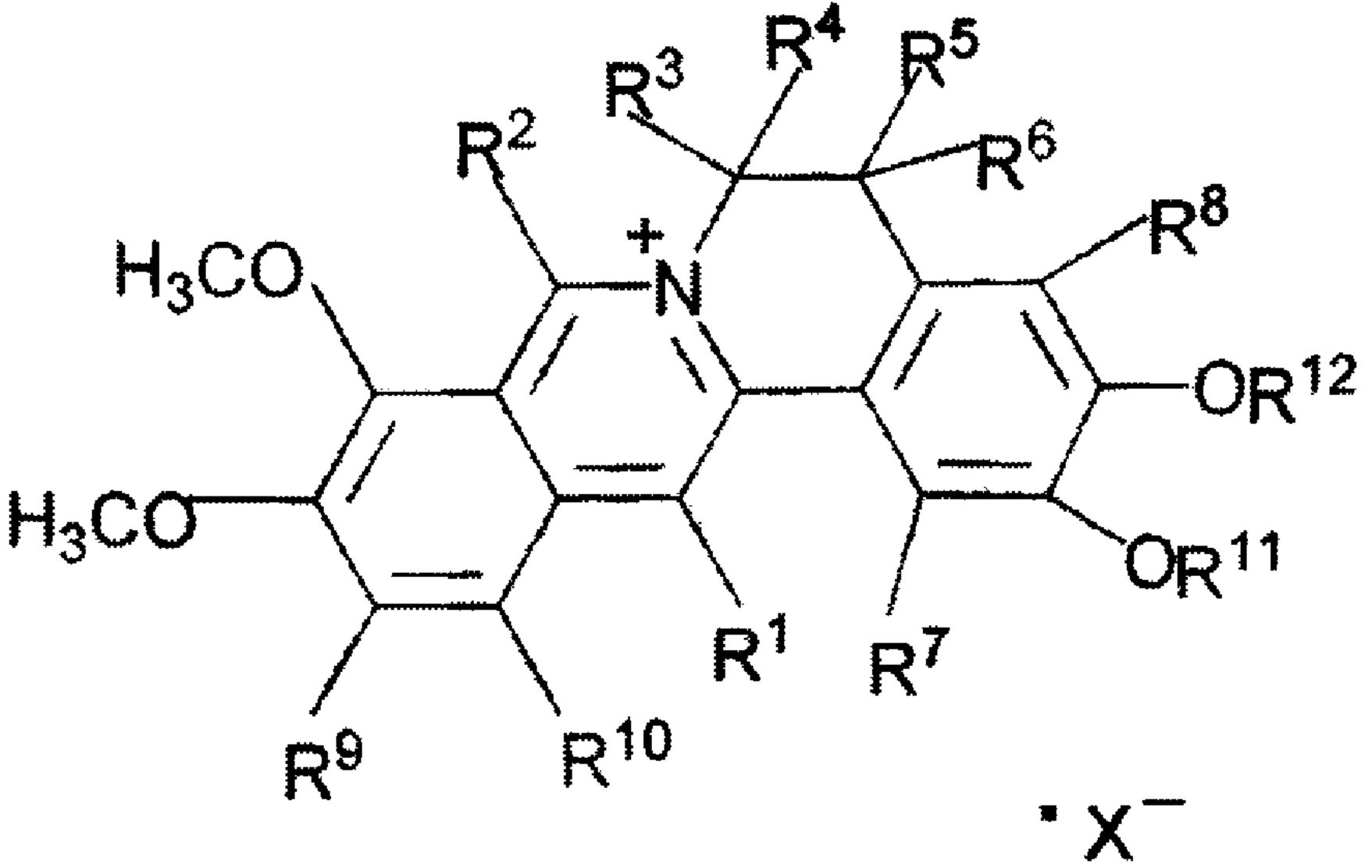
44. The use of claim 35 or 36 in which the compound of Formula (1) and the polysaccharide dialdehyde are for simultaneous administration.

45. The use of claim 44 wherein the compound of Formula (1) and the polysaccharide dialdehyde are for administration in the form of a composition containing both the compound of Formula (1) and the polysaccharide dialdehyde.

46. A modified food containing 0.1 to 50 ppm of a compound of Formula (1) and from 1 to 400 ppm of a polysaccharide dialdehyde.

47. The modified food in accordance with claim 46 wherein the food contains from 2 to 10 ppm of a compound of Formula (1) and from 10 to 200 ppm of a compound of Formula (2).

48. The modified food according to claim 46 wherein Formula (1) is berberine chloride and wherein the polysaccharide dialdehyde is oxidized cellulose.



Formula (1)