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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 July 2022 (14.07.2022)

WIPO | PCT

(10) International Publication Number
WO 2022/147594 A1

(51) International Patent Classification:
A23L 11/00 (2021.01) *A23J 3/14* (2006.01)
A23J 3/26 (2006.01) *A23P 30/20* (2016.01)
A23J 3/22 (2006.01)

(21) International Application Number:
PCT/AU2021/051500

(22) International Filing Date:
16 December 2021 (16.12.2021)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2021900045 11 January 2021 (11.01.2021) AU

(71) Applicant: **VIGA FOODS PTY LTD** [AU/AU]; 500A Kurmond Road, Freemans Reach, New South Wales 2756 (AU).

(72) Inventor: **NUNN, Garry Robert**; 500A Kurmond Road, Freemans Reach, New South Wales 2756 (AU).

(74) Agent: **WRAYS PTY LTD**; Level 7, 863 Hay Street, Perth, Western Australia 6000 (AU).

(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, IT, 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, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, 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:** METHOD FOR PRODUCING A LEGUME-BASED COMPOSITION WITH IMPROVED BINDING PROPERTIES AND FORMED FOOD PRODUCTS COMPRISING SAME

(57) **Abstract:** A method for producing a legume composition with improved binding properties, the method comprising the steps of; at least partially germinating a legume such that a radicle and/or root of the at least partially germinated legume is up to 2 cm in length; mincing the at least partially germinated legume to provide a minced legume composition; heating the minced legume composition to a temperature of 75°C or greater, to provide the legume composition with improved binding properties.

WO 2022/147594 A1

Method for producing a legume-based composition with improved binding properties and formed food products comprising same

TECHNICAL FIELD

[0001] The present invention relates to a method for producing a legume-based composition having improved binding properties, and formed foods produced using the composition. In a specific form of the invention, the legume is the seed from a plant of the genus Vigna.

[0002] This specification claims priority from Australian provisional patent specification 2021900045, the contents of which are hereby incorporated by reference.

BACKGROUND ART

[0003] The health and environmental benefits of vegetarian and vegan diets are well recognized, and consumers are increasingly making conscious efforts to decrease their intake of animal derived food items. To meet the rising demand for vegetarian and vegan dietary products and to address the environmental burden associated with animal meat consumption, food scientists have engaged in efforts to develop protein-rich food products that are not derived from animals but provide similar textural properties and nutritional benefits as animal-derived food products.

[0004] The nutritional benefits of legumes are well known, in particular as sources of protein. However, legumes processed by known methods have limited binding properties, so do not contribute to the cohesiveness of the compositions in which they are used, often necessitating the use of dedicated binding agents to allow the production of formed food products.

[0005] It is one object of the present invention to provide a legume composition with advantageous binding properties, thereby allowing the use of lower quantities of binding agent when producing a formed food product.

[0006] The preceding discussion of the background art is intended to facilitate an understanding of the present invention only. The discussion is not an acknowledgement or admission that any of the material referred to is or was part of the common general knowledge as at the priority date of the application.

SUMMARY OF INVENTION

[0007] The present invention provides a method for producing a legume composition with improved binding properties, the method comprising the steps of;

at least partially germinating a legume such that a radicle and/or root of the at least partially germinated legume is up to 2 cm in length;

mincing the at least partially germinated legume to provide a minced legume composition;

heating the minced legume composition to a temperature of 75°C or greater, to provide the legume composition with improved binding properties.

[0008] The invention also provides legume compositions produced by such a method, and formed food products providing such legume composition.

[0009] The invention further provides formed food products comprising the legume compositions of the invention with reduced binding agent concentrations relative to known formed food compositions, including formed food products consisting essentially of the legume composition of the present invention and, optionally water and flavouring agents.

DETAILED DESCRIPTION OF THE INVENTION

[0010] Throughout this specification, unless the context requires otherwise, the word "comprise" or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

[0011] Throughout this specification, unless the context requires otherwise, the term “legume” is a plant of the family Fabaceae or Leguminosae or the seed of such a plant.

[0012] Throughout this specification, unless the context requires otherwise, the term mung bean refers to the fruit or seed of the plant *Vigna radiata*, which was formerly known as *Phasoleus aureus* of *Phasoleus radiatus*.

[0013] The term “binding” as used herein refers to promoting, supporting, or enabling holding together ingredients in one cohesive mass. A method for quantifying binding of a formed food product is described in the Examples section below.

[0014] The term “binding agent” as used herein refers to an agent that mediates binding.

[0015] Throughout this specification, unless the context requires otherwise, reference to “improved” binding properties (and variations thereof, such as “improvement”) means that the properties are improved relative to the binding properties of legume compositions that have not been subjected to the methods of the present invention.

