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(12) **United States Patent**
Navarro y Koren et al.(10) **Patent No.:** **US 7,422,764 B2**(45) **Date of Patent:** ***Sep. 9, 2008**(54) **MATRIX-FORMING COMPOSITION
CONTAINING PECTIN**(75) Inventors: **Peter Antonio Navarro y Koren**, Ede
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patent is extended or adjusted under 35
U.S.C. 154(b) by 632 days.This patent is subject to a terminal dis-
claimer.(21) Appl. No.: **10/871,107**(22) Filed: **Jun. 21, 2004**(65) **Prior Publication Data**

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00856, filed on Dec. 20, 2002.(30) **Foreign Application Priority Data**Jun. 7, 2002 (EP) 02077222
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A23L 2/00 (2006.01)(52) **U.S. Cl.** **426/590**; 426/2; 426/575;
426/576; 426/577; 424/439; 514/909; 514/910;
514/911(58) **Field of Classification Search** 426/590,
426/2, 575-577; 424/439; 514/909-911
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Primary Examiner—Carolyn Paden(74) *Attorney, Agent, or Firm*—Young & Thompson(57) **ABSTRACT**A liquid edible composition with a pH of more than 6, a
viscosity below 600 mPas at a shear rate of 100s-1 and 20° C.,
and a viscosity of at least 125% of the aforementioned vis-
cosity at a pH below 5 and a temperature of 37° C., the
composition comprising at least 0.05 wt. % of pectin having
a degree of methoxylation between 2 and 50 and/or of algi-
nate; at least 5 mg calcium per 100 ml; and at least 0.1 wt. %
indigestible oligosaccharide having a degree of polymerisa-
tion between 2 and 60. Another aspect of the invention relates
to a method for the treatment or prevention of overweight or
obesity in mammals, the method comprising the enteral
administration to a mammal of an effective amount of the
aforementioned composition.**13 Claims, No Drawings**

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MATRIX-FORMING COMPOSITION CONTAINING PECTIN

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of international application PCT/NL02/00856 filed on Dec. 20, 2002, which designates the USA, and which claims priority to U.S. application Ser. No. 10/279,968 now U.S. Pat. No. 6,989,166, filed on Oct. 25, 2002, and U.S. application Ser. No. 10/022,372 filed on Dec. 20, 2001, the contents of which are hereby incorporated by reference. U.S. application Ser. No. 10/279,968 is a continuation-in-part of U.S. application Ser. No. 10/022,372 now U.S. Pat. No. 6,834,445.

FIELD OF THE INVENTION

The present invention relates to a composition, which is liquid at around neutral pH and forms a viscous matrix at low pH, the composition comprising pectin, calcium and oligosaccharides. The present composition is particularly suitable for use in a method of treating or preventing overweight or obesity. Hence the present invention also encompasses a method of treating overweight or obesity in mammals, which method comprises the enteral (e.g. oral) administration of an effective amount of the aforementioned composition.

BACKGROUND OF THE INVENTION

Obesity is a major health problem with approximately ninety-seven million people considered clinically overweight in the United States.

Various chemical approaches have been proposed for controlling obesity. Anorectic agents such as dextroamphetamine, the combination of the non-amphetamine drugs phentermine and fenfluramine (Phen-Fen), and dexfenfluramine (Redux) alone, are associated with serious side effects. Indigestible materials such as olestra, mineral oil or neopentyl esters have been proposed as substitutes for dietary fat. Garcinia acid and derivatives thereof have been described as treating obesity by interfering with fatty acid synthesis. Surgical techniques such as temporary ileal bypass surgery, are employed in extreme cases.

However, methods for treating obesity, such as those described above have serious shortcomings. Controlling the diet remains the most prevalent technique for controlling obesity. Hence, new compositions suitable for the treatment of obesity are needed.

The accumulation or maintenance of body fat bears a direct relationship to caloric intake. Therefore, one of the most common methods for weight control to combat obesity is the use of relatively low-fat, high fiber diets. Especially high viscosity fibers may advantageously be employed in anti-obesity diets. The high viscosity fibers may induce a sensation of satiety when ingested in a sufficient amount.

JP2000189109 describes a food composition for the prevention and treatment of obesity having a prolonged retention time in the stomach, which is usable for the treatment of obesity and/or diabetes and which becomes gel-like at low pH. The composition includes pectin having a DE of 40% or less as a soluble fiber. The product does not include calcium or oligosaccharides.

U.S. Pat. No. 4,784,861 describes a packaged weight-control powder which can be used as a food additive to be employed before eating. Each package includes a dose to be sprinkled on the foodstuff to be eaten. The powder is formed

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of a mixture of oat, wheat and corn brans mixed with pectin, guar gum, psyllium and cutin. Mineral supplements are employed to replace those removed by the fibers of the brans. The powder is prepared in an atmosphere of less than 50% humidity and is packed in individual water-proof packages of relatively small size.

Additionally, pectin-containing preparations are for example used as medicine carriers to provide a slow-release of bioactive agents, as antacid composition and as antifatulent composition

WO9633694 describes pectic preparations which comprise at least one pectin associated with a complex composition comprising firstly an effervescent pair which easily disperses the pectin in water and hydrates it and regulates the gellification process irrespective of the hardness of the water used for the suspension, and secondly a mixture of compounds which provide the calcium ions necessary for the formation of the gel in an acid medium, together with magnesium ions regulating the kinetics of the calcium availability.

WO9959542 describes a pectic preparation useful as medicine carrier, to be orally administered and capable of forming a gel in an acid medium, comprising at least a pectin having a degree of methoxylation higher than 15% and calcium ions, containing a gelling process inhibitor with a pH higher than 6. The pectic preparation does not comprise oligosaccharides.

U.S. Pat. No. 5,068,109 relates to an antacid composition with floating properties, and a method of treating or alleviating upper gastrointestinal dyspeptic disorders. The antacid composition comprises a substance a) which is soluble in water at a neutral or alkaline pH, but is capable of forming a cohesive gel at an acid pH; a substance capable of being captured in the gel structure formed by substance a) at an acid pH and one or more acid neutralizing agents capable of being trapped in the gel structure formed by substance a) at an acid pH, at least one of which causes the gel to foam when contacted with an acid. Substance a) may be a low-methoxylated pectin or an amidated pectin composition. The antacid composition lacks oligosaccharide.

SUMMARY OF THE INVENTION

The pectin containing compositions described above are not perfectly suited for the treatment of obesity or overweight, mainly because of the undesired effect on bioavailability of calcium and/or because of insufficient viscosity of the pectin matrix which is formed in the stomach at low pH. The present invention provides a solution to the above problems.

The present invention provides a composition which comprises pectin and/or alginate, calcium and oligosaccharide. The present composition is liquid (at around neutral pH) and exhibits increased viscosity at an acidic pH due to the formation of a viscous matrix. Following ingestion, the present composition will form a viscous matrix in the stomach which induces a strong satiety effect, whilst the oligosaccharide component promotes calcium bioavailability throughout the lower gastrointestinal tract.

For the formation of a rigid matrix, low methoxylated pectin and/or alginate is required. The low methoxylated pectin and/or alginate forms a sufficiently rigid matrix when reacted with calcium to induce satiety feelings. The present inventors found that particular downsides are attached to the use of high levels of low methoxylated pectins and/or alginate in compositions for the treatment of obesity or overweight. It was found by the current inventors that compositions provid-

ing a satiety effect through the gellation of low-methoxylated pectin and/or alginate significantly reduce calcium absorption and/or bioavailability.

