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(54) **Title**: PECTINS IMPROVING ENERGY REDISTRIBUTION IN ANIMALS

(57) **Abstract**: The current invention relates to a composition comprising a carbohydrate, whereby said carbohydrate is pectin with an esterification degree less than 65%, a feed comprising such composition and use of said composition or feed for improving the feed intake pattern in animals and humans.

PECTINS IMPROVING ENERGY REDISTRIBUTION IN ANIMALS

Technical field

This invention relates to energy redistribution in animals by pectins with a specific degree of esterification. This energy redistribution is explained by a modified feed intake pattern due to the presence of pectins with a specific degree of esterification in the feed. This feed intake pattern is characterised by first latency to feed intake (delayed first meal), smaller meals, but more frequent meals. As a result, the total feed intake in the animal life is not affected, only the feed intake pattern is improved.

Background of the invention

Improvement of feed efficiency towards lean meat is mandatory to ensure the worldwide demand for healthy animal derived food, such as meat. To achieve that goal the world is depending upon new technologies in intensive animal food production. In this context, the production rate in animals and more particularly lean meat quality is becoming increasingly important for animal (and subsequently human) health. In addition, the rising incidence of obesity among populations in industrialized areas has fueled the demand for a different feeding pattern (behavior as well as type of food products, such as meat with a lower fat content). This way, using functional carbohydrates to influence feeding behavior and/or fat deposition in livestock animals and – both indirectly and directly - in humans, will be an important tool to tackle the obesity problems in the human population.

Carbohydrates have been shown to be an essential feed ingredient in regulation hunger and satiety. The current invention aimed to identify specific carbohydrates, which are regulating satiety processes and have at the same time beneficial effects on the energy balance of animals, as an important health parameter. This target will become increasingly more important in animal health care.

Summary of the invention

The current invention aims to provide a composition useful to be used as feed supplement, which provides an improved intake pattern, thereby resulting in a repartitioning of energy. The current invention thereto provides a composition according to claim 1 and use of such composition according to claim 7 or 12.

Figures

Figure 1 shows parts of the structure of pectin as well as (partially) esterified pectin.

Description of invention

Pectins are found in the primary cell wall and middle lamella of the plant tissues as complex polymers of α-D-(1→4) galacturonic acid (McCready, 1970). They contribute to many functions in plants, affecting cell size and shape, tissue resistance, ion transport, water holding capacity, defence against pathogens and wounding (Voragen *et al.*, 2001). At various stages of maturity of the plant the pectins are partially in the methyl ester form and may contain some acetyl groups (Jeraci and Lewis, 1989). However, in most research today, pectins are not further characterized, and observed effects cannot be attributed to a specific (sub)structure of pectins. Although it is expected that different pectic fractions can markedly affect the chemico-physical and the biological properties of the dietary fibre (Voragen *et al.*, 2001; Bailoni et al. 2005), most research on nutritional effects of pectins lack structural research and therefore pectins are referred rather to antinutritional nutrients in feed, lowering overall feed intake resulting in lower animal performance.

Pectins are produced commercially as a white to light brown powder, mainly extracted from citrus fruits, and is used in food mainly as a gelling agent, particularly in jams and jellies. It is also used in fillings, medicines, sweets, as a stabilizer in fruit juices and milk drinks, and as a source of dietary fiber.
Figure 1 shows parts of the structure of pectin as well as (partially) esterified pectin. The formula shows that the esterification is a methoxylation, but also other alkyl groups can be used (such as acetyl). It is clear that a pectin can be esterified with one group only (such as CH3 or COCH3) or with more than one group in the same structure. Preferably the esterification type of the pectin is either methylation and/or acetylation, more preferably methylation.

As seen in figure 1, pectin is a complex polysaccharide composed of a α-1,4-linked D-galacturonic acid (GalA) backbone (the so-called homogalacturonan or smooth region) and segments consisting of alternating sequences of α-(1,2)-linked L-rhamnosyl and α-1,4-linked D-galacturonosyl residues ramified with side chains of

arabinans, arabinogalactans and galactans (branched rhamnogalacturonans or hairy regions). Pectins are decorated with neutral sugars (NS), mainly being galactose, arabinose and rhamnose.