[0016] In one form of the invention, the improved binding properties of the compositions of the invention are improved relative to the binding properties of legume compositions that have not been subjected to the methods of the present invention, as measured by guillotine resistance according to weight. In a preferred form of the invention, the improved binding properties of the compositions of the invention are improved relative to the binding properties of legume compositions that have not been subjected to the methods of the present invention, as measured by guillotine resistance according to weight as described in the Examples section below.

[0017] Throughout this specification, unless the context requires otherwise, the phrase “formed food product” means a food product that has been formed into a predetermines shape, such as a patty for use in a burger, a nugget *etc*.

[0018] The present invention is intended for the processing of legumes on a commercial scale. Within a quantity of legumes, there will be variation in the rate at which individual legumes germinate. As such, references to emerging root and/or radicle length in this specification are to be understood to be a reference to a mean length across the population of legumes subjected to the method, as determined by measuring the root and/or radicle length of legumes in a representative sample of the population. In a specific form of the invention, the sample is of sufficient size to determine the mean of the population to a 95% confidence interval.

[0019] In one aspect, the present invention provides a method for producing a legume composition with improved binding properties, the method comprising the steps of;

at least partially germinating a legume such that a radicle and/or root of the at least partially germinated legume is up to 2 cm in length;

mincing the at least partially germinated legume to provide a minced legume composition;

heating the minced legume composition to a temperature of 75°C or greater, to provide the legume composition with improved binding properties.

[0020] As would be understood by a person skilled in the art, the radicle is the first part of a seedling to emerge from the seed during the process of germination. The radicle is the embryonic root of the plant, so becomes the root of the plant. The point of transition from radicle to root is not important to the present invention. Rather the present invention requires that the radicle be up to 2 cm in length, the root be up to 2 cm in length, or a combination between the root and radicle be up to 2 cm in length.

[0021] As would also be understood by a person skilled in the art, the radicle may appear with adventitious roots. Any adventitious roots will be shorter than the radicle, so the radicle and/or root derived from the radicle is readily identifiable. For the purposes of determining whether a radicle and/or root of the at least partially germinated legume is up to 2 cm in length, adventitious roots are disregarded.

[0022] The length of the radicle and/or root is determined by measuring from the edge of the legume seed to the tip of the extended root. Any internal portion of the radicle is not relevant for the purposes of this invention.

[0023] In preferred forms of the invention, the step of at least partially germinating a legume such that a radicle and/or root of the at least partially germinated legume is up to 2 cm in length more specifically comprises:

at least partially germinating a legume such that a radicle and/or root of the at least partially germinated legume is from 1cm to 2 cm in length.

[0024] In a preferred form of the invention, the quantity of legume subjected to the method of the invention is 2 kg or greater. Preferably still 5 kg or greater. Further and still preferably 10 kg or greater. Further and still preferably 20 kg or greater. Further and still preferably 50 kg or greater. Further and still preferably 100 kg or greater.

[0025] The present invention includes legume compositions produced by this method.

[0026] Without wishing to be bound by theory, the inventors believe that the method of the present invention reflects two processes, one biochemical and one physicochemical. First, the at least partial germination of the legume through natural enzymatic reaction causes starches to be converted to soluble fibres, complex polysaccharides such as pectins. However, the

inventors have found that if the radicle or emerging root is longer than 2cm then the binding capacity of the soluble fibres are greatly diminished. Again, without wishing to be bound by theory, the inventors believe that this reflects the essential complex polysaccharides being converted from long chain polysaccharides to short chain sugar and glucose, which have negligible binding capacity. As shown in the data disclosed in the Examples section of this specification, an even more advantageous embodiment involves controlling germination such that the radicle or emerging root is from 1 cm to 2 cm long. The second key process is that the polysaccharides, including pectins, key to the binding process must be solubilized to achieve the desired binding properties in the composition, and the inventors have discovered that it is necessary to heat the composition to 75°C or greater to achieve the necessary binding properties.

[0027] The method of the present invention is capable of providing a legume composition with binding properties sufficient to obviate the need for conventional binding agents in the preparation of a formed food product comprising the legume composition. That is, the formed food composition may exclusively comprise the legume composition and, optionally, water. Such formed food products are within the scope of the present invention.

[0028] Furthermore, the legume composition has application in the production of formed food products comprising other ingredients having binding properties insufficient to enable the formation of a formed food product from that ingredient alone. The ratio of legume composition to other ingredient in the formed food product to enable a sufficiently bound formed food product would be readily ascertainable by persons skilled in the art. Such formed food products are within the scope of the present invention.

