



(51) International Patent Classification:

C12P 19/14 (2006.01) A23L 2/39 (2006.01)
A21D 13/04 (2017.01) A23L 7/104 (2016.01)

(21) International Application Number:

PCT/US2019/039153

(22) International Filing Date:

26 June 2019 (26.06.2019)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/689,971 26 June 2018 (26.06.2018) US
62/690,649 27 June 2018 (27.06.2018) US
62/767,137 14 November 2018 (14.11.2018) US

(71) Applicant: **CARGILL, INCORPORATED** [US/US];
15407 McGinty Road West, Wayzata, Minnesota 55391 (US).

(72) Inventors: **GOLDSTEIN, Avi**; 415 North 1st Street, Apartment 408, Minneapolis, Minnesota 55401 (US).
HAN, Xian-Zhong; 11901 Central Parke Way, Apartment 2436, Maple Grove, Minnesota 55369 (US). **VAMADE-VAN, Varatharajan**; 5205 Holly Lane North Unit 5, Plymouth, Minnesota 55446 (US).

(74) Agent: **JENKINS, Jihan A. R.**; 15407 McGinty Road West, Mailstop 24, 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, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, 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, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, 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, 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))

(54) Title: SOLUBLE FLOUR AND METHODS OF MANUFACTURING SAME

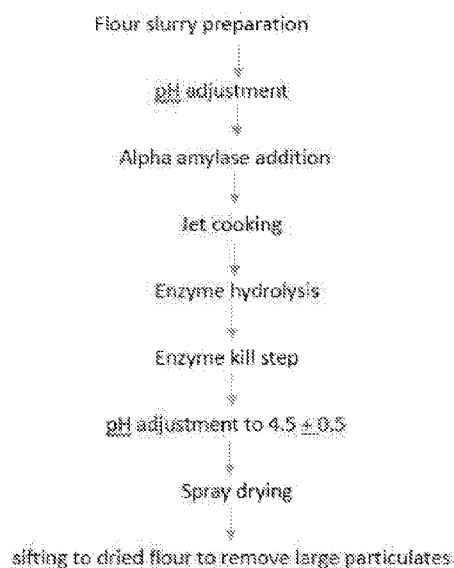


FIGURE 1

(57) Abstract: Described herein is a method of manufacturing a soluble flour comprising preparing a flour-water slurry, adjusting the pH of the slurry to a pH ranging from 3.5-6, adding an enzyme to the pH adjusted slurry in an amount ranging from 0.02-2.0 g enzyme/g flour to form a reaction mixture, cooking the reaction mixture at a temperature ranging from 60-140C until a dextrose equivalent of 5 to 18 is achieved, inactivating enzyme to obtain a soluble flour; and adjusting pH of the soluble flour to range from 4-5. The soluble flour obtained has a dextrose equivalent value ranging from 5 to 18, a solubility greater than 50% (at 5% solids), and a viscosity between 0.001 and 1.0 Pa* at temperatures ranging from 20-50C (at 10% solids).



WO 2020/006030 A1

SOLUBLE FLOUR AND METHODS OF MANUFACTURING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application 62/689,971, filed June 26, 2018, U.S. Provisional Application 62/690,649, filed June 27, 2018 and U.S. Provisional Application 62/767,137, filed November 14, 2018, which are hereby incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] This application relates to soluble flour compositions and methods of manufacturing the same.

BACKGROUND

[0003] Consumers are asking for label friendly alternatives to maltodextrin in food and beverage applications. While there is a desire to create label-friendly alternatives, there is also a desire for such alternatives to have similar functionality as that of maltodextrin.

SUMMARY

[0004] Described herein is a method of manufacturing a soluble flour comprising preparing a flour-water slurry, adjusting the pH of the slurry to a pH ranging from 3.5-6.0, adding an enzyme to the pH adjusted slurry in an amount ranging from 0.02-0.1 % enzyme relative to weight of the flour to form a reaction mixture, cooking the reaction mixture at a temperature ranging from 60-140C until a dextrose equivalent of 5 to 18 is achieved, inactivating enzyme to obtain a soluble flour; and adjusting pH of the soluble flour to range from 3-6. The soluble flour obtained has a dextrose equivalent value ranging from 5 to 18, a solubility greater than 50% (at 5% solids), and a viscosity between 0.001 and 1.0 Pa*s at temperatures ranging from 20-50C (at 10% solids).

FIGURES

[0005] Figure 1 illustrates the process of manufacturing the soluble flour as described herein.

[0006] Figure 2 graphically illustrates viscosities of the soluble flour as described herein in water (10 wt% soluble flour concentration).

[0007] Figure 3 graphically illustrates the particle size distribution of soluble cassava flour.

[0008] Figure 4 graphically illustrates the particle size distribution of soluble rice flour.

DETAILED DESCRIPTION

[0009] Described herein is a method of manufacturing a soluble flour that can be used in food and beverage applications as a maltodextrin replacement. As used herein, the term “soluble” flour also includes hydrolyzed, enzymatically treated, enzymatically-modified, and/or solubilized flour. Such soluble flour has been treated to promote greater solubility of their principle components in liquids such as water. Further, such soluble flour demonstrates similar functionality as that of maltodextrin, has a desirable “clean flavor”, mouthfeel, and texture suitable for food and beverage applications. An illustration of the general process can be found in Figure 1. As used herein, the term “soluble” is referencing solubility of flour components in water. As used herein, the term “flour” encompasses (1) non-grain flours and (2) fractionated, non-whole grain flours wherein a portion of bran and germ have been removed.

[0010] A first step in the process is the preparing of a slurry made up of flour and water. The flour can be of many sources, for example but not limited to, non-grain sources such as root or tuber sources, and more specifically potato, cassava, sweet potato, taro, yam, arrowroot, lotus root, shoti, Kudzu, banana, waxy cassava, waxy tapioca, or grain flours such as rice, waxy cereal flours, normal cereal flours, or high amylose cereal flours. Sugary-1 mutant flours, and flours containing phytoglycogen can also be used. Flours used as starting materials inherently have low levels of solubility in water.