This finding is not in line with observations made in the relevant scientific literature. For instance, in a recent review paper, Greger et al (*Journal of Nutrition*. 1999;129:1434S-1435S) observe that investigators have observed that the addition of pectin to diets generally did not alter the absorption of most minerals, except magnesium. This observation differs from earlier findings which were published by Bagheri et al. (1985). Bagheri et al studied the effect of low methoxylated pectin on the absorption and retention of calcium in pigs. The absorption of calcium in a diet containing high methoxylated apple pectin was about 76% compared to a control diet. When low methoxylated pectin was consumed, the absorption of calcium was reduced to about 1% compared to the control diet.

Calcium is essential in a diet. Calcium deficiency may result in the following symptoms: muscle cramps, brittle nails, eczema, aching joints, increased cholesterol levels, rheumatoid arthritis, tooth decay and numbness in the arms and/or legs. Additionally, it is of importance in compositions, which are used to prevent or treat overweight and obesity. It has been described that calcium contributes to the prevention of overweight when absorbed by the body. Consequently there are severe limitations to the use of low methoxylated pectins in compositions designed to reduce body weight and/or to prevent body weight increase due to the impact of pectin and/or alginate on the bioavailability of calcium.

The ingestion of a nutritional composition, including those that are designed to prevent or treat excessive body weight, should not become an undue burden. Humans participating in a weight control program including a specific diet (i.e. having the desire to lose body weight and pursuing that goal) often prematurely discontinue the program due to the adverse taste, insufficient palatability or difficulty of consuming the dietary components. It is the inventors experience that compositions which are to be consumed in liquid form, form less of a burden for subjects participating in a weight control program than do solid or semisolid formulations. It is therefore a prerequisite that a composition designed to reduce body weight or control the caloric intake is provided in a liquid form, with limited viscosity. However, this provides an additional challenge, since calcium and low methoxylated pectins form a viscous mass when present in an aqueous environment.

It was found by the inventors that the calcium absorption inhibitory effect of low methoxylated pectins and/or alginate present in liquid edible composition can be decreased effectively through the coadministration of indigestible oligosaccharides with a degree of polymerisation between 2 and 60 and calcium. The present liquid edible composition uses a calcium salt which provides only limited amounts of free calcium ions at around neutral pH and an increased amount of free calcium ions at acidic pH. The present composition thus provides a composition which is easy to consume, which induces feelings of satiety after ingestion and which ensures sufficient calcium bioavailability.

Without wishing to be bound by theory, the inventors believe that the oligosaccharides used in accordance with the present invention provide a readily metabolisable substrate for the intestinal flora. Ingestion of oligosaccharides will result in an increase of the mass of intestinal bacteria (particularly bifidobacteria and/or lactobacilli) and/or increase the activity of these bacteria, and thereby stimulate the degradation of the pectin matrix. Through the stimulated breakdown of the pectin matrix in the small intestine and colon, the

calcium bioavailability will be increased through stimulated release of the pectin bound calcium. Still the pectins will have provided the desired satiety inducing effect through the formation of a viscous matrix in the stomach and/or intestine.

Additionally, the fermentation of the oligosaccharides by the intestinal bacteria will yield lactate and/or short chain fatty acids (SCFA), including butyrate, propionate and acetate, resulting in a decreased pH in the colon, which increases mineral solubility, hence raises the concentration of ionized calcium and accelerates the passive diffusion of calcium. Additionally, SCFA may be responsible for a rise in caecal blood flow and consequently increase mineral absorption. Furthermore, oligosaccharides may stimulate intestinal calcium transport by hypertrophy of the caecal wall, thereby increasing the surface area where mineral exchange takes place, thus improving calcium absorption.

The present composition can be advantageously used in a method for the prevention or treatment of obesity or overweight and is especially useful for subjects, preferably humans, which participate in a weight control program (e.g. the ingestion of a particular diet with the aim to reduce body weight).

The composition according to the invention aims to provide several advantageous health effects to overweight or obese subjects:

Satiety: The composition will, after ingestion, provide a feeling of satiety and thereby reduce or eliminate the desire for further food intake. The satiety inducing effect can be at least partially be contributed to the increased viscosity of the chyme in the stomach by the action of the low methoxylated pectin and/or alginate and calcium. An important advantage of the present composition resides in the fact that the resulting satiety will not rapidly disappear as is the case with many, particularly low caloric foodstuffs.

Bioavailable calcium: Overweight subjects benefit from the intake of bioavailable calcium. However, sufficient daily intake of calcium is often not reached, for example, because obese or overweight subjects tend to consume insufficient calcium rich dairy products, and instead consume vast amounts of soft drinks. Soft drinks are generally high in phosphates, the phosphates being responsible for a further decrease in the bioavailability of calcium. Calcium stored in fat cells (intracellular calcium) causes the metabolic derangements associated with obesity. Low calcium diets increase circulatory calcitrophic hormones levels, which stimulate adipocyte calcium influx which subsequently results in an increased lipogenesis and a decreased lipolysis.

Help reduce or prevent the increase of blood serum cholesterol levels: Overweight or obese subjects often suffer from increased cholesterol levels and/or an increased risk at coronary disease. The soluble fiber present in the composition, especially pectin optionally combined with beta-glucan, will lower blood serum cholesterol level by binding ileal bile acid in the intestine. The soluble fibers are able to interact with bile acids, which results in an increased fecal excretion of bile acids. Bile acids are derived from cholesterol, and are normally effectively recycled by reabsorption from the ileum and resecretion by the liver as bile salts. To the extent that bile acids are lost with the feces, the liver must replace the lost bile salts using cholesterol. Additionally, the viscosity and gelling properties of soluble fibers may have important effects on the hydrolysis and absorption of cholesterol and the absorption of bile acids in the small intestine.

Increase stool frequency: Oligosaccharides are known to improve bowel movement, stool output and stool frequency. This is advantageous for many subjects suffering from overweight, because many obese or overweight subjects suffer from constipation.

Provides sufficient water: It is the inventors believe that individuals tend to eat a constant volume of food because stomach distension triggers afferent vagal signals of fullness. According to this hypothesis, consumption of foods with high energy density (ED) will encourage consumption of excess energy because of the small volume of food in relation to energy content. A study of Bell et al. (Am J Clin Nutr 1998; 67:412-20) demonstrates that energy density influences energy intake. Significantly more energy is consumed in the condition of high energy density than in the medium or low energy density conditions. Variations in water contents between foods have a big impact in ED because water has zero energy content.

Helps to control blood glucose levels and blood insulin levels, particularly postprandial blood insulin levels. This is advantageous to many subjects, particularly those suffering from overweight and/or diabetes type II.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

One aspect of the present invention relates to a liquid edible composition with a pH of more than 6, preferably a pH of 6-9, a viscosity below 600 mPas (mPa·s) at a shear rate of 100s⁻¹ and 20° C. at around neutral pH and a viscosity of at least 125% of the aforementioned viscosity at a pH below 5 and a temperature of 37° C., the composition comprising:

- a. at least 0.05 wt. % of pectin having a degree of methoxylation between 2 and 50 and/or of alginate;
- b. at least 5 mg calcium per 100 ml; and
- c. at least 0.1 wt. % indigestible oligosaccharide having a degree of polymerisation between 2 and 60.

Another aspect of the present invention concerns a method for the treatment or prevention of overweight or obesity in mammals, said method comprising the enteral administration to a mammal of an effective amount of the aforementioned composition. The present method is particularly suitable for treating or preventing overweight or obesity in humans.

Pectins

Pectins are carbohydrates generally obtained from dilute acid extracts of citrus or apple pulp. They are also present in the cellular walls of vegetables and fruits. Pectins are also found in root crops such as carrots and beetroot, as well as in tubers, such as potatoes. Pectins are chemically defined as partial methyl esters of polygalacturonic acids, whereof the molecular weight can reach 200,000.