[0029] While certain legume compositions of the present invention may obviate the use of binding agents altogether, compositions of the invention may be utilized with conventional binding agents, enabling the use of lower amounts of said conventional binding agents.

[0030] Binding agents

[0031] In one form, the present invention provides a formed food product comprising the legume composition of the present invention, and less than 20% w/w binding agent(s).

[0032] Throughout this specification, unless the context requires otherwise, the term “binding agent” or variations such as “binding agents” should be understood to be a reference to conventional binding agents, and not include the legume compositions of the present invention.

[0033] As would be understood by a person skilled in the art, a single formed food product may employ more than one binding agent to achieve the necessary binding property. Throughout this specification, unless the context requires otherwise, references to a particular percentage of binding agent(s) in a formed food product should be understood to be a reference to the percentage of all of the binding agents (other than the legume composition of the invention, as described above) in the formed food product.

[0034] In preferred forms of the invention, the formed food product comprises an amount of binding agent(s) less than a % w/w selected from the group: 15%, 10%, 5%, 2.5%, 1%, 0.5%, 0.25%, 0.1%, 0.05%, and 0.01%.

[0035] In specific forms of the invention, the maximum %w/w of binding agent in the formed food composition refers to a the sum of the %w/w of any of the following binding agents: purees (e.g., bean puree, sweet potato puree, pumpkin puree, applesauce, yam puree, banana puree, plantain puree, date puree, prune puree, fig puree, zucchini puree, carrot puree, coconut puree), native or modified starches (e.g., starches from grains, starches from tuber, potato starch, sweet potato starch, corn starch, waxy corn starch, tapioca starch, tapioca, arrowroot starch, taro starch, pea starch, chickpea starch, rice starch, waxy rice starch, lentil starch, barley starch, sorghum starch, wheat starch, and physical or chemical modifications thereof [including, e.g. pre-gelatinized starch, acetylated starch, phosphate bonded starch, carboxymethylated starch, hydroxypropylated starch]), flours derived from grains or legumes or roots (e.g. from taro, banana, jackfruit, konjac, lentil, fava, lupin bean, pea, bean, rice, wheat, barley, rye, corn, sweet rice, soy, teff, buckwheat, amaranth, chickpea, sorghum, almond, chia seed, flaxseed, potato, tapioca, potato), protein isolates (e.g. from potato, soy, pea, lentil, chickpea, lupin, oat, canola, wheat), hydrolyzed protein isolates (e.g. hydrolyzed pea protein isolate, hydrolyzed soy protein isolate), protein concentrates (e.g. from algae, lentil, pea, soy, chickpea, rice, hemp, fava bean, pigeon pea, cowpea, vital wheat gluten), beta-glucans (e.g. from bacteria [e.g., curdlan], oat, rye, wheat, yeast, barley, algae, mushroom), gums (e.g. xanthan gum, guar gum, locust bean gum, gellan gum, gum arabic, vegetable gum, tara gum, tragacanth gum, konjac gum, fenugreek gum, gum karaya, gellan gum, high-acetyl gellan gum, low-acetyl gellan gum), native or relatively folded (i.e. not fully in the native functional state but not fully denatured) proteins (e.g. fava protein, lentil protein, pea protein, ribulose-1,5-bisphosphate carboxylase/oxygenase [Rubisco], chickpea protein, mung bean protein, pigeon pea protein, lupin bean protein, soybean protein, white bean protein, black bean protein, navy bean protein, adzuki bean protein, sunflower seed protein), polysaccharides and modified polysaccharides (e.g. methylcellulose, hydroxypropyl methylcellulose, carboxymethyl cellulose, maltodextrin, carrageenan and its salts, alginic acid and its salts, agar, agarose, agaropectin, pectin,

alginate), nut and seed butters (e.g. almond butter, cashew butter, hazelnut butter, macadamia nut butter, peanut butter, pecan butter, pistachio butter, walnut butter, pumpkin seed butter, sesame seed butter, soybean butter, sunflower seed butter), enzymes (e.g. transglutaminase, thio-oxidoreductase), prolamin proteins (e.g., Zein protein), gelatin, egg protein, potato flakes, okra, tubers, fibers (e.g. psyllium husk), and derivatives thereof.

[0036] A formed food product wherein the binding agent is any one of the group: wheat, oats, corn flour, maize, flax seed, potato starch, and methylcellose.

[0037] Preferred legumes

[0038] In a preferred form of the invention, the legume is a fruit or seed of a plant of the genus Vigna.

[0039] In a particularly preferred form of the invention, the legume is a fruit or seed of *Vigna radiata.*

[0040] Temperature treatment step

[0041] In a preferred form of the invention, the step of heating the minced legume composition to a temperature of 75°C or greater more specifically comprises:

heating the minced legume composition to a temperature from 75°C to 90°C.