Commercial pectins usually contain low amounts of neutral sugar as a result of the acid extraction (the neutral sugar content is around 5%). Other structural elements of pectins are xylogalacturonan and rhamnogalacturonan II. Rhamnogalacturonan II is carrying peculiar sugar residues such as Api (D-apiose), AceA (3-C-carboxy-5-deoxy-L-xylose), Dha (2-keto-3-deoxy-D-lyxo-heptulosaric acid) and Kdo (2-keto-3-deoxy-D-manno-octulosonic acid). The relative proportions of these different structural elements may vary significantly for different plant origins and the various derived commercial products.

The various substituents of pectin can be esterified. The major types of esterification are: O-methyl, O-acetyl and O-feruloyl. Not excluding any other types of esterification. Most of the esterifications reside in the homogalacturonan region on the GalA residues. The GalA residues can be thus present as free carboxyl groups or as esterified. Esterification can occur as mono-esterification, but also as double or even a triple esterification of single residues. The esterification on a single residue can be through a single type of alkyl group (i.e. methyl or acetyl), but is can also be a mixed type. Thus, GalA can also be acetylated (for example on the C-2 and/or C-3 position), which occurs as such in sugar beet and potato tuber pectins.

The degree of esterification (DE) is by definition the amount of esters (in moles) present per 100 moles of total galacturonic acids (free GalA and substituted GalA summed together). As most commercial pectins are essentially having esterifications of the methyl-ester type, the DE is often expressed as the degree of methylation (DM).

In that case, the degree of esterification is by definition the amount of methyl-esters (in moles) present per 100 moles of total galacturonic acids (free GalA and substituted GalA summed together). In the case that the esterification is of the acetyl type, the DE is often expressed as the degree of acetylation (i.e. DA). In that case, the degree of esterification is by definition the amount of acetyl-esters (in moles) present per 100 moles of total galacturonic acids (free GalA and substituted GalA summed together). In the case of multiple types of esterification, the DE is often expressed split in a degree of methylation (i.e. DM) and a degree

of acetylation (i.e. DA). These are calculated as described above. Alternatively, the DE can be expressed as the degree of esterification, defined the by amount of galacturonic acid residues modified with one or more esterifications (in moles) present per 100 moles of total galacturonic acids (free GalA and substituted GalA summed together).

Commercial pectins can be a mixture of several populations: the distribution of the substituents can differ in an intramolecular level (within one single pectin polymeric chain) or in an intermolecular level (within one single pectin sample). This holds for all substituents, thus the sugars as well as the esterifications, and therefore both categories are meant with the word 'substituents' in the following. The substituents can be distributed completely at random. This random distribution can follow an even distribution pattern, when the substituents are regularly distributed over a single pectin polymeric chain, leading to a more homogenous pectin polymeric chain. If all pectin polymeric chains in a single pectin sample are of the same homogenous type, also the sample can be called homogeneous.

However, a single homogenous pectin polymeric chain can be present in a composition with other homogenous pectin polymeric chains but having a different intramolecular (but still homogeneous) distribution of the substituents. In this case, the pectin sample should be considered heterogeneous.

This invention describes the surprising observation that supplying pectins with a specific range of esterification to animals and rats, the objects consume same amounts of feed but by an improved intake pattern, characterised by first latency to feed intake (delayed first meal), smaller meals, but more frequent meals. This intake pattern lowers glucose and insulin levels in the blood and slows down gastric emptying. This finally results in a repartition of energy (fat tissue) improving the lean tissue composition. This mode of action of specific pectins is novel and not earlier described for animal and even human nutrition.

The degree of esterification in the context of the present invention is preferably determined by the HPLC method as described by Voragen at al. (2001), in the publication titled "Determination of the degree of methylation and acetylation of pectins by h.p.l.c,", published in Food Hydrocolloids vol. I no. I pp.65 -70. 1986.

The term "animal" means an animal likely to develop or suffering energetic unbalances, including avian, bovine, canine, equine, galline, feline, hircine, lapine, murine, musteline, ovine, piscine, porcine and vulpine animals. Preferably, the animal is a porcine, galline, bovine, ovine, canine, feline.

