



(51) International Patent Classification:

A23L 29/231 (2016.01)

A23C 9/137 (2006.01)

A23C 9/12 (2006.01)

(21) International Application Number:

PCT/US2023/020159

(22) International Filing Date:

27 April 2023 (27.04.2023)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

202210469805.5

28 April 2022 (28.04.2022)

CN

22177157.9

03 June 2022 (03.06.2022)

EP

(71) Applicant: CARGILL, INCORPORATED [US/US];

15407 McGinty Road West, Wayzata, Minnesota 55391 (US).

(72) **Inventors:** **LIU, Jia**; No. 11, Fazhan Road, Beijing International Information Industry Base, Huilongguan, Changping District, Beijing 102206 (CN). **MA, Jiahui**; No. 11, Fazhan Road, Beijing International Information Industry Base, Huilongguan, Changping District, Beijing 102206 (CN). **SONG, Guangwei**; No. 11, Fazhan Road, Beijing International Information Industry Base, Huilongguan, Changping District, Beijing 102206 (CN). **WEI, Xiaodie**; No. 11, Fazhan Road, Beijing International Information Industry Base, Huilongguan, Changping District, Beijing 102206 (CN).

(74) **Agent:** **LODGE, Alexander M.**; 15407 McGinty Road West, Wayzata, Minnesota 55391 (US).

(81) **Designated States** (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG,

(54) **Title:** HIGH METHOXYL PECTIN COMPOSITION, A METHOD FOR PREPARING THE SAME AND A FOOD COMPOSITION THEREOF

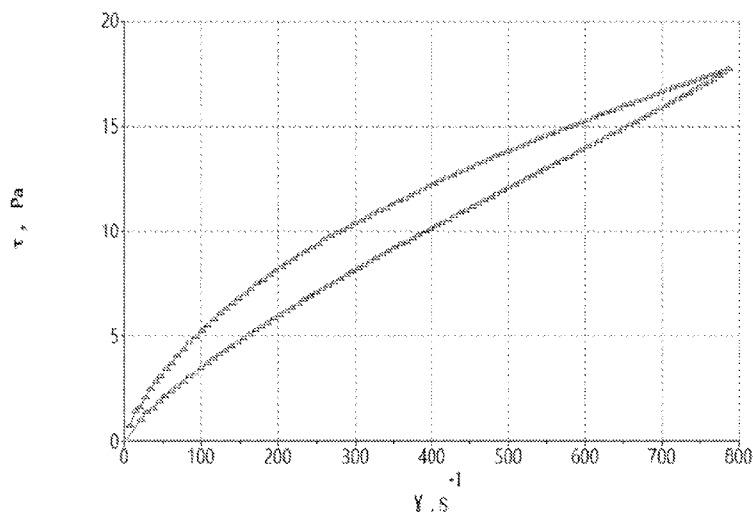


FIG. 1

(57) **Abstract:** The present disclosure provides a high methoxyl pectin composition, methods for preparing the same, and food compositions thereof. The high methoxyl pectin composition comprises a high methoxyl pectin mixture, wherein the high methoxyl pectin mixture consists of at least two types of high methoxyl pectins, wherein degree of methoxylation of the high methoxyl pectin mixture is greater than 50%, and thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0, and wherein the thixotropic ratio is a ratio B1/B2 of an area of thixotropic loop B1 of a high methoxyl pectin to be measured under a test system to an area of thixotropic loop B2 of a same amount of control measured under the same test system, and wherein the control is water.



KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY,
MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA,
NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO,
RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH,
TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS,
ZA, ZM, ZW.

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

Published:

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

**HIGH METHOXYL PECTIN COMPOSITION, A METHOD FOR PREPARING THE
SAME AND A FOOD COMPOSITION THEREOF**

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Chinese Application No. 202210469805.5, filed April 28, 2022 and European Application No. #2177157.9, filed June 3, 2022, each of which is incorporated by reference herein in its entirety.

FIELD OF THE INVENTION

[0002] The present disclosure relates to a high methoxyl pectin composition and method for preparing the same, and a food composition. The high methoxyl pectin composition described herein can be used as an ingredient or an additive to produce acidic milk, flavored acidic milk, fermented milk or flavored fermented milk, especially drinkable yoghurt.

BACKGROUND OF THE INVENTION

[0003] Pectin, a plant-derived water-soluble hydrophilic colloid, is a food ingredient extracted typically from citrus pomace, apple pomace, beet pomace or the like, and it is believed to meet the standard of “clean label”.

[0004] Pectin has been widely used in fermented milk, flavored fermented milk and lactic acid beverages (or, lactic acid bacteria fermented beverages).

[0005] The fermented milk and the flavored fermented milk mainly use low methoxyl pectin and amidated pectin. Adding pectin during the acidification of milk would typically strengthen the structure of the gel, and attempt to improve the gel property of the yoghurt, to control water separation, and to improve the mouthfeel.

[0006] The lactic acid beverages (or, lactic acid bacteria fermented beverages) mainly use a high methoxyl pectin, which has an effect of stabilization. Negatively charged pectin would bind to positively charged casein particles, cover the surface of the protein, wrap up the protein molecules, and form a hydrophilic layer to prevent the aggregation of proteins, an effect known as electrostatic stabilization. In addition, the increase in viscosity generally achieved by pectin addition, can also improve the protein stability of the acidified milk beverage and prevent the

precipitation effect which might be caused by the aggregation of proteins. Therefore, a high methoxyl pectin has the potential to increase the viscosity of the system, increase the stability of the protein and improve the taste in lactic acid beverages (or, lactic acid bacteria fermented beverages).

[0007] The Chinese patent application with an application No. CN961969687 and a publication No. CN1112855C discloses a process for stabilizing proteins in acidic environment with high methoxyl pectin, comprising: a) purifying a pectin methylesterase capable of enzymatically deesterifying pectins in a block-wise manner; b) adding the purified pectin methylesterase capable of enzymatically deesterifying pectins in a block-wise manner into the pectin; c) preparing a block-wise enzymatically deesterify pectin from the pectin by the purified pectin methylesterase capable of enzymatically deesterifying pectins in a block-wise manner; wherein the block-wise enzymatically deesterify pectin is a high methoxyl pectin containing 70% to 80% methoxyl groups; d) adding block-wise enzymatically deesterified pectin to an acidic environment containing at least one protein; and e) stabilizing the protein by the block-wise enzymatically deesterified pectin.

[0008] The Chinese patent application with an application No. CN202011143835.4 and a publication No. CN113261591A discloses a pectin-containing acidic milk beverage and preparation method thereof. The objective of CN113261591A is to provide an acid milk beverage and more in particular such a beverage having a low solids-not-fat concentration, which show no or reduced precipitation, no or reduced aggregation, less whey separation, and has a refreshing mouthfeel. The acid milk beverage of CN113261591A comprises a base and a pectin, the pectin having an intrinsic viscosity of 5.9 to 8.5, a degree of methoxylation of 74 to 80, and a calcium reactivity of 230 or lower. But it fails to correlate pectin with the mouthfeel of the acidic milk beverage.

SUMMARY OF THE INVENTION

[0009] The present disclosure provides a high methoxyl pectin composition. The high methoxyl pectin composition comprises a high methoxyl pectin mixture, wherein the high methoxyl pectin mixture consists of at least two types of high methoxyl pectins, wherein degree of methoxylation of the high methoxyl pectin mixture is greater than 50%, and thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0, and wherein the thixotropic ratio is a ratio B1/B2 of an area of thixotropic loop B1 of a high methoxyl pectin to be measured under a test system

to an area of thixotropic loop B2 of a same amount of control measured under the same test system, and wherein the control is water.

[0010] “At least two types of high methoxyl pectins”, as used herein, means that said pectins are extracted from at least two different botanical sources, for example, at least a first type of pectin is extracted from a first botanical source and at least a second type of pectin is extracted from a second botanical source which is different than the first botanical source.

[0011] Preferably, the thixotropic ratio of the high methoxyl pectin mixture is 2.5-7, preferably the thixotropic ratio of the high methoxyl pectin mixture is 3-6, and more preferably the thixotropic ratio of the high methoxyl pectin mixture is 4-6.

[0012] Preferably, degree of methoxylation of the high methoxyl pectin mixture is no less than 60%, preferably 65-85%, and more preferably is 68-80%; and more preferably, degree of methoxylation of each of the at least two types of high methoxyl pectins is no less than 60%, preferably 65-85%, and more preferably 68-80%.

[0013] Preferably, the high methoxyl pectin composition, as measured at 23°C under 1% aqueous solution by weight, has a viscosity range of 14-70 mPa·s, preferably 15-65 mPa·s, more preferably 25-55 mPa·s, and even more preferably 25-50 mPa·s.

[0014] Preferably, in the high methoxyl pectin mixture, thixotropic ratio of at least one of the at least two types of high methoxyl pectins is equal to or less than 2, and thixotropic ratio of at least one of the at least two types of high methoxyl pectins is equal to or greater than 8.

[0015] Preferably, the at least two types of high methoxyl pectins belong to *Rutaceae* family, more preferably they belong to the *Citrus* genus.

[0016] Preferably, the high methoxyl pectin mixture consist of high methoxyl pectins obtained from two or more botanical source chosen from the group consisting of tangerine, pomelo, orange, lemon, and lime. Most preferably, the pectins are extracted from the peel of the fruits belonging to the above mentioned source.

[0017] Preferably, the high methoxyl pectin mixture consist of a combination of two or more high methoxyl pectins, wherein at least a first pectin is obtained from orange peel and at least a second pectin is obtained from lemon peel, tangerine peel, pomelo peel or lime peel. Preferably, the high methoxyl pectin mixture consist of a combination of two or more high methoxyl pectins, wherein at least a first pectin is obtained from pomelo peel and at least a second pectin is obtained from lemon peel, tangerine peel or lime peel. Preferably, the high methoxyl pectin mixture consist of a combination of two or more high methoxyl pectins, wherein at least a

first pectin is obtained from lemon peel and at least a second pectin is obtained from tangerine peel or lime peel. Preferably, the high methoxyl pectin mixture consist of a combination of two or more high methoxyl pectins, wherein at least a first pectin is obtained from lime peel and at least a second pectin is obtained from tangerine peel.

[0018] Most preferably, the high methoxyl pectin mixture consist of a combination of two or more high methoxyl pectins, wherein at least a first pectin is obtained from orange peel and at least a second pectin is obtained from lemon peel. Preferably the weight ratio of the orange peel high methoxyl pectin to the lemon peel high methoxyl pectin is 0.1 to 10, preferably 0.2 to 7, and more preferably 0.5 to 1.5.

[0019] Preferably, the high methoxyl pectin mixture consists of tangerine peel high methoxyl pectin and lime peel high methoxyl pectin. Preferably the weight ratio of the tangerine peel high methoxyl pectin to the lime peel high methoxyl pectin is 3:100 to 15:1, and more preferably 3:50 to 10:1.

[0020] Preferably, the high methoxyl pectin mixture consists of orange peel high methoxyl pectin, tangerine peel high methoxyl pectin, lemon peel high methoxyl pectin, and lime peel high methoxyl pectin. Preferably the weight ratio of the orange peel high methoxyl pectin to the tangerine peel high methoxyl pectin to the lemon peel high methoxyl pectin to the lime peel high methoxyl pectin is (3-30): (3-30): (3-50): (3-50).

[0021] Preferably, the high methoxyl pectin composition further comprises an edible ingredient. Non-limiting examples of edible ingredients include saccharides, starches, dextrin, vegetable fibers, powdered fruit juices, sweetening agents, flavors, colorants, emulsifying agents, acidulants, vitamins, calcium salts, milk, powdered fats and oils, and the like can also be appropriately selected and used. In addition, food powders such as cocoa, powdered green tea, soybean (soybean flour), black tea, and coffee; and functional materials such as powdered green vegetable juice, creatine, polyphenol, catechin, collagen peptides, glucosamine, chondroitin sulfate, and hyaluronic acid.