[0042] Preferably still, the temperature is from 75°C to 85°C. Further and still preferably, the temperature is from 74°C to 84°C. Further and still preferably, the temperature is from 73°C to 83°C. Further and still preferably, the temperature is from 72°C to 82°C. In a highly preferred form of the invention, the temperature is from 71°C to 81°C.

[0043] Mincing

[0044] Mincing is a necessary step to enable the legume composition of the present invention to be formed into a food product. The mincing step also at least partially homogenises the legume composition of the present invention to enable the distribution of the polysaccharides that impart the desirable binding properties throughout the composition. Apparatus for mincing compositions, such as the legume composition of the present invention, are known to persons skilled in the art. For example known industrial mincers used for

processing meat products, bowl cutters, such as those used for making smallgoods, food processors and graters.

[0045] Mincing also affords an opportunity to effect a physical separation of less desirable components of the legume composition, such as skins, as well as affording an opportunity to impart a desirable texture to the composition.

[0046] In one form of the present invention, the step of mincing the at least partially germinated legume to provide a minced legume composition more specifically comprises the step of:

> mincing the at least partially germinated legume through a first mincer plate having holes of a diameter of from 3 to 5 mm; then
>
> mincing the at least partially germinated legume through a second mincer plate having holes of a diameter of from 1 to 3 mm.

[0047] This preferred mincing method achieves two desirable outcomes, especially when the legume composition is formed from mung beans. The first mincer plate effectively removes at least a portion of the skins of the legume, while the second mincer plate produces a range of particle sizes that has a desirable mouthfeel and texture n the formed food product is intended for use as a meat substitute.

[0048] In preferred forms of the invention the holes of the first mincer plate have a diameter of 3.5 to 4.5 mm.

[0049] In preferred forms of the invention, the holes of the second mincer plate have a diameter of 1.5 to 2.5 mm.

[0050] Methods for at least partial germination

[0051] Any method for partial germination of the legume to the specified extent has utility in the present invention. For example, the legume could simply be soaked in water at room temperature for a predetermined period of time, with ungerminated legumes optionally being physically separated from legumes that have germinated to the necessary extent. However, commercial expediency means that the following are advantageous: (i) the at least partial

germination happens relatively quickly and (ii) that in a batch of legumes, a large portion are germinated to the necessary extent.

[0052] In one form of the invention, the step of at least partially germinating a legume such that a radicle and/or root of the at least partially germinated legume is up to 2 cm in length more specifically comprises:

soaking an ungerminated legume in water.

[0053] In a preferred form of the invention, the ratio of water to ungerminated legume is from 10:1 to 1:1 v/v Preferably still, the ratio of water to ungerminated legume is from 5:1 to 1:1 v/v. Preferably still, the ratio of water to ungerminated legume is from 3:1 to 1:1 v/v. Preferably still, the ratio of water to ungerminated legume is from 2.5:1 to 1:1 v/v. In a highly preferred form of the invention, the ratio of water to ungerminated legume is from 2:1 to 1:1 v/v.

[0054] In one form of the invention, the step of soaking an ungerminated legume in water comprises introducing the ungerminated legume into a vessel and covering the ungerminated legume in water.

[0055] While elevated temperatures may initiate more rapid germination of the legume, the inventors have discovered that prolonged exposure to elevated temperatures produce the undesirable effect of effectively cooking the legume, thereby denaturing the proteins necessary for the formation of the polysaccharides necessary to provide the desirable binding properties of the legume compositions of the present invention. The inventors have also discovered a heating and cooling regimen that they have demonstrated effects efficient germination to the necessary extent, while at the same time preserving the binding properties of the ultimately formed composition.

[0056] In a preferred form of the invention, where the step of at least partially germinating a legume such that a radicle and/or root of the at least partially germinated legume is up to 2 cm in length comprises the step of soaking an ungerminated legume in water, the step of soaking an ungerminated legume in water more specifically comprises:

soaking an ungerminated legume in water wherein the temperature of the legume-water mixture is from 55°C to 80°C, and wherein after a period of 5 minutes, the temperature of the legume-water mixture is less than or equal to 65°C, and wherein after a period of 40 minutes the temperature of the legume-water mixture is less than or equal to 50°C.

[0057] In one form of the invention, after a period of 40 minutes the temperature of the legume-water mixture is less than or equal to 40°C.

[0058] The inventors have found that this approach – an initial flush of hot water which is quickly cooled – provides an advantageous improvement in the proportion of legume that germinates to the necessary extent.

[0059] In preferred forms of the invention, the temperature ranges described in the preceding paragraph are achieved by the addition of a quantity of pre-heated water to the legume, then by the addition of cooler water. Heating a mixture of legume and water from room temperature to the desired temperature range within the desired time frame.