Pectin is the methylated ester of polygalacturonic acid. It is commercially extracted from citrus peels, apple pomace and sugar beet pulp. A typical pectin molecule comprises 200 to 1000 galacturonic acid units connected in a linear chain.

Pectin is divided into two main categories: high methoxylated pectin (hereafter referred to as HM pectin), which are characterized by a degree of methoxylation above 50% and low methoxylated pectin (hereafter referred to as LM pectin) having a degree of methoxylation below 50%. As used herein, "degree of methoxylation" (also referred to as DE or "degree of esterification") is intended to mean the extent to which free carboxylic acid groups contained in the polygalacturonic acid chain have been esterified (e.g. by methylation).

The LM pectins are further subdivided into two groups: low methoxylated amidated, and low methoxylated conventional. As used herein the "degree of amidation" (DA) is intended to mean the extent to which ester groups contained in the polygalacturonic acid chain have been converted to amide groups by reaction with e.g. an ammonium hydroxide in solution.

The LM pectins as used in the present invention are characterized by a degree of methoxylation below 50%, preferably between 5% and 45%, more preferably between 10% and 40%, even more preferably between 15% and 35%.

According to a further preferred embodiment, the LM pectins are amidated, the degree of amidation preferably being below 30%, preferably below 25%, even more preferably below 20%. The preferred lower limit of the degree of amidation is 5%, more preferably 10%.

The LM pectins in the composition according to the present invention are capable of forming a sufficiently rigid matrix at a pH as present in the stomach of a normal human, e.g. pH 3. It is therefore necessary to include at least 0.05 g LM pectin per 100 ml (0.05 wt %) of the composition according to the present invention, preferably at least 0.1 g LM pectin, more preferably at least 0.25 g, even more preferably at least 0.5 g, most preferably at least 0.65 g per 100 ml. However, LM pectin cannot be included unrestrictedly, since at high concentrations the composition will acquire an unacceptable high viscosity. Preferably the composition has a LM pectin content below 5 wt. %, more preferably below 1.5 wt. % even more preferably below 1 wt. %.

Alginate

Alginates are linear unbranched polymers containing β -(1→4)-linked D-mannuronic acid and α -(1→4)-linked L-guluronic acid residues, with a wide range of average molecular weights (100-100000 residues) to suit the application. Suitable sources of alginate include seaweeds and bacterial alginates. Preferably sodium alginate and potassium alginate are used as a source of alginate.

The alginate in the present composition should be capable of forming a sufficiently rigid matrix at a pH as present in the stomach of a normal human, e.g. pH 3. It is therefore necessary to include at least 0.05 g alginate per 100 ml (0.05 wt %) of the present composition, preferably at least 0.1 g per 100 ml, more preferably at least 0.25 g per 100 ml, even more preferably at least 0.4 g per 100 ml. However, alginate cannot be included unrestrictedly, since the composition will become unacceptably viscous. Preferably the present composition has an alginate content below 5 wt. %, more preferably below 2.5 wt. % even more preferably below 1 wt. %.

Calcium Salt

The composition according to the invention preferably contains a calcium salt, which is substantially less soluble in water at 20° C. and at the pH of the composition than at 37° C. and a pH below 5. Such a calcium salt, when present in the composition in an amount that exceeds its maximum solubility, will solubilise in the stomach under the influence of pH-reduction and/or temperature increase. Thus the calcium ion concentration in the composition will increase, which will automatically stimulate pectin and/or alginate gellation.

Because of the gellation inducing effect of calcium ions, the concentration of such ions in the present liquid composition (at near neutral pH) is preferably relatively low. The limited presence of (dissolved) calcium ions at around neutral pH prevents the formation of a gel matrix which would impart unacceptably high viscosity. Thus, in a preferred embodiment, the calcium salt(s) used in the present composition has a solubility below 0.15, more preferably below 0.1 gram, even

more preferably below 0.06 gram per 100 ml (demineralised) water at 20° C. and pH 7. Preferably, the calcium salt(s) provide more than 0.2 gram dissolved calcium per 100 ml water at a pH below 5 and a temperature of 37° C., more preferably it provides more than 0.5 g/100 ml under these conditions. The calcium salt is preferably selected from the group consisting of calcium phosphate (e.g. tribasic, dibasic, monobasic or penta calcium triphosphate), calcium carbonate, calcium sulfate, calcium oxide, calcium citrate (e.g. mono calcium citrate or tri calcium citrate), a calcium salt coated with a substance which has limited solubility in water at pH 7 and is soluble at a pH below about 5 (hereafter referred to as coated calcium salts) and mixtures thereof. Examples of coatings and methods for the preparations of coated calcium salts are given in WO0038829, the entire content of which is hereby incorporated by reference. More preferably, the calcium salt is selected from the group consisting of coated calcium salt, calcium carbonate, calcium phosphate and mixtures thereof. Most preferably the majority of calcium salt is provided by calcium carbonate.

To provide optimal gelling characteristics, the composition according to the invention contains at least 1.25 mM calcium (equivalent to 5 mg Ca per 100 ml). Preferably the calcium concentration exceeds 2.5 mM (equivalent to 10 mg Ca/100 ml), more preferably it exceeds 5 mM, most preferably it exceeds 10 mM. Furthermore, the calcium concentration in the composition preferably does not exceed 1 M, more preferably it does not exceed 500 mM, even more preferably it does not exceed 100 mM.

The calcium concentration in the composition may be determined by first completely solubilising the calcium, followed by the determination of the calcium concentration. The majority of the calcium will be present as a calcium complex and/or insoluble calcium salt when the composition is at neutral pH and thus unavailable to form a viscous matrix with the LM pectins. At a pH between 1 and 5, the calcium will mostly be solubilized from and/or present as a pectin-calcium complex.

In order to decrease unfavorable effects of the LM pectin containing composition on the calcium intestinal absorption, the composition preferably contains a concentration of calcium, which exceeds 0.5 times the concentration of negative charges provided by the LM pectin.

The concentration of negative charges can be calculated using the following formula:

$$\text{Concentration negative charges} = \frac{MW_p}{MW_g + (MW_e \times DE)} \times \frac{(100 - DE)}{100} \times C_p$$

MW_p = Molecular weight pectin (g/mol)

MW_g = Molecular weight galacturon unit (g/mol) = 194 g/mol

MW_e = Molecular weight side chain (g/mol) = 14 g/mol

DE = degree of esterification (%)

C_p = concentration pectin (g/l)

Oligosaccharide

The term indigestible oligosaccharides as used in the present invention refers to saccharides which have a degree of polymerisation of monose units exceeding 2, more preferably exceeding 3, most preferably exceeding 4, which are not or only partially digested in the intestine by the action of acids or digestive enzymes present in the human upper digestive tract (small intestine and stomach) but which are fermented by the human intestinal flora.

The degree of polymerisation of the oligosaccharide is below 60 monose units, preferably below 40, even more

preferably below 20, most preferably below 10. The term monose units refers units having a closed ring structure, preferably hexose, e.g. the pyranose or furanose forms.

The oligosaccharide preferably comprises at least 90%, more preferably at least 95% monose units selected from the group consisting of mannose, arabinose, fructose, fucose, rhamnose, galactose, β -D-galactopyranose, ribose, glucose, galacturonic acid, glucuronic acid, xylose and derivatives thereof, calculated on the total number of monose units contained therein.

Suitable oligosaccharides are preferably fermented by the gut flora. The oligosaccharide used in the composition according to the present invention is preferably capable of significantly increasing the total cecal and/or colonic SCFA content. According to a preferred embodiment of the invention, the oligosaccharide, when administered in a sufficient amount, is capable of increasing total cecal SCFA content by at least 20%, compared to a composition wherein the oligosaccharide is absent, more preferably at least 50%, even more preferably at least 100%, most preferably at least 150%. The increase of total cecal SCFA content can be determined according to the method described by Campbell et al. (The Journal of Nutrition Vol. 127 No. 1 January 1997, pp. 130-136), the entire content of which is hereby incorporated by reference.