[0022] Preferably, the high methoxyl pectin composition further comprises sugar, and preferably the sugar is in a content of 3-45% by weight, preferably 5-40% by weight, in the high methoxyl pectin composition.

[0023] Preferably, the sugar comprises at least one of glucose, sucrose, fructose, maltose or trehalose.

[0024] The high methoxyl pectin composition may also include one or more additional stabilizing additives, such as water-soluble soybean polysaccharide, carboxy methyl cellulose, polyglycolic acid (PGA), locust bean gum, tamarind seed polysaccharide, gellan gum, xanthan gum, guar gum, tara gum, gum Arabic, kalaya gum, carrageenan, or agar.

[0025] Preferably, the high methoxyl pectin mixture accounts for 50-99% by weight, preferably 60-95% by weight, more preferably 65-90% by weight, and even more preferably 70-85% by weight, of the high methoxyl pectin composition.

[0026] The present disclosure also provides a food, feed or beverage product comprising the high methoxyl pectin composition described herein. Non-limiting examples of the above mentioned products include water, teas, milk, juices, isotonic beverages, fruit juices, miso soup, soups, and concentrated liquid foods. The pectin composition of the present invention can be used as a viscosity adjusting agent intended for imparting viscosity, or a gelling agent intended for gelation. Furthermore, the pectin composition of the present invention can be widely used in a viscosity adjusting agent for concentrated liquid foods, a gelling agent, diet foods, condiments such as sauces and dressings, baby foods, pet foods, animal feeds, and the like.

[0027] Preferably, the high methoxyl pectin composition accounts for 0.05-10% by weight, preferably 0.05-1% by weight, more preferably 0.2-0.8% by weight, more preferably 0.3-0.6% by weight, and even more preferably 0.4-0.5% by weight, of the food composition.

[0028] Preferably, the food composition is a fermented milk product, more preferably a drinkable yoghurt. Fermented milk drinks are typically prepared from natural milk by fermentation with a bacterial culture so that the product attains an acidic pH, such as, for example, less than 4.4.

[0029] Methods are provided for making a fermented milk product, generally comprising (1) combining milk and the high methoxyl pectin composition described herein to form a mixture, (2) heat treating the mixture, and (3) fermenting the mixture. In some embodiments, the methods further comprise homogenizing the mixture before the heat treating step. In further embodiments, the methods further comprise homogenizing the mixture after the fermenting step. It may be advantageous for manufacturers to add pectin to milk prior to the heat treatment that precedes fermentation. For example, adding said pectin composition before the heat treatment and fermentation may make it easier to prevent infections from unwanted microorganisms, since no ingredients would be introduced after the heat treatment.

[0030] Preferably, the fermented milk product is an acidified milk drink (AMD). AMD is a generic term that includes fluid products that contain protein of milk origin and are at least slightly acidic so that the proteins are prevented or inhibited from forming the suspension present in natural milk. Typically, in this context, "fluid" implies that the products are suitable for drinking. Fermented milk drinks, which include drinkable or liquid yogurt, are one type of AMDs. Liquid yogurt, i.e., drinkable yogurt, includes yogurt products that have a relatively low viscosity compared to traditional yogurt that is consumed with a spoon. The milk used generally may include any milk that is suitable for human consumption. For example, the milk may include bovine milk, soybean milk, goat's milk, powdered milk, sweetened milk, concentrated condensed milk, and processed milk fortified with minerals (such as calcium, vitamins, etc.). Any of the milks used in the methods may be whole, reduced fat, no fat milks, or a combination thereof.

[0031] Preferably, the drinkable yoghurt comprises a yoghurt base material, wherein the yoghurt base material accounts for 50-90% by weight, preferably 60-80% by weight, and more preferably 70-78% by weight, of the drinkable yoghurt.

[0032] Preferably, the weight ratio of the high methoxyl pectin composition to the yoghurt base material is (1-10): (500-900), preferably (3-6): (600 -800), and more preferably (4-6): (700-780).

[0033] Preferably, instability index of the drinkable yoghurt is no greater than 0.1, preferably no greater than 0.07, more preferably no greater than 0.05, and even more preferably no greater than 0.02.

[0034] Preferably, the pectin composition is added to an amount sufficient to achieve a viscosity of the drinkable yoghurt of 2500-7000 mPa·s when measured at 23°C.

[0035] Preferably, the yoghurt base material is obtained by fermenting at least one of whole fresh cow milk, whole fresh goat milk, whole fresh camel milk, skimmed fresh cow milk, skimmed fresh goat milk, skimmed fresh camel milk, whole cow milk powder, whole goat milk powder, whole camel milk powder, skimmed cow milk powder, skimmed goat milk powder or skimmed camel milk powder.

[0036] The present disclosure further provides a method for preparing the high methoxyl pectin composition described herein, comprising:

- (i) mixing at least two types of high methoxyl pectins to obtain a high methoxyl pectin mixture in a way that degree of methoxylation of the high methoxyl pectin mixture is greater than 50% and thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0.

[0037] Preferably, the at least two types of high methoxyl pectins are prepared from a plurality of raw materials, wherein the plurality of raw materials comprise at least one of tangerine peel raw material, pomelo peel raw material, orange peel raw material, lemon peel raw material, or lime peel raw material, and preferably the tangerine peel raw material is tangerine peel pomace, the pomelo peel raw material is pomelo peel pomace, the orange peel raw material is orange peel pomace, the lemon peel raw material is lemon peel pomace and/or the lime peel raw material is lime peel pomace.

[0038] Preferably, at least one of high methoxyl pectin having a thixotropic ratio of 2 or less than 2 is mixed with at least one of high methoxyl pectin having a thixotropic ratio of 8 or greater than 8 to obtain a high methoxyl pectin mixture in a way such that degree of methoxylation of the high methoxyl pectin mixture is greater than 50% and thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0.

[0039] Preferably, at least one of high methoxyl pectin having a thixotropic ratio of 2 or less than 2 is mixed with at least one of high methoxyl pectin having a thixotropic ratio of 8 or greater than 8 to obtain a high methoxyl pectin mixture in a way such that degree of methoxylation of the high methoxyl pectin mixture is greater than 50%, thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0, and the high methoxyl pectin composition has a viscosity range of 14-70 mPa·s as measured under 1% aqueous solution at 23°C.

[0040] Preferably, the method further comprises adding sugar.

[0041] Preferably, the sugar comprises at least one of glucose, sucrose, fructose, maltose or trehalose.

[0042] The present disclosure further provides a use of the high methoxyl pectin composition described herein for preparing a food, wherein preferably the food is a drinkable yoghurt.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] Figure 1 schematically shows a thixotropic test curve from which a thixotropic area can be calculated. The objective of Figure 1 is to better understand how to calculate the thixotropic area and thus the thixotropic ratio based on the thixotropic test curve, but not to represent a data of the present disclosure.

DETAILED DESCRIPTION

[0044] In order to make the objectives, technical solutions and advantages of the present disclosure clearer, the technical solutions in the embodiments of the present disclosure will be described below in a clear, complete manner. If specific conditions are not indicated in the description, the conventional conditions or the conditions suggested by the manufacturer will apply. The reagents or instruments used without the names of the manufacturers are conventional products commercially available from the market.

[0045] Unless otherwise defined herein, scientific and technical terms used in connection with the present disclosure shall have the meanings commonly understood by those ordinarily skilled in the art. Exemplary methods and materials are described below, but methods and materials similar or equivalent to those described herein can also be used for practicing or testing of the present disclosure.

[0046] The present disclosure provides a high methoxyl pectin mixture which consists of at least two types of high methoxyl pectins, wherein degree of methoxylation of the high methoxyl pectin mixture is greater than 50%. Preferably, thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0. The thixotropic ratio is a ratio B1/B2 of an area of thixotropic loop B1 of a high methoxyl pectin to be measured under a test system to an area of thixotropic loop B2 of a same amount of control measured under the same test system, and wherein the control is water.

[0047] The present disclosure provides a high methoxyl pectin composition comprising a high methoxyl pectin mixture.

[0048] The present disclosure provides a high methoxyl pectin composition, wherein the high methoxyl pectin composition comprises a high methoxyl pectin mixture, and wherein the high methoxyl pectin mixture consists of at least two types of high methoxyl pectins. Preferably, degree of methoxylation of the high methoxyl pectin mixture is greater than 50%. Preferably, thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0, wherein the thixotropic ratio is a ratio B1/B2 of an area of thixotropic loop B1 of a high methoxyl pectin to be measured under a test system to an area of thixotropic loop B2 of a same amount of control measured under the same test system, and wherein the control is water.

[0049] In the system of drinkable yoghurt, the drinkable yoghurt products have high protein content and low pH, which has higher requirement on the pectin ingredients. There is a challenge in the art of how to produce drinkable yoghurt with not only good fluidity and stability, but also excellent mouthfeel. This puts forward higher requirements on the thickness, protein stability and flavor-releasing property of pectin, and these cannot be achieved by ordinary high

methoxyl pectins in the market. The inventors of the present disclosure found that any commercially available high methoxyl pectin in the market, when being used alone, cannot balance the mouthfeel of yoghurt products between freshness and body, let alone simultaneously having good flowability and stability. In particular, there is no good index applicable for evaluating a high methoxyl pectin in terms of improving the mouthfeel of yoghurt products in the art.

[0050] In view of the above, the present disclosure has developed a high methoxyl pectin composition for use in acidic milk, flavored acidic milk, fermented milk or flavored fermented milk, by using various parameters, in particular thixotropic ratio as performance index of the high methoxyl pectin, and using pectins from different plant sources as raw materials. The high methoxyl pectin composition of the present disclosure could provide an excellent mouthfeel with a balanced freshness and body, while simultaneously function to thicken and stabilize the protein.

[0051] As used herein, the term “high methoxyl pectin” generally refers to pectin with a methoxylation degree (or known as degree of methoxylation) no less than 50%, for example, 50-80%. In the field of pectins, degree of methoxylation generally refers to substitution degree of methoxylation. Preferably, degree of methoxylation of the high methoxyl pectin described herein is no less than 50%, such as no less than 52%, such as no less than 54%, such as no less than 56%, such as no less than 58% , such as no less than 60%, such as no less than 62%, such as no less than 64%, such as no less than 65%, such as no less than 66%, such as no less than 67%, no less than 68%, such as no less than 69%, no less than 70%, such as no less than 71%, no less than 72%, such as no less than 73%, no less than 74%, such as no less than 75%, no less than 76%, such as no less than 77%, no less than 78%, such as no less than 79%, no less than 80%, such as no less than 81%, no less than 82%, such as no less than 83%, no less than 84%, such as no less than 85%, no less than 86%, such as no less than 87%, no less than 88 %, no less than 89%, or no less than 90%. Preferably, degree of methoxylation of the high methoxyl pectin described herein is no greater than 90%, no greater than 89%, no greater than 88%, no greater than 87%, no greater than 86%, no greater than 85%, no greater than 84%, no greater than 83%, no greater than 82%, no greater than 81%, no greater than 80%, no greater than 79%, no greater than 78%, no greater than 77%, no greater than 76%, no greater than 75%, or no greater than 74%. For example, degree of methoxylation of the high methoxyl pectin described herein is 60-85%, such as 61-84%, 62-83%, 62-82%, 63-81%, 64-80%, 65-79%, 66-78%, 67-77%, 68-76%, 69-75%, 70-74%, or 71-73%, such as 72%.

[0052] The high methoxyl pectins also have very different properties owing to their different sources. Generally, the high methoxyl pectin is prepared from plant-derived raw materials.

[0053] The inventors of the present disclosure, during their work on the optimization of pectins to be added to the food, has found an index, i.e., thixotropy ratio, that can be used alone or together with other indexes to evaluate the performance of high methoxyl pectin. As used herein, the thixotropic ratio is a ratio $B1/B2$ of an area of thixotropic loop B1 of a high methoxyl pectin to be measured under a test system to an area of thixotropic loop B2 of a same amount of control measured under the same test system.

