

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(10) International Publication Number
WO 2017/132257 A1

(43) International Publication Date
3 August 2017 (03.08.2017)

- (51) International Patent Classification:
A23L 27/60 (2016.01) A23L 11/00 (2016.01)
- (21) International Application Number:
PCT/US2017/014934
- (22) International Filing Date:
25 January 2017 (25.01.2017)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
62/286,643 25 January 2016 (25.01.2016) US
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- (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, 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).

Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

Published:

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



WO 2017/132257 A1

(54) Title: IMPROVED PULSE PROCESSING AND PRODUCTS PRODUCED THEREFROM

(57) Abstract: Improved methods for processing pulses are disclosed. Products produced from such improved methods are further disclosed.

TITLE

IMPROVED PULSE PROCESSING AND PRODUCTS PRODUCED THEREFROM

5

TECHNICAL FIELD

10 **[0001]** The present invention relates generally to food technology and more particularly, to food products produced from pulses.

BACKGROUND

15 **[0002]** Consumers searching for more health and wellness in their diets are turning to pulses. Pulses, which include edible beans, lentils, and peas, are high in protein and fiber and have been growing in popularity. As the worldwide demand for protein continues to grow, pulses are proving to be a cost effective alternative to the other more costly traditional proteins such as meat, fish, and dairy.

20 **[0003]** While other foods are high in protein, some of them suffer from the drawback of being listed as an allergen. For instance, dairy, soybeans, and peanuts, while providing a high quality protein, are considered to be “major food allergens” and are required to be listed on food labels containing such ingredients. This is one reason the food industry is searching for alternative non-meat proteins.

25 **[0004]** Thus, a need exists for new food ingredients that are good sources of protein and fiber, yet that are not allergens and are cost effective.

SUMMARY

30 **[0005]** In each of its various embodiments, the present invention fulfills this need and discloses processes for producing pulse products that are functional as a food ingredient, yet provides the nutritional value of pulses.

[0006] In one embodiment, a process for producing a product comprises homogenizing a slurry comprising water and a comminuted pulse, and mixing an enzyme with the slurry.

35 **[0007]** In a further embodiment, a process for producing a pulse product comprises producing a slurry with a comminuted pulse and water, cooking the slurry, homogenizing the slurry, mixing an enzyme with the slurry, and inactivating the enzyme mixed with the slurry.

[0008] In another embodiment, products produced by the processes of the present invention are also disclosed.

[0009] In a further embodiment, food products incorporating products of the present invention are also disclosed.

5 [0010] In an additional embodiment, a homogenized, enzyme treated, comminuted pulse product comprises a particle size distribution having a mean particle size of less than 250 microns.

[0011] In one embodiment, a method of treating a person having dysphagia comprises feeding a homogenized, enzyme treated, comminuted pulse product of the present invention to
10 the person having the dysphagia.

DESCRIPTION OF THE DRAWINGS

[0012] Figure 1 discloses one embodiment of a process of producing a pulse product of the present invention.

15 [0013] Figure 2 discloses the viscosity of slurries containing various embodiments of the pulse products of the present invention.

[0014] Figure 3 depicts the total sugar content and total DP2-DP10+ content of various pulse products produced using the present invention.

[0015] Figure 4 shows the viscosity of slurries containing various embodiments of the
20 pulse products of the present invention at different temperatures.

[0016] Figure 5 illustrates the viscosity of slurries containing various embodiments of the pulse products of the present invention.

[0017] Figure 6 shows the particle size distribution of various pulse products produced using the present invention.

25 [0018] Figure 7 shows the color of an embodiment of producing a pulse of the present invention.

DESCRIPTION OF THE INVENTION

[0019] In each of its various embodiments, the present invention discloses improved
30 pulse processing, as well as products produced therefrom.

[0020] In one embodiment, a process for producing a product comprises homogenizing a slurry comprising water and a comminuted pulse, and mixing an enzyme with the slurry.

[0021] The process may also include inactivating the enzyme and may further include cooking the homogenized slurry and/or drying the slurry to a powder.

[0022] The comminuted pulse may be a pre-cooked, dehydrated pulse powder. In such embodiment, the process further comprises mixing the pre-cooked, dehydrated pulse powder
5 with the water, thus producing the slurry.

[0023] The pulse powder may be present in the slurry of the process of the present invention at 5-50% solids, 10-40% solids, 10-15% solids, 15-35% solids, 15-25% solids, or about 20% solids.

[0024] In a further embodiment, the homogenizing may take place under pressure such
10 as 2,000-15,000 psi, 5,000-10,000 psi, 8,000-10,000 psi, or about 10,000 psi.

[0025] The process may further include mixing a second enzyme with the slurry, wherein the second enzyme has a different activity than the enzyme. The process may further include homogenizing the slurry a second time after enzyme treatment.

[0026] The process may further include incubating the slurry and the enzyme and/or the
15 second enzyme for a period of time. The temperature may be at least 35°C, at least 45°C, at least 55°C, 55-57°C, at least 65°C, between 50-90°C, 60-80°C, or about 70°C, and the incubating may occur for at least 5 minutes, at least 15 minutes, at least 25 minutes, at least 35 minutes, at least 45 minutes, at least 55 minutes, at least 65 minutes, at least 75 minutes, at least 85 minutes, between 45-135 minutes, between 55-125 minutes, between 65-115 minutes, between 75-105
20 minutes, between 85-95 minutes, or about 90 minutes.

[0027] In an embodiment, the enzyme has alpha-amylase activity and the second enzyme has xylanase activity.

[0028] The enzyme and/or the second enzyme may be inactivated by heating the slurry to a temperature of at least 70°C, at least 72°C, at least 74°C, at least 75°C, at least 76°C, at least
25 80°C, at least 85°C, at least 90°C, at least 93°C, or at least 95°C. Such inactivation may occur for a time of at least 30 seconds, at least 1 minute, at least 90 seconds, at least 2 minutes, at least 5 minutes, no more than 4 minutes, at least 10 minutes, at least 15 minutes, at least 20 minutes, at least 25 minutes, at least 30 minutes, at least 35 minutes, at least 40 minutes, at least 45 minutes, at least 50 minutes, at least 55 minutes, at least 60 minutes, at least 65 minutes, or at
30 least 70 minutes.

[0029] In a further embodiment, the inactivating occurs for at least 30 seconds and a temperature of at least 90°C, for at least 45 minutes and a temperature of at least 74°C, for about 60 minutes at about 76°C, or for about one minute at about 93°C.

[0030] The process may further include holding the slurry, the enzyme, and/or the second enzyme at a temperature, such as between 30-70°C, between 35-65°C, between 40-60°C, between 45-55°C, or about 50°C.

5 [0031] In a further embodiment, drying the slurry to the powder may comprise spray draying, such as to less than 10% moisture. The spray drying may include an inlet temperature of between 500-520°F and an outlet temperature of 185-200°F.