Preferably the oligosaccharide is selected from the group consisting of: cellobiose (4-O- β -D-glucopyranosyl-D-glucose), cellodextrins((4-O- β -D-glucopyranosyl) $_n$ -D-glucose), B-cyclodextrins (Cyclic molecules of α -1-4-linked D-glucose; α -cyclodextrin-hexamer, β -cyclodextrin-heptamer and γ -cyclodextrin-octamer), indigestible dextrin, gentiooligosaccharides (mixture of β -1-6 linked glucose residues, some 1-4 linkages), glucooligosaccharides (mixture of α -D-glucose), isomaltooligosaccharides (linear α -1-6 linked glucose residues with some 1-4 linkages), isomaltose(6-O- α -D-glucopyranosyl-D-glucose); isomaltotriose(6-O- α -D-glucopyranosyl-(1-6)- α -D-glucopyranosyl-D-glucose), panose (6-O- α -D-glucopyranosyl-(1-6)- α -D-glucopyranosyl-(1-4)-D-glucose), leucrose(5-O- α -D-glucopyranosyl-D-fructopyranoside), palatinose or isomaltulose (6-O- α -D-glucopyranosyl-D-fructose), theanderose(O- α -D-glucopyranosyl-(1-6)--O- α -D-glucopyranosyl-(1-2)-B-D-fructofuranoside), D-agatose, D-lyxo-hexulose, lactosucrose (O- β -D-galactopyranosyl-(1-4)-O- α -D-glucopyranosyl-(1-2)- β -D-fructofuranoside), α -galactooligosaccharides including raffinose, stachyose and other soy oligosaccharides (O- α -D-galactopyranosyl-(1-6)- α -D-glucopyranosyl- β -D-fructofuranoside), β -galactooligosaccharides or transgalacto-oligosaccharides (β -D-galactopyranosyl-(1-6)-[β -D-glucopyranosyl] $_n$ -(1-4) α -D glucose), lactulose(4-O- β -D-galactopyranosyl-D-fructose), 4'-galatosyllactose(O-D-galactopyranosyl-(1-4)-O- β -D-glucopyranosyl-(1-4)-D-glucopyranose), synthetic galactooligosaccharide (neogalactobiose, isogalactobiose, galsucrose, isolactosel, II and III), fructans-Levan-type (β -D-(2 \rightarrow 6)-fructofuranosyl) $_n$, α -D-glucopyranoside), fructans-Inulin-type (β -D-((2 \rightarrow 1)-fructofuranosyl) $_n$, α -D-glucopyranoside), 1 f- β -fructofuranosyl-nystose(β -D-((2 \rightarrow 1)-fructofuranosyl) $_n$ B-D-fructofuranoside), xylooligosaccharides (B-D-((1 \rightarrow 4)-xylose) $_n$, lafinose, lactosucrose, arabinooligosaccharides and mixtures thereof.

According to a further preferred embodiment the oligosaccharide is selected from the group consisting of fructans, fructooligosaccharides, indigestible dextrins galactooligosaccharides (including transgalactooligosaccharides), xylooligosaccharides, soybean oligosaccharides, arabinooli-

gosaccharides, glucooligosaccharides, mannoooligosaccharides, fucooligosaccharides and mixtures thereof.

Suitable oligosaccharides and their production methods are further described in Laere KJM (Laere, KJM, Degradation of structurally different non-digestible oligosaccharides by intestinal bacteria: glycosylhydrolases of *Bi. adolescentis*. PhD-thesis, Wageningen Agricultural University, Wageningen, The Netherlands) the entire content of which is hereby incorporated by reference.

The term fructans as used in this document can be divided in two classes, levan and inulin. Levans are β -2,6-linked fructans with variable degrees of β -2,1-linked side chains that are produced by a large variety of bacteria. Inulins and fructooligosaccharides on the other hand, are a group of linear glucosyl α (1 \rightarrow 2)(fructosyl) $_{n-1}$ β (2 \rightarrow 1)fructose polymers with a degree of polymerisation (DP) ranging from 2 up to 60. Fructooligosaccharides are produced, either by enzymatic hydrolysis of inulin or by transfructosylation of sucrose. If oligosaccharides have a DP lower than 9, they are named fructooligosaccharides. The main fructooligosaccharides are 1-kestose (GF₁), nystose (GF₂) and fructosylnystose (GF₃) (GF=glycosylfructo-oligosaccharide). The fructans components with a higher DP are named inulin. Inulin is for example sold under the trademark Raftiline™ (Orafti Active Food Ingredients, Belgium). Fructooligosaccharides and oligofructose are for example sold under the trademark Raftilose™ (Orafti Active Food Ingredients, Belgium) and NutraFlora™ (Golden Technologies Company)

NutraFlora has been described to increase total cecal SCFA content by about 260%. Raftilose has been described to increase total cecal SCFA content by about 244%. (Campbell et al: The Journal of Nutrition Vol. 127 No. 1 January 1997, pp. 130-136). Hydrolyzed inulin is available from Rhone-Poulenc, Inc, Cranbury, N.J.

The term galacto-oligosaccharides (including transgalactooligosaccharides) refers to non-digestible carbohydrates structured as chains rich in galactose with mostly a glucose end-unit. Two types of galactooligosaccharides are distinguished. The galactooligosaccharides can be produced from lactose by the transglycosylating activity of β -galactosidase or by hydrolysis of polymeric galactans. β -galacto-oligosaccharides may consist of a number of β -1,6-linked galactosyl residues linked to a terminal glucose unit via an α 1,4-bond. Another type of galactooligosaccharides is isolated from soybeans. These α -galacto-oligosaccharides (galactosyl-sucrose oligosaccharides) include raffinose, stachyose and verbascose and consist of galactose residues linked α -1,6 to the glucose moiety of sucrose. The physiological effects of these oligosaccharides appear to be similar to the β -linked galactose oligomers. The composition of galactooligosaccharides may vary in chain length and type of linkage between the monomer units.

Transgalactooligosaccharides are for example sold under the trademark Elix'or™ (Borculo Domo Ingredients, Netherlands). Galactooligosaccharides are available from Solabia, Pantin Cedex, France.

Indigestible dextrin, which may be produced by pyrolysis of corn starch, comprises α (1 \rightarrow 4) and α (1 \rightarrow 6) glucosidic bonds, as are present in the native starch, and contains 1 \rightarrow 2 and 1 \rightarrow 3 linkages and levoglucosan. Due to these structural characteristics, indigestible dextrin contains well-developed, branched particles that are partially hydrolysed by human digestive enzymes.

Numerous other commercial sources of indigestible oligosaccharides are readily available and known to skilled person. For example, transgalactooligosaccharide is available from Yakult Honsha Co., Tokyo, Japan. Soybean oligosac-

charide is available from Calpis Corporation distributed by Ajinomoto U.S.A. Inc., Teaneck, N.J.

The oligosaccharides are preferably included in the composition according to the invention in an amount exceeding 0.1 wt. %, preferably exceeding 0.2 wt. %, more preferably exceeding 0.5 wt. % and even more preferably exceeding 0.9 wt. %. Although the administration of considerable amounts of oligosaccharides will generally not lead to undesirable side effects, the present composition preferably has an oligosaccharide content below 20 wt. %, more preferably below 10 wt. % even more preferably below 5 wt. %.

It is important to recognize that the amount of LM pectins administered to the subject will determine the required amount of oligosaccharides present in the composition according to the invention. Preferably the weight ratio oligosaccharides to pectins exceeds 0.25, more preferably is between 0.5 and 100, even more preferably between 0.75 and 50, most preferably between 1 and 5.