In a first aspect, the current invention provides a composition comprising a carbohydrate, whereby said carbohydrate is pectin with a esterification degree less than 65%, or derivatives thereof.

Preferably the esterification type of the pectin according to the current invention is either methylation and/or acetylation, more preferably methylation.

Said derivatives may include salts (pectinates or pectates) such as Ca2+, Na+ or K+ salts, modified citrus pectin (MCP) or amidated pectin whereby said at least part of the galacturonic acid is converted with ammonia to carboxylic acid amide, substitution (alkylation, amidation, quaternization, thiolation, sulfation, oxidation, etc.), chain elongation (cross-linking and grafting) and depolymerization (chemical, physical and enzymatic degradation). The presence of an amide group is typically at the C-6 position of the amidated GalA residues. However this does not exclude amide groups being present on of any of the other positions. If pectin is amidated, the DE is often expressed as the degree of amidation (i.e. DAM). In that case, the degree of esterification is by definition the amount of amides (in moles) present per 100 moles of total galacturonic acids (free GalA and substituted GalA summed together).

The following distinction is made among the esterified pectins:

(i) Low-esterified pectins (LEP)

(ii) High-esterified pectins (HEP).

Low–esterified pectins have a degree of esterification (DE) of less than 50%. This means that less than 50% of the possible positions are esterified.
High–esterified pectins have a DE of more than 50%. This means that more than 50% of the possible positions are esterified.

In a further embodiment, said degree of esterificaton is less than 65%, more preferably less than 60%, more preferably less than 55%, more preferably less than 50%, more preferably less than 45, more preferably less than 40%, 35%, 30%. By preference, said pectin is a low-esterified pectin (LEP).

Usually the pectin has a DE of at least 1%, preferably of at least 2, more preferably of at least 3%. Therefore there is a range of 1 – 65 %, 2-65%, 3 – 65%, 1 – 60 %, 2-60%, 3 – 60%, 1 – 55 %, 2-55% and 3 – 55%.

In another embodiment, said degree of esterification is between 0 and 65%, more preferably between 5 and 60%, more preferably between 5 and 55%, more preferably between 5 and 50%.

By preference, said pectin comprises one or more polymers of α-D-(1→4) galacturonic acid or mixtures of one or more of said polymers.

It was surprisingly found that the composition as described above has a positive effect on the energy redistribution in animals. This energy redistribution is explained by a modified feed intake pattern which on its turn is characterised by first latency to feed intake (delayed first meal), smaller meals, but more frequent meals. As a result, the total feed intake in the human or animal life is not affected, only the feed intake pattern is improved. Pectins with a specific degree of esterification according to the current invention act as specific carbohydrates on the mechanism of nutrient absorption in the intestinal tract of animals and humans.

The source of these pectins is not essential for the observed effect. In the context of the present the pectins can be obtained from any known sources. Pears, apples, guavas, quince, plums, gooseberries, oranges, and other citrus fruits contain large amounts of pectin, while soft fruits like cherries, grapes, and strawberries contain small amounts of pectin. Also other plant sources than fruits can comprise pectin. For example, pectin can be sourced from potato, soy, sugar beet, chicory, carrot, tomato, pea, parsnip, and (green) beans.

As mentioned, pectins are present in almost all higher plants. Several by-products of the food industries are used for their extraction, such as citrus peels (by-product of lemon juice production), apple pommace (by-product of apple juice manufacture), sugar beet (by-product of the beet-sugar industry) and in a minor extend potatoes fibres, sunflower heads (by-product of oil production) and onions. Note that this list is not exhaustive. The methods for obtaining pectins with specifc degree of esterification are well known in the art.