[0032] In yet a further embodiment, the process may further include hydrating the pulse powder and incorporating the hydrated powder into a food product or incorporating the pulse containing slurry into a food product.

10 [0033] In another embodiment, a second composition is homogenized with the water and the comminuted pulse. The second composition may be selected from the group consisting of a product of wheat, oat, sorghum, an ancient grain, corn, buckwheat, quinoa, chia, rice, barley, millet, rye, triticale, fonio, teff, wild rice, spelt, einkorn, emmer, durum, kamut, and combinations of any thereof.

15 [0034] Further embodiments include cooling the cooked slurry and/or filtering the slurry.

[0035] A product produced by any of the processes of the present invention is also disclosed.

[0036] In one embodiment, the pulse may be beans of a Phaseolus species, beans of a Vigna species, beans of Vicia species, peas, chickpeas, lentils, and combinations of any thereof.

20 [0037] In a further embodiment, a process for producing a pulse product comprises producing a slurry with a comminuted pulse and water, cooking the slurry, homogenizing the slurry, mixing an enzyme with the slurry, and inactivating the enzyme mixed with the slurry. The slurry may be further dried to a powder. The slurry may be cooled after cooking, and the slurry may be optionally filtered.

25 [0038] The process may further include mixing a second enzyme with the slurry, where the second enzyme has a different activity than the enzyme. After enzyme treatment, the slurry may be homogenized a second time. The enzyme may have amylase activity and the second enzyme may have xylanase activity.

30 [0039] The slurry may be produced by comminuting the pulse and placed such comminuted pulse in water.

[0040] The slurry may have a solids content of 10-30%. Inactivating the enzyme may include heating the slurry and the enzyme to a temperature sufficient to inactivate the enzyme. Drying the slurry may comprise spray drying the slurry.

[0041] In an additional embodiment, a homogenized, enzyme treated, comminuted pulse product has a particle size distribution having a mean particle size of less than 250 microns. The mean particle size may also be less than 200 microns, less than 150 microns, less than 100 microns, or less than 50 microns.

5 [0042] Upon dispersion of the homogenized, enzyme treated, comminuted pulse product in water, the dispersed, homogenized, enzyme treated pulse product has a lowered viscosity as compared to the comminuted, pulse product that has not been homogenized and enzyme treated.

[0043] The homogenized, enzyme treated, comminuted pulse product may also have less dietary fiber, more soluble fiber, less insoluble fiber, and combinations of any thereof as
10 compared to the comminuted pulse product that has not been homogenized and enzyme treated.

[0044] A method of treating a person having dysphagia is further disclosed. Such method includes feeding one embodiment of a homogenized, enzyme treated, comminuted pulse product of the present invention to the person having dysphagia.

[0045] In an embodiment, the edible bean may be of a *Phaseolus* species (i.e., beans).
15 In other embodiments, the pulse may comprise green or yellow peas (i.e., *Pisum*), green, red, or yellow lentils (i.e., *Lens vulgaris*), chickpeas or garbanzos, (i.e., *Cicera arietenum*), and combinations of any thereof. In further embodiments, varieties of beans that may be used to produce the pulse products of the present invention include, without limitation, Pinto beans, Great Northern beans, Navy beans, Red beans, Black beans, Black Turtle beans, dark or light
20 Red Kidney beans, Fava beans, Green Baby Lima beans, Pink beans, MYASI beans, Mayocoba beans, Yellow beans, Peruvian beans, Small Red beans, Black Eyed beans, Cow peas, Garbanzo beans, Cranberry beans, White Beans, Rice beans, Butter beans, Pea beans, African Giraffe beans and any combinations thereof.

[0046] In an embodiment, the comminuted pulse product may be produced using the
25 process described in US Patent Application 2005/0095346 assigned to Archer-Daniels-Midland Company of Decatur, IL, entitled Process for the Production of Reconstitutable Bean Products published May 5, 2005, the contents of the entirety of which is incorporated by this reference. In another embodiment, the process for dehydrating the pulse may include blanching the pulse or pulse product, cooking the blanched pulse or pulse product, and/or dehydrating the cooked
30 pulse or pulse product to form a dehydrated or reconstitutable pulse or pulse product. In a further embodiment, water may be used to blanch and/or cook the pulse or pulse product, and an organic acid may optionally be added to the blanching water, the cooking water, or both.

[0047] In other embodiments, the process for producing the dehydrated pulse products includes conditioning the pulse by subjecting the pulse to hydration; cooking the pulse; depressurizing the cooked pulse; and/or dehydrating the pulse to form a reconstitutable pulse. In other embodiments, the process for dehydrating the pulse may also include use of an organic acid
5 in the hydration, blanching, and/or cooking step, and the process may further include washing and/or destoning raw pulses used in the process.

[0048] The invention is further explained by use of the following exemplary embodiments.

[0049] Example 1.

10 [0050] A pre-cooked, dehydrated Navy bean powder was mixed with water to produce a slurry at 20% weight/weight of the Navy bean powder. The Navy bean slurry was homogenized by being pumped through a GEA-Niro Souvi homogenizer at 8,000-10,000 psi. The homogenized Navy bean slurry was collected in containers. An enzyme was added to the homogenized, Navy bean slurry at a 0.04% dosage and allowed to incubate at about 70°C for about 90 minutes. The
15 enzyme used could be an alpha-amylase, a xylanase, or a combination thereof.

[0051] After the homogenized, Navy bean and enzyme slurry incubated, the slurry was heated to a temperature of greater than 75°C (e.g., about 76°C) and mixed for one hour to inactivate the alpha-amylase enzyme. The enzyme may also be inactivated by jet cooking the slurry at about 93°C for one minute. The slurry was transferred to a sterile, jacketed surge tank
20 and maintained at a temperature of about 50°C, during which time the slurry was pumped into a spray drier to produce a powdered product having a moisture content of about 9.1%. The spray drier has an inlet temperature of about 511°F and an average outlet temperature of about 193°F.

[0052] Example 2.

[0053] FIG. 1 shows a flowchart of one process used to produce the homogenized, enzyme treated pulses. Raw, Navy beans were cracked in a cracker at 10, thus producing Navy
25 bean grits at 12. The Navy bean grits were placed in 90°C water in a Likwifier blender at 14 and blended. The blended Navy bean grits were placed in an in-line shear mixer at 14 and re-circulated in the blender at 16 for no more than 45 minutes. The blended Navy bean grits may have 10-15% total solids at this point.