Water

Water is of great importance for the prevention of body weight increase and/or reducing obesity. The present composition preferably contains between 50 and 99 wt. % water, more preferably between 60 and 95 wt. %, even more preferably between 75 and 90 wt. %.

Supplementary Components

The composition according to the invention can suitably be used to replace one or more meals or snacks during the day. The composition preferably contains additional nutritional ingredients, which further contribute to a healthy diet.

Bioactive Agents

Vitamins are preferably added to the composition according to the invention. The vitamins added may suitably be selected from the group consisting of Vitamin A, Vitamin E, Vitamin K, Vitamin C, Vitamin D, Thiamin, Riboflavin, Niacin, Vitamin B6, Folic acid, Vitamin B 12, Biotin, Pantothenic acid and mixtures thereof. Preferably the composition contains at least 3 specified bioactive agents selected from this group. According to a preferred embodiment, at least vitamin D is present in the composition to further aid the calcium absorption. Obese or overweight subjects often suffer from vitamin D deficiency.

The easiest and most natural way to get Vitamin D is from exposure to sunlight, which causes the body to manufacture its own. However, humans wishing to reduce body weight often have a low self-esteem, and are therefore hesitant to expose themselves to sunlight, e.g. by sunbathing. Furthermore, common sources of vitamin D, such as dairy products like milk are often replaced by soda drinks in the diets of overweight subjects. The bioactive agents may be present in the composition according to the invention in an amount ranging from 5% of the recommended daily intake (RDA) to 250% of the RDA of the specific bioactive agents. The RDA has been published by the US Food and Drug Administration.

Minerals

Minerals may be added to the present composition. The minerals added may suitably be selected from the group consisting of iron, zinc, copper, chromium, iodine, selenium, magnesium, manganese, molybdenum, choline, potassium, phosphate, chloride and mixtures thereof and preferably contains at least 3 specified minerals selected from this group.

The minerals are preferably present in the composition according to the invention in an amount ranging from 5% of the recommended daily intake (RDA) to 250%, preferably

between 10 and 50% of the RDA of the specific minerals. The RDA has been published by the US Food and Drug Administration

Fibers

The composition preferably includes one or more additional fibers other than LM pectins or non-digestible oligosaccharide having a degree of polymerisation between 2 and 60. The additional fiber may be selected from the group of soluble and insoluble fibers. The fiber may further stimulate the satiety effect of LM pectins by decreasing the rate of stomach emptying and/or provide a slow release of sugars in the intestine which also contributes to an extended feeling of satiety. Furthermore, the fibers may prevent or decrease constipation and further contribute to a blood serum cholesterol lowering effect of the composition according to the present invention.

When the additional fibre is soluble fibre, the soluble fibre of the present invention is preferably selected from the group consisting of high methoxylated pectin, chitosan, beta-glucan, soluble fibre from psyllium husk (hereafter referred to as psyllium), xanthan gum, guar gum, locust bean gum, gum arabic, soy fibre and mixtures thereof, more preferably from the group consisting of psyllium, pectin, beta-glucan or mixtures thereof. The beta-glucan is preferably obtained from whole oat, and even more preferably is part of a whole oat soluble fiber composition.

Preferably the additional fiber is included in the composition in an amount between 0.1 g and 10 gram fiber per 100 ml, more preferably between 0.2 and 5 gram, which preferably includes between 0.05 and 2 gram beta-glucan per 100 ml.

Protein

Proteins are essential in human nutrition. The composition according to the invention therefore preferably includes between 1 and 20 grams protein per 100 ml of the composition, more preferably between 2 and 10 grams.

The protein is preferably obtained from a vegetable source, more preferably includes at least about 1 gram soy protein per 100 ml, wherein the soy protein is preferably selected from soy protein concentrate and soy protein isolate.

Digestible Carbohydrates

The composition may contain digestible carbohydrates. When the composition is designed to replace one or more meals, it is desirable to include digestible carbohydrates. The term digestible carbohydrates includes digestible polysaccharides and monosaccharides, i.e. carbohydrates which are digested by the intestinal acids and/or intestinal enzymes and/or are absorbed by the intestinal cells. The digestible carbohydrate may for example be a starch, a maltodextrin or a monosaccharide. Preferably the composition includes 0.2 to 5 wt. % monosaccharide, even more preferably between 1 and 3 wt. %. According to a further preferred embodiment the monosaccharide mainly consists of fructose.

The inclusion of digestible polysaccharides such as starches and maltodextrins in the present composition may further contribute to the feeling of satiety. When the composition is in a ready-to-drink form, the composition preferably has a low (non-maltodextrin) starch content because inclusion of an appreciable amount of starch will inevitably lead to a strong viscosity increase during heat processing (e.g. sterilization). Hence, preferably the composition contains below 1 gram starch per 100 ml, more preferably below 0.5 gram, even more preferably below 0.2 grams. Digestible maltodextrins (DE between 5 and 30, preferably around 20) are advantageously added to the present composition to provide a satiety effect as maltodextrins, in contrast to other starch and

starch derivatives, can suitably be used in heat processed liquids. Preferably, the present composition preparation contains between 0.5 and 20 g maltodextrins per 100 ml, even more preferably between 2 and 10 grams maltodextrins per 100 ml.

Fat

When the composition is aimed to replace one or more meals, it is desirable to include lipids or fat. Preferably the lipids are obtained from plant sources, e.g. canola oil or olive oil, which have a relatively high content of monounsaturated and/or polyunsaturated fatty acids. Preferably at least about 10 wt. % of the lipids included in the product are polyunsaturated fatty acids. The content of lipids included in the composition is preferably between 0.2 and 10 wt. %, more preferably between 0.5 and 5 wt. %.

Liquid Composition of Pectin, Calcium, Oligosaccharides and Water

For subjects who desire to reduce their caloric intake, the present composition may be provided substantially free of high caloric ingredients. Hence, the present composition preferably contains less than 5 wt. % of digestible carbohydrate and fat, based on the total weight of the liquid composition, more preferably less than 2 wt. %, even more preferably less than 1 wt. %. In a further embodiment, the present invention provides a liquid edible composition with a pH of more than 6, a viscosity below 600 mPa.s at a shear rate of 100s^{-1} and 20°C ., and a viscosity of at least 125% of the aforementioned viscosity at a pH below 5 and a temperature of 37°C ., wherein at least 95 wt. % of the composition consists of pectin, calcium salt, oligosaccharide and water. In a preferred embodiment at least 95 wt. % of the present composition consists of at least 0.05 wt. % of pectin having a degree of methoxylation between 2 and 50 and/or of alginate; at least 5 mg calcium per 100 ml; at least 0.1 wt. % indigestible oligosaccharide having a degree of polymerisation between 2 and 60; and water.

According to a further preferred embodiment, the above described compositions at least 98 wt. % of the total weight of the composition consists of pectin, oligosaccharide, calcium salt and water, more preferably at least 99 wt. %. The preceding composition thus may comprise taste modifiers such as flavors, low caloric sweeteners, colorants and/or stabilizers. Additionally the composition may contain minor amounts of other nutritional components, which are for example present in the raw material(s) necessary to formulate the composition, e.g. many pectin raw materials include for example minor amounts of sucrose. The above composition, consisting of a limited amount of ingredients, preferably has a nutritional value below about 50 kcal/100 ml, more preferably below about 25 kcal/100 ml, even more preferably below 10 kcal/100 ml.