The composition according to the current invention may further comprise additional raw materials (additives) and/or growth-promoting substances. The additives are, in a preferred embodiment, selected from the group consisting of aroma's and plant extracts. In a further preferred embodiment, the growth-promoting components are selected from the group, consisting of antibiotics, vitamins, trace elements, probiotics, prebiotics, essential oils, enzymes, fatty acids, and (in)organic acids. Non-limiting examples of organic acids which can be used in an embodiment of the invention, comprise C1-C12 carboxylic acids, in particular unsubstituted carboxylic acids such as formic acid, acetic acid, propionic acid, butyric acid, valeric acid, medium chain fatty acids; and/or substituted carboxylic acids such as adipic acid, maleic acid, succinic acid, citric acid, fumaric acid, tartaric acid, lactic acid, gluconic acid, succinic acid and ascorbic acid, including cyclic carboxylic acids such as picolinic acid. The organic acids may contain one or more substituted or unsubstituted carboxylic acids, as well as mixtures thereof, as well as saturated, unsaturated, cyclic, and/or aliphatic carboxylic acids or mixtures thereof, as well as metal complexes and/or salts thereof, as well as racemic and/or enantiomeric forms thereof. Non-limiting examples of inorganic acids which can be used in an embodiment of the invention include strong acids in small amounts, such as perchloric acid (hydroperchloric acid), hydrogen iodide, hydrogen bromide (hydrobromic acid), hydrogen chloride (hydrochloric acid), sulfuric acid and nitric acid; as well as weak inorganic acids such as phosphoric acid, hydrofluoric acid, hypochlorous acid, and nitrous acid.

In one embodiment, the pectins in the composition according to the invention are present in liquid or solid form. In a further embodiment, the composition according to the invention as described herein is formulated as a liquid or a solid form. The term "solid form" means a powder in particular. The term "liquid form", in particular, means a solution in water or means a solution in oil. In particular, the composition is suitable for oral administration.

The composition according to the current invention is typically useful to be used as food or feed supplement. In one embodiment, the concentration of the pectin, as described herein, amounts at least 1, 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85 , 90, 95, 99, 100 % by weight of the composition. In a further embodiment, the pectin, as described herein, amounts to (based on dry weight) between 1 g/100 g composition (1% by weight) and 100 g/100 g composition (100% by weight), preferably be-tween 50 g/100 g and 90 g/100 g

composition (50-90% by weight), more preferably between 60 g/100g and 80 g/100g.

The composition according to the current invention is typically relates to an animal feed comprising the composition as mentioned above. By preference, said composition is present in 0,01 to 10 wt% of the total amount of weight of said composition. In another embodiment, said pectins with a DE according to the current invention (as described above) are present in an amount of 0,01 to 5 wt% based on the total weight of the feed formulation.

In particular, the composition or feed as described in one or more of the embodiments above, are used for improving the feed intake pattern of animals, thereby redistributing the energy in animals. Such use is characterised by latency to feed intake (delayed first meal), smaller but more frequent meals. For the purpose of the current invention, the term 'energy' is to be understood as representing the fat tissue present in animals.

By using the composition or feed according to the current invention, less fat is deposited in the visceral tissue of the animal, improving the leanness of meat and other derived animal products such as eggs and/or milk.

Conclusive, the use of pectins with a degree of esterification less than 65 % contribute to a redistribution of energy in the body of the animal, by showing first latency to feed intake (delayed first meal), and consuming subsequently smaller meals, but at a more frequent rate. In order that the present invention may be more clearly understood, the preferred form will be described with reference to the following examples.

Example 1: Incorporation of LM pectin in diets leads to more and smaller meals

Rat feeding trial set-up

17 Male Wistar rats (weight ±320 g; Harlan Netherlands BV, Horst, The Netherlands) were individually housed in TSE cages in a climate-controlled room (21C ± 1) under a 12 h : 12 h light-dark cycle (lights on at 10:00 AM). These specialized cages were equipped with food weighing sensor for continuous registration of food intake for multiple days (TSE Systems GmbH, Bad Homburg, Germany) to monitor circadian feeding patterns, meal sizes and meal numbers.

Circadian food intake patterns were calculated as an average of the last two consecutive days, the first day was used for adaptation. These plexiglass cages (40x23x15 cm) consist of a sensitive weight balanced food station (stainless steel food container for standard size food pellets).

Animals were maintained ad libitum on the diets. Water was available ad libitum throughout the study. Food intake and body weights were measured daily at 10 AM. For weighing a laboratory scale was used (sensitivity 0,1 gram). Experiments were approved by the Ethical Committee of Animal Experiments of the University of Groningen.