[0011] In preferred aspects, the flour is either cassava flour or rice flour. The slurry comprises about 15 wt% to 30 wt% of the flour, and in more preferred aspects comprises about 20 wt% to 40 wt% flour. In preferred aspects, the slurry is agitated by an agitation means to prevent settling of the flour solids.

[0012] The slurry is then pH adjusted to a desirable pH ranging from about 3.5 to 6.0. In preferred aspects from 4.5 to 5.5, in more preferred aspects from 4.7 to 5.3, and in most

preferred aspects from 4.8 to 5.2. The pH can be adjusted using acid solutions such as hydrochloric acid.

[0013] Once the pH of the slurry is adjusted to fall within the desired range, an enzyme is then added to the slurry. In preferred aspects, the enzyme is an alpha-amylase enzyme, however other bacterial or fungal enzymes may also be used, for example but not limited to iso-, gluco-, beta-, pullulanase, and/or alpha enzymes, and/or combinations thereof. In preferred aspects, the alpha-amylase is a thermal stable alpha-amylase. In preferred aspects, the enzyme is added in an amount ranging from 0.02-2 % enzyme relative to weight of the flour, 0.02-0.1 % enzyme relative to weight of the flour, and more preferably from 0.045-0.085 % enzyme relative to weight of the flour, to form a reaction mixture. The enzyme and slurry make up the reaction mixture. The reaction mixture can be treated at a temperature ranging from 60C to 140 C, preferably 85 C to 140 C, more preferably 90 C to 100 C, such treatment promotes gelatinization and further solubilization. The reaction mixture is treated until a dextrose equivalent (“DE”) of between 5 and 18 is achieved. In preferred aspects, the cooking would take place until a DE of between 8 and 12 is achieved. Preferably, a jet cooker is used to facilitate the reaction. Once the reaction is complete and the desired DE is achieved, the enzyme is inactivated utilizing common methods such as the addition of acid or heat, and a soluble flour is obtained. The soluble flour is cooled to a temperature ranging from 50 C to 60 C and the pH of the soluble flour is adjusted to a range from about 3 to about 6. The pH can be adjusted using base solutions such as sodium hydroxide. The soluble flour can undergo additional processing, for example spray drying and sifting.

[0014] The obtained soluble flour has a solubility ranging from 50% to 100%, (measured at 5% soluble flour concentration also referred to as “5% solids”), and more preferably a solubility ranging from 75% to 85%, and a DE value ranging from 5 to 18 and more preferably a DE value ranging from 8 to 12. The soluble flour also demonstrates desirable viscosity characteristics in water (10 wt% soluble flour concentration also referred to as “10% solids”) ranging from 0.001 and 1 Pa*s. In preferred aspects, the soluble flour has a viscosity ranging from 0.001 and 0.01 Pa*s at temperatures ranging from 20 – 50 C as shown in Figure 2. In some aspects, the viscosity characteristics of the soluble flour in water ranges from 0.001 to 0.1 Pa*s.

[0015] The soluble flour – water sample was made using an overhead propeller mixer to dissolve soluble solids at 8000 rpm and were tested using an Anton Paar MCR 502 rheometer couette geometry at 20 s⁻¹ of shear rate. The soluble flour also has desirable

molecular weight distribution profiles and polydispersity characteristics. Solubility of flours were determined by thoroughly mixing soluble flours in water (5% solids), filtering the sample mixture through filter paper, and determining %Brix of the filtrate using a DR301-95 Digital Refractometer (Kruss GmbH, Hamburg, Germany). In order to determine solubility from the experimentally determined %Brix, one must complete a calculation accounting for the percent of total solids initially added to the system. The DE values of spray dried soluble flours was achieved by quantifying the amount of reducing sugars by Schoolr's method analysis.

[0016] In preferred aspects, the soluble flour has a protein content ranging from 0 to 10 wt%, from 0.01 to 10 wt%, and from 0.1 to 10 wt%. In preferred aspects, the soluble flour has a dietary fiber content ranging from 0.5 to 15 wt%.

[0017] The soluble flour as described herein is desirable for use in food applications. Notable food applications include but are not limited to beverages, beverage mixes, infant food, medicinal products, food emulsions, convenience foods, bakery, dairy, and snack-based fillings or food products. Beverages and beverage mixes can include instant mixes for hot or cold beverages, flavored milk including chocolate milk, carbonated soft drinks, fruit juices, sports beverages, nutrition beverages, and infant formula. Dairy can include ice cream, yogurt, sour cream, whip cream, and non-dairy vegan alternatives. Convenience foods include but are not limited to salad dressings (pourable and spoonable), sauces (instant and prepare), condiments, puddings, bars, cereals, coatings for cereal, spreads, low-fat spreads, icings, hard candies, soft candies, gummy products, and dry mix seasonings. Bakery can include cookies, cakes, muffins, crackers, pastries, and laminated baked products.

[0018] The soluble flour as described herein can be used as at least a partial replacement of maltodextrin in food applications and in many cases can be used as a full replacement of maltodextrin in food applications. Such soluble flower can be an effective maltodextrin replacement in any food application in which maltodextrins are currently used. The soluble flour demonstrates similar functionality (e.g., pH, solubility, and viscosity) as maltodextrin making it a suitable replacement for maltodextrin in food applications. Such replacement allows for consumer-friendly labelling as soluble flours may be more well received by some consumers as compared to maltodextrin.

[0019] Further, such soluble flour additionally has the capability to replace maltodextrins in flavor encapsulation applications wherein a flavor emulsion is created and spray dried, to convert a liquid flavor into a solid. In these applications maltodextrins may be used alongside a lipophilic starch, or alternately used alone to create a flavor emulsion.