Application

A consumer may suitably prepare the present liquid edible composition from e.g. a powder that contains the pectin and/or alginate, calcium and oligosaccharide by simply adding a predetermined amount of water and/or milk. Hence, one aspect of the present invention provides a mixture for making a liquid edible composition comprising, in reconstitutable form, a) a polysaccharide selected from the group consisting of low methoxylated pectin, alginate and mixtures thereof; b) calcium; and c) oligosaccharide, wherein an aliquot of the composition can be dissolved in a premeasured amount of a suitable solvent to produce the present liquid edible composition. The suitable solvent preferably has a pH above 6, and may suitably be selected from the group consisting of water,

milk and mixtures thereof. Preferably the mixture for making the present liquid edible composition is in powder form.

The invention also provides a process for preparing the present liquid edible composition, said process comprising admixing the aforementioned mixture with a solvent that is preferably selected from the group consisting of water, milk and mixtures thereof. The term "reconstitutable form" as used herein refers to a preparation that needs addition of a suitable liquid (preferably water) to obtain the present edible liquid composition. Preferably the reconstitutable preparation is a reconstitutable powder. The present composition may also be in a ready-to-drink form, which can be consumed without the need for further preparation, i.e. does not require the addition of water before ingestion.

According to a preferred embodiment, the present composition is provided as a packaged beverage product comprising at least 25 ml, more preferably at least 50 ml, even more preferably at least 100 ml of the composition. Preferably the contents of the packaged beverage product do not exceed 2000 ml, more preferably the contents are below 1000 ml, even more preferably below 500 ml, most preferably below 400 ml. When the present composition is supplied in powder form, it is preferably accompanied with a instruction to reconstitute the powder in a predetermined volume of water, for example by shaking or blending, to obtain the composition according to the present invention. Preferably the composition is consumed within about 60 minutes after reconstitution.

The present liquid composition is preferably thermally treated prior to consumption, preferably by means of pasteurization, sterilization or ultra-pasteurization. Furthermore the present composition preferably contains one or more flavorings and/or colorants. The composition is preferably used to replace one or more meals, preferably one or more meals selected from breakfast, lunch or dinner. Preferably the composition is consumed more than one time per day.

Whenever the term dose or dosage is used within this document, this refers to the total consumption of the present composition within a fairly narrow time span. Whenever reference is made to a certain quantity that is administered per dose or dosage, said quantity is preferably administered within one hour, more preferably within 30 minutes, even more preferably within 10 minutes.

Viscosity

The present liquid composition has a viscosity below 600 mPas at a shear rate of 100 s^{-1} at 20° C . and a viscosity of at least 125% of said viscosity at a pH below 5 and a temperature of 37° C .

The liquid edible composition preferably has a limited viscosity. Therefore, according to a preferred embodiment the present composition has a viscosity below 250 mPas, more preferably below 100 mPas, most preferably below 50 mPas at a shear rate of 100 s^{-1} at 20° C .

Preferably, at pH 3 and 37° C . the composition has a viscosity which is at least 150% of the aforementioned viscosity at near neutral pH, more preferably above 200%, even more preferably above 400%. Preferably the composition has a viscosity at pH 3 and 37° C . which exceeds 250 mPas, more preferably exceeds 300 mPas, most preferably exceeds 400 mPas.

Whenever the term viscosity used in the present document, this refers to the physical parameter which is determined according to the following method:

The viscosity may be determined using a Carri-Med CSL rheometer. The used geometry is of conical shape (6 cm 2 deg acrylic cone) and the gap between plate and geometry is set on 55 μm . A linear continuous ramp shear rate is used from 0 to

150 s^{-1} in 20 seconds. The rheometer's thermostat is set on the appropriate temperature (e.g. 20° C . or 37° C .).

In order to determine the viscosity at acidic pH (pH 3), first a sufficient amount of 1 M HCl is homogeneously admixed (drop-wise under very gentle stirring for about 20 sec, to prevent the breakdown of the gel) to the liquid composition to adjust the pH of the composition to pH 3. Thereafter the composition is left standing at 20° C . for about 10 minutes. Subsequently the composition thus obtained is used to determine the viscosity at pH 3, according to the method described above.

To decrease the viscosity of the present composition (at near neutral pH), ingredients may advantageously be added that are selected from the group of polyols, e.g. sorbitol, maltitol, or erytritol. These ingredients offer the advantage that they hardly affect the viscosity of the present composition at low pH. Preferably these viscosity decreasing ingredients are added in an amount of 0.5 to 50 wt. %. Suitable examples of the use of polyols in the present preparation are given in WO0038829, the entire content of which is hereby incorporated by reference.

According to another embodiment of the invention the present composition may additionally comprise an anion which forms a complex or insoluble salt with calcium at pH 7. Exemplary and preferably the anion is provided by a salt that is soluble at pH 7. The salt may be a potassium or sodium salt of citrate or phosphate. Preferably such salt is used in an amount between 0.2 and 10 wt. %.

A problem with pectin and calcium containing drinks is the limited shelf life of such products. Over time, the pectin containing product increases in viscosity, resulting in a hardly drinkable formulation, or even worse, the composition may turn to a solid or jelly consistence. Therefore, the prior art generally does not combine calcium salt and LM pectin in a composition that is marketed in liquid form.

The specific combination of ingredients of the present composition ensures a good shelf life. The present composition is preferably formulated in such way that the viscosity of the liquid edible composition after storing the composition for a period of 60 days (at 20° C .) is below 300% of the starting viscosity, more preferably below 200%, even more preferably below 150%. The starting viscosity is determined 2 days after manufacture of the composition.

Methods of Treatment

Preferably the present composition is used in the treatment or prevention of a disease or a disorder. In a preferred embodiment the present composition is used in a method for the prophylactic or curative treatment of overweight in a mammal. The term overweight as used in the present invention refers to a bodyweight and/or an adipose tissue mass that is above the desired bodyweight and/or desired adipose tissue mass. The present method can thus suitably be used to reduce adipose tissue mass or prevent an increase in adipose tissue mass, a method for increasing the ratio lean body mass to adipose tissue mass and/or the ratio muscle mass to adipose tissue mass.

The present method can both be used to treat or prevent overweight in a medical sense and/or for the cosmetic treatment or prevention of overweight. Preferably the present method is used to prevent or treat overweight in humans.

It was further found that the present composition can be suitably used to induce satiety. Hence the present composition can be advantageously used in a method for stimulating satiety, particular postprandial satiety in mammals. The present composition will provide a feeling of satiety in those patients who would normally not be able to experience this

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feeling because the food consumption is restricted, e.g. those patients which have difficulty consuming solid food or which are required to consume liquid foods, particularly hospitalized patients and elderly. In particular those patients that receive most or all of their daily nutritional requirements passively (by oral tube feeding) in order to sustain protein synthesis and avoid malnutrition can use the present composition advantageously. Hence the present composition can be suitably used in a method that comprises the oral tube feeding of the present composition.

It was further found that the present composition can be used to control blood insulin levels. Hence, the present composition can be advantageously used in a method for the reduction of blood insulin levels, in particular postprandial blood insulin levels. Additionally the present composition can be used to reduce (postprandial) insulin peaks or (postprandial) insulin secretion. The present composition can thus be advantageously used in the management of healthy insulin levels. Hence, the present composition can be advantageously used in a method for the treatment and/or prevention of diabetes type II, said method comprising administering to a subject an effective dose of the present composition.

In the above methods, the present composition is preferably used to at least partially replace one or more meals.