[0060] Once the temperature has been reduced, the legumes may be left to soak in the water for an extended period without the risk of cooking the legumes.

[0061] In a preferred form of the invention, the step of soaking an ungerminated legume in water more specifically comprises the step of:

soaking an ungerminated legume in water a predetermined period of from 6 to 24 hours.

[0062] Preferably still, the predetermined period is from 8 to 22 hours. Preferably still, the predetermined period is from 10 to 20 hours. In a highly preferred form of the invention, the predetermined period is from 12 to 18 hours.

[0063] Depending on the amount of water used in the at least partial germination step, at least some of the water may be separated from the legume prior to the mincing step.

[0064] The period between contacting the legume with water and making the formed food product may be adjusted to effect the necessary extent of germination of the legume such that the emerging root/radicle is up to 2 cm and, preferably from 1 cm to 2 cm. Part of this time period may be while the legume is soaking in water, and part may be after the legume has been at least partially separated from the water. For legumes in the form of mung beans, this period is approximately 48 hours.

[0065] Making the formed food product

[0066] In one form, the invention comprises a method for producing a formed food product, the method comprising:

producing a legume composition by a method as described above;

after the step of exposing the minced legume composition to a temperature of 75°C or greater, and

without letting the temperature drop below 40°C, forming the formed food product.

[0067] Preferably, the temperature does not drop below 45°C. Preferably, the temperature does not drop below 50°C. Preferably still, the temperature does not drop below 55°C. Preferably still, the temperature does not drop below 60°C. In highly preferred forms of the invention, the temperature does not drop below 65°C. In highly preferred forms of the invention, the temperature does not drop below 70°C. In highly preferred forms of the invention, the temperature does not drop below 75°C.

[0068] In preferred forms of the invention, the step of forming the formed food product takes place at a temperature from 40°C to 90°C. Preferably the step of forming the formed food product takes place at a temperature from 40°C to 80°C. Preferably the step of forming the formed food product takes place at a temperature from 50°C to 80°C. Preferably the step of forming the formed food product takes place at a temperature from 60°C to 80°C. Preferably the step of forming the formed food product takes place at a temperature from 65°C to 80°C. Preferably the step of forming the formed food product takes place at a temperature from 70°C to 80°C. Preferably the step of forming the formed food product takes place at a temperature from 72°C to 78°C. Preferably the step of forming the formed food product takes place at a temperature from 74°C to 76°C. Preferably the step of forming the formed food product takes place at a temperature of approximately 75°C.

General

[0069] Those skilled in the art will appreciate that the invention described herein is susceptible to variations and modifications other than those specifically described. The invention includes all such variation and modifications. The invention also includes all of the steps, features, formulations and compounds referred to or indicated in the specification, individually or collectively and any and all combinations or any two or more of the steps or features.

[0070] Each document, reference, patent application or patent cited in this text is expressly incorporated herein in their entirety by reference, which means that it should be read and considered by the reader as part of this text. That the document, reference, patent application or patent cited in this text is not repeated in this text is merely for reasons of conciseness.

[0071] Any manufacturer's instructions, descriptions, product specifications, and product sheets for any products mentioned herein or in any document incorporated by reference herein, are hereby incorporated herein by reference, and may be employed in the practice of the invention.

[0072] The present invention is not to be limited in scope by any of the specific embodiments described herein. These embodiments are intended for the purpose of exemplification only. Functionally equivalent products, formulations and methods are clearly within the scope of the invention as described herein.

[0073] The invention described herein may include one or more range of values (e.g. size, displacement and field strength etc.). A range of values will be understood to include all values within the range, including the values defining the range, and values adjacent to the range which lead to the same or substantially the same outcome as the values immediately adjacent to that value which defines the boundary to the range.

[0074] Other definitions for selected terms used herein may be found within the detailed description of the invention and apply throughout. Unless otherwise defined, all other scientific and technical terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which the invention belongs. The term "active agent" may mean one active agent, or may encompass two or more active agents.

[0075] Further features of the present invention are more fully described in the following description of several non-limiting embodiments thereof. This description is included solely for the purposes of exemplifying the present invention. It should not be understood as a restriction on the broad summary, disclosure or description of the invention as set out above.

EXAMPLES

[0076] Production of legume composition

[0077] A quantity of legumes in the form of mung beans was placed in a tub, and hot water added to at least cover the beans. The temperature of the water after adding to the mung beans bean mix was 90°C, and the mung beans were at room temperature. The volume of water added was approximately twice the volume of the mung beans, and the temperature of the mixture on addition was 80°C. Cool water was added to the mixture such that within 5 minutes the temperature was at 65°C. A further quantity of cold water was added such that after 40 minutes the temperature was 40°C.

