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(71) Applicant: **CORN PRODUCTS DEVELOPMENT, INC.** [US/US]; 5 Westbrook Corporate Center, Westchester, Illinois 60154 (US).

(72) Inventors: **HANCHETT, Douglas**; 10 Finderne Avenue, Suite C, Bridgewater, New Jersey 08807 (US). **YURGEC, Matt**; 10 Finderne Avenue, Suite C, Bridgewater, New Jersey 08807 (US). **UZUNALIOGLU, Dilek**; 10 Finderne Avenue, Suite C, Bridgewater, New Jersey 08807 (US). **SULLIVAN, Jeffrey**; 10 Finderne Avenue, Suite C, Bridgewater, New Jersey 08807 (US). **LEE, Yiyu**; 10 Finderne Avenue, Suite C, Bridgewater, New Jersey 08807 (US). **NATACIA, Finna**; 10 Finderne Avenue, Suite C, Bridgewater, New Jersey 08807 (US). **GAO, Chloe**; 10 Finderne Avenue, Suite C, Bridgewater, New Jersey 08807 (US). **BAHAMMOU, Rachel**; 10 Finderne Avenue, Suite C, Bridgewater, New Jersey 08807 (US).

(74) Agent: **GRAUCH, Jason** et al.; Ingredion Incorporated, 10 Finderne Avenue, Suite C, Bridgewater, New Jersey 08807 (US).

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(54) Title: BAKED SNACK COATING MADE FROM WAXY CASSAVA

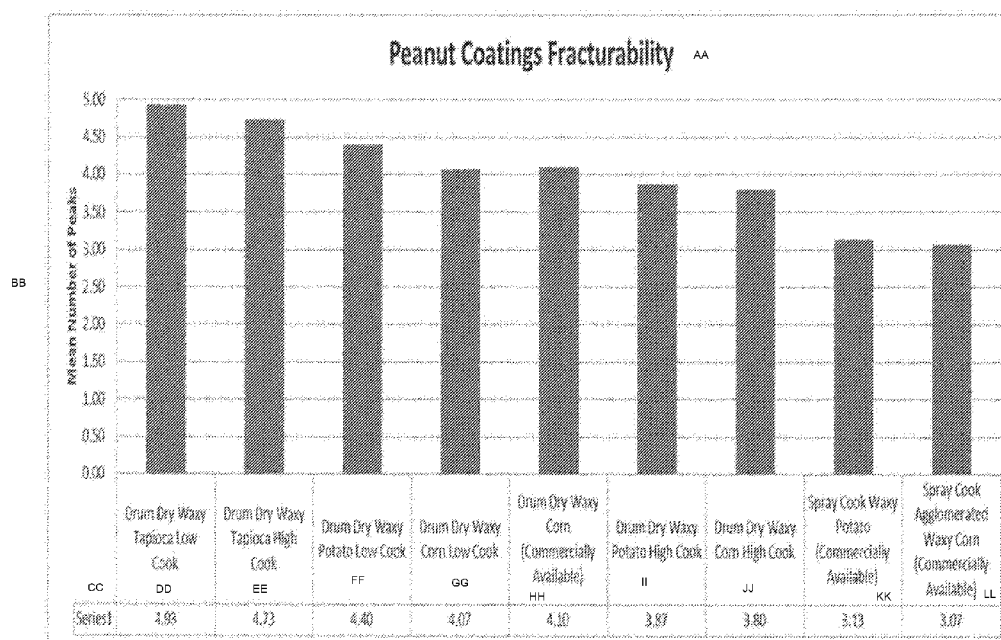


Figure 3

(57) Abstract: Dry mix coatings and mixes for snack crackers are made from pregelatinized waxy cassava and exhibit unique textural properties compared to other starches for example having a less dense, highly facturable, crisper texture than is obtainable using other similarly treated starches.



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Baked Snack Coating Made From Waxy Cassava

BACKGROUND

[0001] Field of the invention: The present invention relates to starch based food coatings made using a low amylose cassava starch. More specifically, the low amylose cassava starch is pregelatinized starch and produces a food coating with high expansion, but a uniform matrix.

[0002] Starch is used in the snack food industry to make crackers and coatings and food coatings in order to provide desirable textures. Examples include coated peanut, snack crackers, and manufacture potato chips. With specific reference to peanut coatings roasted peanuts with multiple alternating layers of sugar syrup and a starch based coating mixture. The coated peanut is then baked or fried, which causes the coating to expand.

[0003] Waxy or low amylose cassava plants have recently been developed and Applicants have discovered that snack products, including for example food coatings and snack crackers made with pregelatinized waxy cassava starch have more uniform matrix than those made from other starches. The result is that coatings using such starches provide baked coated snacks unique and desirable texture profiles.

SUMMARY

[0004] This specification discloses starch based coatings that have high expansion, a uniform coating matrix, lower fracturability and are softer than coatings made from other base starches. The coatings are made from pregelatinized low amylose cassava starch. In embodiments the coating comprises a second starch component, which may be starch or flour. In embodiments it is wheat flour. In embodiments the second starch is gluten free.

[0005] In embodiments the baked coating has higher expansion per amount of starch used as measured by the coating's bulk density. In embodiments the bulk density is between about 0.15 and about 0.25 g/ml. In embodiments it is between about 0.18 and about 0.23 g/ml. In embodiments it is about 0.22 g/ml.

[0006] In embodiments the baked coating has a more uniform coating matrix than coatings made from other waxy starches as measured by the percentage of the matrix's bulk volume made up of pores whose major axis is less than 300 microns. In embodiments more than 50% of the bulk volume is made of pores whose major axis is less than about 300 microns. In embodiments

it is between about 50% and about 75%; in embodiments between about 60% and about 70%; in embodiments about 65% of the volume of the matrix is made from pores having a major axis smaller than 300 microns.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figure 1 is an SEM image (15x) of an illustrative coating made from low amylose tapioca.

[0008] Figure 2a is a principal component analysis (PCA) map of the sensory perception of various mouthfeel attributes of the illustrative peanut coatings using an adhesion liquid comprising ammonium bicarbonate (sum of F1 & F2 = 95%).

[0009] Figure 2b is a principal component analysis (PCA) map of the sensory perception of various mouthfeel attributes of illustrative peanut coatings using an adhesion liquid that does not use a leavening agent (like ammonium bicarbonate) (sum of F1 & F2 = 96%).

[0010] Figure 3 is a graph reporting the fracturability of illustrative peanut coating samples made using various base starches.

[0011] Figure 4 is a graph reporting the hardness of illustrative peanut coating samples made using various base starches.

DETAILED DESCRIPTION

[0012] As used in this specification, the term low amylose cassava starch means a starch derived from cassava plant having roots that are naturally low in amylose. The plants may be as found in nature, genetically modified, or obtained through specialized breeding. This specification uses low amylose and waxy interchangeable, and uses tapioca and cassava interchangeably.

[0013] As used in this specification, low amylose means having less than about 10% amylose, in some embodiments less than about 5% amylose, in other embodiments less than about 3% amylose, in other embodiments the starch has essentially 0% amylose.