[0054] As described herein, “area of thixotropic loop”, also known as area of rheological curve thixotropic loop, is an index for evaluating thixotropy, based on the method of the area of rheological curve thixotropic loop. The method of the area of rheological curve thixotropic loop is a method for evaluating the thixotropy of a fluid by the area of the closed so-called “thixotropic loop”, which is measured by a variable-speed viscometer or rheometer (such as a HAAKE rheometer) by gradually increasing the shearing speed from the initial shearing speed to a predetermined maximum shearing speed (also called terminating shearing speed), and then gradually decreasing the shearing speed. Data measured by gradually increasing the shearing speed and gradually decreasing the shearing speed were dotted in the coordinate system with the shear stress as the ordinate and the shearing speed as the abscissa, and then dots were connected to form the curve, as exemplarily shown in Figure 1. The upper curve in Figure 1 is the curve obtained by gradually increasing the shearing speed, whereas the lower curve is the curve obtained by gradually decreasing the shearing speed. The closed area formed by these two curves is called thixotropic region or thixotropic loop. The shearing speed is, for example, the number of revolutions of the rotor of the rheometer.

[0055] As used herein, a test system includes a test material. The test material includes one or more of milk curd base material, high methoxyl pectin to be tested and water. Preferably, the milk curd base material was obtained by curding at least one of whole fresh cow milk, whole fresh goat milk, whole fresh camel milk, skimmed fresh cow milk, skimmed fresh goat milk, skimmed fresh camel milk, whole cow milk powder, whole goat milk powder, whole camel milk powder, skimmed cow milk powder, skimmed goat milk powder or skimmed camel milk powder, and optionally by stirring, adjusting pH value and/or homogenizing. Curding can be performed using, for example, glucono- δ -lactone. Preferably, adjusting the pH is to adjust the pH to 3-5, such

as 3.2, 3.4, 3.6, 3.8, 4.0, 4.2, 4.4, 4.6, or 4.8. More preferably the pH was adjusted to 4.2. The pH was preferably adjusted using a pH adjuster, such as lactic acid or lactic acid solution.

[0056] In the test system, the content of the high methoxyl pectin to be tested is 0.05-10%, such as 0.1%, 0.15%, 0.2%, 0.25%, 0.3%, 0.35%, 0.4%, 0.45%, 0.5%, 0.55%, 0.6%, 0.65%, 0.7%, 0.75%, 0.8%, 0.85%, 0.9%, 0.95%, 1%, 2%, 3%, 4%, 5%, 6%, 7%, 8% or 9%, by weight.

[0057] The initial shearing speed is $0-10\text{ s}^{-1}$ such as 0.5 s^{-1} , 1.0 s^{-1} , 1.5 s^{-1} , 2.0 s^{-1} , 2.5 s^{-1} , 3.0 s^{-1} , 3.5 s^{-1} , 4.0 s^{-1} , 4.5 s^{-1} , 5.0 s^{-1} , 5.5 s^{-1} , 6.0 s^{-1} , 6.5 s^{-1} , 7.0 s^{-1} , 7.5 s^{-1} , 8.0 s^{-1} , 8.5 s^{-1} , 9.0 s^{-1} , or 9.5 s^{-1} .

[0058] The terminating shearing speed is $50-1500\text{ s}^{-1}$, such as 60 s^{-1} , 70 s^{-1} , 80 s^{-1} , 90 s^{-1} , 100 s^{-1} , 150 s^{-1} , 200 s^{-1} , 250 s^{-1} , 300 s^{-1} , 350 s^{-1} , 400 s^{-1} , 450 s^{-1} , 500 s^{-1} , 550 s^{-1} , 600 s^{-1} , 650 s^{-1} , 700 s^{-1} , 750 s^{-1} , 800 s^{-1} , 850 s^{-1} , 900 s^{-1} , 950 s^{-1} , 1000 s^{-1} , 1100 s^{-1} , 1200 s^{-1} , 1300 s^{-1} , or 1400 s^{-1} .

[0059] Preferably, the test system includes milk curd base material, high methoxyl pectin to be tested and water. Preferably, the concentration of the high methoxyl pectin to be tested in the test system is 0.4% by weight.

[0060] Preferably, the conditions for testing the area of the thixotropic loop include an initial shearing speed of 1 s^{-1} and a terminating shearing speed of 800 s^{-1} .

[0061] Preferably, the device for testing the area of the thixotropic loop includes a HAAKE rheometer.

[0062] The present disclosure further provides a high methoxyl pectin composition, wherein the high methoxyl pectin composition comprises a high methoxyl pectin mixture, wherein the high methoxyl pectin mixture consists of at least two types of high methoxyl pectins, wherein degree of methoxylation of the high methoxyl pectin mixture ranges from 65-85%, preferably 68-80%; the high methoxyl pectin composition, as measured under 1% aqueous solution by weight at 23°C , has a viscosity range of 15-65 mPa·s, preferably 25-55 mPa·s; thixotropic ratio of the high methoxyl pectin mixture is 3-6, preferably 4-6.

[0063] Preferably, the high methoxyl pectin mixture consist of high methoxyl pectins obtained from two or more botanical source chosen from the group consisting of tangerine, pomelo, orange, lemon, and lime. Most preferably, the pectins are extracted from the peel of the fruits belonging to the above mentioned source.

[0064] Most preferably, the high methoxyl pectin mixture consist of a combination of two or more high methoxyl pectins, wherein at least a first pectin is obtained from orange peel and at least a second pectin is obtained from lemon peel.

[0065] Preferably, the high methoxyl pectin mixture comprises a combination of two or more of tangerine peel high methoxyl pectin, pomelo peel high methoxyl pectin, orange peel high methoxyl pectin, lemon peel high methoxyl pectin, or lime peel high methoxyl pectin.

[0066] Preferably, the high methoxyl pectin mixture comprises or consists of orange peel pectin and lemon peel pectin. Preferably the weight ratio of the orange peel high methoxyl pectin to the lemon peel high methoxyl pectin is 0.1 to 10, preferably 0.2 to 7, and more preferably 0.5 to 1.5. In one or more embodiments, the weight ratio of the orange peel high methoxyl pectin to the lemon peel high methoxyl pectin ranges from 0.1 to 10, such as 0.12-9.5, 0.14-9.0, 0.16-8.5, 0.18-8.0, 0.20-7.5, 0.22-7.0, 0.24-6.5, 0.26-6.0, 0.28-5.5, 0.30-5.0, 0.32-4.5, 0.34-4.0, 0.36-3.5, 0.38-3.0, 0.40-2.5, 0.42-2.3, 0.44-2.0, 0.46-1.8, 0.48-1.6, 0.50-1.5, 0.51-1.47, 0.52-1.43, 0.54-1.40, 0.58-1.37, 0.62-1.35, or 0.65-1.33.

[0067] Preferably, the high methoxyl pectin mixture comprises or consists of tangerine peel high methoxyl pectin and lime peel high methoxyl pectin. Preferably the weight ratio of the tangerine peel high methoxyl pectin to the lime peel high methoxyl pectin is 3:100 to 15:1, and more preferably 3:50 to 10:1. The weight ratio of the tangerine peel high methoxyl pectin to the lime peel high methoxyl pectin ranges from such as 0.03-15, 0.04-14.5, 0.05-14, 0.06-13.5, 0.07-13, 0.08-13.5, 0.09-13, 0.1-12.5, 1-12, 2-11.5, 3-11, 4-10.5, 5-10, 6-9 or 7-8.

[0068] Preferably, the high methoxyl pectin mixture comprises or consists of orange peel high methoxyl pectin, tangerine peel high methoxyl pectin, lemon peel high methoxyl pectin, and lime peel high methoxyl pectin. Preferably the weight ratio of the orange peel high methoxyl pectin to the tangerine peel high methoxyl pectin to the lemon peel high methoxyl pectin to the lime peel high methoxyl pectin is (3-30): (3-30): (3-50): (3-50). The weight ratio of the orange peel high methoxyl pectin to the tangerine peel high methoxyl pectin to the lemon peel high methoxyl pectin to the lime peel high methoxyl pectin ranges from such as (5-28): (5-28): (3-50): (3-50), (6-25): (5-28): (3-50): (3-50), (8-23): (5-28): (3-50): (3-50), (12-20): (5-28): (3-50): (3-50), (15-17): (5-28): (3-50): (3-50), (3-30): (6-25): (3-50): (3-50), (3-30): (8-23): (3-50): (3-50), (3-30): (12-20): (3-50): (3-50), (3-30): (15-17): (3-50): (3-50), (3-30): (3-30): (6-45): (3-50), (3-30): (3-30): (8-40): (3-50), (3-30): (3-30): (10-35): (3-50), (3-30): (3-30): (12-30): (3-50), (3-30): (3-30): (15-25): (3-50), (3-30): (3-30): (17-20): (3-50), (3-30): (3-30): (3-50): (5-28), (3-30): (3-30): (3-50): (8-23), (3-30): (3-30): (3-50): (12-20), or (3-30): (3-30): (3-50): (15-17).

[0069] Preferably, thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0, preferably 2.5-7, more preferably 3-6, and even more preferably 4-6. The thixotropic ratio of the

high methoxyl pectin mixture ranges from such as 2.2-7.8, 2.4-7.6, 2.6-7.4, 2.8-7.2, 3.0-7.0, 3.2-6.8, 3.4-6.6, 3.6-6.4, 3.8-6.2, 4.0-6.0, 4.2-5.8, 4.4-5.6, 4.6-5.4, 4.8-5.2, or 4.9-5.1.

[0070] Preferably, the at least two types of high methoxyl pectins each independently have degree of methoxylation no less than 50%, no less than 52%, no less than 54%, no less than 56%, no less than 58%, no less than 60%, no less than 62%, no less than 64%, no less than 65%, no less than 66%, no less than 67%, no less than 68%, no less than 69%, no less than 70%, no less than 71%, no less than 72%, no less than 73%, no less than 74%, no less than 75%, no less than 76%, no less than 77%, no less than 78%, no less than 79%, no less than 80%, no less than 81%, no less than 82%, no less than 83%, no less than 84%, no less than 85%, no less than 86%, no less than 87%, no less than 88%, no less than 89% or no less than 90%. Preferably, the at least two types of high methoxyl pectins each independently have degree of methoxylation no greater than 90%, no greater than 89%, no greater than 88%, no greater than 87%, no greater than 86%, no greater than 85%, no greater than 84%, no greater than 83%, no greater than 82%, no greater than 81%, no greater than 80%, no greater than 79%, no greater than 78%, no greater than 77%, no greater than 76%, no greater than 75%, no greater than 74%. Preferably, the at least two types of high methoxyl pectins each independently have degree of methoxylation of 60-85%, 61-84%, 62-83%, 62-82%, 63-81%, 64-80%, 65-79%, 66-78%, 67-77%, 68-76%, 69-75%, 70-74% or 71-73%.

[0071] Preferably, the high methoxyl pectin composition or the high methoxyl pectin mixture, as measured at 23°C under 1% aqueous solution by weight, has a viscosity range of 14-70 mPa·s, preferably 15-65 mPa·s, more preferably 25-55 mPa·s, and even more preferably 25-50 mPa·s. The high methoxyl pectin composition or the high methoxyl pectin mixture, as measured at 23°C under 1% aqueous solution by weight, has a viscosity range of, such as, 15-69, 16-68, 18-66, 20-64, 22-62, 24-60, 26-58, 28-56, 30-54, 32-52, 34-50, 36-48, 38-46, 40-44, or 41-43 mPa·s.

[0072] Preferably, the at least two types of high methoxyl pectins belong to *Rutaceae* family, more preferably they belong to the *Citrus* genus. Preferably, the at least two types of high methoxyl pectins are from *Rutaceae* plant, preferably from *Citrus* plant, for example selected from tangerine (for example, *Citrus reticulata*), pomelo (for example, *Citrus maxima* or *Citrus grandis*), orange (for example, *Citrus sinensis*), lemon (for example, *Citrus limon*) or lime (for example, *Citrus aurantiifolia*).