[0078] The aim is to ensure all the beans take up water and begin germination and do not cook.

[0079] The early stage germinating beans, having absorbed water, such that the bean is swollen, no discernible root or emerging to 5mm are then minced through a 4mm plate, then again through a 2 mm plate.

[0080] This method creates a mixture of fine and coarse particles in the minced pulp which improves the binding capacity, in the same way that concrete has a mixture of sand and coarse aggregate for binding strength. Passing the beans initially through a 2mm mincer plate causes the skins to block the plate and results in a fine mixture with no coarse fraction. A food processor or bowl cutter can be used to the same effect, although the control of particle sizes is less precise.

[0081] During the second mincing action, flavourings and other food products, such as mushrooms, can be added.

[0082] The pulp is then loaded into a cooking vessel, such as a jacketed scraped pan or preferably an extrusion heat exchanger. The pulp temperature is raised to 80°C.

[0083] The hot pulp is then formed into patties at a range of temperatures as outlined in the binding testing results below.

[0084] Assessment of binding properties

[0085] Patties formed according to the methodology described above were all fried at the same time, for 4 minutes per side with sunflower oil on medium heat.

[0086] Binding properties were assessed using a 1mm thick, flat guillotine on top of which was a vessel to which water could be added to increase weight.

[0087] Patties of similar thickness and width were placed under the guillotine, with the guillotine carefully placed onto the patty surface. Water is slowly added to the vessel until the cutting bar slices through the patty. The higher the weight required to slice the patty indicates higher binding strength. This is an accepted method to determine binding strength, utilized by testing apparatus such as the Bestech Australia TA-1, Amek MT-50, Stable Micro Systems and SAMCO.

[0088] The patties were formed at various temperatures as the mixture cooled. After forming, the patties were left to cool, fried and tested for binding capacity as determined by a guillotine resistance according to weight. Three tests of each patty were performed with an average variation of 100g. Mean results are reported below.

Patty forming temperature (°C)	Resistance weight (kg)
80	4.7
75	4.7
65	4.5
55	4.2
45	3.5
40	2.1
35	1.0

[0089] This shows that maximum binding occurs when patties are formed at maximum temperature as a result of the binding occurring as the product cools.

[0090] Effect of emerging root/radicle length

[0091] Further data was generated with increased emerging root/radicle length. Legumes in the form of mung bean with root at 1cm average, 2 cm maximum length at after 48 hours post contact with water produced better binding results. The test with the mung bean sprout a day later, day 3, with root length between 2 and 3 cm, had zero binding capacity.

Patty forming temperature (°C)	Resistance weight (kg)

60	4.85
65	6.55
70	8.35
72	8.60
75	9.85
78	10.35
80	15.35

[0092] Comparison with commercially available products

[0093] A variety of commercial vegan patties were purchased from supermarkets and tested for binding strength, or cutting resistance. The higher the weight required to slice the patty indicates higher binding strength. The Beyond Meat patty tested at 2.5 kg, providing a guideline for commercially acceptable binding properties.

Patty	Resistance weight (kg)
V2	4.2
Naturali Pea based	4.3
Alternative burger	4.0
Beyond Meat	2.5
Embodiment of invention	4.1

[0094] Other legumes

[0095] Various legumes were treated to the standard soak method (swollen seed, no discernible root or emerging to 5mm), drained, minced and heated to various temperatures. Some beans would not hold shape until forming at higher temperatures. These have been given a bind effect of nil kg.

Legume/ forming T (°C)	60	65	70	75	80
Lentil	6.85	7.35	7.85	8.35	8.55
Soya					1.6
Lima				4.55	6.75
Black eye	4.35	5.50	8.35	9.15	11.85
Great Northern			6.35	7.15	11.35
Broad (Faba)			4.95	6.35	7.35
Berlotti	4.75	5.05	5.95	6.35	6.85

CLAIMS

1. A method for producing a legume composition with improved binding properties, the method comprising the steps of;

   at least partially germinating a legume such that a radicle and/or root of the at least partially germinated legume is up to 2 cm in length;

   mincing the at least partially germinated legume to provide a minced legume composition;

   heating the minced legume composition to a temperature of 75°C or greater, to provide the legume composition with improved binding properties.

2. A legume composition with improved binding properties produced according to the method of claim 1.

3. A formed food product comprising the legume composition of claim 2.

4. A formed food product according to claim 3 characterised in that the formed food product comprises the legume composition of claim 2 and less than 20% w/w binding agent(s).