All animals were instrumented with chronic heart catheters bilaterally in the jugular vein allowing stress free blood sampling during an intravenous glucose tolerance test (IVGTT). Surgeries were carried out under general isoflurane (2%) anesthesia. Animals had at least 10 days to recover before the start of the experiments. Cannulas were checked every week for patency.

The full trial lasted 11 weeks:

- week1: meal pattern measurements (TSE)
- week3: Blood sampling during a single meal of 1,5 grams
- week4: meal pattern measurements (TSE)
- week6: Intravenous Glucose Tolerance Test
- week9: meal pattern measurements (TSE)
- week11: carcass analysis

Diets

9 rats were fed with a control diet, while 8 rats were fed with pectin enriched diet. The composition of the diets was as follows: 95% chow RMH-B meal (obtained from Arie Blok, Woerden, the Netherlands) and 5% Pectin (see Pectin sources). The diets were prepared by mixing all components (including 0,25% TiO_2 as marker) with water to 600 ml/kilo in an industrial mixer until a homogeneous mixture/dough was obtained. After 20 minutes of mixing, the diets were pelleted using a pelleting machine (diameter 1,0 cm). The obtained pellets were dried for 48 hours using compressed air at room temperature.

Pectin sources

Pectin with a DE 33 were isolated from citrus and obtained from Herbstreith & Fox (Neuenbürg/Württingen, Germany).

Feeding pattern analyses

During the second meal pattern measurements the animals were observed and measurements were performed for 48 hours. The obtained data was averaged over all animals fed on a certain diet and is presented in the table below. Statistical analyses were performed using student T test.

	Control diet	Pectin DE 33 diet
Number of meals	20.56 ± 0.84	23.25 ± 0.82
Average meal size (g)	1.99 ± 0.07	1.75 ± 0.11
Average meal duration (min)	8.22 ± 0.54	9.22 ± 0.25
Average eating speed (g/min)	0.32 ± 0.04	0.21 ± 0.01

Surprisingly, pectin fed animals consumed significantly more meals which are smaller in size. Still, the total amount eaten in the period for both diets is not significantly different (40.92 vs 40.69 grams).

Example 2: *Incorporation of LM pectin in diets leads to reduced fat deposition*

The rat trial was as described in example 1. After sacrifice a carcass analysis was performed to determine the amount of fat. Liver, stomach, gut (ilium to rectum), spleen, kidneys were removed and weighed. Retroperitoneal and epididymis fat was weighed as well. The fat content from the skin, carcass and gut was determined using a petroleum based Soxlet fat extractor. Visceral fat here was defined as the total of intestinal fat, epididymal fat and retroperitoneal fat.

	Control diet		Pectin DE 33 diet	
	Grams (or g/g for the ratio)	Relative vs body weight (%)	Grams (or g/g for the ratio)	Relative vs body weight (%)
Total fat	76.03 ± 3.26	19.5	67.74 ± 2.51	17.8
Visceral fat	21.66 ± 1.22	5.5	17.86 ± 1.21	4.7
Gut fat	4.46 ± 0.23	1.1	3.51 ± 0.31	0.9
Ratio fat:lean mass	0.54 ± 0.03	n.a	0.45 ± 0.03	n.a.

Surprisingly, pectin fed animals have a reduced absolute as well as relative percentage of fat. This is also visible for the amount and relative percentage of visceral and gut fat.

Example 3: Effect of Low- and High Esterified Pectins on overall feed intake in piglets.

Context of the example: Pectin with a DM value of 33% have been tested in young pigs and have shown to have beneficial effects on feed intake compared to DM>65.

During a 35-d experimental period 621 weaned piglets (7.4 kg bodyweight) were assigned to either 1) a control group 2) a diet containing 3% pectin 33% DM or 3) a diet containing 3% pectin >65% DM. Piglets were housed in weanling pig facilities in pens with 7- 9 piglets per pen resulting in 27 pens (replicates) per treatment. Per treatment 4 of these replicates were housed in pens equipped with IVOG® feeding stations for weanling pigs to enable measurement of individual feed intake characteristics. Piglets were given ad libitum access to feed and water during the whole 35-d period.