[0073] Preferably, in the high methoxyl pectin mixture, the thixotropic ratio of at least one of the at least two types of high methoxyl pectins is equal to or less than 2, and thixotropic ratio

of at least one of the at least two types of high methoxyl pectins is equal to or greater than 8. Non-limiting examples of high methoxyl pectins having thixotropic ratio of 2 or less include orange peel pectin, optionally with a degree of methoxylation of 65%-71.5%, preferably 67%-71%, 68%-70.5% or 69%-70%; tangerine peel pectin, optionally with a degree of methoxylation of 60%-69.5%, preferably 61%-69%, 62%-68%, 63%-67% or 64%-66%; lemon peel pectin, optionally with a degree of methoxylation of 60%-68.5%, preferably 62%-68%, 63%-67% or 64%-66%; lime peel pectin, optionally with a degree of methoxylation of 60%-73%, preferably 61%-72%, 62%-71%, 63%-71%, 64%-70%, 65%-69% or 66%-68%. Non-limiting examples of high methoxyl pectins having thixotropic ratio of 8 or greater include orange peel pectin, optionally with a degree of methoxylation of 72.5%-85%, preferably 73%-80%, 73.5%-78% or 74%-76%; tangerine peel pectin, optionally with a degree of methoxylation of 70.5%-85%, preferably 71%-83%, 71.5%-81%, 72%-80%, 72.5%-79%, 73%-78%, 73.5%-77%, 74%-76% or 74.5%-75.5%; lemon peel pectin, optionally with a degree of methoxylation of 69.5%-85%, preferably 70%-83%, 70.5%-81%, 71%-79%, 71.5%-77%, 72%-75%, 72.5%-74% or 73%-73.5%; lime peel pectin, optionally with a degree of methoxylation of 74%-85%, preferably 75%-84%, 76%-83%, 77%-82%, 78%-81% or 79%-80%.

[0074] Preferably, in the high methoxyl pectin mixture, the thixotropic ratio of at least one of the at least two types of high methoxyl pectins is usually greater than 1 and equal to or less than 2, and thixotropic ratio of at least one of the at least two types of high methoxyl pectins is equal to or greater than 8.

[0075] Preferably, the high methoxyl pectin mixture comprises a combination of two or more of tangerine peel high methoxyl pectin, pomelo peel high methoxyl pectin, orange peel high methoxyl pectin, lemon peel high methoxyl pectin, or lime peel high methoxyl pectin.

[0076] Preferably, the high methoxyl pectin mixture comprises orange peel high methoxyl pectin and lemon peel high methoxyl pectin; or the high methoxyl pectin mixture consists of orange peel high methoxyl pectin and lemon peel high methoxyl pectin. Preferably, the weight ratio of the orange peel high methoxyl pectin to the lemon peel high methoxyl pectin is 0.1 to 10, preferably 0.2 to 7, and more preferably 0.5 to 1.5. Preferably, the weight ratio of the orange peel high methoxyl pectin to the lemon peel high methoxyl pectin ranges from 0.1 to 10, such as 0.12-9.5, 0.14-9.0, 0.16-8.5, 0.18-8.0, 0.20-7.5, 0.22-7.0, 0.24-6.5, 0.26-6.0, 0.28-5.5, 0.30-5.0, 0.32-4.5, 0.34-4.0, 0.36-3.5, 0.38-3.0, 0.40-2.5, 0.42-2.3, 0.44-2.0, 0.46-1.8, 0.48-1.6, 0.50-1.5, 0.51-1.47, 0.52-1.43, 0.54-1.40, 0.58-1.37, 0.62-1.35, or 0.65-1.33.

[0077] Preferably, the high methoxyl pectin mixture comprises tangerine peel high methoxyl pectin and lime peel high methoxyl pectin; or the high methoxyl pectin mixture consists of tangerine peel high methoxyl pectin and lime peel high methoxyl pectin. Preferably, the weight ratio of the tangerine peel high methoxyl pectin to the lime peel high methoxyl pectin is 3:100 to 15:1, and more preferably 3:50 to 10:1. The weight ratio of the tangerine peel high methoxyl pectin to the lime peel high methoxyl pectin ranges from, for example, 0.03-15, 0.04-14.5, 0.05-14, 0.06-13.5, 0.07-13, 0.08-13.5, 0.09-13, 0.1-12.5, 1-12, 2-11.5, 3-11, 4-10.5, 5-10, 6-9 or 7-8.

[0078] Preferably, the high methoxyl pectin mixture comprises orange peel high methoxyl pectin, tangerine peel high methoxyl pectin, lemon peel high methoxyl pectin, and lime peel high methoxyl pectin; or the high methoxyl pectin mixture consists of orange peel high methoxyl pectin, tangerine peel high methoxyl pectin, lemon peel high methoxyl pectin, and lime peel high methoxyl pectin. Preferably, the weight ratio of the orange peel high methoxyl pectin to the tangerine peel high methoxyl pectin to the lemon peel high methoxyl pectin to the lime peel high methoxyl pectin is (3-30): (3-30): (3-50): (3-50). The weight ratio of the orange peel high methoxyl pectin to the tangerine peel high methoxyl pectin to the lemon peel high methoxyl pectin to the lime peel high methoxyl pectin ranges from (5-28): (5-28): (3-50): (3-50), (6-25): (5-28): (3-50): (3-50), (8-23): (5-28): (3-50): (3-50), (12-20): (5-28): (3-50): (3-50), (15-17): (5-28): (3-50): (3-50), (3-30): (6-25): (3-50): (3-50), (3-30): (8-23): (3-50): (3-50), (3-30): (12-20): (3-50): (3-50), (3-30): (15-17): (3-50): (3-50), (3-30): (3-30): (6-45): (3-50), (3-30): (3-30): (8-40): (3-50), (3-30): (3-30): (10-35): (3-50), (3-30): (3-30): (12-30): (3-50), (3-30): (3-30): (15-25): (3-50), (3-30): (3-30): (17-20): (3-50), (3-30): (3-30): (3-50): (5-28), (3-30): (3-30): (3-50): (8-23), (3-30): (3-30): (3-50): (12-20), or (3-30): (3-30): (3-50): (15-17).

[0079] Preferably, degree of methoxylation of the tangerine peel high methoxyl pectin is no less than 50%, such as no less than 52%, such as no less than 54%, such as no less than 56%, such as no less than 58%, such as no less than 60%, such as no less than 62%, such as no less than 64%, such as no less than 65%, such as no less than 66%, such as no less than 67%, no less than 68%, such as no less than 69%, no less than 70%, such as no less than 71%, no less than 72%, such as no less than 73%, no less than 74%, such as no less than 75%, no less than 76%, such as no less than 77%, no less than 78%, such as no less than 79%, no less than 80%, such as no less than 81%, no less than 82%, such as no less than 83%, no less than 84%, such as no less than 85%, no less than 86%, such as no less than 87%, no less than 88%, no less than 89%, or no less than 90%. Preferably, degree of methoxylation of the tangerine peel high methoxyl pectin is no greater

than 90%, no greater than 89%, no greater than 88%, no greater than 87%, no greater than 86%, no greater than 85%, no greater than 84%, no greater than 83%, no greater than 82%, no greater than 81%, no greater than 80%, no greater than 79%, no greater than 78%, no greater than 77%, no greater than 76%, no greater than 75%, or no greater than 74%. For example, degree of methoxylation of the tangerine peel high methoxyl pectin is 60-85%, such as 61-84%, 62-83%, 62-82%, 63-81%, 64-80%, 65-79%, 66-78%, 67-77%, 68-76%, 69-75%, 70-74%, or 71-73%, such as 72%.

[0080] Preferably, degree of methoxylation of the pomelo peel high methoxyl pectin is no less than 50%, such as no less than 52%, such as no less than 54%, such as no less than 56%, such as no less than 58% , such as no less than 60%, such as no less than 62%, such as no less than 64%, such as no less than 65%, such as no less than 66%, such as no less than 67%, no less than 68%, such as no less than 69%, no less than 70%, such as no less than 71%, no less than 72%, such as no less than 73%, no less than 74%, such as no less than 75%, no less than 76%, such as no less than 77%, no less than 78%, such as no less than 79%, no less than 80%, such as no less than 81%, no less than 82%, such as no less than 83%, no less than 84%, such as no less than 85%, no less than 86%, such as no less than 87%, no less than 88 %, no less than 89%, or no less than 90%. Preferably, degree of methoxylation of the pomelo peel high methoxyl pectin is no greater than 90%, no greater than 89%, no greater than 88%, no greater than 87%, no greater than 86%, no greater than 85%, no greater than 84%, no greater than 83%, no greater than 82%, no greater than 81%, no greater than 80%, no greater than 79%, no greater than 78%, no greater than 77%, no greater than 76%, no greater than 75%, or no greater than 74%. For example, degree of methoxylation of the pomelo peel high methoxyl pectin is 60-85%, such as 61-84%, 62-83%, 62-82%, 63-81%, 64-80%, 65-79%, 66-78%, 67-77%, 68-76%, 69-75%, 70-74%, or 71-73%, such as 72%.

[0081] Preferably, degree of methoxylation of the orange peel high methoxyl pectin is no less than 50%, such as no less than 52%, such as no less than 54%, such as no less than 56%, such as no less than 58% , such as no less than 60%, such as no less than 62%, such as no less than 64%, such as no less than 65%, such as no less than 66%, such as no less than 67%, no less than 68%, such as no less than 69%, no less than 70%, such as no less than 71%, no less than 72%, such as no less than 73%, no less than 74%, such as no less than 75%, no less than 76%, such as no less than 77%, no less than 78%, such as no less than 79%, no less than 80%, such as no less than 81%, no less than 82%, such as no less than 83%, no less than 84%, such as no less than 85%,

no less than 86%, such as no less than 87%, no less than 88 %, no less than 89%, or no less than 90%. Preferably, degree of methoxylation of the orange peel high methoxyl pectin is no greater than 90%, no greater than 89%, no greater than 88%, no greater than 87%, no greater than 86%, no greater than 85%, no greater than 84%, no greater than 83%, no greater than 82%, no greater than 81%, no greater than 80%, no greater than 79%, no greater than 78%, no greater than 77%, no greater than 76%, no greater than 75%, or no greater than 74%. For example, degree of methoxylation of the orange peel high methoxyl pectin is 60-85%, such as 61-84%, 62-83%, 62-82%, 63-81%, 64-80%, 65-79%, 66-78%, 67-77%, 68-76%, 69-75%, 70-74%, or 71-73%, such as 72%.

[0082] Preferably, degree of methoxylation of the lemon peel high methoxyl pectin is no less than 50%, such as no less than 52%, such as no less than 54%, such as no less than 56%, such as no less than 58% , such as no less than 60%, such as no less than 62%, such as no less than 64%, such as no less than 65%, such as no less than 66%, such as no less than 67%, no less than 68%, such as no less than 69%, no less than 70%, such as no less than 71%, no less than 72%, such as no less than 73%, no less than 74%, such as no less than 75%, no less than 76%, such as no less than 77%, no less than 78%, such as no less than 79%, no less than 80%, such as no less than 81%, no less than 82%, such as no less than 83%, no less than 84%, such as no less than 85%, no less than 86%, such as no less than 87%, no less than 88 %, no less than 89%, or no less than 90%. Preferably, degree of methoxylation of the lemon peel high methoxyl pectin is no greater than 90%, no greater than 89%, no greater than 88%, no greater than 87%, no greater than 86%, no greater than 85%, no greater than 84%, no greater than 83%, no greater than 82%, no greater than 81%, no greater than 80%, no greater than 79%, no greater than 78%, no greater than 77%, no greater than 76%, no greater than 75%, or no greater than 74%. For example, degree of methoxylation of the lemon peel high methoxyl pectin is 60-85%, such as 61-84%, 62-83%, 62-82%, 63-81%, 64-80%, 65-79%, 66-78%, 67-77%, 68-76%, 69-75%, 70-74%, or 71-73%, such as 72%.