30 [0054] The sheared/blended Navy beans were jet cooked at 18 with steam at 221°F for between about 2-4 minutes. The jet cooked Navy beans were passed through a chill tank at 22 to trim cool the jet cooked Navy beans to about 70-80°C. The cooled, jet cooked Navy beans were passed into a GEA brand NS3006L Panther homogenizer at 24 and homogenized at 10,000 PSI

(about 800 bar). The homogenizer may also be a GEA brand Niro Soavi homogenizer. The homogenized Navy beans were transferred to a cooling jacket at 26 and cooled to about 47-53°C. The cooled, homogenized Navy beans were placed in a tank at 28 along with the amylase and the xylanase and incubated with agitation at about 55-57°C for a minimum of about 45 minutes, or a
5 time of about 1.5 hours. The enzyme treated Navy beans were transferred back to the homogenizer at 30 and homogenized. The enzyme treated, homogenized Navy beans were placed in a vessel and jet cooked at about 195°F for no more than 4 minutes at 32 to de-activate the enzyme. The Navy beans were passed through a 150 micron sock filter at 34 into a hold tank at 36 jacketed with 70°C water. The act of passing through the filter may be optional. The Navy bean slurry was spray
10 dried at about 800°F in a spray drier at 38 with an outlet temperature of about 194°F.

[0055] Viscosities of the homogenized, enzyme treated Navy beans were determined at various points during the process of Example 2. FIG. 2 illustrates the viscosities of the treated Navy beans upon treatment with the amylase and the xylanase and treatment with the amylase. As can be seen in FIG. 2, treating the Navy beans with the combination of the two enzymes resulted
15 in a product with a lower viscosity as compared to treatment with the xylanase alone.

[0056] Example 3.

[0057] Pre-cooked Navy beans were processed according to Example 2 using a xylanase enzyme, and a combination of an amylase enzyme and a xylanase enzyme. The amylase was CLARASE L brand alpha amylase available from DuPont. The xylanase was ROHALASE SEP
20 brand xylanase available from AB Enzymes. The graphs of FIG. 3 shows that the xylanase treatment, and the amylase and xylanase treatments were able to make the dp2-dp10+ oligosaccharides from the Navy beans increase and soluble, but not increase the total sugar content. FIG. 3 illustrates, for each incubation time in minutes, the Total Dp2-Dp10+ content on the left and the total sugars on the right.

25 **[0058]** Example 4.

[0059] Samples were taken at various times of the process of Example 2 and viscosities were determined. FIG. 4 shows the viscosity of the raw, Navy bean product before homogenization (i.e., the control) and the viscosity of the raw, Navy bean product after the first homogenization of FIG. 1. The viscosities were determined at various temperatures. FIG. 5 shows
30 the viscosity of the raw, Navy bean product after the second homogenization of FIG. 1. As can be seen from the graphs of FIGS. 4 and 5, the viscosity after the second homogenization and enzyme treatment reduces the viscosity of the raw, Navy bean product.

[0060] Samples of raw, Navy beans were also taken during various points of the process of FIG. 1 and particle size analysis was performed. The results are shown in FIG. 6. The particle size distribution is shown in the graph and the mean particle size is presented in the table of FIG. 6. The mean particle size decreases throughout of the process.

5 [0061] Example 5.

[0062] The enzyme modified, Navy bean powder produced in accordance with Example 2 has the following nutritional information: about 4.21% moisture; about 21.3% protein; about 3% fat, about 67.5% carbohydrate; about 4% ash; and about 95% of the particles will pass through a #80 sieve. The enzyme modified, Navy bean powder also has the following nutritional characteristics per 100 g of dry product: about 382 calories; 3 g total fat; 67.5 g of total carbohydrate; 46.8 g of available carbohydrates; 20.7 g of dietary fiber; 7 g of soluble fiber; 13.7 g of insoluble fiber; 2.26 g of total sugar; and 21 g of protein. The enzyme modified, Navy bean powder has a cup density of about 0.523 g/mL; a bulk density of about 0.567 g/mL; and a tapped density of about 0.810 g/mL after about 500 taps.

15 [0063] On a dry basis, the enzyme modified, Navy bean powder of the present invention has different functionality as compared to dehydrated, whole Navy bean powder available under the brand VEGEFULL from Archer-Daniels-Midland Company, of Decatur, Illinois. The enzyme modified, Navy bean powder also has a different nutritional profile as compared to the dehydrated, whole Navy bean powder which has, on a dry basis, per 100 g: 310 calories; 66 g of total carbohydrates; 48 g of available carbohydrates; 23 g of dietary fiber; 5 g of soluble fiber; 18 grams
20 of insoluble fiber; 4.5 g of total sugar; and 22 g of total protein.

[0064] Example 6.

[0065] The color of the enzyme modified, Navy bean powder produced in accordance with Example 2 was also determined. Such color was compared to a precooked, Navy bean powder
25 available under the name VEGEFULL, available from Archer-Daniels-Midland Company, Decatur, IL. The comparison is shown in FIG.

[0066] Example 7.

[0067] The enzyme modified, Navy bean powder produced according to Example 2 was also evaluated for use in different food stuffs. Table 1 describes various compositions that were prepared including various amounts of the enzyme modified, Navy bean powder. Each
30 composition has a different viscosity and may have various target applications as depicted in the Table.

[0068] Table 1.

Protein Content	Amount of Navy bean powder	Concentration per 250 mL	Target Application	Viscosity @15 RPM 4°C (CPs)
3 grams	14.28 grams	5.71%	Beverage, dairy and soup	77
5 grams	23.8 grams	9.52%	Beverage, dairy, soup, batter	2959
7.5 grams	35.71 grams	14.28%	Dips, dairy, soup	9868

[0069] Example 8.

[0070] An enzyme modified, homogenized Navy bean product produced according to an embodiment of the present invention has utility as an ingredient or component of a food fed to persons suffering with dysphagia. Dysphagia is difficulty with swallowing and may be caused by old age and related health complications (i.e., dementia). Dysphagia may also be a result of a medical condition such as stroke, neurological related disease, head/neck/spinal injury, Parkinson’s disease, multiple sclerosis, Alzheimer’s, or other medical condition. Dysphagia is thought to affect up to 219 million persons worldwide including 15 million in the United States, where up to 1 million dysphagia patients are hospitalized each year in the United States. If dysphagia is not treated properly, there is a risk of aspiration, dehydration, poor nutrition, and less enjoyment of foods.

[0071] Treatment of dysphagia includes preparing thickened liquids that may be consumed. Depending on the severity of the dysphagia, thickened liquids may be prepared such as thin liquids with a viscosity of 1-50 mPa, nectar-like liquids with a viscosity of 51-350 mPa, honey-like liquids with a viscosity of 351-1750 mPa, and spoon-thick liquids with a viscosity of more than 1750 mPa.