Maltodextrins are typically used in this space due to their ability to form matrices that positively contribute to encapsulation. The soluble flour described herein can replace maltodextrins in this space due to their bland flavor, low viscosity, and low cost. Additionally, soluble flours can replace maltodextrin in plating oil-based flavors.

[0020] In preferred aspects, the soluble flour as described herein can be used for instant sauces (e.g., dry mix that is reconstituted to a sauce form by the consumer), prepared sauces, dry mix seasoning, and flavor encapsulation. Such soluble flours can be added in varying amounts and consistently demonstrate similar taste and functionality as maltodextrin.

EXAMPLES

Example #1: Manufacturing process to prepare soluble flour

[0021] In a mixing tank, prepare 25% (w/w flour solids) flour slurry in water using 10 Kg flour (wet basis). Table 1 provides information on starting corn maltodextrin, cassava flour, and rice flour materials. Maintain slurry at ambient temperature. Adjust speed of mixing to prevent settling of flour solids.

Table 1

Maltodextrin	Cargill "Dry MD" 01909 common corn 10 DE maltodextrin
Cassava Flour	Premium Cassava Flour (American Key Food Products, Closter, New Jersey, USA)
Rice Flour	Medium/Short Grain White Rice Flour Fine-7011 (PGP International, Woodland, California, USA)

[0022] The pH of the slurry in the tank is adjusted to pH of 4.8 - 5.2 using 1:1 HCl acid solution. After pH adjustment, continue mixing of the slurry at a gentle speed. Then weigh the required quantity of a thermal-stable alpha amylase enzyme (0.045-0.085 % enzyme relative to weight of the flour) and add enzyme into the slurry. After 5 minutes of adding enzyme, check the pH to confirm it is within the range of 4.8-5.2 and record

temperature of the slurry once again. Ideal product temperature is between 15-25°C.

Continue mixing.

[0023] Using water as the feed for the jet cooker, prepare jet cooker and equilibrate the cooking temperature between 110-117°C and outlet temperature of 95°C (atmospheric flash in product tank). Once the cooking conditions are set, start feeding the flour slurry into the jet cooker. Record this time as time 0 by starting a stop watch. Keep the stop watch running until the completion of the liquefacts hold and enzyme kill steps to record total liquefaction time. Continue mixing of the slurry while the slurry is being pumped through jet cooker. Keep an eye for the liquefact when it starts to come out of the jet-cooker output. Carefully record this time as the residence time of liquefacts in jet cooker piping. Record this time as "First Liquefaction time". Collect liquefact into product tank which is equipped with overhead mixer and temperature control up to 95°C.

[0024] Hold liquefacts in product tank at 95°C for a desired holding time that corresponds to a DE (extent of hydrolysis) value desired in final products (typically targeting a DE between 8 and 12). To increase the rate of reaction, additional alpha amylase can be added at this point (0.025-0.035 % enzyme relative to weight of the flour). Continue mixing the liquefacts at a slow speed to avoid splashing of hot liquid.

[0025] Soon after completion of desired holding times, adjust pH to 2.7 - 3 at 95°C and hold for 15 minutes. Continue mixing the liquefacts at a slow speed to avoid splashing of hot liquid. For ensure complete inactivation of enzyme, accurately control temperature and holding time of 15 minutes.

[0026] Soon after completion of enzyme kill step, turn off heating by adjusting the steam value and let the slurry cool down to 55-60°C (use cooling water circulation if needed). Continue mixing of liquefacts at a slow speed to avoid splashing of hot liquid. Adjust pH to 4.5 ± 0.5 in liquefacts using NaOH base solution.

[0027] Ensure liquefact prepared by jet cooker is stored in product tank at 50-65°C while continuously stirring the contents at slow speed to prevent stratification. Transfer approximately 8-10 L of hot liquefact (at 65-75°C) from product tank to a 5 gallon white plastic pail. Immerse this plastic pail into a 60°C water bath. Set an overhead mixer to continuously mix the contents in the pail at a slow speed. Record % solids in the liquefact using moisture meter. As needed, adjust % solids in liquefact to lower level using sanitized water to ensure optimum spray drying operation. Feed deionized water into the spray dryer to equilibrate the inlet temperature of the dryer to approximately 200°C and the outlet temperature to approximately 100°C. Switch the feed from water to liquefaction. Monitor

both the inlet and outlet temperatures. Record feed rate, inlet and outlet temperatures of spray dryer. Collect dried product, and store in air tight packaging. Record the final weight and % moisture of the dried hydrolyzed flour product.

[0028] Sift dried soluble flour product through a 425 micron (μm) screen to remove any large particulates, or which may have been formed during the drying process.

[0029] Table 2 provides solubility (measured at 5% solids) and DE data of the soluble flours, Table 3 provides the molecular weight distribution of the soluble flours, and Table 4 provides information on composition per 100g of final soluble flour product. Note the data in Table 3 represents the mass distribution of the soluble component within the flour products. Molar mass was determined using the SEC MALS RI method described in Example #5. Figures 3 and 4 show the particle size distribution of soluble cassava flour and rice flour, respectively.