[0083] Preferably, degree of methoxylation of the lime peel high methoxyl pectin is no less than 50%, such as no less than 52%, such as no less than 54%, such as no less than 56%, such as no less than 58% , such as no less than 60%, such as no less than 62%, such as no less than 64%, such as no less than 65%, such as no less than 66%, such as no less than 67%, no less than 68%, such as no less than 69%, no less than 70%, such as no less than 71%, no less than 72%, such as no less than 73%, no less than 74%, such as no less than 75%, no less than 76%, such as

no less than 77%, no less than 78%, such as no less than 79%, no less than 80%, such as no less than 81%, no less than 82%, such as no less than 83%, no less than 84%, such as no less than 85%, no less than 86%, such as no less than 87%, no less than 88 %, no less than 89%, or no less than 90%. Preferably, degree of methoxylation of the lime peel high methoxyl pectin is no greater than 90%, no greater than 89%, no greater than 88%, no greater than 87%, no greater than 86%, no greater than 85%, no greater than 84%, no greater than 83%, no greater than 82%, no greater than 81%, no greater than 80%, no greater than 79%, no greater than 78%, no greater than 77%, no greater than 76%, no greater than 75%, or no greater than 74%. For example, degree of methoxylation of the lime peel high methoxyl pectin is 60-85%, such as 61-84%, 62-83%, 62-82%, 63-81%, 64-80%, 65-79%, 66-78%, 67-77%, 68-76%, 69-75%, 70-74%, or 71-73%, such as 72%.

[0084] Preferably, the high methoxyl pectin composition further comprises sugar. Preferably, the sugar comprises at least one of glucose, sucrose, fructose, maltose or trehalose. Preferably, the sucrose is granulated sugar. Preferably the sugar is in a content of 3-45% by weight, preferably 5-40% by weight, in the high methoxyl pectin composition. For example, the sugar is in a content of 4-44%, 5-43%, 6-42%, 7-41%, 8-40%, 9-39%, 10-38%, 11-37%, 12-36%, 13-35%, 14-34%, 15-33%, 16-32%, 17-31%, 18-30%, 19-29%, 20-28%, 21-27%, 22-26%, or 23-25% by weight, in the high methoxyl pectin composition.

[0085] Preferably, the high methoxyl pectin mixture accounts for 50-99% by weight, preferably 60-95% by weight, more preferably 65-90% by weight, and even more preferably 70-85% by weight, of the high methoxyl pectin composition. For example, the high methoxyl pectin mixture is in a content of, such as, 51-98%, 52-97%, 53-96%, 54-95%, 55-94%, 56-93%, 57-92%, 58-91%, 59-90%, 60-89%, 61-88%, 62-87%, 63-86%, 64-85%, 65-84%, 66-83%, 67-82%, 68-81%, 69-80%, 70-79%, 71-78%, 72-77%, 73-76%, or 74-75% by weight in the high methoxyl pectin composition.

[0086] The present disclosure also provides a food, feed or beverage product comprising the high methoxyl pectin composition described herein. Non-limiting examples of the above mentioned products include water, teas, milk, juices, isotonic beverages, fruit juices, miso soup, soups, and concentrated liquid foods. The pectin composition of the present invention can be used as a viscosity adjusting agent intended for imparting viscosity, or a gelling agent intended for gelation. Furthermore, the pectin composition of the present invention can be widely used in a

viscosity adjusting agent for concentrated liquid foods, a gelling agent, diet foods, condiments such as sauces and dressings, baby foods, pet foods, animal feeds, and the like.

[0087] Preferably, the high methoxyl pectin composition accounts for 0.05-10% by weight, preferably 0.1-1% by weight, more preferably 0.2-0.8% by weight, more preferably 0.3-0.6% by weight, and even more preferably 0.4-0.5% by weight, of the food composition. The high methoxyl pectin composition accounts for such as 0.06-9%, 0.07-8%, 0.08-7%, 0.09-6%, 0.10-5%, 0.11-4%, 0.12-3%, 0.13-2%, 0.14-1%, 0.15-0.9%, 0.16-0.8%, 0.17-0.7%, 0.18-0.69%, 0.19-0.68%, 0.20-0.67%, 0.21-0.66%, 0.22-0.65%, 0.23-0.64%, 0.24-0.63%, 0.25-0.62%, 0.26-0.61%, 0.27-0.60%, 0.28-0.59%, 0.29-0.58%, 0.30-0.57%, 0.31-0.56%, 0.32-0.55%, 0.33-0.54%, 0.34-0.53%, 0.35-0.52%, 0.36-0.51%, 0.37-0.50%, 0.38-0.49%, 0.40-0.48%, 0.41-0.47%, 0.42-0.45%, or 0.43-0.44% by weight, of the food composition, for example, of the drinkable yoghurt.

[0088] Preferably, the food composition is a fermented milk product, more preferably a drinkable yoghurt. Fermented milk drinks are typically prepared from natural milk by fermentation with a bacterial culture so that the product attains an acidic pH, such as, for example, less than 4.4.

[0089] As described herein, the term “fermented milk” generally refers to a product which was sterilized and then fermented with raw milk such as raw cow (goat) milk or milk powder as raw materials, and which has a reduced pH value (GB 19302-2010). Preferably, the protein in the fermented milk is ≥ 2.9 .

[0090] The fermented milk can be divided, based on the tissue state of the product, into coagulated yoghurt and stirring-type yoghurt. The coagulated yoghurt was fermented in the packaging container, so that the finished product remains in a curd state due to fermentation. The stirring-type yoghurt is a semi-fluid product with a certain viscosity made by stirring the fermented curd before or during the filling process, with (or without) fruit, jam, etc. added.

[0091] Yoghurt can be divided, based on the way of consumption (viscosity), into drinkable yoghurt and spoonable yoghurt. As described herein, the term “drinkable yoghurt” is one type of stirring-type yoghurt, and is different from the spoonable yoghurt.

[0092] Preferably, the drinkable yoghurt further comprises a yoghurt base material, wherein the yoghurt base material accounts for 50-90% by weight, preferably 60-80% by weight, and more preferably 70-78% by weight, of the drinkable yoghurt. The yoghurt base material accounts for, such as, 51-89%, 52-88%, 53-87%, 54-86%, 55-85%, 56-84%, 57-83%, 58-82%,

59-81%, 60-80%, 61-79%, 62-78%, 63-77%, 64-76%, 65-75%, 66-74%, 67-73%, 68-72%, or 69-71% by weight, of the drinkable yoghurt.

[0093] Preferably, the weight ratio of the high methoxyl pectin composition to the yoghurt base material is (1-10): (500-900), preferably (3-6): (600-800), and more preferably (4-6): (700-780), in the food composition, for example, in the drinkable yoghurt. The weight ratio of the high methoxyl pectin composition to the yoghurt base material ranges from, for example, 0.002-0.019, 0.003-0.018, 0.004-0.017, 0.005-0.016, 0.006-0.015, 0.007-0.014, 0.008-0.013, 0.009-0.012, or 0.010-0.011.

[0094] Preferably, the food composition, for example the drinkable yoghurt, further comprises water.

[0095] Preferably, the food composition, for example the drinkable yoghurt, further comprises sugar. Preferably, the sugar comprises at least one of glucose, sucrose, fructose, maltose or trehalose. Preferably, the sugar, such as sucrose, preferably granulated sugar, accounts for 0.1-10%, 0.2-9%, 0.3-8%, 0.4-7%, 0.5-6%, 0.6-5%, 0.7-4%, 0.8-3%, 0.9-2.5%, 1-2.4%, 1.2-2.3%, 1.4-2.1%, or 1.6-2% by weight, of the food composition for example the drinkable yoghurt.

[0096] Preferably, the food composition, for example the drinkable yoghurt, may further comprise a food additive commonly used in the field of food, like those used in the field of yoghurt.

[0097] Preferably, the food composition, for example the drinkable yoghurt, comprises or consists of yoghurt base material, sugar, high methoxyl pectin and water. Preferably, the content and the ratio of one or more of yoghurt base material, sugar, high methoxyl pectin and water are as defined above.

[0098] Preferably, the instability index of the drinkable yoghurt as described herein is no greater than 0.1, preferably no greater than 0.07, more preferably no greater than 0.05, and even more preferably no greater than 0.02. The instability index of the drinkable yoghurt is such as no greater than 0.09, no greater than 0.08, no greater than 0.07, no greater than 0.06, no greater than 0.05, no greater than 0.04, no greater than 0.03, no greater than 0.02, or no greater than 0.015.

[0099] As described herein, the term “instability index” is an index commonly used in the art to assess the stability of fermented milk such as drinkable yoghurt. The greater the instability index is, the more unstable the yoghurt will be. The instability index can be measured by a dedicated analyzer, such as the LUMiSizer Stability Analyser 611 analyzer.

[0100] Preferably, the pectin composition is added to an amount sufficient to achieve a viscosity of the drinkable yoghurt of 2500-7000 mPa·s when measured at 23°C. The viscosity of

the drinkable yoghurt is, for example, 2650-6900 mPa·s, 2700-6800 mPa·s, 2750-6700 mPa·s, 2800-6600 mPa·s, 2850-6500 mPa·s, 2900-6400 mPa·s, 2950-6300 mPa·s, 3000-6200 mPa·s, 3050-6100 mPa·s, 3100-6000 mPa·s, 3150-5900 mPa·s, 3200-5800 mPa·s, 3250-5700 mPa·s, 3300-5600 mPa·s, 3350-5500 mPa·s, 3400-5400 mPa·s, 3450-5300 mPa·s, 3500-5200 mPa·s, 3550-5100 mPa·s, 3600-5000 mPa·s, 3650-4900 mPa·s, 3700-4800 mPa·s, 3750-4750 mPa·s, 3800-4700 mPa·s, 3850-4650 mPa·s, 3900-4600 mPa·s, 3950-4550 mPa·s, 4000-4500 mPa·s, 4050-4450 mPa·s, 4100-4400 mPa·s, 4150-4350 mPa·s, 4200-4300 mPa·s, or 4250-4280 mPa·s when being measured at 23°C.

[0101] Preferably, the yoghurt base material is obtained by fermenting at least one of whole fresh cow milk, whole fresh goat milk, whole fresh camel milk, skimmed fresh cow milk, skimmed fresh goat milk, skimmed fresh camel milk, whole cow milk powder, whole goat milk powder, whole camel milk powder, skimmed cow milk powder, skimmed goat milk powder or skimmed camel milk powder. Preferably, commercially available starter, such as fermentation strain CH-1 and/or Lactobacillus casein Casein 01 from Chr-Hansen can be used for the fermentation. The raw materials for the fermentation include animal milk as described above, such as goat milk, cow milk or camel milk; sugars such as glucose; strains such as CH-1 and Lactobacillus casein 01; and water.

[0102] The present disclosure provides a method for preparing the high methoxyl pectin mixture or a method for preparing the high methoxyl pectin composition, comprising mixing at least two types of high methoxyl pectins to obtain a high methoxyl pectin mixture in a way that:

-degree of methoxylation of the high methoxyl pectin mixture is no less than 50%, such as no less than 52%, such as no less than 54%, such as no less than 56%, such as no less than 58%, such as no less than 60%, such as no less than 62%, such as no less than 64%, such as no less than 65%, such as no less than 66%, such as no less than 67%, no less than 68%, such as no less than 69%, no less than 70%, such as no less than 71%, no less than 72%, such as no less than 73%, no less than 74%, such as no less than 75%, no less than 76%, such as no less than 77%, no less than 78%, such as no less than 79%, no less than 80%, such as no less than 81%, no less than 82%, such as no less than 83%, no less than 84%, such as no less than 85%; or 60-85%, such as 61-84%, 62-83%, 62-82%, 63-81%, 64-80%, 65-79 %, 66-78%, 67-77%, 68-76%, 69-75%, 70-74%, or 71-73%; and

-thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0, such as 2.2-7.8, 2.4-7.6, 2.5-7, 2.6-7.4, 2.8-7.2, 3-6, 3.0-7.0, 3.2-6.8, 3.4-6.6, 3.6-6.4, 3.8-6.2, 4.0-6.0, 4.2-5.8, 4.4-5.6, 4.6-5.4, 4.8-5.2, or 4.9-5.1.