[0014] As used in this specification fracturability is a descriptor used to characterize how a substance breaks when force is applied to it, and as applied to the disclosed foodstuffs describes the perception of crumbling versus shattering upon biting the foodstuff. A substance that has low

fracturability is perceived to crumble. In contrast, a substance that has high fracturability is perceived to shatter. Also, fracturability, can be measured using a texture analyzer by measuring the number of force peaks measured by a probe as it is pressed against the sample. Each force peak represents a surface that the probe must break through as it passes through the sample. The higher the number of peaks the lower the fracturability.

[0015] Within this specification, when using a texture analyzer to measure fracturability, measurements are run according to the following: Testing was done with a P/2 2 mm cylindrical stainless steel probe. The probe had a pre-test speed of 2.00 mm/s and a test speed of 3.00 mm/s. The probe advanced 1.00 mm over the course of the test.

[0016] As used in this specification, hardness is the amount of force needed to deform a sample. A substance having high hardness, may be referred to as hard, and is perceived to require more bite force to deform or break, than a substance having low hardness, which may be referred to as soft. Hardness can also be measured using a texture analyzer and correlates to amount of force (g) measured during testing. The higher the measured force, the harder the sample.

[0017] Within this specification, when using a texture analyzer to measure hardness, measurements are run according to the following: Testing was done with a P/2 2 mm cylindrical stainless steel probe. The probe had a pre-test speed of 2.00 mm/s and a test speed of 3.00 mm/s. The probe advanced 1.00 mm over the course of the test.

[0018] As used in this specification, dissolvability refers to the rate at which a substance dissolves on the tongue. A substance having high dissolvability is perceived to dissolve quickly, whereas a substance having low dissolvability is perceived to dissolve slowly, if at all, on the tongue.

[0019] As used in this specification, cake flour means one of a commercially available class of wheat flours that are bleached and are typically finer than commercially available all-purpose flours, and have a relatively low percentage, by weight of protein (around 8% versus 10%) compared to all-purpose flour.

[0020] As used in this specification unmodified, with regard to a starch or flour, means that the starch or flour is not modified in any way such as by chemical, physical, or enzymatic modification; a pregelatinized starch or flour is modified.

[0021] As used in this specification the term coating thickness is the length of the coating as measured from the inside edge of the coating to its outside edge after baking.

[0022] As used herein low protein flour refers to flours having no more than about 8% protein by weight.

[0023] As used herein the major axis of a pore is the longest straight line distance between points on the pore. The major axis may, but does not necessarily, include the center of the pore. Also, it may, but does not necessarily, run entirely within a pore.

[0024] As used herein bulk density means the coating mass divided by its volume.

[0025] As used herein pregelatinized starch is a starch that has been heated in the presence of water to break down the intermolecular bonds within the starch granule.

[0026] Methods for pregelatinizing starch are known within the industry are described in this specification.

[0027] Unless otherwise specified all percentages are weight percentages.

[0028] Starch can be pregelatinized by various means including spray cooking, drum drying, extrusion, or chemical means. In preferred embodiments the starch is drum dried. In a drum-drying process, raw starch is dried at relatively low temperatures over rotating, high-capacity drums that produce sheets of drum-dried product. There are two common types of drum dryers, the single drum dryer and the double drum dryer. In the typical single drum process starch slurry (30-40% solids w/w) is fed directly between the applicator roll and the heated drum. In the double drum process, the slurry is fed onto the heated surfaces at the gap position between the two drums. The cooked and dried starch film is removed from the drum surfaces by using a blade and ground to the desirable particle size. The amounts of starch solids, speed of rotation, temperature of the drum, and time on the drum heat transfer characteristics, surface area of the drum and condensate removal in the drum can all affect the amount of pregelatinization

[0029] In embodiments the starch can be drum dried at temperatures between 50° and 150° C, at a rotation of between 15 and 30 rpm, for a time between 15 and 30 minutes.

[0030] The disclosed starch dry mix coatings use a first component being a pregelatinized waxy cassava starch. The coatings also comprise at least one second component. The second component, which may be starch or flour, and may or may not be modified. Illustrative modifications to starches include etherification, esterification, crosslinking, dextrinization, shear, pregelatinization, thermal annealing, thermal inhibition, heat moisture treatments, acid conversions, oxidation, enzymatic conversion, etc. In embodiments the second component is wheat flour, or other gluten containing flour. In embodiments the wheat flour is cake flour or other low protein flour. The first and second components are mixed in a ratio of between 3:1 and 1:3, and all ratios in between. In other embodiments the first and second components are mixed in ratios of between 3:2 and 2:3, in embodiments between 55:45 and 45:55, and in embodiments 1:1. In other embodiments the second component is a gluten free starch or flour.

[0031] The starch and flour are mixed together. Additional ingredients may be added to the mix as desired such as chemical leavening agents like bicarbonate salts, for example sodium bicarbonate, and ammonium bicarbonate. Such leavening agents may also contain acid salts such as calcium phosphate, ammonium sulfate, or sodium sulfate. They may also contain tartaric acid. Such leavening agents will typically be used in an amount ranging from about 0.1% to about 1% by weight of the coating composition. Coatings may also include sugar in amount of from about 10% to about 40% of the dry mix. The dry mix may also use other seasoning and flavorings commonly used in the snack foods including but not limited to salt (NaCl).

[0032] In embodiments the coating contains no leavening agent.

[0033] The dry mix coating is applied to a foodstuff substrate with an adhesion liquid such as water, or syrup made from sugar, gums, modified starches (such as those listed above) and starch derivatives, maltodextrins and the like. Preferred syrups include simple syrups comprising sugar and water. Sugar can be dissolved in water in a weight ratio of between about 1:4 sugar to water to about 4:1 sugar to water and all ratios in between (for example between about 1:3 and 3:1 or between about 1:2 and 2:1). In an embodiment the sugar to water ratio is about 1:1. If modified starch or gum is added to the syrup it may be added in amounts of from about 1% to about 25% of the syrup, although more typically less than about 20%, and in other embodiments less than about 15%, and in other embodiments around about 10%. In embodiments water will be the predominant component in syrup using sugar, water, and starch or gum – that is the syrup will

comprise at least about 50% water. Sugar is used in amounts of less than about 50% (that is between about 1% and about 50%) but typically the coating will have been about 25% and about 50% sugar, in embodiments between about 30% and about 45%, in other embodiments about 35% sugar. In an embodiment the syrup comprises about 55% water about 35% sugar, and about 10% modified starch. The syrup may also include other water soluble components such as salt or chemical leavening agents of the types described above.

[0034] A pan coater may be used to coat the peanuts with adhesion liquid and starch coating. This allows for application of alternate coats of adhesion liquid and starch mix. The coater applies substantially uniform coatings to the substrate. The substrate may be coated more than once, by alternately coating it with adhesion liquid and coating mix. Embodiments use more than one coating, others use 5 or more and others 10 or more. In embodiments coatings having 11 layers weigh about 70 g and about 80 g.