Table 2

Sample	Solubility (%)	DE
Cargill Dry MD 01909	100	10
Soluble Rice Flour	81	8.3
Soluble Cassava Flour	81	11.5

Table 3

DP	Molar Mass (Da)	Soluble Cassava Flour	Soluble Rice Flour	Cargill Dry MD 01909
1 -> 5	0-909	0	0	10
6 -> 9	909-1557	0	0	13.13
10 -> 19	1557-3177	0	14	17.95
20 -> 45	3177-7389	0	9	6.55
46 -> 125	7389-20349	8	20	9.26
126 -> 280	20349-45459	65	21	13.66
281 -> 600	45459-97299	16	15	11.76
601 -> 1500	97299-243828	7	12	11.07
> 1500	> 243828	3	9	6.61
	DE	10	8	11.5
	Mn (kDa)	31	9	2.5
	Mw (kDa)	59	78	59
	Polydispersity (Mw/Mn)	1.9	8.6	23
	rh(v)z (nm)	8	9	<10

Table 4: Approximate Composition per 100 g final product

Ingredient	Carbohydrate (wt%)	Fat (wt%)	Dietary Fiber (wt%)	Protein (wt%)	Ash (wt%)
Cargill 01909 (common corn 10 DE maltodextrin)	95	0.01	0	0	0.01
Soluble Cassava Flour-Final product	81	<0.5	10.8	1.5	1.26
Soluble Rice flour-final product	82	0.8	0.9	6.8	0.8

Example #2: Soluble Flours in Chocolate Milk Mix

[0030] Soluble cassava flour and soluble rice flour were compared to a control made with 10 DE maltodextrin (prepared as described in Example #1) in chocolate milk mix. The formulation of the chocolate milk mix is provided in Tables 5, 6 and 7.

Table 5

Control Chocolate milk mix				FORMULATION	
Ingredient Description	Supplier	Product Code	Lot#	% WT	Grams
Whey	Retail			38.0270%	11.4081
Maltodextrin 10 DE Cargill Dry MD*	Cargill	01909		30.0000%	9.0000
Cocoa Powder	Cargill	Russet Plus		30.0000%	9.0000
Satiexane CX90	Cargill			0.4410%	0.1323
Salt	Cargill	Top Flow		1.0000%	0.3000
Sucralose	Tate & Lyle			0.1500%	0.0450
Vanilla Flv. (Nesquik vanilla type)	Givaudan	EK-291-228-7		0.3820%	0.1146
TOTALS				100.00%	30.00

Table 6

Soluble Rice flour Chocolate milk mix				FORMULATION	
Ingredient Description	Supplier	Product Code	Lot#	% WT	Grams
Whey	Retail			38.0270%	11.4081
Soluble rice flour	Cargill			30.0000%	9.0000
Cocoa Powder	Cargill	Russet Plus		30.0000%	9.0000
Satiexane CX90	Cargill			0.4410%	0.1323

Salt	Cargill	Top Flow		1.0000%	0.3000
Sucralose	Tate & Lyle			0.1500%	0.0450
Vanilla Flv. (Nesquik vanilla type)	Givaudan	EK-291-228-7		0.3820%	0.1146
TOTALS				100.00%	30.00

Table 7

Soluble Cassava flour Chocolate milk mix				FORMULATION	
Ingredient Description	Supplier	Product Code	Lot#	% WT	Grams
Whey	Retail			38.0270%	11.4081
Soluble cassava flour	Cargill			30.0000%	9.0000
Cocoa Powder	Cargill	Russet Plus		30.0000%	9.0000
Satiexane CX90	Cargill			0.4410%	0.1323
Salt	Cargill	Top Flow		1.0000%	0.3000
Sucralose	Tate & Lyle			0.1500%	0.0450
Vanilla Flv. (Nesquik vanilla type)	Givaudan	EK-291-228-7		0.3820%	0.1146
TOTALS				100.00%	30.00

*Same amount of soluble cassava and soluble rice was used in both prototypes as the 10 DE control.

[0031] Add listed amounts of whey, cocoa powder, satiexane CX90, salt, sucralose, and vanilla are to a resealable bag. Shake the bag for up to two minutes. Combine 7.7 grams of the blend to 3.3 grams of maltodextrin or soluble flour (rice or cassava) in a 100 mL tri-pour. Mix well by gently stirring with a spoon. Weigh milk in an appropriate container for heating (8 oz – 241.46 g) and heat milk in the microwave for about 20 seconds. Add dry mix to the milk in the warm container. Stir well and evaluate. Table 8 provides evaluation data for the samples. The time for dry mix to go into solution is greater than 2 minutes because an agglomeration step, ordinarily typical for bulking agents in beverage powders, was not carried out. If an agglomeration step is performed, the time will be significantly shorter. Viscosity was determined using a Brookfield Programmable DV-11+ Viscometer (Model: RVRV-II) equipped with LV spindle 61 at a speed of 60 rpm and a temperature of 20°C.

Table 8

Product	pH	Viscosity (Cp)	Time it takes for dry mix to go into solution*
Control - 10 DE Maltodextrin	6.48	11.7	2:12

Cassava - 2X amylase_savage #1	6.46	12.8	2:38
Rice 2x amylase_Savage #3	6.47	14.9	2:29

Example #3: Soluble Flours in Peach Water Enhancer

[0032] Soluble cassava flour and soluble rice flour were compared to a control made with 10 DE maltodextrin (prepared as described in Example #1) in peach water enhancer.

The formulation of the peach base is provided in Tables 9, 10 and 11.

Table 9

Peach Water Enhancer Base- Control Formula				FORMULATION	
Ingredient Description	Supplier	Product Code	Lot#	% WT	Grams
Maltodextrin 10 DE – Cargill Dry MD*	Retail	09109		54.997%	5.736
Citric Acid, Anhydrous, Fine	Cargill			10.690%	1.115
Malic Acid	Cargill			0.820%	0.860
ViaTech™ TS 300+	Cargill			1.439%	0.150
Granulated Sugar	Cargill			29.690%	3.097
Potassium Citrate	Tate & Lyle			0.914%	0.095
Natural Peach Flavor	Givaudan			1.450%	0.151
TOTALS				100.00%	10.43

Table 10

Peach Water Enhancer Base- Soluble Rice flour				FORMULATION	
Ingredient Description	Supplier	Product Code	Lot#	% WT	Grams
Soluble rice flour	Retail			54.997%	5.736
Citric Acid, Anhydrous, Fine	Cargill			10.690%	1.115
Malic Acid	Cargill			0.820%	0.860
ViaTech™ TS 300+	Cargill			1.439%	0.150
Granulated Sugar	Cargill			29.690%	3.097
Potassium Citrate	Tate & Lyle			0.914%	0.095
Natural Peach Flavor	Givaudan			1.450%	0.151
TOTALS				100.00%	10.43