5. A formed food product according to claim 4 characterised in that the binding agent is any of the group: purees (e.g., bean puree, sweet potato puree, pumpkin puree, applesauce, yam puree, banana puree, plantain puree, date puree, prune puree, fig puree, zucchini puree, carrot puree, coconut puree), native or modified starches (e.g., starches from grains, starches from tuber, potato starch, sweet potato starch, corn starch, waxy corn starch, tapioca starch, tapioca, arrowroot starch, taro starch, pea starch, chickpea starch, rice starch, waxy rice starch, lentil starch, barley starch, sorghum starch, wheat starch, and physical or chemical modifications thereof [including, e.g. pre-gelatinized starch, acetylated starch, phosphate bonded starch, carboxymethylated starch, hydroxypropylated starch]), flours derived from grains or legumes or roots (e.g. from taro, banana, jackfruit, konjac, lentil, fava, lupin bean, pea, bean, rice, wheat, barley, rye, corn, sweet rice, soy, teff, buckwheat, amaranth, chickpea, sorghum, almond, chia seed, flaxseed, potato, tapioca, potato), protein isolates (e.g. from potato, soy, pea, lentil, chickpea, lupin, oat, canola, wheat), hydrolyzed protein isolates (e.g. hydrolyzed pea protein isolate, hydrolyzed soy protein isolate), protein concentrates (e.g. from algae, lentil, pea, soy, chickpea, rice, hemp, fava bean, pigeon pea, cowpea, vital wheat gluten),

beta-glucans (e.g. from bacteria [e.g., curdlan], oat, rye, wheat, yeast, barley, algae, mushroom), gums (e.g. xanthan gum, guar gum, locust bean gum, gellan gum, gum arabic, vegetable gum, tara gum, tragacanth gum, konjac gum, fenugreek gum, gum karaya, gellan gum, high-acetyl gellan gum, low-acetyl gellan gum), native or relatively folded (i.e. not fully in the native functional state but not fully denatured) proteins (e.g. fava protein, lentil protein, pea protein, ribulose-1,5-bisphosphate carboxylase/oxygenase [Rubisco], chickpea protein, mung bean protein, pigeon pea protein, lupin bean protein, soybean protein, white bean protein, black bean protein, navy bean protein, adzuki bean protein, sunflower seed protein), polysaccharides and modified polysaccharides (e.g. methylcellulose, hydroxypropyl methylcellulose, carboxymethyl cellulose, maltodextrin, carrageenan and its salts, alginic acid and its salts, agar, agarose, agaropectin, pectin, alginate), nut and seed butters (e.g. almond butter, cashew butter, hazelnut butter, macadamia nut butter, peanut butter, pecan butter, pistachio butter, walnut butter, pumpkin seed butter, sesame seed butter, soybean butter, sunflower seed butter), enzymes (e.g. transglutaminase, thio-oxidoreductase), prolamin proteins (e.g., Zein protein), gelatin, egg protein, potato flakes, okra, tubers, fibers (e.g. psyllium husk), and derivatives thereof.

6. A formed food product according to claim 5 characterised in that the binding agent is any one of the group: Wheat, oats, cornflour, maize, flax seed, potato starch, and methylcellulose.

7. A method, a legume composition or a formed food product according to any one of the preceding claims, characterised in that the legume is a fruit or seed of a plant of the genus Vigna.

8. A method, a legume composition or a formed food product according to claim 7 characterised in that the legume is a fruit or seed of *Vigna radiata.*

9. A method, a legume composition or a formed food product according to any one of the preceding claims characterised in that the step of at least partially germinating a legume such that a radicle and/or root of the at least partially germinated legume is up to 2 cm in length more specifically comprises:

    at least partially germinating a legume such that a radicle and/or root of the at least partially germinated legume is from 1 to 2 cm in length

10. A method, a legume composition or a formed food product according to any one of the preceding claims characterised in that the step of heating the minced legume composition to a temperature of 75°C or greater more specifically comprises:
heating the minced legume composition to a temperature from 75°C to 90°C.

11. A method, a legume composition or a formed food product according to any one of the preceding claims characterised in that the step of mincing the at least partially germinated legume to provide a minced legume composition more specifically comprises the step of:
mincing the at least partially germinated legume through a first mincer plate having holes of a diameter of from 3 to 5 mm; then

mincing the at least partially germinated legume through a second mincer plate having holes of a diameter of from 1 to 3 mm.

12. A method, a legume composition or a formed food product according to any one of the preceding claims wherein the step of at least partially germinating a legume such that a radicle and/or root of the at least partially germinated legume is up to 2 cm in length more specifically comprises:
soaking an ungerminated legume in water.