EXAMPLES

Example 1

A composition is prepared comprising:

0.55 gram 31% methoxylated, 17% amidated apple pectin
154 mg calcium carbonate
0.4 g tri potassium citrate
1 gram Fibersol 2™ (Matsutani Chemical industry Co., Japan)

Filled up with water to 100 ml (pH adjusted to 7 with 10% KOH solution)

At pH 7 the composition has a viscosity of 32 mPas at a shear rate of 100 s^{-1} , 20°C . At pH 3, 37°C . a rigid gel is formed. (viscosity $>>1000 \text{ mPas}$)

Example 2

A composition is prepared comprising:

0.62 gram 31% methoxylated, 17% amidated apple pectin
154 mg calcium carbonate
0.42 g tri potassium citrate
1 gram Fibersol 2™ (Matsutani Chemical industry Co., Japan)

4.55 gram soy protein isolate

0.86 gram oat bran

3.18 gram maltodextrin 19 DE

1.54 gram fructose

0.31 gram canola oil

0.31 gram olive oil

80 mg vitamin blend

60 mg minerals and trace element blend

Filled up with water to 100 ml (pH adjusted to 7 with 10% KOH solution)

This composition is homogenized and sterilized. At pH 7 and 20°C . the composition has a viscosity of 27 mPas at a shear rate of 100 s^{-1} . At pH 3 and 37°C . the composition has a viscosity of 150 mPas at a shear rate of 100 s^{-1} .

Example 3

A composition comprising:

0.1 gram 31% methoxylated, 17% amidated apple pectin
50 mg calcium carbonate

0.4 g tri potassium citrate

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1 gram Fibersol 2™ (Matsutani Chemical industry Co., Japan)

0.5 gram sucrose

5 gram full cream milk powder

11 gram oat bran

Filled up with water to 100 ml (pH adjusted to 7 with 10% KOH solution)

At pH 7 the composition has a viscosity of 48 mPas at a shear rate of 100 s^{-1} . At pH 3 a rigid gel is formed (viscosity $>>1000 \text{ mPas}$).

Example 4

A placebo controlled, double blind, randomized cross over study was conducted to evaluate the effect of the ingestion of the present composition on postprandial blood glucose and insulin, and appetite feelings.

Study Population

Volunteers were recruited in Wageningen and surroundings. Posters at several locations at the university and student flats and advertisements in local newspapers were used. Inclusion criteria for study participation were: Body Mass Index (BMI) $18.5\text{--}27 \text{ kg/m}^2$, fasting glucose level $<6.0 \text{ mmol/L}$, non-smoking, age 18-55 years. Exclusion criteria were: use of medication affecting the gastrointestinal tract (e.g. antibiotics, laxatives), diabetes mellitus type I or II confirmed by a general practitioner, change in body weight $>10\%$ during last year, unusual dietary habits (e.g. specific diets, vegans), pregnancy or intention to get pregnant, lactation, stomach or bowel surgeries, psychiatric illness.

During the screening visit fasting glucose level, body weight and body height were determined. Body weight was measured to the nearest 0.1 kg using a precision scale without shoes with subjects dressed in light clothing. Height was determined to the nearest cm without shoes. BMI was calculated from weight and height: $\text{weight}(\text{kg})/(\text{height}(\text{m}))^2$. Depending on these results it was decided whether the subject could participate in the study.

Thirty-three healthy non-smoking subjects (7 men, 21 women) in the age of 25 ± 9 years (mean \pm SD), BMI $21.9 \pm 2.4 \text{ kg/m}^2$ (mean \pm SD) and fasting glucose levels of $4.4 \pm 0.5 \text{ mmol/l}$ (mean \pm SD) were recruited. The study was explained by the investigator. All subjects signed informed consent forms prior to their entry into the study.

Study Design

Participants were randomized over 2 groups. Each group received both CarboMix and ControlMix in different order (ingredients of CarboMix and ControlMix are provided below, see Test products). Postprandial blood glucose response and appetite were measured on two occasions once after ingestion of CarboMix and once after ingestion of ControlMix. The measurements were separated by at least 4 days. The evening prior to each study day, the subjects consumed a standardized pasta meal. It was not allowed to do any sports.

On each study day, after a 12 hour overnight fast, a teflon catheter was inserted in the forearm vein of one arm to obtain a fasting blood sample. The catheter was maintained to allow repeated sampling. At the same time, participants were asked to rate their appetite feelings. Subsequently, participants consumed the CarboMix or the ControlMix within 10 minutes. Postprandial blood samples were taken at 10, 20, 30, 40, 50, 60, 75, 90, 120, 150 and 180 minutes after consumption of the first swallow of the mix for blood glucose and insulin measurements. After each blood sample, 1 ml heparine (=200 units) was inserted in the teflon catheter to prevent blood clotting in the catheter. Therefore each blood sampling started

with a small sample of approximately 2-3 ml to remove the heparine from the catheter, followed by two blood samples of 4.5 ml. This resulted in a total blood sample of approximately 132-144 ml per day of measurement. At each moment of blood sampling, participants were asked to rate their appetite feelings in a questionnaire. After at least 4 days, this procedure was repeated with the other mix. Subjects who missed one of the two measurements (CarboMix or ControlMix) were excluded from the study.

Test Products

CarboMix: carbohydrate mix consisting of 50 gram available carbohydrates and 14.3 gram fiber (mix A dissolved in 281 ml water) ControlMix: carbohydrate mix consisting of 50 gram available carbohydrates, no fiber. (mix B dissolved in 292 ml water). Both carbohydrate mixes had an end volume of 325 ml. The ingredients of Mix A and Mix B are specified in Table 1.

TABLE 1

Ingredient type	Mix A		Mix B	
	kcal	g	kcal	g
Carbohydrates total		64.28		50
Digestible carbohydrates	200	50	200	50
Fructose		10.2		
Glucose				10.2#
Maltodextrins (DE19)		39.8* ¹		
Maltodextrins (DE39)				39.8* ²
Fibers total		14.28		
Insoluble fiber from oat fiber		2.14**		
Soluble fiber from oat		0.11**		
Pectin		4.08***		
Indigestible maltodextrins		7.94****		
Calcium (CaCO ₃)		1.00		
K ₂ HPO ₄		1.50		
Powderflavor*****		0.33		0.33
Coloring agent*****		0.002		0.002

*¹Provided by 41.5 grams Glucidex 19 (Roquette)

*²Provided by 41.5 grams Glucidex 39 (Roquette)

**Provided by 4.45 grams Snow White Oat Fibre 500 (Canadian Harvest)

***Provided by 4.54 grams Genu-pectin LM-104 AS (Orffa-Hercules)

****Provided by 8.86 grams Fibersol-2 ® (Matsutani)

*****Orange 610582H (Givaudan)

*****Sunset yellow (Eurocert)

#Provided by 11.2 grams glucose monohydrate (Referose ®, Roquette)

Biochemical Measurements

Plasma glucose and insulin concentrations were measured. For glucose analyses the samples were collected in potassium oxalate tubes. After centrifugation, plasma samples were stored at -20° C. and glucose was measured according to standard laboratory methods. For insulin analyses the samples were collected in clotting tubes and centrifuged after clotting. Plasma samples were stored at -20° C. and insulin were measured using radio-immuno-assay.

Appetite Questionnaires

Scores for appetite were determined using visual analogue scales (VAS scores) from 100 mm by means of a slash on each labeled line. The term 'not at all' was placed at the left side and the term 'extremely' at the right side to score for each label. The labels were placed above the lines. The label 'appetite for a meal' referred to appetite for a whole meal, either a hot meal or a sandwich meal. 'Satiety (fullness)' referred to fullness or the feeling of having eaten too much. The label 'feeble, weak with hunger' referred to a strong urge to eat with clear physical symptoms (de Graaf C et al, Short-term effects of different amounts of protein, fats, and carbohydrates on satiety. Am J Clin Nutr 1992; 55:33-8).