Table 11

Peach Water Enhancer Base- Soluble Cassava flour				FORMULATION	
Ingredient Description	Supplier	Product Code	Lot#	% WT	Grams
Soluble cassava flour	Retail			54.997%	5.736

Citric Acid, Anhydrous, Fine	Cargill			10.690%	1.115
Malic Acid	Cargill			0.820%	0.860
ViaTech™ TS 300+	Cargill			1.439%	0.150
Granulated Sugar	Cargill			29.690%	3.097
Potassium Citrate	Tate & Lyle			0.914%	0.095
Natural Peach Flavor	Givaudan			1.450%	0.151
TOTALS				100.00%	10.43

[0033] Add listed amounts of citric acid, malic acid, ViaTech TS 300+, granulated sugar, potassium citrate, and natural peach flavor to a resealable bag. Shake the bag for up to two minutes. Add 4.694 grams of the blend to 5.736 grams of maltodextrin, soluble rice flour, or soluble cassava flour in a 100 mL tri-pour. Mix well by gently stirring with a spoon. Weigh water in an appropriate container and add peach base to the water (453.6 g) Stir well and evaluate. Table 12 provides evaluation data for the samples. Note the time for dry mix to go into solution is greater than 2 minutes because an agglomeration step, ordinarily typical for bulking agents in beverage powders, was not carried out. If an agglomeration step is performed, the time will be significantly shorter.

Table 12

Clean Label Maltodextrin Testing Results - Peach Water Enhancer			
Product	pH	Viscosity (Cp)	Time it takes for peach base to go into solution
Control - 10 DE Maltodextrin	2.66	6.4	0:25
Cassava - 2X amylase_savage #1	2.62	8.53	1:15
Rice 2x amylase_Savage #3	2.57	11.7	1:10

Example #4: Soluble Flours in Salad Dressing

[0034] Soluble cassava flour and soluble rice flour were compared to full fat control dressing and a reduced fat dressing control made with 10 DE maltodextrin (prepared as described in Example #1). The formulations are shown in Tables 13-16.

Table 13

Positive Control (Full Fat, 35% Oil)	

INGREDIENT	%	GRAMS
Water	49.38	246.90
Vegetable Oil	35.00	175.00
Vinegar	7.00	35.00
Sugar	3.00	15.00
Salt	1.70	8.50
Egg Yolk Powder	1.50	7.50
HiForm Starch 12754	1.60	8.00
Ground Mustard	0.50	2.50
Potassium Sorbate	0.12	0.60
Xanthan gum	0.20	1.00
Total	100.00	500.00

Table 14

Maltodextrin Control (Reduced Fat, 17.5% Oil)		
INGREDIENT	%	GRAMS
Water	48.98	244.90
Vegetable Oil	17.50	87.50
Maltodextrin (Cargill Dry MD 01909)	16.70	83.50
Vinegar	7.00	35.00
Sugar	3.00	15.00
Salt	1.70	8.50
Egg Yolk Powder	1.50	7.50
HiForm Starch 12754	2.80	14.00
Ground Mustard	0.50	2.50
Potassium Sorbate	0.12	0.60
Xanthan gum	0.20	1.00
Total	100.00	500.00

Table 15

Soluble Rice Flour (Reduced Fat, 17.5% Oil)		
INGREDIENT	%	GRAMS
Water	48.98	244.90
Vegetable Oil	17.50	87.50
Soluble Rice Flour	16.70	83.50
Vinegar	7.00	35.00
Sugar	3.00	15.00
Salt	1.70	8.50
Egg Yolk Powder	1.50	7.50
HiForm Starch 12754	2.80	14.00
Ground Mustard	0.50	2.50
Potassium Sorbate	0.12	0.60

Xanthan gum	0.20	1.00
Total	100.00	500.00

Table 16

Soluble Cassava Flour (Reduced Fat, 17.5% Oil)		
INGREDIENT	%	GRAMS
Water	48.98	244.90
Vegetable Oil	17.50	87.50
Soluble Cassava Flour	16.70	83.50
Vinegar	7.00	35.00
Sugar	3.00	15.00
Salt	1.70	8.50
Egg Yolk Powder	1.50	7.50
HiForm Starch 12754	2.80	14.00
Ground Mustard	0.50	2.50
Potassium Sorbate	0.12	0.60
Xanthan gum	0.20	1.00
Total	100.00	500.00

[0035] Water is combined with the dry ingredients and mixed in a Cuisinart food processor for approximately 3 minutes. The oil is slowly added to the mixer and mixed for approximately 5 minutes. Vinegar is then added and mixed for approximately 1 minutes. Bostwick measurements are then measured and described in Table 17. Measurements were completed utilizing Bostwick Consistometer (CSC Scientific Company, Inc., Fairfax, Virginia, USA) with a sample loading weight of 100 grams, and a measurement window of 30 seconds. Samples were also tested using an Anton Paar MCR 502 rheometer couette geometry at shear rates of 0.1 to 100 s⁻¹ of at a controlled temperature of 4°C and described in Table 18.