[0103] Preferably, the at least two types of high methoxyl pectins are prepared from a plurality of raw materials, wherein the plurality of raw materials comprise at least one of tangerine peel raw material, pomelo peel raw material, orange peel raw material, lemon peel raw material, or lime peel raw material, and preferably the tangerine peel raw material is tangerine peel pomace, the pomelo peel raw material is pomelo peel pomace, the orange peel raw material is orange peel pomace, the lemon peel raw material is lemon peel pomace and/or the lime peel raw material is lime peel pomace.

[0104] In one or more embodiments, in the above method, the at least two types of high methoxyl pectins each independently have degree of methoxylation no less than 50%, no less than 52%, no less than 54%, no less than 56%, no less than 58%, no less than 60%, no less than 62%, no less than 64%, no less than 65%, no less than 66%, no less than 67%, no less than 68%, no less than 69%, no less than 70%, no less than 71%, no less than 72%, no less than 73%, no less than 74%, no less than 75%, no less than 76%, no less than 77%, no less than 78%, no less than 79%, no less than 80%, no less than 81%, no less than 82%, no less than 83%, no less than 84%, no less than 85%, no less than 86%, no less than 87%, no less than 88%, no less than 89% or no less than 90%. In one or more embodiments, the at least two types of high methoxyl pectins each independently have degree of methoxylation no greater than 90%, no greater than 89%, no greater than 88%, no greater than 87%, no greater than 86%, no greater than 85%, no greater than 84%, no greater than 83%, no greater than 82%, no greater than 81%, no greater than 80%, no greater than 79%, no greater than 78%, no greater than 77%, no greater than 76%, no greater than 75%, or no greater than 74%. The at least two types of high methoxyl pectins each independently have degree of methoxylation of 60-85%, 61-84%, 62-83%, 62-82%, 63-81%, 64-80%, 65-79%, 66-78%, 67-77%, 68-76%, 69-75%, 70-74% or 71-73%.

[0105] Preferably, at least one of high methoxyl pectin having a thixotropic ratio of 2 or less than 2 is mixed with at least one of high methoxyl pectin having a thixotropic ratio of 8 or greater than 8 to obtain a high methoxyl pectin mixture in a way such that degree of methoxylation of the high methoxyl pectin mixture is greater than 50% and thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0.

[0106] Preferably, at least one of high methoxyl pectin having a thixotropic ratio of 2 or less than 2 is mixed with at least one of high methoxyl pectin having a thixotropic ratio of 8 or greater than 8 to obtain a high methoxyl pectin mixture in a way such that:

-degree of methoxylation of the high methoxyl pectin mixture is no less than 50%, such as no less than 52%, such as no less than 54%, such as no less than 56%, such as no less than 58%, such as no less than 60%, such as no less than 62%, such as no less than 64%, such as no less than 65%, such as no less than 66%, such as no less than 67%, no less than 68%, such as no less than 69%, no less than 70%, such as no less than 71%, no less than 72%, such as no less than 73%, no less than 74%, such as no less than 75%, no less than 76%, such as no less than 77%, no less than 78%, such as no less than 79%, no less than 80%, such as no less than 81%, no less than 82%, such as no less than 83%, no less than 84%, such as no less than 85%; or 60-85%, such as 61-84%, 62-83%, 62-82%, 63-81%, 64-80%, 65-79 %, 66-78%, 67-77%, 68-76%, 69-75%, 70-74%, or 71-73%;

-thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0 such as 2.2-7.8, 2.4-7.6, 2.5-7, 2.6-7.4, 2.8-7.2, 3-6, 3.0-7.0, 3.2-6.8, 3.4-6.6, 3.6-6.4, 3.8-6.2, 4.0-6.0, 4.2- 5.8, 4.4-5.6, 4.6-5.4, 4.8-5.2, or 4.9-5.1; and

-the high methoxyl pectin composition, as measured at 23°C under 1% aqueous solution by weight, has a viscosity range of 14-70 mPa·s, such as 15-69 mPa·s, 16-68 mPa·s, 17-67 mPa·s, 18-66 mPa·s, 19-65 mPa·s, 20-64 mPa·s, 21-63 mPa·s, 22-62 mPa·s, 23-61 mPa·s, 24-60 mPa·s, 25-59 mPa·s, 26-58 mPa·s, 27-57 mPa·s, 28 -56 mPa·s, 29-55 mPa·s, 30-54 mPa·s, 31-53 mPa·s, 32-52 mPa·s, 33-51 mPa·s, 33-50 mPa·s, 34- 49 mPa·s, 35-48 mPa·s, 36-47 mPa·s, 37-46 mPa·s, 38-45 mPa·s, 39-44 mPa·s, 40-43 mPa·s, 25-48 mPa·s, 26-49 mPa·s, 27-50 mPa·s, 28-51 mPa·s, 29-52 mPa·s, or 30-53 mPa·s.

[0107] Preferably, the method further comprises adding sugar. Preferably, the sugar comprises at least one of glucose, granulated sugar, fructose, maltose or trehalose.

[0108] The present disclosure further provides a high methoxyl pectin product, where the degree of methoxylation of the high methoxyl pectin product ranges from 65-85%, preferably 68-80%; the viscosity under 1% aqueous solution ranges from 15-65 mPa.s, preferably 25-55 mPa.s; and the thixotropic ratio is 2.0-8.0, preferably 3.0-6.0.

[0109] Preferably, the high methoxyl pectin product comprises one or more of tangerine peel pectin, orange peel pectin, lemon peel pectin, and lime peel pectin.

[0110] The present disclosure further provides a use of the high methoxyl pectin composition described herein for preparing a food, wherein preferably the food is a drinkable yoghurt.

[0111] The inventor of the present disclosure obtained high methoxyl pectin for drinkable yoghurt in the following manner. The viscosity value was obtained by a viscometer or a rheometer that aims to test pectins from different plant sources; the thixotropy of the pectins from different plant sources was measured by a rheometer; and the thickening ratio and the thixotropy ratio of the pectin were calculated. Then the pectins from different plant sources were chosen for mixing based on their viscosity value, the thickening ratio and the thixotropic ratio, and the mixture was standardized with sugar. The pectin of the present disclosure could achieve a balanced mouthfeel of freshness and body, while having good property of thickening and stabilization of the protein, and the product can be applied to drinkable yoghurt.

Methods and Measurements

Raw Material and Device

[0112] High methoxyl pectin (lemon peel pectin, orange peel pectin, lime peel pectin, tangerine peel pectin) of food grade, manufactured by Cargill Asia Pacific Food Systems (Beijing) Co., Ltd. The product is a white and slightly yellowish powder, and contains a small amount of protein, etc;

[0113] Whole cow milk, skimmed cow milk, reconstituted whole cow milk, reconstituted skimmed cow milk, glucose, granulated sugar, fructose, maltose, trehalose, glucono- δ -lactone, and lactic acid all of food grade;

Strain CH-1, Lactobacillus casein Casein 01, purchased from Chr-Hansen Co., Ltd.

[0114] The device used herein, the model and the manufacturer are as follows:

Stirrer: Model IKA RW20, IKA, Germany

Viscometer: Model Brookfield DV-II, Brookfield, USA

Full-featured stability analyzer: Model LUMiSizer Stability Analyser 611, LUM, Germany

Constant temperature water tank: Model DZKW-4 Beijing Zhongxingweiye Instrument Co., Ltd.

Homogenizer: Model APV-1000, APV, Germany

Measurement of Thixotropic Ratio

1. Preparation of milk curd base material: a defined amount of fresh milk or reconstituted milk was weighed, heated to 90°C and stirred for 15 minutes, and then was cooled to 40°C. A defined amount of coagulant was weighed and added into the milk, and stirred for 5 minutes. It was placed at 40°C for 3 hours. Then it was placed at 20°C for 30 minutes and get ready for use.

2. A defined amount of pectin was dissolved, and added to a defined amount of milk curd base material, where pH value of the yoghurt was adjusted to a defined range with 10% of lactic acid solution. A pectin yoghurt solution 1 was obtained after homogenization. In the meantime, the same mass of deionized water was weighed and added to milk curd base material with the same mass as 1, where pH value of the yoghurt was adjusted to a defined range with 10% of lactic acid solution, and a control yoghurt solution 2 was obtained after homogenization.

3. Thixotropy test was performed on the pectin yoghurt solution 1 and the control yoghurt solution 2 to obtain a thixotropy test curve, such as the curve shown in Figure 1. For example, an area between the closed curves was calculated by a software to obtain a thixotropic area. The thixotropic ratio was obtained by calculating a ratio B1/B2 of an area of thixotropic loop B1 of a high methoxyl pectin to be measured under a test system to an area of thixotropic loop B2 of a same amount of control measured under the same test system.

Pectin Mixing

4. According to the test results from Step 3, pectins with different thixotropic ratios were selected for mixing, where the thixotropic ratio was controlled within a defined range.

5. The pectin prepared from Step 4 was added with a defined amount of sugar, and stirred evenly, where the viscosity value was controlled within a defined range to obtain a high methoxyl pectin that can be used for drinkable yoghurt.

[0115] Preferably, the fresh milk or reconstituted milk in the above Step 1 comprises at least one of whole cow milk, skimmed cow milk, reconstituted whole cow milk or reconstituted skimmed cow milk.

[0116] Preferably, the coagulant in the above Step 1 refers to glucono- δ -lactone, and the added amount is preferably 2% of the fresh milk or the reconstituted milk.

[0117] Preferably, the pectin yoghurt solution 1 and the control yoghurt solution 2 in the above Step 2 were homogenized at a pressure of 200 bar and at a temperature of 65 degrees Celsius.

[0118] Preferably, the pectin yoghurt solution 1 in the above Step 2 has a protein content of 3.0%, a pH value of 4.2, and a pectin concentration of 4000 ppm.

[0119] Preferably, the pectin in the above Step 2 refers to a high methoxyl pectin prepared by using tangerine peel pomace, orange peel pomace, lemon peel pomace, and lime peel pomace as raw materials. Degree of methoxylation of the pectin ranges from 65-85%. Preferably degree of methoxylation of the pectin ranges from 68-80%.

[0120] Preferably, the thixotropy test in the above Step 3 was conducted by a rheometer with a concentric cylindrical rotor, where the detection temperature was 23 degrees Celsius, the initial shearing speed was 1 /s, the terminating shearing speed was 800 /s, and the shearing time was 360 seconds.

[0121] Preferably, the thixotropic ratio in the above Step 4 ranges from 2.0-8.0. Preferably, the thixotropic ratio in the above Step 4 ranges from 3.0-6.0.

[0122] Preferably, the relative thickening index in the above Step 4 ranges from 2.0-8.0. Preferably, the relative thickening index in the above Step 4 ranges from 3.0-6.0.

[0123] Preferably, the concentration of the aqueous pectin solution in the above Step 5 was 1%, and the test temperature was 23 degrees Celsius. The test instrument was a viscometer, and the test rotational speed was 60 RPM.

[0124] Preferably, the sugar in the above Step 5 comprises at least one of glucose, sucrose, fructose, maltose or trehalose.

[0125] In the following Examples, the steps of determining the thixotropic ratio and formulating pectin based on the thixotropy are as follows:

[0126] The thixotropic ratio is measured based on area of the thixotropic loop, for example, by the following exemplary steps:

1. Preparation of milk curd base material: a defined amount of fresh milk or reconstituted milk was weighed, heated to 90°C, and stirred for 15 minutes. It was cooled to 40°C, and a defined amount of coagulant was weighed and added into the milk, and stirred for 5 minutes. It was placed at 40°C for 3 hours. It was placed at 20°C for 30 minutes and was ready for use.

2. A defined amount of pectin was dissolved, and added to a defined amount of milk curd base material, where pH value of the yoghurt was adjusted to a defined range with 10% of lactic acid solution. A pectin yoghurt solution 1 was obtained after homogenization. In the meantime, the same mass of deionized water was weighed and added to milk curd base material with the same

mass as 1, where pH value of the yoghurt was adjusted to a defined range with 10% of lactic acid solution, and a control yoghurt solution 2 was obtained after homogenization.