[0072] The enzyme modified, homogenized pulse products of the present invention typically have a reduced viscosity compared to the pulses from which they are prepared. For instance, the enzyme modified, homogenized Navy bean products have a lower viscosity than the non-enzyme modified, non-homogenized Navy bean counterparts. Thus, such reduced viscosity can be manipulated to be suitable to be fed to a person suffering from dysphagia. Further, since food products containing the enzyme modified, homogenized pulse products of the present invention have excellent nutrition profiles, food products including the enzyme modified, homogenized food products of the present invention are good sources of protein and fiber, two nutrients of which may be difficult to consume in a liquid diet.

[0073] Examples of foods that may include the pulse products of the present invention include, but are not limited to, beverages, soup, batter, dips, dairy substitutes, or any other food product.

5 [0074] In an embodiment, an enzyme modified, homogenized Navy bean product of the present invention may be incorporated into a composition and configured to have a viscosity suitable for feeding to a patient suffering from dysphagia. The enzyme modified, homogenized Navy bean product may be fed by itself to the patient suffering from dysphagia or combined with other food ingredients such as pre-gel starches (i.e., yellow dent corn starch), starch maltodextrins, xanthan gum, grain based powders, purees, or combinations of any thereof. Such ingredients may
10 be agglomerated into a dry mix, which may be subsequently pre-hydrated to a desired consistency for feeding to the patient suffering from dysphagia. The enzyme modified, homogenized food products of the present invention are able to be uniformly dispersed in water or other aqueous based liquids and formed into a powder, liquid, or puree.

[0075] The present invention has been described with reference to certain exemplary
15 embodiments, compositions, and uses thereof. However, it will be recognized by those of ordinary skill in the art that various substitutions, modifications or combinations of any of the exemplary embodiments may be made without departing from the spirit and scope of the invention. Thus, the invention is not limited by the description of the exemplary embodiment, but rather by the appended claims as originally filed.

20

CLAIMS

What is claimed is:

1. A process for producing a product, the process comprising:
homogenizing a slurry comprising water and a comminuted pulse; and
5 mixing an enzyme with the slurry.
2. The process of claim 1, further comprising inactivating the enzyme.
3. The process of claim 1 or claim 2, further comprising cooking the homogenized
slurry.
4. The process of any one of claims 1-3, further comprising drying the slurry to a
10 powder.
5. The process of any one of claims 1-4, wherein the comminuted pulse comprises a
pre-cooked, dehydrated pulse powder, the process further comprising:
mixing the pre-cooked, dehydrated pulse powder with the water, thus producing the
slurry.
- 15 6. The process of any one of claims 1-5, wherein the comminuted pulse is present in
the slurry at 5-50% solids, 10-40% solids, 15-35% solids, 15-25% solids, or 10-15% solids.
7. The process of any one of claims 1-6, wherein the homogenizing takes place
under pressure.
8. The process of claim 7, wherein the pressure is 2,000-15,000 psi, 5,000-10,000
20 psi, 8,000-10,000 psi, or about 10,000 psi.
9. The process of any one of claims 1-8, further comprising mixing a second
enzyme with the slurry, wherein the second enzyme is different than the enzyme.
10. The process of claim 9, further comprising homogenizing the slurry for a second
time.
- 25 11. The process of any one of claims 1-10, further comprising incubating the slurry
and the enzyme for a period of time.
12. The process of claim 11, wherein the incubating occurs at a temperature of at
least 35°C, at least 45°C, at least 55°C, 55-57°C at least 65°C, between 50-90°C, 60-80°C, or
about 70°C.
- 30 13. The process of claim 11 or claim 12, wherein the incubating occurs for at least 5
minutes, at least 15 minutes, at least 25 minutes, at least 35 minutes, at least 45 minutes, at least
55 minutes, at least 65 minutes, at least 75 minutes, at least 85 minutes, between 45-135

minutes, between 55-125 minutes, between 65-115 minutes, between 75-105 minutes, between 85-95 minutes, or about 90 minutes.

14. The process of any one of claims 1-13, wherein the enzyme has alpha-amylase activity.

5 15. The process of any one of claims 2-14, wherein the inactivating comprises heating the enzyme and the slurry to a temperature of at least 70°C, at least 72°C, at least 74°C, at least 75°C, at least 76°C, at least 80°C, at least 85°C, at least 90°C, at least 93°C, or at least 95°C.

10 16. The process of any one of claims 2-15, wherein the inactivating occurs at a time of at least 30 seconds, at least 1 minute, at least 90 seconds, at least 2 minutes, at least 5 minutes, no more than 4 minutes, at least 10 minutes, at least 15 minutes, at least 20 minutes, at least 25 minutes, at least 30 minutes, at least 35 minutes, at least 40 minutes, at least 45 minutes, at least 50 minutes, at least 55 minutes, at least 60 minutes, at least 65 minutes, or at least 70 minutes.

15 17. The process of claim 16, wherein the inactivating occurs for; at least 30 seconds and a temperature of at least 90°C; for at least 45 minutes and a temperature of at least 74°C; about 60 minutes at about 76°C; or about one minute at about 93°C.

18. The process of any one of claims 1-17, further comprising holding the slurry and the enzyme at a temperature.

20 19. The process of claim 18, wherein the temperature is between 30-70°C, between 35-65°C, between 40-60°C, between 45-55°C, or about 50°C.

20 20. The process of any one of claims 4-19, wherein the drying the slurry to the powder comprises spray draying.

21. The process of any one of claims 4-20, wherein the powder comprises less than 10% moisture.

25 22. The process of claim 20 or 21, wherein spray drying comprises an inlet temperature of between 500-520°F and an outlet temperature of 185-200°F.

23. The process of any one of claims 4-22, further comprising:
hydrating the powder; and
incorporating the hydrated powder into a food product.

30 24. The process of any one of claims 1-3, further comprising incorporating the slurry into a food product.

25. The process of any one of claims 1-24, further comprising homogenizing a second composition with the water and the comminuted pulse.

26. The process of any one of claims 3-25, further comprising cooling the cooked slurry.
27. The process of any one of claims 1-26, further comprising filtering the slurry.
28. The process of any one of claims 1-27, wherein the pulse is selected from the
5 group consisting of beans of Phaseolus species, beans of Vigna species, beans of Vicia species, peas, chickpeas, lentils, and combinations of any thereof.
29. The process of claim 25, wherein the second composition is selected from the group consisting of a product of wheat, oat, sorghum, an ancient grain, corn, buckwheat, quinoa, chia, rice, barley, millet, rye, triticale, fonio, teff, wild rice, spelt, einkorn, emmer, durum,
10 kamut, and combinations of any thereof.
30. A product produced by the process of any one of claims 1-29.
31. A process for producing a pulse product, comprising:
producing a slurry with a comminuted pulse and water;
cooking the slurry;
15 homogenizing the slurry;
mixing an enzyme with the slurry; and
inactivating the enzyme mixed with the slurry.
32. The process of claim 31, further comprising drying the slurry to a powder.
33. The process of claim 31 or claim 32, further comprising mixing a second enzyme
20 with the slurry, wherein the second enzyme has a different activity than the enzyme.
34. The process of any one of claims 31-33, further comprising homogenizing the slurry a second time after the enzyme treatment.
35. The process of any one of claims 31-34, wherein the enzyme has an amylase activity.
- 25 36. The process of any of one claims 33-35, wherein the second enzyme has a xylanase activity.
37. The process of any one of claims 31-36, wherein producing the slurry comprises:
comminuting the pulse; and
placing the comminuted pulse in the water.
- 30 38. The process of any one of claims 31-37, wherein the slurry has a solids content of 10-30%.