[0035] Coated food stuffs are baked in any type of industrial oven such as conventional ovens, fluidized bed reactors and driers, mixers and blenders equipped with heating devices, and other types of heaters. Food stuffs are baked at temperatures between about 130° C and about 190° C. In embodiments between about 150° C and about 180° C, and in other embodiments around about 170° C. Food stuffs are baked for between about 10 and about 60 minutes more typically between about 20 and about 30 minutes, and more typically about 25 minutes. In embodiments the coated food stuff is baked for 22 minutes.

[0036] In embodiments the baked coating has a more uniform coating matrix than coatings made from other waxy starches as measured by the percentage of the coating's bulk volume that is made up of pores whose major axis is less than 300 microns. In embodiments more than about 50% of the bulk volume is made of pores whose major axis is less than about 300 microns. In embodiments between about 50% and about 75% of coating's volume is made of pores having a major axis of less than about 300 microns. In embodiments that percentage is between about 60% and about 70%, in embodiments the percentage is about 65%.

[0037] In embodiments the baked coating has higher expansion per amount of starch used as measured by the coating's bulk density (weight/volume). In embodiments the bulk density is between about 0.15 and about 0.25 g/ml. In embodiments about 0.18 and about 0.23 g/ml, in embodiments about 0.22 g/ml.

[0038] In embodiments coatings having 11 layers expand to between 4000 and 6000 microns.

[0039] In embodiments the coating has low fracturability; in other words, the coating is perceived to crumble, and not shatter. While not being bound by theory it is believed the low fracturability results from the uniformity of the coating matrix.

[0040] With reference now to Figures 2a and 2b, which depict PCA maps of various sensory attributes, Figure 2a (95% data capture from 3D sensory data into the 2D plot) depicts results for an illustrative coated peanut made with an adhesion liquid comprising ammonium bicarbonate, and Figure 2b (96% data capture from 3D sensory data not the 2D plot) depicts results for an illustrative coated peanut made with an adhesion liquid that does not include a leavening agent. The attributes are grouped along the perimeter of the map with points closest to the attribute being higher in the attribute. As shown, the fracturability, density, volume of sound during bite, pitch of sound during bite, dissolvability (how the coating dissolves on the tongue), and hardness were evaluated. Also as shown, coatings made from waxy tapioca had the highest dissolvability but were lower in all other measured attributes than coatings made from other pregelatinized waxy starches.

[0041] Fracturability also correlates to the number of force peaks developed as the probe passes through the samples. A surface with higher fracturability will register fewer force peaks and one with lower fracturability will exhibit more force peaks. As shown in Figure 3 peanut coatings made using drum dried waxy cassava had more peaks than coatings made from other base starches. In embodiments coatings have greater than about 4.5 peaks, measured by the process describe below, in embodiments between about 4.5 and about 5.5 peaks, in embodiments between about 4.7 and about 5.2 peaks, in embodiments between about 4.9 and about 5.1 peaks.

[0042] Hardness, can also be measured by texture analyzer and relates to the amount of force needed to break a sample. The more force needed to advance the probe through the sample, the harder the substance. As shown in Figure 4, peanut coatings made using drum dried waxy cassava were softer than coatings made from other base starches. In embodiments the coatings have a hardness of between 500 g and 850 g, and all ranges and amounts between. In illustrative embodiments the maximum hardness is less than 800 g, in other embodiments less than 750 g. In embodiments it is less than 700 g, in embodiments less than 600 g, and in embodiments about 550 g.

[0043] Although some examples are specifically described as peanut coatings, the invention is not so limited. As the coating may be converted to a mix to make other snack foods commonly using starch such as crackers or manufactured potato chips.

[0044] Illustrative recipes using for making a cracker also use a mixture of low protein flour and pregelatinized waxy cassava starch, although typically will use more flour than starch. For example recipes may use up to about 9 parts flour to 1 part starch, although more common recipes will use 5 and 6 parts flour to 1 part starch. Additional embodiments may use less flour relative to starch including mixtures that use more waxy cassava starch than flour, for example in a 1:9 ratio flour to starch (and all ratio in between those disclosed above). Crackers also typically require the addition of fat and liquids. The fat may be a vegetable or oil, or shortening, and the liquid may include water and liquid sweeteners such as high fructose corn syrup. Crackers may also use one or more leavening agents such as monocalcium phosphate or sodium bicarbonate, flavors such as sucrose, or other sweetener including rebaudioside M or other rebaudioside, or allulose, and may include salt. An illustrative recipe is provide in Table 1

Table 1

Ingredient	True %	150 lbs batch size
Part A		
Wheat Flour (weak)	54.48	81.7
Specialty Starch	10.65	16.0
Sucrose	4.59	6.9
Monocalcium Phosphate	0.84	1.3
Sodium Bicarbonate	0.84	1.3
Salt	0.42	0.6
Part B		
Shortening	7.93	11.9
Part C		
Water	18.16	27.2
HFCS 42	2.09	3.1

TOTAL	100	150
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[0045] Illustrative recipes for making manufactured potato chips include potato flakes, or some other potato sourced material containing potato starch in place of the flour. The recipe will typically use more potato material than starch, typically in amounts between 3:1 potato to cassava, or in other embodiments in amounts of between 2:1 or even amounts close 1:1. An illustrative recipe is provided in Table 2.

Ingredients	Formula 3
Potato Flakes	45.74
Specialty Pre-gelatinized Starch ¹	23.07
Monocalcium Phosphate (leavening)	0.41
Water	25.00
Sugar	4.61
Salt	0.76
Sodium Bicarbonate (leavening)	0.41
TOTAL	100

[0046] The uniform matrix and high expansion seen with food coatings is also observed in snack crackers. The high expansion is also useful in manufactured potato chips because it can eliminate the need for corn starch, which tends to make the chips weaker and more prone to breakage.

[0047] With specific reference to use of mixes for coatings, any foodstuff may be used as substrate for the coating. Non-exclusive examples include nuts (e.g. including almonds, cashews, etc.), seeds (e.g. sunflower seeds, fennel seeds, pumpkin seeds, etc.), legumes or pulses (e.g. peanuts, peas, chickpeas, etc.), vegetables or any other foodstuff appropriate for coating. In embodiments the food stuff is dried, has a native moisture level, or is of a composition so that little moisture transfers from the foodstuff to the coating prior to or during baking. Typically such foodstuffs are fully cooked before coating and baking, and have moisture content of less than about 5%.

[0048] Although the embodiments specifically discussed in this application use wheat flour as the second component the invention is not so limited. The pregelatinized waxy tapioca starch may be mixed with starch or flour from oats, sago, corn, tapioca, pea or other pulse flours,

barley, amaranth, arrowroot, canna, quinoa and sorghum, and waxy (i.e. low amylose), and high amylose variant of the above starch sources. The second starch or flour is preferably not pregelatinized, and more preferably is not modified in any way. In other embodiments the starch or flour of the second component may be modified using standard modifications such as etherification, esterification, cross linking, conversion, annealing, heat moisture treatment, thermal inhibition, and the like. In embodiments the second starch is a gluten free starch. The second component may also be a mixture of the starches, for example a mixture of rice and wheat starch.