13. A method, a legume composition or a formed food product according to claim 12 characterised in that the step of soaking an ungerminated legume in water more specifically comprises:
soaking an ungerminated legume in water wherein the temperature of the legume-water mixture is from 55°C to 80°C, and wherein after a period of 5 minutes, the temperature of the legume-water mixture is less than or equal to 65°C, and wherein after a period of 40 minutes the temperature of the legume-water mixture is less than or equal to 50°C.

14. A method, a legume composition or a formed food product according to any one of claims 12 or 13 characterised in that the step of soaking an ungerminated legume in water more specifically comprises the step of:
soaking an ungerminated legume in water a predetermined period of from 6 to 24 hours.

15. A method for producing a formed food product, the method comprising the steps of:
producing a legume composition by a method according to any one of claims 1 or 7 to 14;

after the step of exposing the minced legume composition to a temperature of 75°C or greater, and

without letting the temperature of the minced legume composition drop below 40°C, forming the formed food product.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2021/051500

A. CLASSIFICATION OF SUBJECT MATTER

A23L 11/00 (2021.01) A23J 3/26 (2006.01) A23J 3/22 (2006.01) A23J 3/14 (2006.01) A23P 30/20 (2016.01)

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)

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)

Databases: Google, PATENW, CAPLUS, BIOSIS, EMBASE, FSTA, MEDLINE, Mintel

Keywords: A23V2002/00, A23V2200/264, A23V2200/262, A23V2250/548, A23V2300/31, A23J3/227, A23L11/00, A23L11/05, A23L11/70, A01G22/00, A01G22/40, A23J3/14, mung bean, legume, germinate, sprout, radicle, meat substitute, hot water, mincing, vegan, vegetarian, plant based, pasta, fritter, flour, burger, pattie, noodle, and like terms.

Applicant and inventor were also searched.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
	Documents are listed in the continuation of Box C	

[X] Further documents are listed in the continuation of Box C

[X] 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

"D" document cited by the applicant in the international application

"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
18 February 2022	18 February 2022

Name and mailing address of the ISA/AU

AUSTRALIAN PATENT OFFICE
PO BOX 200, WODEN ACT 2606, AUSTRALIA
Email address: pct@ipaustralia.gov.au

Authorised officer

Sally Hunter
AUSTRALIAN PATENT OFFICE
(ISO 9001 Quality Certified Service)
Telephone No. +61262837921

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 108541872 A (HARBIN WEIPING TECHNOLOGY DEV CO LTD) 18 September 2018 paragraphs [0008]-[0012] and [0018]-[0022]	1-15
X	CN 104026584 B (GUIZHOU BEZON FOOD CO LTD) 18 November 2015 abstract, paragraphs [0014] and [0018]-[0024], examples 1, 2 and 3	1-15
X	CN 103416661 B (UNIV HUAZHONG AGRICULTURAL) 28 May 2014 embodiments 2, 4, 5 and 6	1-15
X	Eggless Sprouted Mung Bean Pasta, Spring Style [Retrieved from internet on 19 January 2022] < URL: https://golubkakitchen.com/eggless-sprouted-mung-bean-pasta-spring-style/> Published on 18 May 2016 as per Wayback Machine method steps for both the pasta and for sprouting the beans	1-15
X	Sprouted Mung Bean Burger with Mint-Cilantro Chutney [Retrieved from internet 19 January 2022] < URL: https://holycowvegan.net/sprouted-mung-bean-burger-with-mint-cilantro-chutney/> Published on 20 December 2016 as per Wayback Machine method steps	1-15
X	WO 2017014654 A1 (KUBARA) 26 January 2017 examples 1, 2, 3, 4, 7 and 11	1-15
A	Discussion thread: Grow mung bean sprouts [Retrieved from internet 10 February 2022] < URL: https://food52.com/hotline/14612-grow-mung-bean-sprouts> Comment published 13 May 2012	
A	CN 109043322 A (UNIV HUAZHONG AGRICULTURAL) 21 December 2018	

INTERNATIONAL SEARCH REPORT Information on patent family members	International application No. **PCT/AU2021/051500**

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document/s Cited in Search Report		Patent Family Member/s	
Publication Number	**Publication Date**	**Publication Number**	**Publication Date**
CN 108541872 A	18 September 2018	CN 108541872 A	18 Sep 2018
CN 104026584 B	18 November 2015	CN 104026584 A	10 Sep 2014
		CN 104026584 B	18 Nov 2015
CN 103416661 B	28 May 2014	CN 103416661 A	04 Dec 2013
		CN 103416661 B	28 May 2014
WO 2017014654 A1	26 January 2017	WO 2017014654 A1	26 Jan 2017
		PL 413181 A1	30 Jan 2017
CN 109043322 A	21 December 2018	CN 109043322 A	21 Dec 2018

End of Annex

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.