Table 17

Sample	Initial Bostwick: Sample temperature 20°C (30 sec)	24 hours Bostwick: Sample temperature 4°C (30 sec)
--------	---	---

Full Fat Control (35% Oil)	7.5 cm	7 cm
Maltodextrin Control (Cargill Dry MD 01909) (17.5% Oil)	16 cm	14 cm
Soluble Rice Flour	10 cm	9.5 cm
Soluble Cassava Flour	6 cm	5 cm

Table 18

<u>Formula</u>	<u>Viscosity (Pa*s)</u>
<u>Salad Dressing- Full Fat Control</u>	<u>16.6</u>
<u>Salad Dressing- Control Maltodextrin</u>	<u>8.67</u>
<u>Salad Dressing- Soluble Cassava Flour</u>	<u>55</u>
<u>Salada Dressing-Soluble Rice Flour</u>	<u>23.5</u>

Example #5: Molar mass distribution method

Instruments:

- HPLC: Agilent 1260 Infinity System
- Multi-angle light scattering Detector (MALS): Wyatt Technology DAWN HELEOS II
- Refractive Index Detector (RI): Wyatt Technology Optilab TrEX
- Column Heater
- *Instrument Set Up*: HPLC-Column heater-MALS-RI

Columns:

- Phenomenex Phenogel 10u (7.8x300mm)
 - Columns in series: guard column-10E6A-10E5A-10E3A
- Column Temperature: 55°C

Sample Preparation Procedure:

1. Add 100 mg sample into a 25x150 mm culture tube with cap.

- Note: Before sample addition remove particles from tube & cap using canned air (Duster)
2. Add 20 mL of 50 mM LiBr 100% DMSO mobile phase (isocratic, run time; 70 minutes) to the tube using a 25 mL graduated cylinder.
 - Note: Make sure to wash down any sample stuck on the tube sides.
 3. Add mini-stir bar and immediately set on stir plate.
 4. Stir samples for 1 hour at low rpm.
 5. Place tubes in water bath.
 6. Heat water until vigorous boil with continuous sample solution stirring.
 7. Turn off hot plate.
 8. Leave samples in the water bath stirring on hot plate until tubes are at room temperature.
 9. De-pressurize the tubes by quickly loosening then re-tightening the cap.
 10. Mix samples with vortex mixer.
 11. Place samples on stir plate and stir overnight.
 12. Filter sample through a 1 um PTFE syringe filter into a 2 mL HPLC vial.
 13. Analyze samples by SEC-MALLS-RI system.

CLAIMS

1. A method of manufacturing a soluble flour comprising:

preparing a flour-water slurry;

adjusting the pH of the slurry to a pH ranging from 3.5-6.0;

adding an enzyme to the pH adjusted slurry in an amount ranging from 0.02-2 % enzyme relative to weight of the flour to form a reaction mixture;

cooking the reaction mixture at a temperature ranging from 60-140C until a dextrose equivalent of 5 to 18 is achieved;

inactivating enzyme to obtain a soluble flour; and

adjusting pH of the soluble flour to range from 3-6.
2. The method of claim 1, adjusting the pH of the slurry to a pH ranging from 4.8-5.2.
3. The method of claim 1, wherein the enzyme is added in an amount ranging from 0.045-0.085% enzyme relative to weight of the flour.
4. The method of claim 1, wherein the flour-water slurry comprises 20-40 wt% flour.
5. The method of claim 1, wherein the reaction mixture cooking takes place in a jet cooker.
6. The method of claim 1, wherein the temperature during cooking ranges from 90C to 100C.
7. The method of claim 1, further comprising spray drying the pH adjusted soluble flour.
8. The method of claim 1, wherein the flour is a non-grain flour.
9. The method of claim 8, wherein the non-grain flour is a root or tuber flour.

10. The method of claim 8, wherein the non-grain flour is potato, cassava, sweet potato, taro, yam, arrowroot, lotus root, shoti, Kudzu, banana, waxy cassava, or waxy tapioca flour.
11. The method of claim 1, wherein the flour is rice, waxy cereal, normal cereal, or high amylose cereal flours.
12. The method of claim 1, wherein the enzyme is an alpha-amylase.
13. The method of claim 12, wherein the alpha-amylase is a thermal stable alpha-amylase.
14. The method of claim 1, wherein the soluble flour has a dextrose equivalent ranging from 8 to 12.
15. The method of claim 1, wherein the soluble flour has a solubility greater than 50% at 5% solids.
16. The method of claim 1, wherein the soluble flour has a solubility ranging from 50% to 100% at 5% solids.
17. The method of claim 1, wherein the soluble flour has a viscosity between 0.001 and 1.0 Pa*s at temperatures ranging from 20-50 C at 10% solids.
18. A soluble flour, comprising a dextrose equivalent value ranging from 5 to 18, a solubility greater than 50% at 5% solids, and a viscosity between 0.001 and 1.0 Pa*s at temperatures ranging from 20-50 C at 10% solids.
19. The soluble flour of claim 18, wherein the soluble flour has a dextrose equivalent ranging from 8 to 12.
20. The soluble flour of claim 18, wherein the soluble flour has a protein content ranging from 0 to 10 wt%.

21. The soluble flour of claim 18, wherein the soluble flour has a dietary fiber content ranging from 0.5 to 15 wt%.
22. The soluble flour of claim 18, wherein the solubility ranges from 50% to 100%.
23. The soluble flour of claim 18, wherein the flour is potato flour.
24. The soluble flour of claim 18, wherein the flour is cassava flour.
25. The soluble flour of claim 18, wherein the flour is rice flour.
26. A food product, comprising the soluble flour of claim 18.
27. The food product of claim 26 being a beverage mix, infant food, a medicinal product, an emulsion, convenience foods, or a snack-based filling.
28. The food product of claim 26 wherein the soluble flour is at least a partial replacement of maltodextrin.
29. Use of a soluble potato, cassava, or rice flour in beverage mix, infant food, medicinal products, emulsions, convenience foods, or snack-based fillings or food products.
30. The use of claim 29, wherein the soluble potato, cassava, or rice flour at least partially replaces maltodextrin.
31. Use of a soluble non-grain flour in beverage mix, infant food, medicinal products, emulsions, convenience foods, or snack-based fillings or food products.
32. The use of claim 31, wherein the soluble non-grain flour at least partially replaces maltodextrin.