[0049] Although the embodiments specifically discussed in this application are baked, the invention includes fried coatings. Foodstuffs using fried coatings may be made similarly to those described above. Namely the coating mix is adhered to the substrate using an adhesion liquid. The foodstuff may be coated multiple times. The coated foodstuff is then fried in hot oil, or fat, or frying liquid according to times and methods known in the art. In illustrative embodiments the frying liquid will be heated to between around 300° and 400° C. The food stuff will be fried between 1 and 20 minutes, more typically between 5 and 10 minutes.

[0050] The above disclosed ranges include all sub-ranges within the larger range whether expressly said or not.

[0051] Within this specification reference to grams (g) as a measure of force means gram-force (gf). For intended uses the two units are taken to have equivalent magnitude such that one gram of mass is equal to one gram-force of force.

[0052] Certain aspects of the present invention are further described by way of the following examples, which are provided as illustrations and should not be construed to limit the scope of the invention in any way. Persons of ordinary skill in the art will recognize that routine modifications may be made to the methods and materials used in the examples, which would still fall within the spirit and scope of the present invention.

PROCEDURAL

[0053] Data for sensory analysis is obtained by trained panelists; there were 12 panelists for set A (using ammonium bicarbonate) and 15 panelists for set B (no leavening agent). In general panelists are screened on a series of sensitivity tests to gauge sensory acuity. Once qualified they

are trained and are subject to routine performance checks. Specifically panelists are evaluated on their ability to differentiate the product attributes being evaluated, their ability to provide similar results for the same product over multiple evaluations, and how far their evaluation differs from the panel consensus.

[0054] With regard to the specific attributes evaluated for the peanut coatings, panelists had several practice sessions prior to the actual evaluation, to assist in defining distinguishable attributes. After the attributes to be evaluated were defined, panelists were subject to standardized control samples using similar commercial products (peanut crackers) to ensure familiarity of the attributes to be evaluated and to calibrate measurements of those attributes.

[0055] The six attributes are measured as follows:

- Hardness is evaluated as the force required to deform the product. Results are averaged over multiple samples.
- Volume is evaluated on first bite and is measured as the volume of the noise generated upon compression of the sample.
- Pitch is evaluated on the first bite and is measured as the pitch of the noise generated upon compression of the sample.
- Denseness is evaluated on the first bite. It measures the perceived compactness of the foodstuff, on a scale running between airy (low perceived denseness) and dense (high perceived denseness).
- Fracturability is measured on the first bite. Low fracturability is perceived as crumbling, whereas high fracturability is perceived as shattering.
- Dissolvability is measured at the rate at which sample dissolves during chew down.

[0056] The data sets for the sensory attributes were generated by testing according to a 15-point scale. All samples were labelled with a randomized code and were presented to the panelists at the same time. Panelists cleansed their palate before and during evaluations with water, and were given a two-minute break between products to rest their palates. Data was entered by panelists directly into a computer running Compusense[®] software, which was used to

collect the data. The texture map was generated via Principal Component Analysis (PCA) of the data.

[0057] Pore size measurements: Pores were measured by preparing samples for SEM analysis. Coatings were split using a thin blade. Samples were coated with gold for six minutes (10kV). Images were taken at 15x, 25x, 50x, and 100x magnifications. Figure 1 shows the SEM image of a coated peanut using low amylose waxy tapioca starch coating at 15x magnification. Average pore size, pore volume, and pore size distribution were calculated using ImageJ image analysis software.

[0058] Volume measurements: Coated peanut crackers, 80 pieces, were measured in a graduated cylinder via volume displacement method using glass beads with mean diameter of 1 mm.

[0059] Coating weight is the difference between the amounts of coating added to the pan coater to coat peanuts prior to coating after all coatings were applied.

[0060] Bulk density is calculated by dividing the coating weight by the coating volume.

[0061] Texture analysis was conducted as follows:

[0062] Instrument Set Up: Measurements were run on a Texture Analyzer TA.XT.plus from Stable Micro Systems. Tests were run using a P/2 2 mm cylindrical stainless steel probe. The probe had a pre-test speed of 2.00 mm/s and a test speed of 3.00 mm/s. The probe advanced 1.00 mm over the course of the test.

[0063] Measurements were taken on a text analyzer. Samples were placed with the peanut's main axis aligned to the top surface of the texture analyzer. Samples were secured to the platform by adhesive tape. Applicants took 15 measurements for each trial.

[0064] Result Analysis is as follows:

[0065] Maximum force (g) correlates to hardness with the hardest sample exhibiting the highest force peak. Fracturability correlates to the number of peaks observed, and is obtained by counting the number of peaks at minimum force threshold set internally to 0.25 g of force. This setting visually shows all expected peaks are counted within the Force vs Displacement profile.

Coating Process and Recipe

[0066] The coating process required preparation of the coating material, adhesion syrup and peanuts.

Peanut preparation: Raw peanuts were par-roasted at 170° C for 10 minutes. Peanuts were then selected to have an even distribution in size and shape with smooth intact skin based on visual inspection.

Adhesion syrup: The syrup is made from sugar, water and ammonium bicarbonate. The sugar, water, and ammonium bicarbonate are and then heated to 85° C to completely dissolve the sugar. The solution was then cooled in an ice bath to 25° C, and ammonium bicarbonate is added and mixed until completely dissolved.

Dry mix coating: The coating was made from equal parts cake flour and test starch, which are mixed together.

Peanut snack preparation: Equal amounts, by weight of peanuts and dry mix were weighed out. Peanuts were evenly coated with adhesion syrup, then evenly coated with a first layer of dry mix coating. The process is repeated to provide the peanuts eleven total coats of dry mix coating. The coated peanuts were baked at 170° C for 22 minutes until lightly brown in color.

[0067] The specific recipe for syrup, peanut and dry mix coating were prepared according to the recipe provided in Table 1.

Table 1

Ingredient	Percentage of part (%)	Ratio of part used
<i>Part A – Adhesion syrup</i>		1
Water	54.6	
Castor Sugar	35	
Modified starch ¹	10	
Ammonium Bicarbonate	0.4	
Total	100	
<i>Part B – Dry mix</i>		1
Cake flour	50	
Test starch	50	
Total	100	
<i>Part C- Substrate</i>		1
Half-Roasted Peanuts (with intact skin)	100	
Total	100	

¹Purity Gum[®] 40, from Ingredion Incorporated

Results

[0068] Coating volume, weight and bulk density measurements for peanuts coated with 11 layers of coating are reported in Table 2. Weights are measured in grams, volume is in milliliters, and bulk density is measured in grams per milliliter.

Table 2

		Low Cook Waxy Tapioca	High Cook Waxy Tapioca	Low Cook Waxy Potato	High Cook Waxy Potato	Low Cook Waxy Corn	High Cook Waxy Corn
Coating Weight	Reading 1	73.72	75.97	74.70	70.58	73.72	79.36
	Reading 2	73.05	73.22	73.74	69.82	73.26	78.43
	Mean	73.39	74.60	74.22	70.20	73.49	78.90
	Variance	0.33	1.38	0.48	0.38	0.23	0.47
Coating Volume	Reading 1	323.00	292.59	258.00	266.11	208.00	250.53
	Reading 2	338.49	303.95	277.93	267.16	220.00	240.71
	Mean	330.75	298.27	267.97	266.63	214.00	245.62
	Variance	7.75	5.68	9.97	0.53	6.00	4.91
Bulk Density	Reading 1	0.23	0.25	0.29	0.27	0.35	0.32
	Reading 2	0.22	0.25	0.27	0.26	0.33	0.33
	Mean	0.22	0.25	0.28	0.26	0.34	0.32
	Variance	0.01	0.00	0.01	0.00	0.01	0.00

[0069] As shown, samples made using waxy tapioca exhibited greater coating expansion per weight of coating. Weights are measured in grams, volume is in milliliters, and bulk density is measured in grams per milliliter.