39. The process of any one of claims 31-38, wherein inactivating the enzyme comprises heating the slurry and the enzyme to a temperature sufficient to inactivate the enzyme.

5 40. The process of any one of claims 32-39, wherein the drying the slurry comprises spray drying the slurry.

41. The process of any one of claims 31-40, further comprising cooling the slurry after the cooking.

42. The process of any one of claims 31-41, further comprising filtering the slurry.

10 43. A homogenized, enzyme treated, comminuted pulse product, comprising: a particle size distribution having a mean particle size of less than 250 microns.

44. The homogenized, enzyme treated, comminuted pulse product of claim 43, having a mean particle size of less than 200 microns, less than 150 microns, less than 100 microns, or less than 50 microns.

15 45. The homogenized, enzyme treated, comminuted pulse product of claim 43 or claim 44, wherein upon dispersion in water at a solids content of between 10-15% solids, the dispersed homogenized, enzyme treated, pulse product has a lowered viscosity as compared to the comminuted, pulse product that has not been homogenized and enzyme treated.

20 46. The homogenized, enzyme treated, comminuted pulse product of any one of claims 43-45, wherein the dispersed homogenized, enzyme treated, pulse product has less dietary fiber, more soluble fiber, less insoluble fiber, and combinations of any thereof as compared to the comminuted, pulse product that has not been homogenized and enzyme treated.

25 47. The homogenized, enzyme treated, comminuted pulse product of any one of claims 43-46, wherein the pulse is selected from the group consisting of beans of Phaseolus species, beans of Vigna species, beans of Vicia species, peas, chickpeas, lentils, and combinations of any thereof.

48. A method of treating a person having dysphagia, the method comprising: feeding the homogenized, enzyme treated, comminuted pulse product of any one of claims 43-47 to the person having dysphagia.

30 49. The method of claim 48, further comprising incorporating the homogenized, enzyme treated, comminuted pulse product into a food product having a viscosity of 1-50 mPa, 51-350 mPa, 351-1750 mPa, or more than 1750 mPa.

50. A food product comprising the homogenized, enzyme treated, comminuted pulse product of any one of claims 43-47.

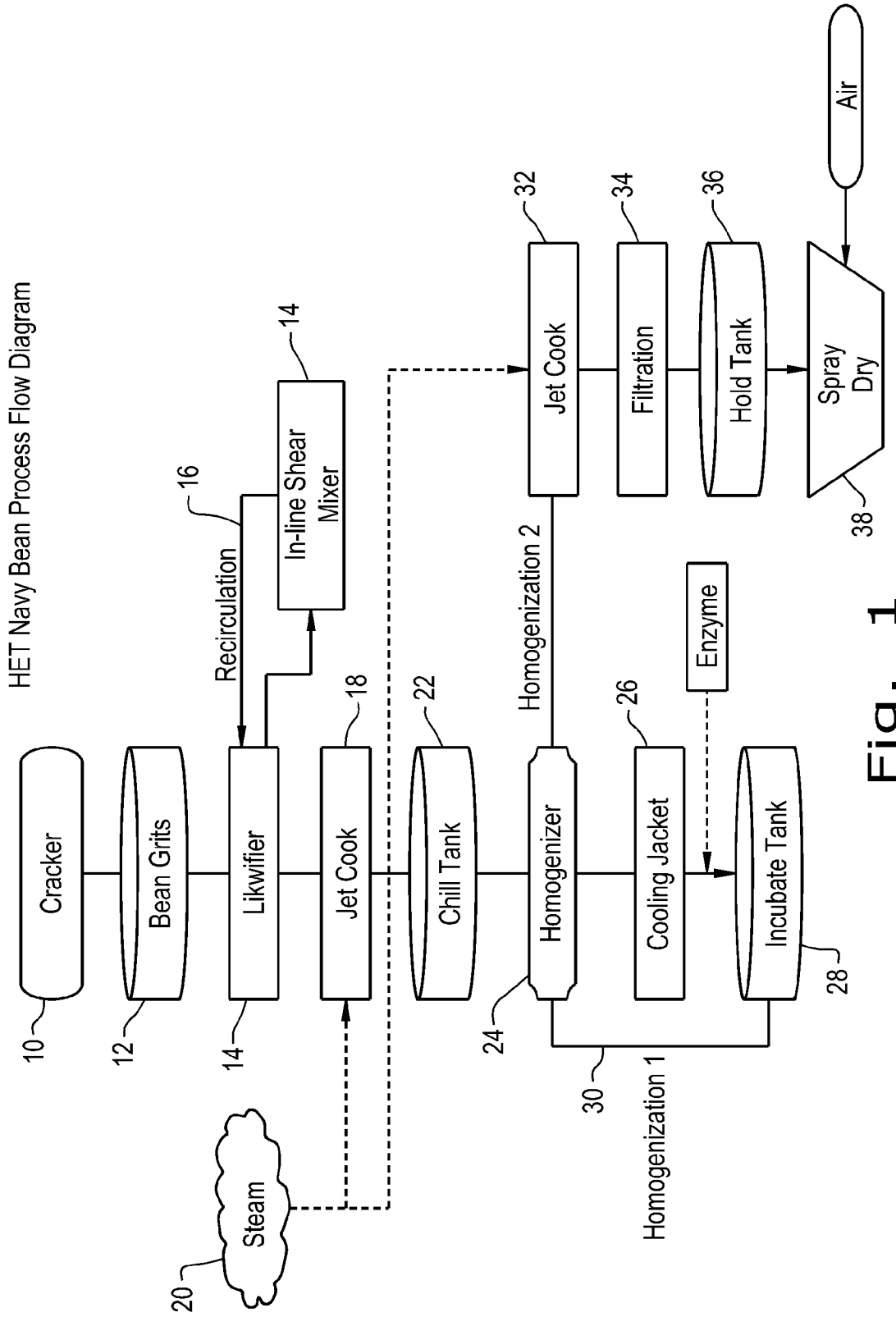
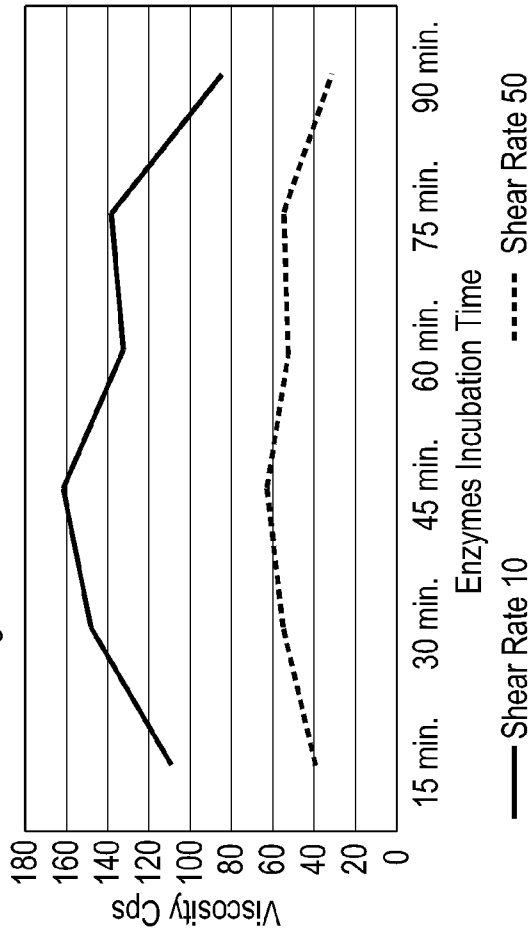