	Control	Pectin DE 33	Pectin DE >65	p-value
Feed intake	455.58 a	475.78 a	407.13 b	<.001

Surprisingly, Low-esterified pectins (represented by pectin DE 33) maintain feed intake over the piglet growth time, while High-esterified pectins (represented by pectin DE >65) affects feed intake in a negative way.

References

- JERACI, J. L. & LEWIS, B. A. (1989). Determination of soluble fibre components: (1-> 3; 1->4) –β-D-glucans and pectins. Anim. Feed Sci. Technol. 23:15-25.
- BAILONI, L., SCHIAVON, S., PAGNIN, G., TAGLIAPIETRA, F. & BONSEMBIANTE, M. (2005). Quanti-qualitative evaluation of pectins in the dietary fibre of 24 foods, Ital. J. Anim. Sci. 4: 49-58.
- MCCREADY, R. M. (1970). Pectin. In: JOSLYN, M.A. (ed.) Methods in food analysis: physical, chemical and instrumental method of analysis. Academic Press, New York, USA, 565-595.

- VORAGEN, A. G. J., BELDMAN, G. & SCHOLS, H. (2001). Chemistry and Enzymology of Pectins. In: MCCLEARY, R.M. & PROSKY, L. (eds.) Advanced dietary fibre technology. Blackwell Sci. Ltd., Oxford, UK, 379-398.

Claims

1. A composition comprising a carbohydrate, whereby said carbohydrate comprises at least one pectin with an esterification degree less than 65 %.
2. Composition according to claim 1, characterized in that said pectin has a degree of esterification less than 55%.
3. Composition according to claim 1 or 2, characterized in that said pectin comprises one or more polymers of α-D-(1→4) galacturonic acid or mixtures of one or more of said polymers.
4. Composition according to any one of the claims 1 to 3, characterized in that said composition further comprises vitamins, trace elements, minerals or carboxylic acids and/or salts thereof, selected from the group of valeric acid, formic acid, acetic acid, propionic acid, medium chain fatty acids, lactic acid, butyric acid, citric acid, maleic acid, fumaric acid, benzoic acid, succinic acid, sorbic acid, tartaric acid.
5. Composition according to any one of the claims 1 to 4, characterized in that said pectin is present in said composition in concentration of between 1 to 100% of total weight of said composition.
6. Feed comprising a composition according to any of the claims 1 to 5.
7. Feed according to claim 6, characterized in that said composition is present in 0,01 to 10 % of the total amount of weight of said composition.
8. Feed according to claim 6 or 7, comprising 0,01 to 5 % wt pectins based on the total weight of the feed formulation.
9. Composition according to anyone of the claims 1 to 5 or animal feed according to claims 6 to 8, for use in improving the feed intake pattern of animals and humans in order to repartition energy in humans and animals.
10. Composition or feed for use according to claim 9, wherein the improved feed pattern is characterised by latency to feed intake (delayed first meal), smaller but more frequent meals.
11. Composition or feed for use according to claim 9 or 10, wherein animals are belonging to the group of animals likely to develop or suffering from energetic unbalances, including avian, bovine, canine, equine, galline, feline, hircine, lapine, murine, musteline, ovine, piscine, porcine and vulpine animals.
12. Composition or feed for use according to claim 11, wherein animals are preferentially porcine, galline, bovine, ovine, canine, feline.
13. Composition or feed for use according to any one of the claims 9 to 12, wherein energy represents the fat tissue of the animal or human.

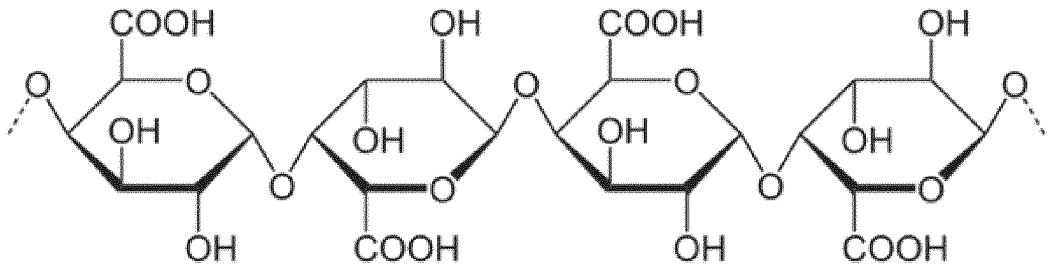
14. Composition according to anyone of the claims 1 to 5 or feed according to the claims 6 to 8 for use in improving the leanness of meat and other derived animal products.