[0070] Bulk density testing was also run on samples using the formulation of Table 1 but without the ammonium bicarbonate. The bulk density testing is reported in Table 3.

Table 3

Set B		Drum Dried Waxy Tapioca, Low Cook	Drum Dried Waxy Tapioca, High Cook	Drum Dried Waxy Corn, Low Cook	Drum Dried Waxy Corn, High Cook	Drum Dried Waxy Potato, Low Cook	Drum Dried Waxy Potato, High Cook	Spray Cooked Waxy Potato (Commercially Available)	Spray Cooked Agglomerated Waxy Corn (Commercially Available)	Drum Dried Waxy Corn (Commercially Available)
Coating Weight	Reading 1	82.27	80.24	78.43	77.9	79.12	84.64	74.91	78.95	80.51
	Reading 2	80.5	81.32	73.54	73.92	77.85	84.39	74.63	78.52	80.33
	Mean	81.39	80.78	75.99	75.91	78.49	84.52	74.77	78.74	80.42
	Variance	0.88	0.54	2.44	1.99	0.64	0.13	0.14	0.22	0.09
Coating Volume	Reading 1	359.816	322.25	280	279.887	311.548	300.72	230.415	207.667	287
	Reading 2	375.333	336.192	257.404	250.333	302.417	308.753	207.362	201.932	295.778
	Mean	367.57	329.22	268.70	265.11	306.98	304.74	218.89	204.80	291.39
	Variance	7.76	6.97	11.30	14.78	4.57	4.02	11.53	2.87	4.39
Bulk Density	Reading 1	0.22864	0.249	0.28011	0.27833	0.25396	0.28146	0.32511	0.38018	0.28052
	Reading 2	0.21448	0.24189	0.2857	0.29529	0.25743	0.27333	0.3599	0.38884	0.27159
	Mean	0.22	0.25	0.28	0.29	0.26	0.28	0.34	0.38	0.28
	Variance	0.01	0.00	0.00	0.01	0.00	0.00	0.02	0.00	0.00

[0071] As shown ammonium bicarbonate did not change the general trend among samples in the two tests, as waxy tapioca, regardless of cook, had lower bulk density than coatings made using other pregelatinized waxy starch.

[0072] Table 4 illustrates the difference in percentage of the coating made up of pores having a major axis less than 300 microns. All samples are drum dried. The waxy corn and waxy potato are commercially available samples.

Table 4

	Pores (volume fraction <300 μm)	Pore (volume fraction >300 μm)
Waxy Cassava	68%	30%
Waxy Corn	35%	65%
Waxy Corn	20%	80%
Waxy Potato	28%	72%

[0073] As can be seen coatings made using waxy cassava had a significantly large percentage of their matrix made up of pores having a major axis small than 300 microns.

[0074] Fracturability as represented by the number of peaks is presented in Table 5.

Table 5

Peanut Coating Fracturability	
Product Type	Avg. Number of Peaks
Drum Dry Waxy Tapioca Low Cook	4.93
Drum Dry Waxy Tapioca High Cook	4.73
Drum Dry Waxy Potato Low Cook	4.40

Drum Dry Waxy Corn Low Cook	4.07
Drum Dry Waxy Corn (Commercially Available)	4.10
Drum Dry Waxy Potato High Cook	3.87
Drum Dry Waxy Corn High Cook	3.80
Spray Cook Waxy Potato (Commercially Available)	3.13
Spray Cook Agglomerated Waxy Corn (Commercially Available)	3.07

[0075] As shown, coatings made from waxy cassava had more peaks and so lower fracturability. This is consistent with the principal component analyses depicted in Figures 2a and 2b, which also show that the coatings were perceived to have low fracturability.

[0076] Hardness is presented in table 6.

Table 6

Peanut Coating Mean Hardness	
Product Type	Avg. Force (g)
Spray Cook Waxy Potato (Commercially Available)	2985.00
Spray Cook Agglomerated Waxy Corn (Commercially Available)	2468.20
Drum Dry Waxy Potato Low Cook	1781.10
Drum Dry Waxy Potato High Cook	1398.20
Drum Dry Waxy Corn Low Cook	1175.40
Drum Dry Waxy Corn High Cook	865.70
Drum Dry Waxy Corn (Commercially Available)	860.10
Drum Dry Waxy Tapioca High Cook	708.60
Drum Dry Waxy Tapioca Low Cook	544.80

[0077] As shown, coatings made from waxy cassava had the lowest, maximum force, and so were softest. This too corresponds with the principal component analysis depicted in Figure 2a and 2b, which show that coatings made from waxy cassava were the softest.

CLAIMS

What is claimed is:

1. A coated foodstuff comprising.
 - a) an edible substrate having a moisture content of less than about 5%; and
 - b) a coating comprising at least one layer of a mixture comprising a pregelatinized waxy cassava starch and a second component being a starch or flour in a weight ratio of between about 3:1 and about 1:3 and
 - c) an adhesion syrup;
2. The coated foodstuff of claim 1 wherein the coating is further characterized by a bulk density of between 0.15 and 0.25 g/ml.
3. The coated foodstuff of claim 1 wherein the coating is further characterized by a bulk density of between 0.18 and 0.23 g/ml.
4. The coated foodstuff of claim 1 wherein the coating is further characterized by having between 50% and 75% of its bulk volume made up of pores having a major axis shorter than 300 microns.
5. The coated foodstuff of claim 1 wherein the coating is further characterized by having between 60% and 70% of its bulk volume made up of pores having a major axis shorter than 300 microns.
6. The coating of claim 1 wherein the second component is gluten free.
7. The coated foodstuff of claim 1 wherein the second component is an unmodified wheat flour.
8. The coated foodstuff of claim 1 wherein the edible substrate is a nut, legume, or seed
9. The coated foodstuff of claim 1 wherein the edible substrate is a peanut.
- 10 The coated foodstuff of syrup of claim 1 wherein the adhesion syrup further comprising water, sugar, and at least one starch or gum.
11. The coated foodstuff of claim 1 having a structure comprising a layer of adhesion liquid applied to the edible substrate, and a layer of the coating mixture applied to the adhesion liquid.
12. The coated foodstuff of claim 1 wherein the adhesion syrup comprises at least 50% water, at least 35% sugar and at least 7.5% modified starch.

13. The coated foodstuff of claim 1 having 10 coatings the coating being further characterized by an expansion of between 4000 and 6000 microns.

14. The coated foodstuff of claim 1 wherein the coating is made by baking and wherein the coating is further characterized by a bulk density of 0.18 and 0.23 g/ml and by having between 60% and 70% of its bulk volume made up of pores having a major axis shorter than 300 microns.