Fig. 1

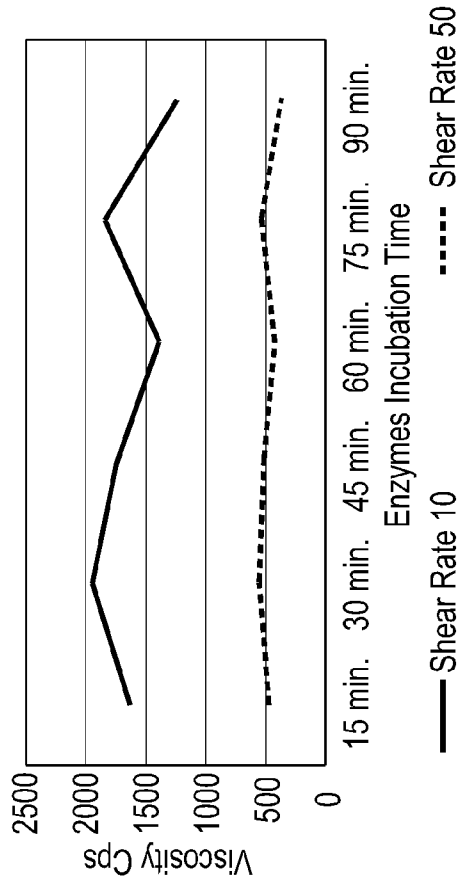
HET-Homogenized Enzyme Treated Edible Bean

Viscosity profile of 10.12% solids of navy bean solution during incubation with Clarase and Rohalase



The effect of Clarase and Rohalase upon bean solution taken from incubation tank at specific time interval at 57 C

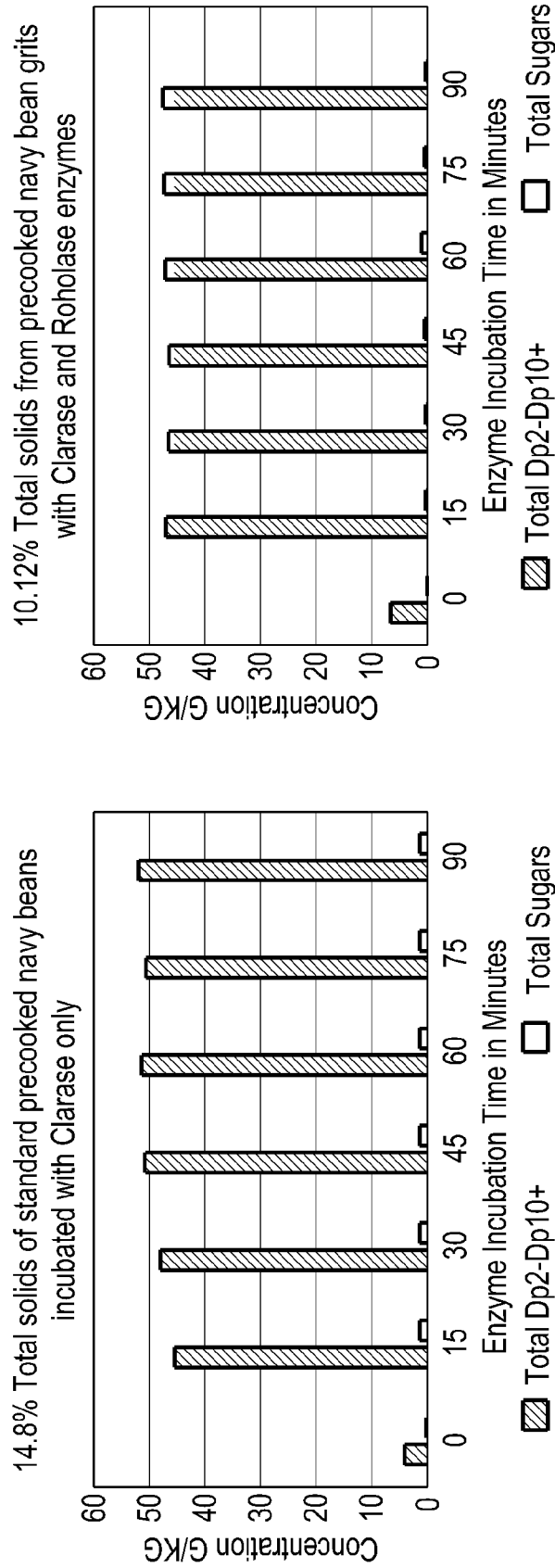
Viscosity measurement 10.12% total solids of navy bean treated with Rohalase enzyme



The effect of Rohalase enzyme injected in bean solution after homogenizer1 and incubated at specific time interval within oven at 57 C