15. Composition or feed for use according to claim 14, wherein derived animal products are meat, eggs and milk.

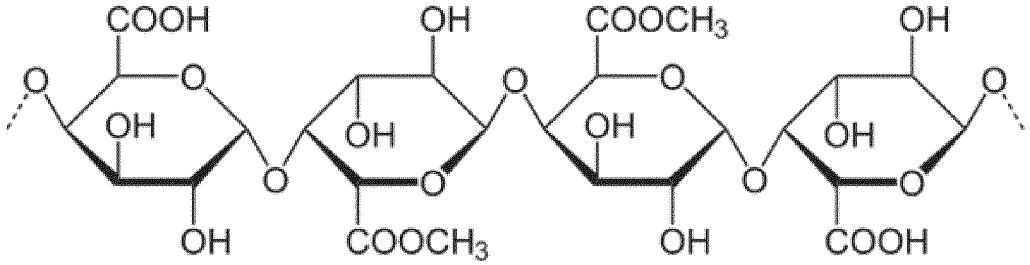
Figures

Figure 1

Structure of pectin (polygalacturonic acid)



Structure of (partially) methylated pectin



INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/066354

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23K20/163 A23L29/231 A23L33/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A23K A23L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal, WPI Data, BIOSIS, FSTA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/275118 A1 (VAN LAERE KATRIEN M J [NL] ET AL) 29 November 2007 (2007-11-29) paragraph [0082] - paragraph [0089]; claims 1,5,7,13,14,16; examples 1,2; tables I, III -----	1-11,13
X	WO 2010/115890 A1 (GERVAIS DANONE SA [FR]; NOBLE OLIVIER [FR]; LE DOUARON MORGANE [FR]) 14 October 2010 (2010-10-14) page 5, line 7 - page 6, line 12 page 8, line 4 - page 10, line 5; table 1 page 14, line 8 - page 18, line 28; figure 1; examples 1,2,3; tables 3,4 -----	1-11
X	EP 1 410 722 A1 (NUTRICIA NV [NL]) 21 April 2004 (2004-04-21) paragraph [0022] - paragraph [0041] paragraph [0070] - paragraph [0072] -----	1-9,11, 13
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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
2 August 2016	11/08/2016

Name and mailing address of the ISA/	Authorized officer
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 588 629 A1 (NUTRICIA NV [NL]) 26 October 2005 (2005-10-26) paragraph [0026] - paragraph [0027] paragraph [0044] paragraph [0058]; examples 1,2,3,4	1-11,13
X	KIRSTYN LOGAN ET AL: "Correlating the structure and in vitro digestion viscosities of different pectin fibers to in vivo human satiety", FOOD & FUNCTION, vol. 6, no. 1, 1 January 2015 (2015-01-01), pages 62-70, XP055218031, ISSN: 2042-6496, DOI: 10.1039/C4FO00543K abstract paragraph [03.4] - paragraph [03.6]; figure 3; table 1	1-11
X	DATABASE MEDLINE [Online] US NATIONAL LIBRARY OF MEDICINE (NLM), BETHESDA, MD, US; May 1990 (1990-05), DROCHNER W ET AL: "[The effect of increasing additions of low-esterified pectins in the diet on the metabolism of laying hens--tested by pair-feeding studies].", XP002745372, Database accession no. NLM2241569 abstract & ARCHIV FÜR TIERERNÄHRUNG 1990 MAY-JUN, vol. 40, no. 5-6, May 1990 (1990-05), pages 431-442, ISSN: 0003-942X	1-10, 12-15
X	WO 2014/005853 A1 (UNILEVER NV [NL]; UNILEVER PLC [GB]; CONOPCO INC DBA UNILEVER [US]) 9 January 2014 (2014-01-09) claims 1-3,8,9,10; examples 1-5	1-8
X	WO 97/49298 A1 (NESTLE SA [CH]; TURQUOIS TRISTAN [CH]; BEST ERIC [US]; VANACKER PASCAL) 31 December 1997 (1997-12-31) page 10; claims 1-4; examples 4-6 page 7, line 21 - line 28 page 6, line 1 - line 9	1-8
X	WO 2010/129153 A2 (CP KELCO US INC [US]; KNARREBORG LISBETH [DK]; WALDHAUER INGER CAROLIN) 11 November 2010 (2010-11-11) claims 1-4; example 8	1-8