15. The coated foodstuff of claim 1 wherein a test coated roasted peanut having 11 layers of coating mix, the coating mix consisting of drum dried waxy tapioca and cake flour in a 1:1 ratio the coating adhered to the peanut by an adhesions syrup consisting of about 55% water, about 35% sugar and about 10% modified starch, and the test coated peanut being baked for 22 minutes at 170° C has a coating characterized by a) a bulk density of 0.18 and 0.23 g/ml, b) having between 60% and 70% of its bulk volume made up of pores having a major axis shorter than 300 microns, and c) an expansion of between 4000 and 6000 microns.

16. The coated foodstuff of claim 1 wherein the test coated roasted peanut is further characterized by having a fracturability of between 4.5 and 5.5.

17. The coated foodstuff of claim 1 wherein the test coated roasted peanut is further characterized by a having hardness of between 850 g and 550 g.

18. The coated foodstuff of claim 1 wherein the coating, being a base coating, is further characterized by having lower fracturability and hardness than a base coating substituting another pregelatinized waxy starch for the pregelatinized waxy cassava starch.

19. The coated foodstuff of claim 19 wherein the base coating is further characterized by having a higher dissolvability than a base coating substituting another pregelatinized waxy starch for the pregelatinized waxy cassava starch.

20. A composition comprising:

a pregelatinized waxy cassava, a second starch or flour and a liquid; wherein the composition is a sheetable dough.