3. A thixotropy test was performed on the pectin yoghurt solution 1 and the control yoghurt solution 2 to obtain a thixotropy test curve, such as the curve shown in Figure 1. For example, an area between closed curves was calculated by software to obtain a thixotropic area. The thixotropic ratio was obtained by calculating a ratio B1/B2 of an area of thixotropic loop B1 of a high methoxyl pectin to be measured under a test system to an area of thixotropic loop B2 of a same amount of control measured under the same test system.

4. According to detection results by Step 3, pectins with different thixotropic ratios were selected for mixing, where the thixotropic ratio was controlled within a defined range.

5. The pectin prepared by Step 4 was added with a defined amount of sugar, and stirred evenly, where the viscosity value was controlled within a defined range to obtain a high methoxyl pectin for drinkable yoghurt.

Examples

Examples 1-3

[0126] 1000 ml of skimmed cow milk was weighed, heated to 90°C, stirred for 15 minutes, and was cooled to 40°C; 20 grams of glucono- δ -lactone was weighed and added to the milk, and stirred for 5 minutes. It was placed at 40°C for 3 hours. It was placed at 20°C for 30 minutes and was ready for use. The protein content of the milk curd base material was measured to be 3.6%.

[0127] 0.8 g of tangerine peel pectin and 0.8 g of lime peel pectin were weighed. The index of pectin was shown in Table 1. 32.5 g of deionized water was added to each of the tangerine peel pectin and the lime peel pectin, and stirred at 75°C until it was dissolved. 166.7 g of milk curd base material was weighed and added into each type of pectin solution, and stirred. The pH was adjusted to 4.2 with 10% lactic acid solution, and then homogenizing was conducted at a pressure of 200 bar and a temperature of 65 degrees Celsius. In the meantime, 33.3g of deionized water was weighed and added to 166.7 g of milk curd base material, and it was stirred evenly, and then the pH was adjusted to 4.2 with 10% lactic acid solution, and the homogenizing was conducted at a pressure of 200 bar and a temperature of 65 degrees Celsius.

[0128] The thixotropy test was conducted by a HAAKE rheometer with a CC27 DG/Ti concentric cylindrical rotor, where the detection temperature was 23 degrees Celsius, the initial

shearing speed was 1 s^{-1} , the terminating shearing speed was 800 s^{-1} , and the shearing time was 360 seconds.

[0129] The thixotropic ratio was obtained by calculating a ratio B1/B2 of an area of thixotropic loop B1 of a tangerine peel pectin and the lime peel pectin under a test system to an area of thixotropic loop B2 of a same amount of control, i.e., deionized water, measured under the same test system.

Table 1. Index of Pectin

Name of the product	Degree of methoxylation of the product (%)
tangerine peel pectin	65
lime peel pectin	80

Table 2. Test Results of Thixotropy

Serial No. of the Sample	Thixotropic Ratio
Control	/
Tangerine peel pectin	1.83
Lime peel pectin	8.73

[0130] Three pectin products, Sample 1, Sample 2 and Sample 3 were obtained by mixing tangerine peel pectin and lime pectin with sugar.

Table 3 Product Formula

Serial No. of the Sample	Tangerine peel pectin (weight%)	Lime peel pectin (weight%)	Sugar (weight%)	Type of Sugar
Sample 1	54	6	40	Glucose
Sample 2	37.5	37.5	25	Fructose
Sample 3	5	80	15	Trehalose

Examples 4-6

[0131] 1000 ml of reconstituted whole cow milk was weighed and heated to 90°C, stirred for 15 minutes, and was cooled to 40°C; 20 grams of glucono- δ -lactone was weighed and added to the milk, and stirred for 5 minutes. It was placed at 40°C for 3 hours. It was placed at 20°C for 30 minutes and was ready for use. The protein content of the milk curd base material was measured to be 3.3%.

[0132] 0.8 g of lemon peel pectin and 0.8 g of orange peel pectin were weighed. The index of pectin was shown in Table 4. 17.4 g of deionized water was added to each of the lemon peel pectin and the orange peel pectin, and stirred at 75°C until it was dissolved. 181.8 g of milk curd base material was weighed and added into each type of the pectin solution, and stirred. The pH was adjusted to 4.2 with 10% lactic acid solution, and then homogenizing was conducted at a pressure of 200 bar and a temperature of 65 degrees Celsius. In the meantime, 18.2g of deionized water was weighed and added to 181.8 g of milk curd base material, and it was stirred evenly, and then the pH was adjusted to 4.2 with 10% lactic acid solution, and then homogenizing was conducted at a pressure of 200 bar and a temperature of 65 degrees Celsius.

[0133] The thixotropy test was conducted by a HAAKE rheometer with a CC25 DIN/Ti concentric cylindrical rotor, where the detection temperature was 23 degrees Celsius, the initial shearing speed was 1 s^{-1} , the terminating shearing speed was 800 s^{-1} , and the shearing time was 360 seconds.

[0134] The thixotropic ratio was obtained by calculating a ratio B1/B2 of an area of thixotropic loop B1 of a lemon peel pectin and the orange peel pectin under a test system to an area of thixotropic loop B2 of a same amount of control, i.e., deionized water, measured under the same test system.

Table 4 Index of Pectin

Name of the Product	Degree of methoxylation of the product
Orange peel pectin	70%
Lemon peel pectin	73%

Table 5 Test Results of thixotropy

Serial No. of the Sample	Thixotropic Ratio
Control	
Orange peel pectin	1.80

Lemon peel pectin	11.24
-------------------	-------

[0135] Three pectin products, Sample 4, Sample 5 and Sample 6 were obtained by mixing orange peel pectin and lemon pectin with sugar, where Sample 6 was not added with sugar.

Table 6 Product Formula

Serial No. of the Sample	Orange peel pectin (weight%)	Lemon peel pectin (weight%)	Sugar (weight%)	Type of Sugar
Sample 4	50	35	15	Glucose
Sample 5	25	48	27	Glucose + Granulated sugar
Sample 6	0	100	0	

Examples 7-10

[0136] 500 ml of whole cow milk and 500 ml of skimmed reconstituted cow milk was mixed, heated to 90°C and stirred for 15 minutes, and then cooled to 40°C; 20 grams of glucono- δ -lactone was weighed and added to the milk, and stirred for 5 minutes. It was placed at 40°C for 3 hours. It was then placed at 20°C for 30 minutes and was ready for use. The protein content of the milk curd base material was detected to be 4.0%.

[0137] 0.8 g of orange peel pectin, 0.8 g of tangerine peel pectin, 0.8 g of lemon peel pectin and 0.8 g of lime peel pectin were weighed. The index of pectins was shown in Table 7. 42.8 g of deionized water was added to each of the orange peel pectin, the tangerine peel pectin, the lemon peel pectin and the lime peel pectin, and stirred at 75°C until they were dissolved. 150 g of milk curd base material was weighed and added into each type of the pectin solutions, and stirred. The pH was adjusted to 4.2 with 10% lactic acid solution, and then homogenizing was conducted at a pressure of 200 bar and a temperature of 65 degrees Celsius. In the meantime, 50g of deionized water was weighed and added to 150 g of milk curd base material, and it was stirred evenly, and then the pH was adjusted to 4.2 with 10% lactic acid solution, and then homogenizing was conducted at a pressure of 200 bar and a temperature of 65 degrees Celsius.

[0138] The thixotropy test was conducted by a HAAKE rheometer with a CC38 rotor, where the detection temperature was 23 degrees Celsius, the initial shearing speed was 1/s, the terminating shearing speed was 800 /s and the shearing time was 360 seconds.

Table 7. Index of Pectin

Name of the Product	Degree of methoxylation of the product
Orange peel pectin	74%
Tangerine peel pectin	75%
Lemon peel pectin	65%
Lime peel pectin	67%

Table 8. Test Results of Thixotropy

Serial No. of the Sample	Thixotropic Ratio
Control	/
Orange peel pectin	8.97
Tangerine peel pectin	9.21
Lemon peel pectin	1.31
Lime peel pectin	1.84

[0139] Three pectin products, Sample 7, Sample 8 and Sample 9 were obtained by mixing the orange peel pectin, the tangerine peel pectin, the lemon peel pectin and the lime peel pectin with sugar.

Table 9. Product Formula

Serial No. of the Sample	Orange peel pectin	Tangerine peel pectin (weight%)	Lemon peel pectin (weight%)	Lime peel pectin (weight%)	Sugar (weight%)	Type of Sugar
Sample 7	5	5	35	35	10	Granulated sugar + Glucose
Sample 8	0	10	40	40	5	Fructose + Maltose
Sample 9	25	25	5	5	40	Granulated sugar + Trehalose

Index Test on Pectin Products

[0140] Degree of methoxylation, viscosity and thixotropic ratio of each pectin products were tested.

Table 10. Index of Products and Test Results

Serial No. of the Sample	Degree of methoxylation*	23°C, 1% viscosity *mPa·s	Thixotropic Ratio
Sample 1	66.5%	15.1	2.08
Sample 2	72.5%	32	5.1
Sample 3	79.1%	64.8	7.8
Sample 4	71.5%	25	4.8
Sample 5	70.5%	38	5.8
Sample 6	73.0%	76	11.2
Sample 7	67.1%	33	2.89
Sample 8	67.0%	46	3.25
Sample 9	73.1%	15.5	7.88
Sample 10*	71.1%	11.1	1.68

*Sample 10 is a commercial pectin product QC 40 CN.

*Degree of methoxylation was detected by the method set forth in the United States Pharmacopoeia USP37 4199-4201.

Viscosity: Viscometer Model Brookfield DV-II, Brookfield, USA, 23 degrees Celsius, 64# rotor 60r/min.

Application Experiments

[0141] Yoghurt products were prepared using the pectin products of Examples 1-9 above.

Table 11. Process Parameters of Yoghurt Base Material

Raw material	Added amount, g/1000g	Added amount, g/10000g
Whole fresh cow milk	120	1200

Glucose	70	700
Strain CH-1	0.075	0.75
Lactobacillus casein, Casein 01	0.015	0.15
Water was added to	1000	10000

Process:

[0142] Skimmed milk powder and glucose powder were added to water having a temperature of 50°C, stirred evenly, and was kept warm for 30 minutes for hydration. The solution was heated to 65°C, and homogenized at 50/200bar. Then it was cooled down to 42°C for fermentation, and it was fermented for about 20 hours.

Table 12. Process Parameters of Secondary Ingredients

Project	Parameter
Yoghurt base material	750g
White sugar	20g
Pectin	4.5g
Water was added to	1000g

[0143] Pectin and white sugar were dissolved in hot water at 65-70°C, stirred for 10 minutes, UHT121°C/4S, to obtain a solution; the solution of pectin and white sugar was cooled to below 30°C; the solution of pectin and white sugar was added to the yoghurt base material, and was stirred evenly for 20 minutes; the volume was metered and homogenizing was conducted at a secondary pressure of 5MPa; UHT sterilization was conducted at 121°C, 4S; a yoghurt product was obtained after filled at 20-25°C.

Characteristic Test of Yoghurt Product

The parameters tested are as follows:

[0144] Instability index of Yoghurt: LUMiSizer Stability Analyser 611 Analytical instrument parameters: Scanning light frequency: 865nm; Centrifugation speed: 4000r/min; Scanning light intensity: 1 fold; Temperature: 25°C; Scanning interval: 10s/time; Scanning times: 360; Scanning time: 1h.

[0145] Viscosity of the yoghurt: Viscometer: Model Brookfield DV-II, Brookfield, USA, measured at 23 degrees Celsius, 64# rotor 60r/min, pH 4.20.

[0146] Mouthfeel: 12 professional sensory reviewers have evaluated the thinness/thickness, high freshness/body, and long/short sweetness and sourness of the product.