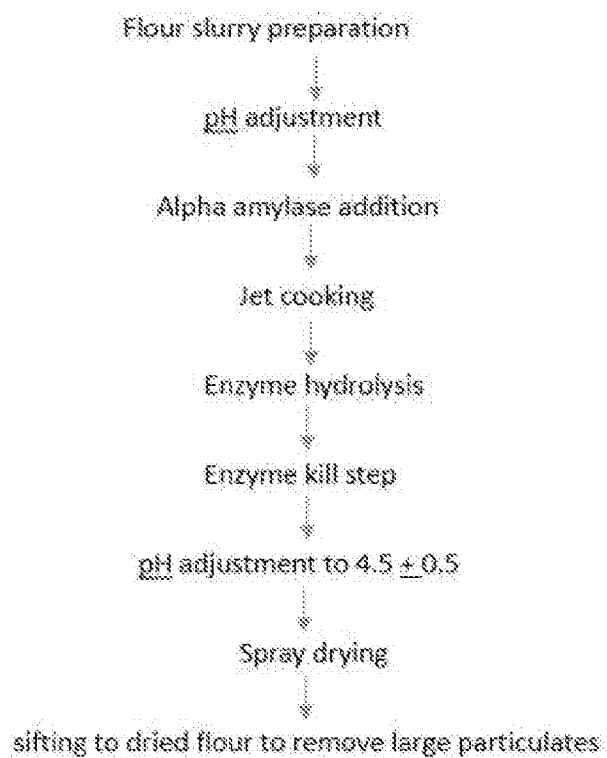


FIGURE 1

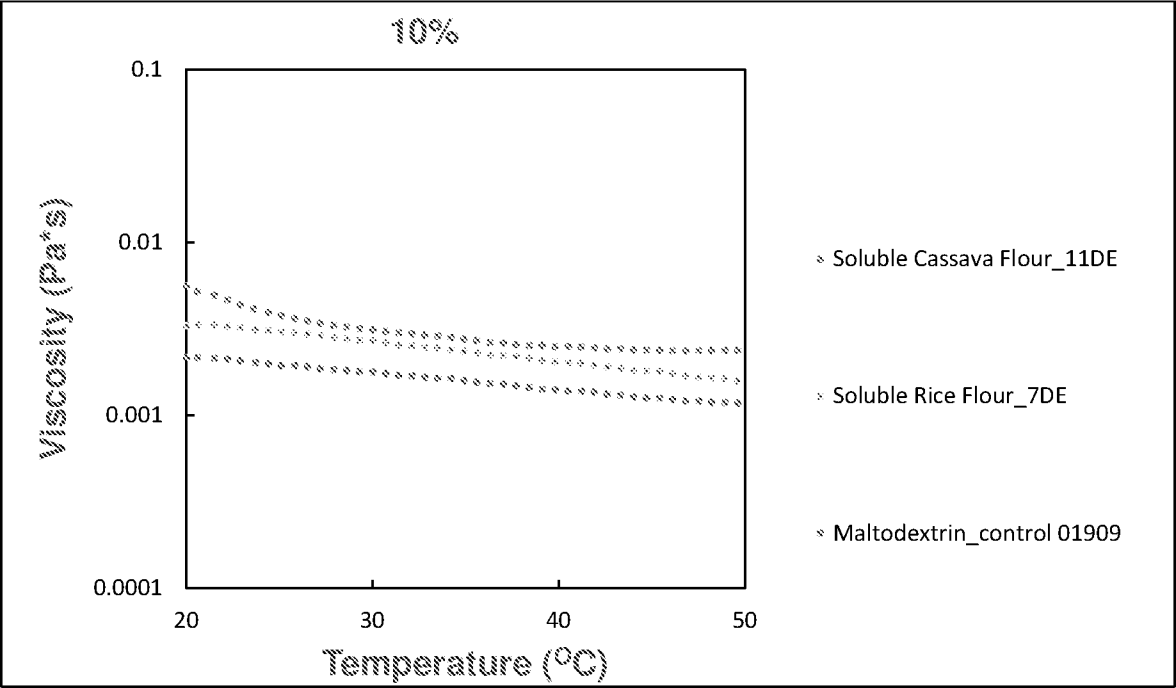


FIGURE 2

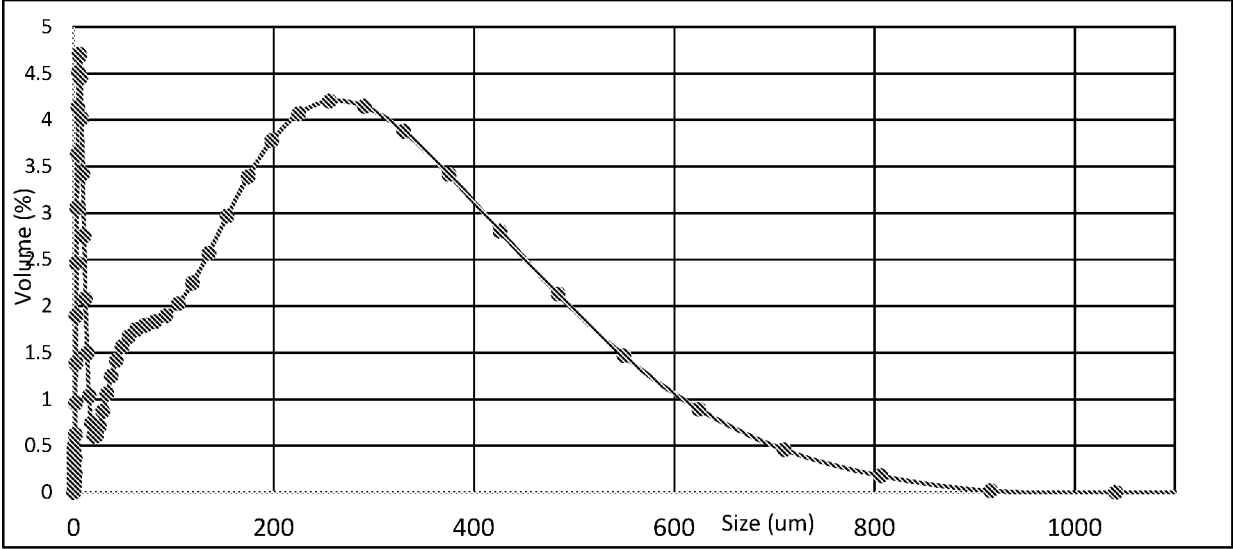


FIGURE 3

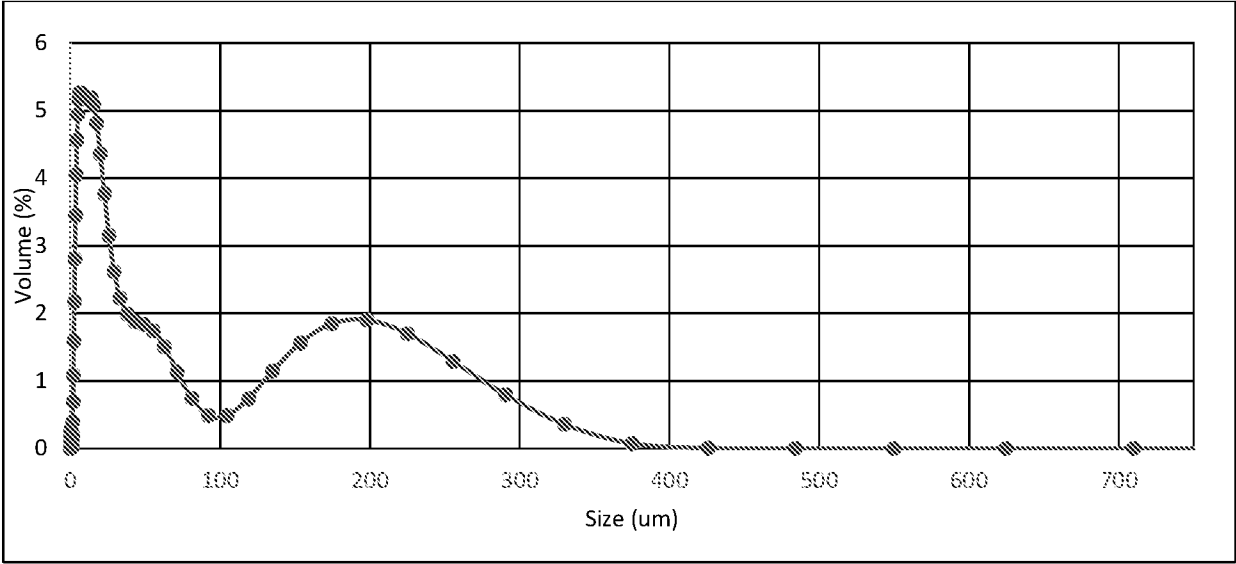


FIGURE 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2019/039153

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - C12P 19/14; A21D 13/04; A23L 2/39; A23L 7/104 (2019.01)

CPC - C12P 19/14; A21D 6/003; A21D 8/042; A21D 13/043; A23L 7/107; A23L 29/273; A23V 2002/00 (2019.08)

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)

See Search History document

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

USPC - 426/456 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3,849,194 A (ARMBRUSTER et al) 19 November 1974 (19.11.1974) entire document	1-17
Y	US 3,897,305 A (HURST) 29 July 1975 (29.07.1975) entire document	1-17
Y	US 2008/0260909 A1 (CHUNG et al) 23 October 2008 (23.10.2008) entire document	7, 15, 16
Y	US 5,789,012 A (SLIMAK) 04 August 1998 (04.08.1998) entire document	8-10
Y	US 2016/0081375 A1 (THE QUAKER OATS COMPANY) 24 March 2016 (24.03.2016) entire document	17

☐ 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

24 September 2019

Date of mailing of the international search report

17 OCT 2019

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, VA 22313-1450
Facsimile No. 571-273-8300

Authorized officer

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2019/039153

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 extra sheet(s).

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 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.:
1-17

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.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2019/039153

Continued from Box No. III Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees need to be paid.

Group I: Claims 1-17 are drawn to methods of manufacturing a soluble flour.

Group II: Claims 18-28 are drawn to soluble flours and food products thereof.

Group III: Claims 29-32 are drawn to uses of soluble flours.