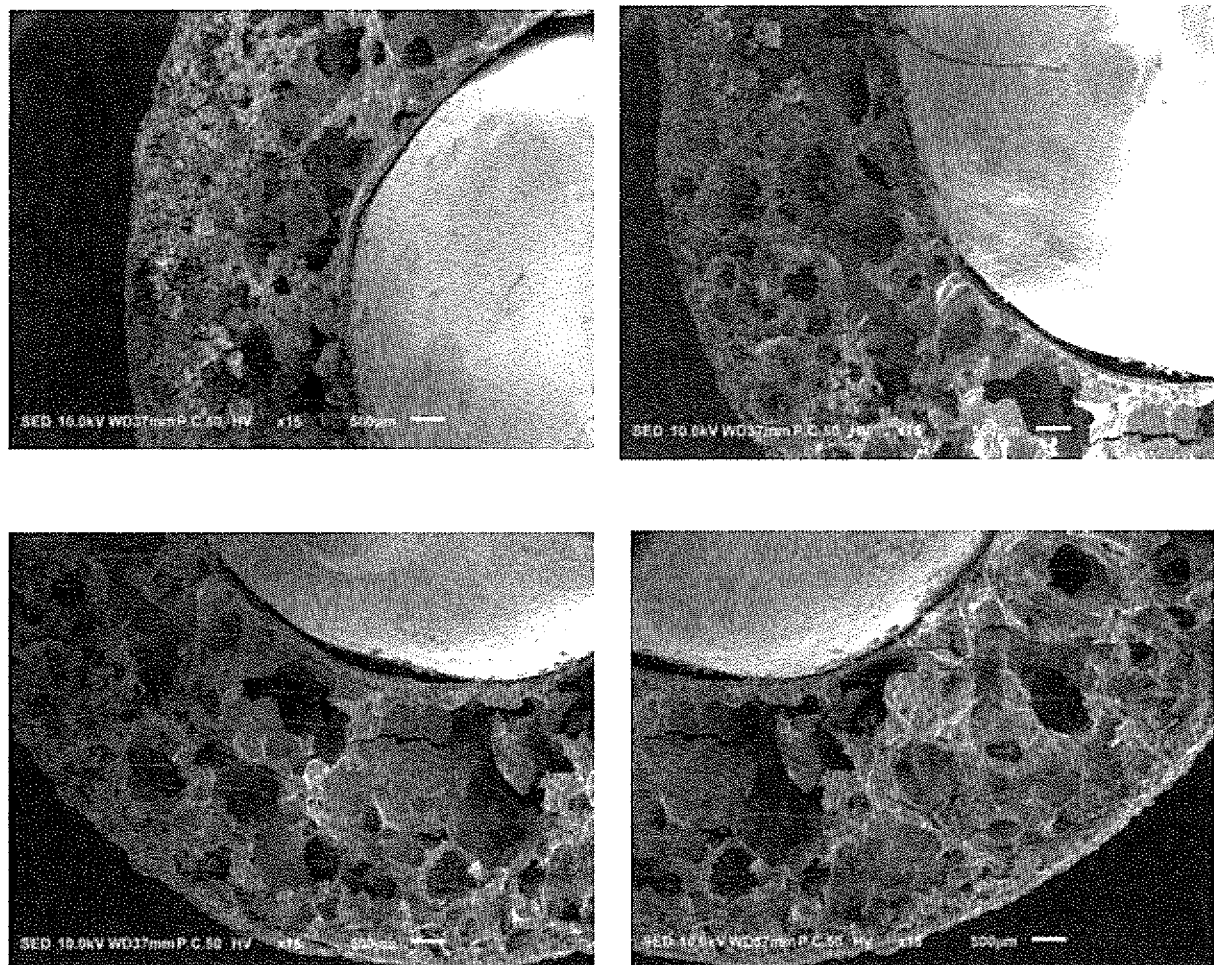


Figure 1

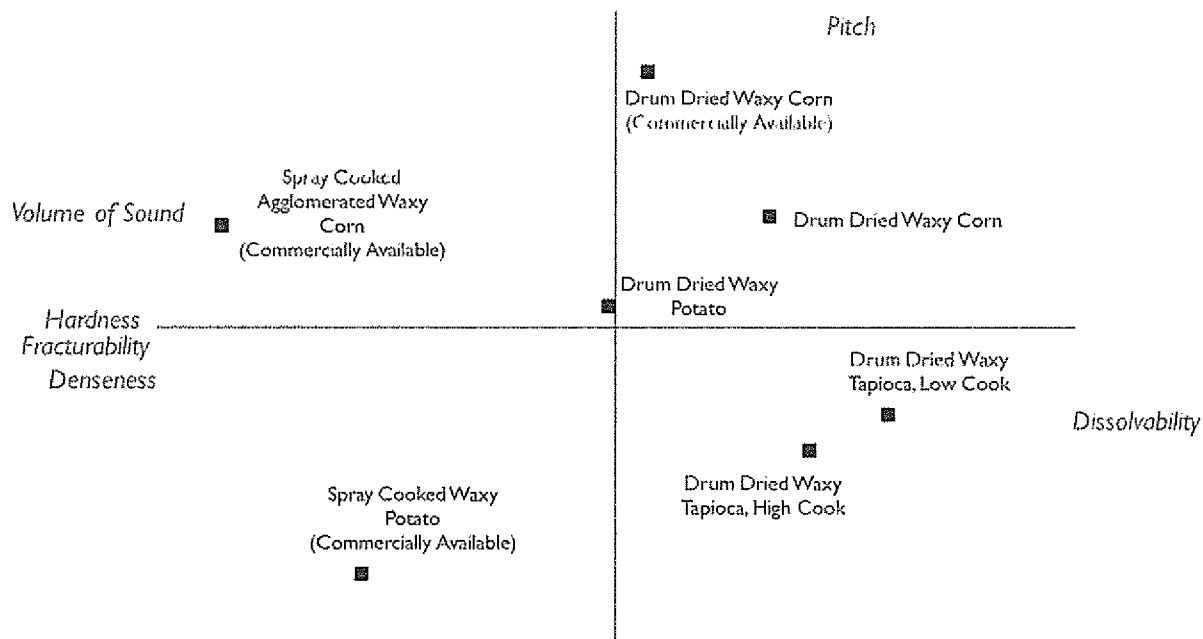


Figure 2a

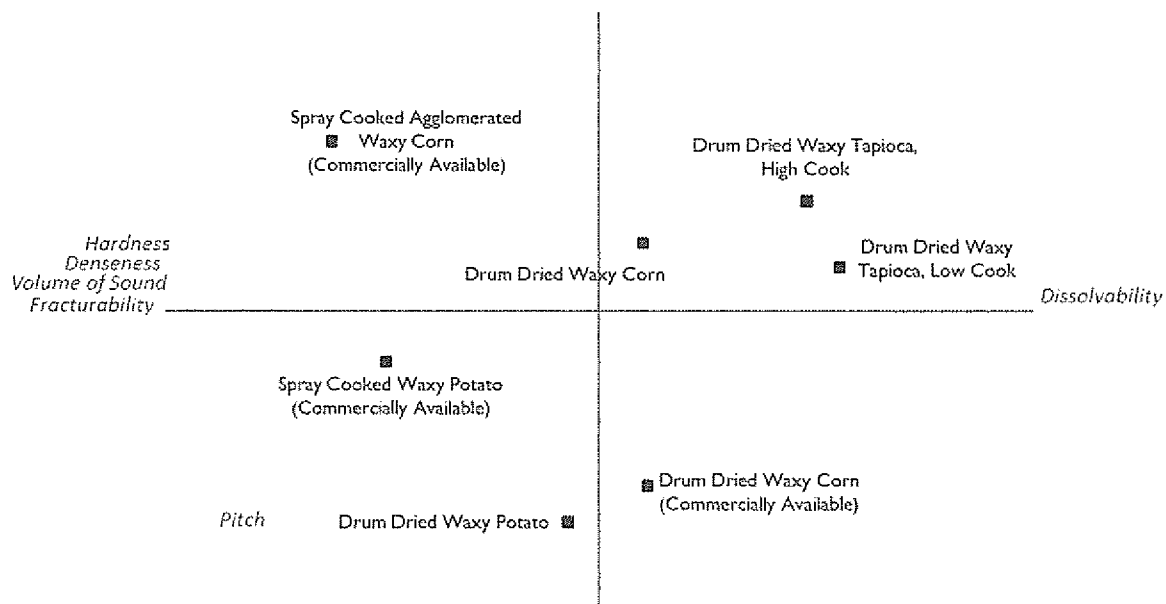


Figure 2b

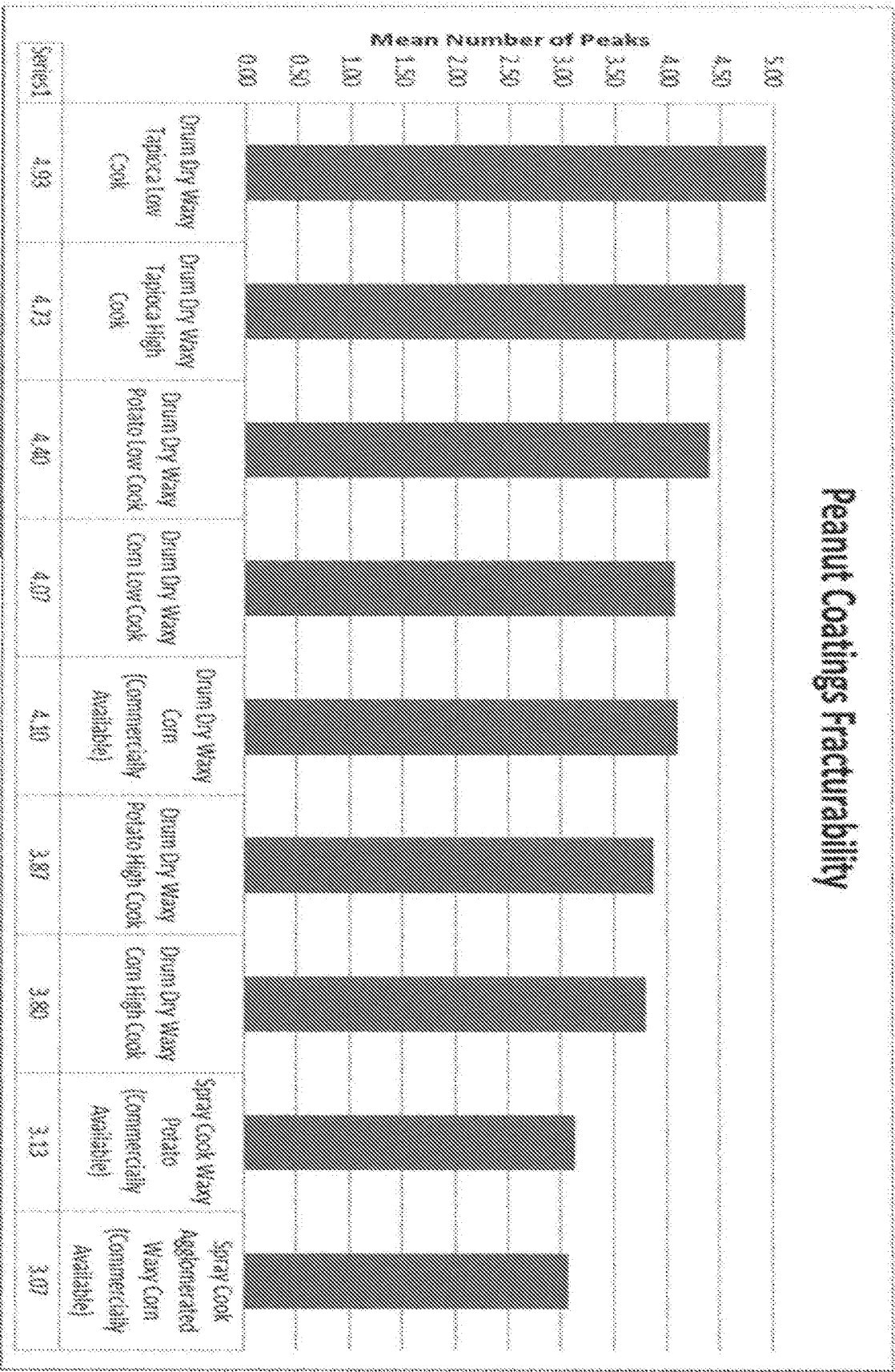


Figure 3

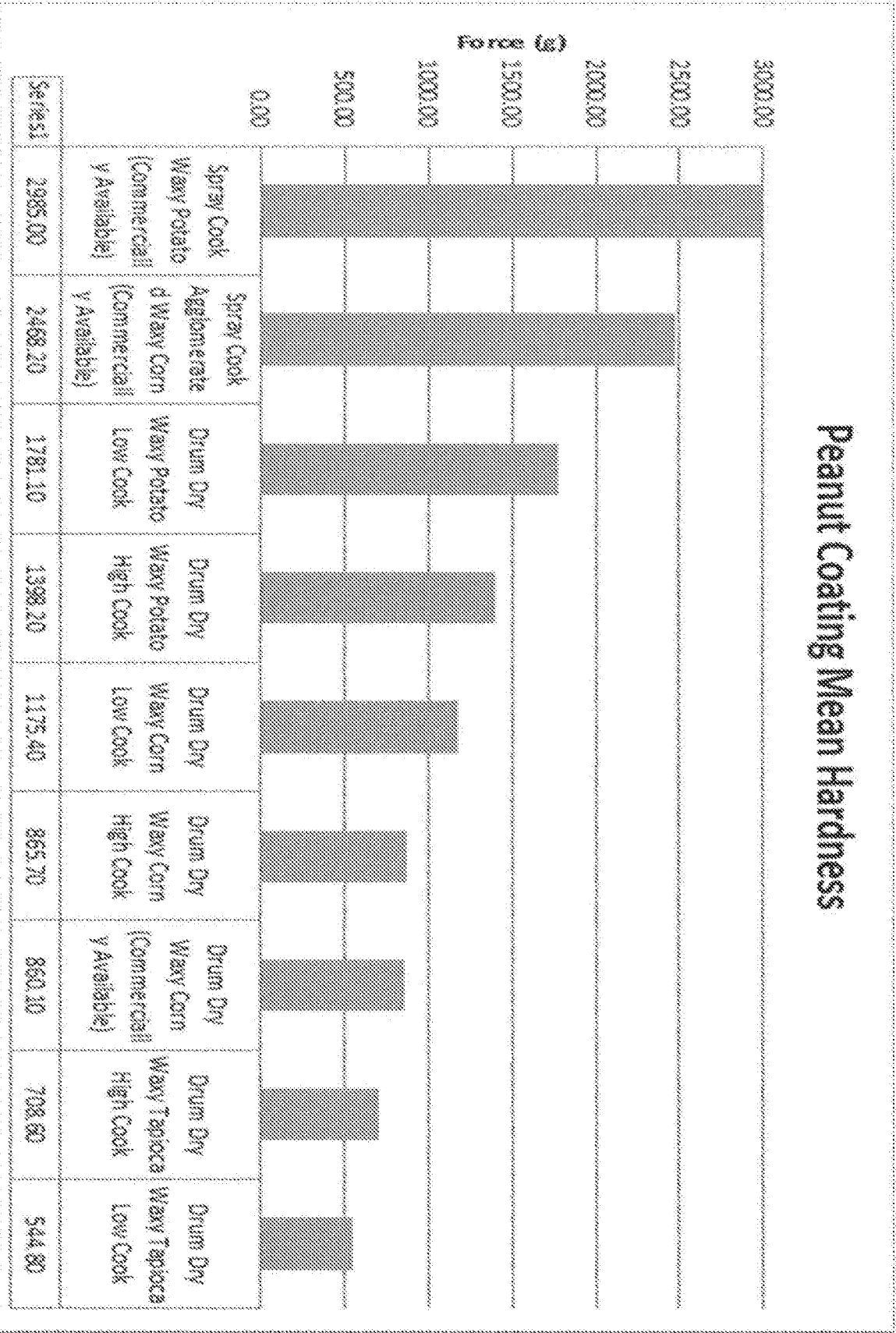


Figure 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/037071

A. CLASSIFICATION OF SUBJECT MATTER				
INV.	A23L25/00	A23L7/122	A23G3/34	A23G3/48
	A23L29/212	A23L11/00	A21D13/24	A21D13/60
	A21D10/00	A21D2/36	A21D2/18	A23P20/10
				A21D13/043
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 A23G A21D C08B A23P				
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched				
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)				
EPO-Internal, WPI Data				
C. DOCUMENTS CONSIDERED TO BE RELEVANT				
Category*	Citation of document, with indication, where appropriate, of the relevant passages			Relevant to claim No.
X	WO 2013/141854 A1 (CONAGRA FOODS RDM INC; PEREZ AGUIRRE BLANCA [MX]; JONES DONALD L [US];) 26 September 2013 (2013-09-26) paragraph [0038] - paragraph [0041]; claims 1-40			1-19
X	US 2012/288590 A1 (SOANE DAVID S [US] ET AL) 15 November 2012 (2012-11-15) paragraph [0030]; claims 1-76			1-19
A	US 2 868 647 A (VOLLINK WILLARD L) 13 January 1959 (1959-01-13) column 2, line 55 - line 56 column 3, line 1 - line 2			1-19
A	US 2010/183771 A1 (MATTSON PETER H [US] ET AL) 22 July 2010 (2010-07-22) claims 1-20			1-19
	----- -/-			
☒ 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			Date of mailing of the international search report	
5 September 2018			07/11/2018	
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 Shadid, Rania	

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2018/037071