Fig. 2

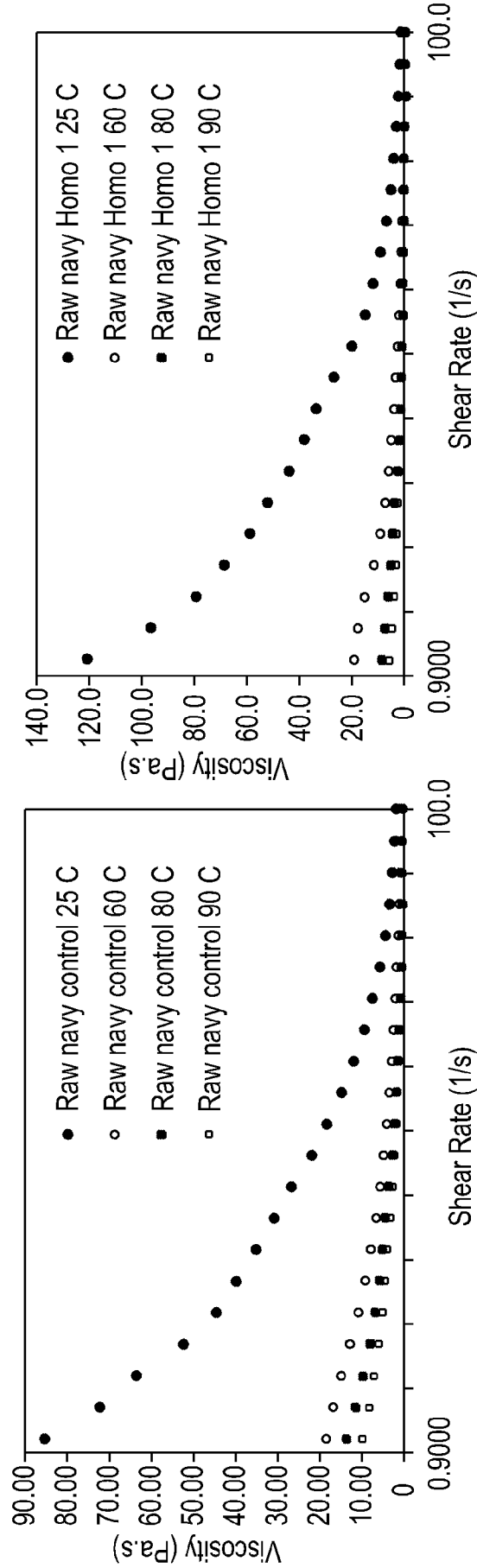
HET - Homogenized Enzyme Treated Edible Beans



The use of Roholase has no effect upon production of DP2-DP10+ and total sugars as well as no effect upon viscosity

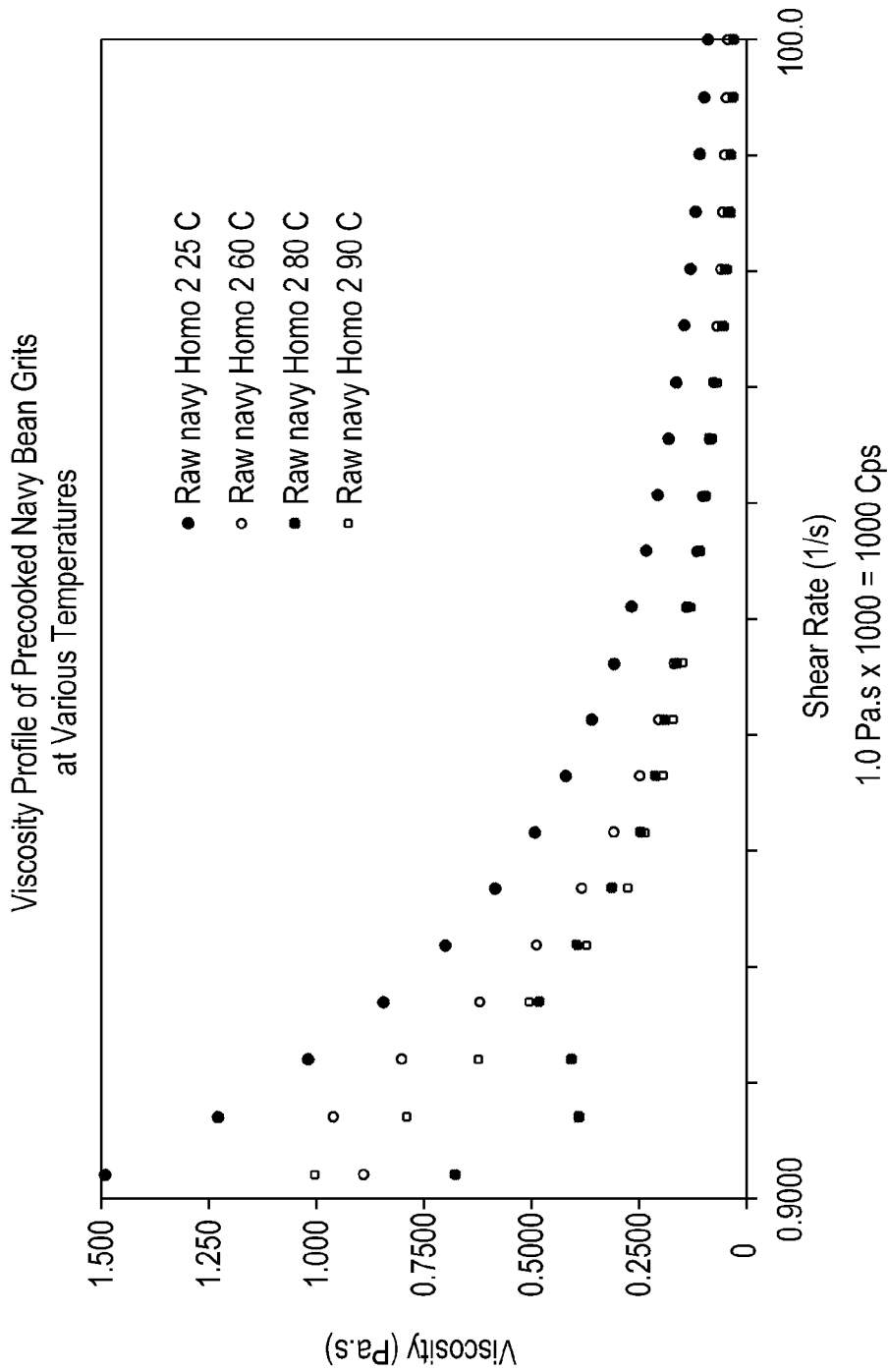
Fig. 3

HET-Viscosity at Various Temperatures



The control and homogenized bean solution has high viscosity at room temperature.
The viscosities are lower at higher temperatures and shear rate.

Fig. 4



The viscosity of bean solution after homogenizer2 exhibit lowest viscosity across various temperatures. This is due to enzymes incubation and homogenization at 10k PSI.