The inventions listed in Groups I-III do not relate to a single general inventive concept under PCT Rule 13.1, because under PCT Rule 13.2 they lack the same or corresponding special technical features for the following reasons:

The special technical features of Group I, methods of manufacturing a soluble flour, are not present in Groups II and III; the special technical features of Group II, soluble flours and food products thereof, are not present in Groups I and III; and, the special technical features of Group III, uses of soluble flours, are not present in Groups I and II.

Groups I-III share the technical features of a soluble flour comprising a dextrose equivalent value ranging from 5 to 18 and the use of a soluble flour in beverage mix, infant food, medicinal products, emulsions, convenience foods, or snack-based fillings or food products. However, these shared technical features do not represent a contribution over the prior art.

US 3,849,194 A to Armbruster et al. teach a soluble flour (Abstract, The present invention provides a process for preparing low D.E. waxy starch hydrolysates and low D.E. waxy starch conversion syrup products which are both liquid and solid. ... Non-hygroscopic water-soluble solids are also obtained by further drying to a moisture content of less than about 15 percent.; Col. 2, Ln. 35-Col. 3, Ln. 5) comprising a dextrose equivalent value ranging from 5 to 18 (Abstract, convert the liquified waxy starch with bacterial alpha amylase to a D.E. from about 5 to about 25; Col. 2, Ln. 35-Col. 3, Ln. 5) and the use of a soluble flour in beverage mix, infant food, medicinal products, emulsions, convenience foods, or snack-based fillings or food products (Col. 7, Lns. 50-64, as components of dry soup mixes, bakery mixes, frosting mixes, spice mixes and blends, beverage powders, condiments, gravy mixes, sauce mixes, the frozen dairy foods).

The inventions listed in Groups I-III therefore lack unity under Rule 13 because they do not share a same or corresponding special technical feature.