Table 13: Evaluation Form of Product

Serial No.	Instability Index	Viscosity	Sensory Evaluation
1	0.068	2819.06	Thinner; relatively high freshness; strong and short sweetness and sourness
2	0.053	4858.96	Moderate thickness; moderate freshness and body; moderate sweetness and sourness
3	0.011	6232.85	Higher thickness; strong body; weak and long sweetness and sourness
4	0.014	4029.03	Moderate thickness; moderate body; moderate sweetness and sourness
5	0.012	4699.00	Moderate thickness; moderate body; moderate sweetness and sourness
6	0.010	8281.98	Thick; not fresh; weak sweetness and sourness
7	0.051	5023.93	Relatively thick; relatively fresh; relatively short sweetness and sourness
8	0.056	5086.91	Relatively thick; Relatively fresh; relatively short sweetness and sourness
9	0.046	3209.02	Relatively low thickness; poor freshness; relatively long sweetness and sourness
10	0.093	2038.88	Thin; too fresh; strong and short sweetness and sourness

[0147] As can be seen from the results in the above table, the yoghurt products prepared by using the pectin product with the thixotropic ratio beyond the range of 2-8 do not seem to have a good mouthfeel, as illustrated in Example 6 and Example 10, for example. The pectin products with the thixotropic ratio of 2-8, for example, the yoghurt products prepared by Examples 1-5 and Examples 7-9 have better mouthfeel than that of the yoghurt products prepared by Example 6 and Example 10. In particular, the pectin products prepared by Examples 4 and 5 have obtained a yoghurt with a good balance in various performance parameters, that is, having the best mouthfeel, and also having very good results in instability index, that is, a good stability property. In addition, it can be seen from the above table that pectin products with a suitable viscosity range as measured under 1% solution also have some influence on the mouthfeel. For example, yoghurt products

prepared with a too high viscosity as measured under 1% solution in Example 6 and prepared with a too low viscosity as measured under 1% solution in Example 10 do not have a good mouthfeel.

[0148] In the state of the art, it is a challenge to obtain a yoghurt product, especially a drinkable yoghurt product, which has a balanced mouthfeel with moderate thickness, moderate body, and moderate sweetness and sourness as well as high stability. The inventors of the present disclosure have gone through a huge number of experiments with trials and errors to discover that a thixotropic index, optionally in combination with, for example, a viscosity index, can be used to screen high methoxyl pectins with high performance suitable for drinkable yoghurt, especially via mixing at least two types of pectins.

[0149] The forgoing are only preferred embodiments of the present disclosure, and are not intended to limit the present disclosure. The present disclosure may have various modifications and changes for those skilled in the art. Any modification, equivalent replacement, improvement, etc. made within the spirit and principle of the present disclosure shall be included within the scope of the present disclosure.

What is claimed is:

1. A high methoxyl pectin composition, wherein the high methoxyl pectin composition comprises a high methoxyl pectin mixture, wherein the high methoxyl pectin mixture consists of at least two types of high methoxyl pectins, wherein degree of methoxylation of the high methoxyl pectin mixture is greater than 50%, and thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0, and wherein the thixotropic ratio is a ratio B1/B2 of an area of thixotropic loop B1 of a high methoxyl pectin to be measured under a test system to an area of thixotropic loop B2 of a same amount of control measured under the same test system, and wherein the control is water.
2. The high methoxyl pectin composition according to claim 1, wherein the thixotropic ratio of the high methoxyl pectin mixture is 2.5-7, preferably the thixotropic ratio of the high methoxyl pectin mixture is 3-6, and more preferably the thixotropic ratio of the high methoxyl pectin mixture is 4-6.
3. The high methoxyl pectin composition according to claim 1 or 2, wherein degree of methoxylation of the high methoxyl pectin mixture is no less than 60%, preferably 65-85%, and more preferably is 68-80%; and optionally, degree of methoxylation of each of the at least two types of high methoxyl pectins is no less than 60%, preferably 65-85%, and more preferably 68-80%.
4. The high methoxyl pectin composition according to any of claims 1-3, wherein the high methoxyl pectin composition, as measured at 23°C under 1% aqueous solution by weight, has a viscosity range of 14-70 mPa·s, preferably 15-65 mPa·s, more preferably 25-55 mPa·s, and even more preferably 25-50 mPa·s.
5. The high methoxyl pectin composition according to any of claims 1-4, wherein the at least two types of high methoxyl pectins are from Rutaceae plant, preferably from Citrus plant.
6. The high methoxyl pectin composition according to any of claims 1-5, wherein in the high methoxyl pectin mixture, thixotropic ratio of at least one of the at least two types of high methoxyl pectins is equal to or less than 2, and thixotropic ratio of at least one of the at least two types of high methoxyl pectins is equal to or greater than 8.
7. The high methoxyl pectin composition according to any of claims 1-5, wherein the high methoxyl pectin mixture comprises a combination of two or more of tangerine peel high methoxyl

pectin, pomelo peel high methoxyl pectin, orange peel high methoxyl pectin, lemon peel high methoxyl pectin, or lime peel high methoxyl pectin; and preferably, the high methoxyl pectin mixture comprises a combination of two or more of tangerine peel high methoxyl pectin, orange peel high methoxyl pectin, or lemon peel high methoxyl pectin.

8. The high methoxyl pectin composition according to any of claims 1-7, wherein the high methoxyl pectin mixture comprises or consists of orange peel high methoxyl pectin and lemon peel high methoxyl pectin, and preferably the weight ratio of the orange peel high methoxyl pectin to the lemon peel high methoxyl pectin is 0.1 to 10, preferably 0.2 to 7, and more preferably 0.5 to 1.5.

9. The high methoxyl pectin composition according to any of claims 1-7, wherein the high methoxyl pectin mixture comprises or consists of tangerine peel high methoxyl pectin and lime peel high methoxyl pectin, and preferably the weight ratio of the tangerine peel high methoxyl pectin to the lime peel high methoxyl pectin is 3:100 to 15:1, and more preferably 3:50 to 10:1.

10. The high methoxyl pectin composition according to any of claims 1-7, wherein the high methoxyl pectin mixture comprises or consists of orange peel high methoxyl pectin, tangerine peel high methoxyl pectin, lemon peel high methoxyl pectin, and lime peel high methoxyl pectin, and preferably the weight ratio of the orange peel high methoxyl pectin to the tangerine peel high methoxyl pectin to the lemon peel high methoxyl pectin to the lime peel high methoxyl pectin is (3-30): (3-30): (3-50): (3-50).

11. The high methoxyl pectin composition according to any of claims 1-10, wherein the high methoxyl pectin composition further comprises sugar, and preferably the sugar is in a content of 3-45% by weight, preferably 5-40% by weight, in the high methoxyl pectin composition, and preferably, the sugar comprises at least one of glucose, sucrose, fructose, maltose or trehalose.

12. The high methoxyl pectin composition according to any of claims 1-11, wherein the high methoxyl pectin mixture accounts for 50-99% by weight, preferably 60-95% by weight, more preferably 65-90% by weight, and even more preferably 70-85% by weight, of the high methoxyl pectin composition.

13. A food composition comprising the high methoxyl pectin composition according to any of claims 1-12, wherein the food composition is preferably a drinkable yoghurt.

14. A method for preparing the high methoxyl pectin composition of any of claims 1-12, comprising:

mixing at least two types of high methoxyl pectins to obtain a high methoxyl pectin mixture in a way that degree of methoxylation of the high methoxyl pectin mixture is greater than 50% and thixotropic ratio of the high methoxyl pectin mixture is 2.0-8.0.

15. Use of the high methoxyl pectin composition according to any of claims 1-12 for preparing a food, wherein preferably the food is a drinkable yoghurt.

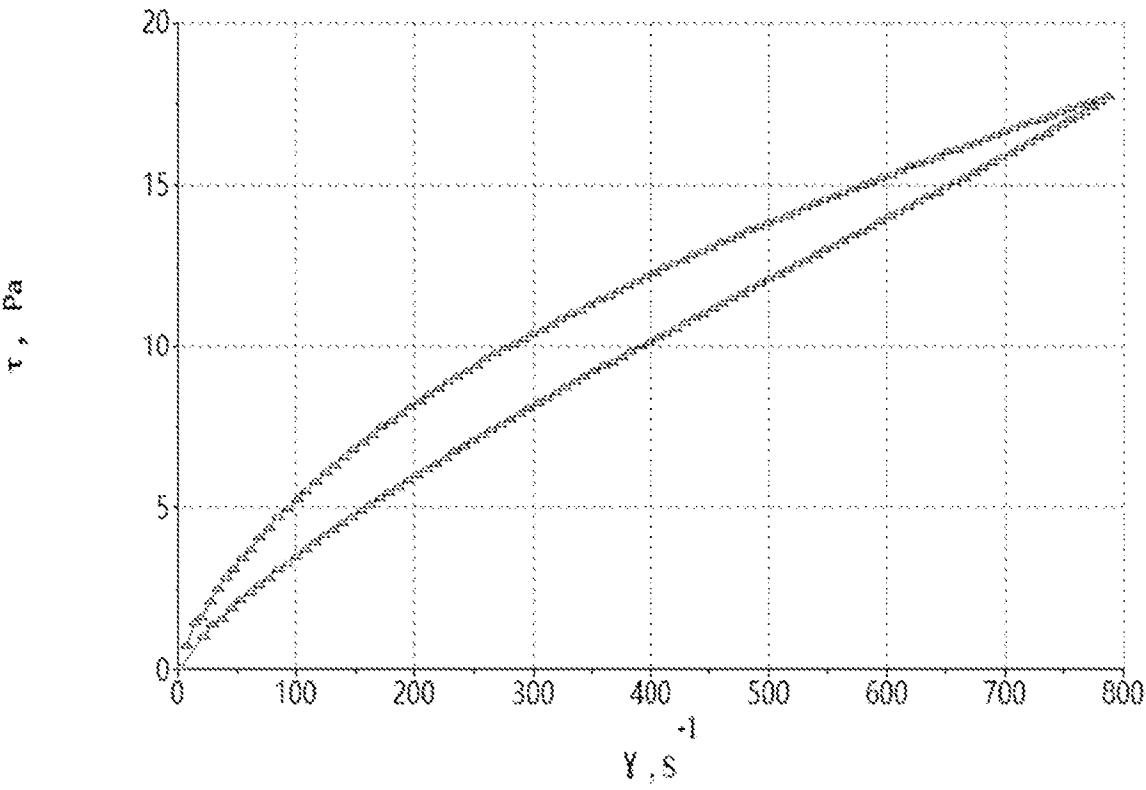


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2023/020159**A. CLASSIFICATION OF SUBJECT MATTER****INV. A23L29/231 A23C9/12 A23C9/137**
ADD.

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A23L A23C

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**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 104 419 737 B (ZHEJIANG GUOYUAN KANGPIN BIOTECHNOLOGY CO LTD)	1, 2, 4-8, 11-15
	6 February 2018 (2018-02-06)	
Y	claim 2	3, 9, 10
	"Background Technique" Section, first paragraph	

Y	US 8 168 765 B2 (CHRISTENSEN STEEN HOJGAARD [DK]; HANSEN KARIN MEYER [DK] ET AL.) 1 May 2012 (2012-05-01)	3, 9, 10
	table 1	

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

16 June 2023

Date of mailing of the international search report

26/06/2023

Name and mailing address of the ISA/

European Patent Office, P.B. 5818 Patentlaan 2

NL - 2280 HV Rijswijk

Tel. (+31-70) 340-2040,

Fax: (+31-70) 340-3016

Authorized officer

Alonso Martínez, D

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2023/020159

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
CN 104419737	B	06-02-2018	NONE
US 8168765	B2	01-05-2012	AU 2003236822 A1 23-01-2004
		BR 0312418 A	19-04-2005
		DK 176653 B1	02-02-2009
		DK 1517925 T3	08-01-2018
		EP 1517925 A1	30-03-2005
		ES 2651865 T3	30-01-2018
		MX PA04012371 A	25-02-2005
		US 2006127991 A1	15-06-2006
		WO 2004005352 A1	15-01-2004