Fig. 5

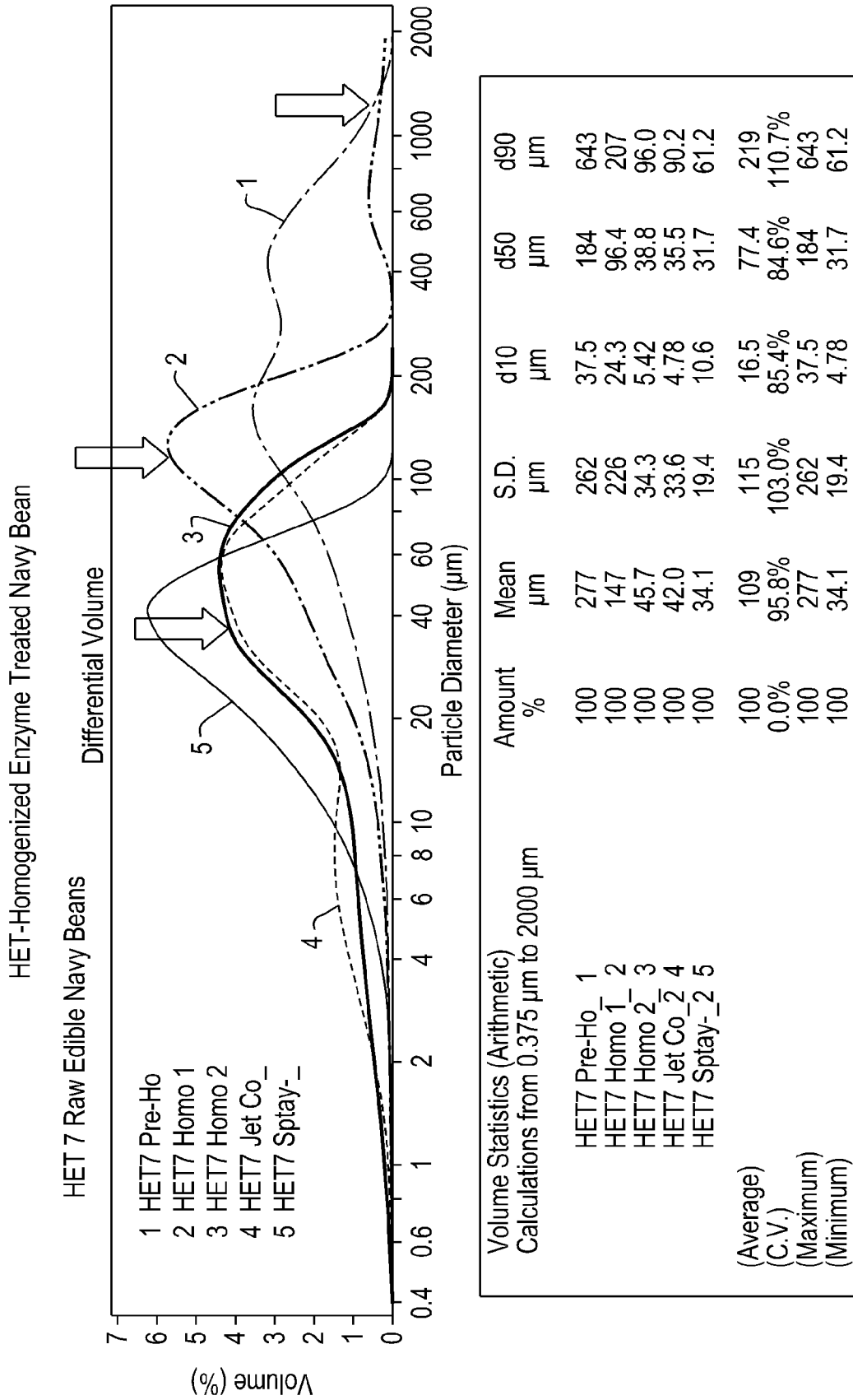


Fig. 6

Color Comparison of HET7 Versus Standard Precooked Navy Bean Powder

HET 7:
L: 73.11
A: -0.39
B: 10.09

Standard:
L: 69.40
A: 4.32
B: 18.76

7/7

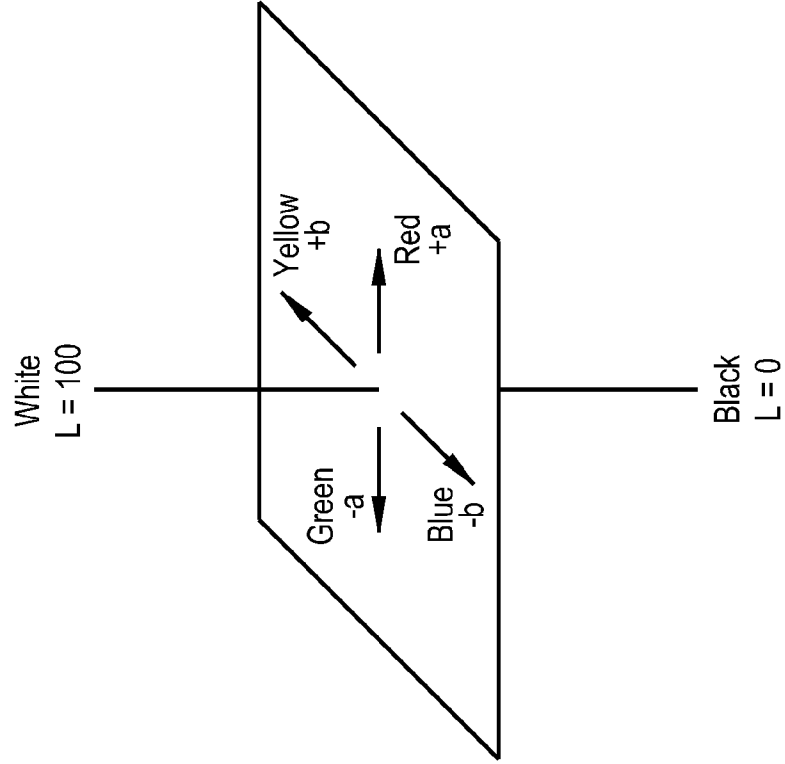


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 17/14934

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.: 4-30, 34-42, 46-50
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:

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.:

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/US 17/14934
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A. CLASSIFICATION OF SUBJECT MATTER
 IPC(8) - A23L 27/60, A23L 11/00 (2017.01)
 CPC - A23L 27/60, A23L 11/05

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
 See Search History Document

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.
X --- Y	US 4,119,733 A (Hsieh et al.) 10 October 1978 (10.10.1978) abstract, col4, ln6, 8, 20-23, 62; col5, ln22-25, 29-30, 38; col6, ln7;	1-3, 31, 43-45 ----- 32, 33/31 and 33/32
Y	US 2002/0197350 A1 (Akazawa) 26 December 2002 (26.12.2002) abstract	32, 33/31 and 33/32
X	US 4,882,180 A (Takao) 21 November 1989 (21.11.1989) abstract	1-2
X	US 2006/0165869 A1 (Suzuki) 27 July 2006 (27.07.2006) abstract	1-2
X	WO 2007/028222 A2 (GOLD NUTRITION PESQUISA DESENV) 15 March 2007 (15.03.2007) abstract	1-2

Further documents are listed in the continuation of Box C.

* Special categories of cited documents:	"I" 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
"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"&" document member of the same patent family
"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	

Date of the actual completion of the international search 14 March 2017	Date of mailing of the international search report 18 APR 2017
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Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774
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