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 2 829 182 A2 (CORN PRODUCTS DEV INC [BR]) 28 January 2015 (2015-01-28) paragraph [0003] -----	1-19
A	DATABASE WPI Week 201563 11 September 2015 (2015-09-11) Thomson Scientific, London, GB; AN 2015-54115Q XP002784396, -& WO 2015/132825 A1 (MATSUTANI CHEM IND LTD) 11 September 2015 (2015-09-11) abstract -----	1-19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2018/037071

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

1-19

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-19

A coated food stuff comprising an edible substrate with a moisture content of less than 5%, a coating comprising a layer of a mixture comprising pre-gelatinized waxy cassava starch and a second starch or flour in a ratio of 3:1-1:3 and an adhesion syrup

2. claim: 20

A sheetable dough composition comprising a pre-gelatinized waxy corn starch, a second starch or flour and a liquid.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2018/037071

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2013141854	A1	26-09-2013	NONE
US 2012288590	A1	15-11-2012	AU 2010292224 A1 08-03-2012 CA 2771343 A1 17-03-2011 CN 102612323 A 25-07-2012 EP 2475266 A1 18-07-2012 NZ 598651 A 25-10-2013 US 2012288590 A1 15-11-2012 WO 2011031841 A1 17-03-2011
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EP 2829182	A2	28-01-2015	AU 2014204533 A1 05-02-2015 CA 2857397 A1 22-01-2015 CN 104323055 A 04-02-2015 EP 2829182 A2 28-01-2015 JP 2015019666 A 02-02-2015 KR 20150011319 A 30-01-2015 NZ 627720 A 27-03-2015 US 2015025158 A1 22-01-2015
WO 2015132825	A1	11-09-2015	CN 106163287 A 23-11-2016 JP 6147688 B2 14-06-2017 JP 2015165777 A 24-09-2015 KR 20160129001 A 08-11-2016 MY 164344 A 15-12-2017 PH 12016501642 A1 06-02-2017 SG 11201607144S A 28-10-2016 WO 2015132825 A1 11-09-2015