Statistical Analysis

For treatment effects, carryover effect was determined. For the variables without carryover effect statistical tests were performed to determine the treatment effect. For all analyses non-parametric tests were used. For the difference in Incremental Area Under the Curve, peak height and time to peak for glucose and insulin and for VAS scores from the appetite questionnaire, the two-sample Mann-Whitney U test for unpaired samples was used. Statistical differences were assumed when $p < 0.05$.

Results

Results are shown as mean \pm SEM.

Blood Glucose

Blood glucose curve was lower after consumption of CarboMix than after consumption of ControlMix. The incremental area under the blood glucose curve after 90 minutes was lower after CarboMix than after ControlMix (Table 2).

TABLE 2

Incremental area under blood glucose curve after 90 minutes (mmol*min/l) (mean \pm SEM)		
CarboMix	ControlMix	P-value
108.4 \pm 14.9	127.2 \pm 17.5	0.294

Insulin

Insulin curve was lower after consumption of CarboMix than after consumption of ControlMix. The incremental area under the insulin curve after 90 minutes was significantly lower after CarboMix than after ControlMix (Table 3). The insulin peak was lower after CarboMix than after ControlMix (Table 4). The time to reach the insulin peak was significantly shorter after CarboMix than after ControlMix (Table 5).

TABLE 3

Incremental area under the insulin curve after 90 minutes (mU*min/l) (mean \pm SEM)		
CarboMix	ControlMix	P-value
1659.2 \pm 151.5	2246.0 \pm 238.6	0.003

TABLE 4

Insulin peak (mU/l) (mean \pm SEM)		
CarboMix	ControlMix	P-value
43.0 \pm 4.4	48.4 \pm 4.9	0.072

TABLE 5

Time to reach insulin peak (minutes) (mean \pm SEM)		
CarboMix	ControlMix	P-value
38.0 \pm 2.1	47.6 \pm 2.9	0.005

Appetite

The values for the question 'Desire to have a meal' were lower after CarboMix than after ControlMix from 10 until 75

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minutes after consumption of the drink. These values were significantly different after 20 and 30 minutes (Table 5).

TABLE 6

Values for the question 'Desire to have a meal' for 20 and 30 minutes (mean \pm SEM)			
	CarboMix	ControlMix	P-value
After 20 minutes	36.2 \pm 4.4	43.3 \pm 4.4	0.034
After 30 minutes	36.9 \pm 3.5	47.6 \pm 4.1	0.007

The values for the question 'Feelings of satiety' were higher for CarboMix than for ControlMix, from 10 until 80 minutes after the first sip of the drink. These values were significantly different after 50 minutes (Table 6).

TABLE 7

Values for the question 'Feelings of satiety' for 50 minutes (mean \pm SEM)			
	CarboMix	ControlMix	P-value
After 50 minutes	41.3 \pm 3.5	31.8 \pm 2.4	0.026

The values for the question 'Feeble with hunger' were higher for CarboMix than for ControlMix, from 10 until 70 minutes after consumption of the drink. These values were significantly different after 20 and 30 minutes (Table 7).

TABLE 8

Values for the question 'Feeble with hunger' for 20 and 30 minutes (mean \pm SEM)			
	CarboMix	ControlMix	P-value
After 20 minutes	26.4 \pm 4.1	36.4 \pm 4.2	0.002
After 30 minutes	29.5 \pm 3.9	39.1 \pm 3.9	0.038

Example 5

Calcium Availability During Fermentation

Preparation of MacFarlane medium	
Buffered peptone water	3.0 g/l
Yeast Extract	2.5 g/l
Tryptone	3.0 g/l
L-Cysteine-HCl	0.4 g/l
Bile salts	0.05 g/l
K ₂ HPO ₄ •3H ₂ O	2.6 g/l
NaHCO ₃	0.2 g/l
NaCl	4.5 g/l
MgSO ₄ •7H ₂ O	0.5 g/l
CaCl ₂	0.228 g/l
FeSO ₄ •7H ₂ O	0.005 g/l

pH was adjusted to 6.3 \pm 0.1 using 2M HCl and subsequently the medium was sterilized.

Preparation of Fecal Suspension:

Under anaerobic conditions, human feces were suspended in McFarlane medium in a weight ratio feces: MacFarlane medium of 1:5. The suspension was subsequently sieved to remove solid components.

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Fermentation

15 ml of the fecal suspension was mixed with a dry mixture consisting of either pectin and calcium; or pectin, calcium and oligosaccharide (see Tabel 9) and incubated for 24 hours at 37° C. under anaerobic conditions. After incubation, the solids were removed from the suspension by centrifugation and pH and free calcium concentration were determined with a calcium electrode (model 720A, ThermoOrion, Beverly, USA). The results are given in Table 9.

TABLE 9

Sample No	LM Pectin*** (mg)	CaPO ₄ (mg)	Oligosaccharide	pH	Free calcium (ppm)
1	100	100	500 mg Fibersol ®*	4.6	200
2	100	100	—	5.5	107
3	200	100	320 mg Fibersol ®*	4.6	180
4	200	100	—	5.3	144
5	50	100	250 mg FOS**	3.9	362
6	50	100	—	5.7	86

*Fibersol-2 ® (Matsutani)

**Raftilose™ (Orafti Active Food Ingredients)

***Genu-pectin LM-104 AS (Orffa-Hercules)

The invention claimed is:

1. A liquid edible composition with a pH of more than 6, a viscosity below 600 mPas at a shear rate of 100 s⁻¹ and 20° C., and a viscosity of at least 125% of the aforementioned viscosity at a pH below 5 and a temperature of 37° C., the composition comprising:

- between 0.65 and 5 wt. % of pectin having a degree of methoxylation below 50%;
- at least 5 mg calcium per 100 ml wherein the calcium is provided by a calcium salt which has a solubility below 0.15 grams per 100 ml demineralized water at 20° C. and pH 7; and
- indigestible oligosaccharide having a degree of polymerisation between 2 and 60 in such an amount that the weight ratio oligosaccharides to pectin is between 1 and 5.

2. A composition according to claim 1, comprising about 1.5 wt. % pectin having a degree of methoxylation between 5% and 45%.

3. A composition according to claim 1, wherein the calcium is provided by a calcium salt which has a solubility below 0.10 grams per 100 ml (demineralized) water at pH 7 and 20° C.

4. A composition according to claim 1, comprising between 0.9 and 10 wt. % indigestible oligosaccharide having a degree of polymerisation between 2 and 40.

5. A composition according to claim 1, wherein the oligosaccharide is selected from the group consisting of fructans, fructooligosaccharides, indigestible dextrans galactooligosaccharides, xylooligosaccharides, soybean oligosaccharides, arabinooligosaccharides and mixtures thereof.

6. A composition according to claim 1, wherein the calcium salt is selected from the group consisting of calcium phosphate, calcium carbonate, calcium sulfate, calcium oxide, calcium citrate, a calcium salt coated with a substance which has limited solubility in water at pH 7 and which is soluble at a pH below 5 and mixtures thereof.

7. A composition according to claim 1 comprising between 50 and 98 wt. % water.

8. A composition according to claim 1, comprising between 1 and 25 grams protein per 100 ml.

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9. A composition according to claim 1, comprising between 0.2 and 10 wt. % fat.

10. A packaged beverage product comprising between 50 and 1000 ml of a composition according to claim 1.

11. A method for stimulating satiety in a mammal, said method comprising administering to said mammal an effective amount of a composition according to claim 1.

12. A method for reducing blood insulin levels, reducing insulin peaks and/or reducing insulin secretion in a mammal,

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said method comprising administering to said mammal an effective amount of a composition according to claim 1.

13. A method for reducing postprandial blood glucose levels in a mammal, said method comprising administering to said mammal an effective amount of a composition according to claim 1 said composition comprising an oligosaccharide selected from the group consisting of 1-ketose, nystose and fructonystose.

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