-/--

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INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/066354

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2008/166465 A1 (CHRISTENSEN STEEN HOJGAARD [DK] ET AL) 10 July 2008 (2008-07-10) paragraph [0031] - paragraph [0038]; claims 1-4; example 1 -----	1-8
A	JP 2011 042604 A (UNITEC FOODS CO LTD) 3 March 2011 (2011-03-03) paragraph [0034] - paragraph [0038]; claims 1-3 -----	9-15

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/066354

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2007275118 A1	29-11-2007	AT 471084 T	15-07-2010
		AU 2003304197 A1	04-01-2005
		CA 2529491 A1	23-12-2004
		CN 1787750 A	14-06-2006
		EP 1633211 A1	15-03-2006
		ES 2346864 T3	21-10-2010
		JP 2006527700 A	07-12-2006
		US 2007275118 A1	29-11-2007
		WO 2004110178 A1	23-12-2004
WO 2010115890 A1	14-10-2010	WO 2010115890 A1	14-10-2010
		WO 2010116210 A1	14-10-2010
EP 1410722 A1	21-04-2004	NONE	
EP 1588629 A1	26-10-2005	AT 294510 T	15-05-2005
		AT 362331 T	15-06-2007
		AT 431705 T	15-06-2009
		AU 2002358348 A1	09-07-2003
		AU 2002359091 A1	09-07-2003
		CA 2470791 A1	03-07-2003
		CA 2470837 A1	03-07-2003
		CN 1620257 A	25-05-2005
		CN 1649517 A	03-08-2005
		DE 60204058 D1	09-06-2005
		DE 60204058 T2	06-10-2005
		DE 60220182 T2	17-01-2008
		DK 1455605 T3	24-09-2007
		DK 1465504 T3	20-06-2005
		EP 1455605 A1	15-09-2004
		EP 1465504 A1	13-10-2004
		EP 1588629 A1	26-10-2005
		ES 2239268 T3	16-09-2005
		ES 2286317 T3	01-12-2007
		ES 2327539 T3	30-10-2009
		JP 4504683 B2	14-07-2010
		JP 4509563 B2	21-07-2010
		JP 2005513077 A	12-05-2005
		JP 2005513079 A	12-05-2005
		PT 1455605 E	24-08-2007
		PT 1465504 E	31-08-2005
		PT 1588629 E	01-09-2009
		RU 2313259 C2	27-12-2007
		RU 2322089 C2	20-04-2008
		US 2003134027 A1	17-07-2003
		US 2004228903 A1	18-11-2004
		US 2004258826 A1	23-12-2004
		WO 03053165 A1	03-07-2003
		WO 03053169 A1	03-07-2003
WO 2014005853 A1	09-01-2014	AR 091653 A1	18-02-2015
		AU 2013286172 A1	11-12-2014
		CA 2878120 A1	09-01-2014
		CN 104394717 A	04-03-2015
		EA 201500081 A1	30-10-2015
		EP 2866590 A1	06-05-2015
		PH 12014502579 A1	21-01-2015
		US 2015359248 A1	17-12-2015

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2016/066354

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		WO 2014005853 A1	09-01-2014
WO 9749298 A1	31-12-1997	AU 3343597 A	14-01-1998
		EP 0907326 A1	14-04-1999
		WO 9749298 A1	31-12-1997
WO 2010129153 A2	11-11-2010	NONE	
US 2008166465 A1	10-07-2008	US 2008166465 A1	10-07-2008
		WO 2008086263 A1	17-07-2008
JP 2011042604 A	03-03-2011	NONE	