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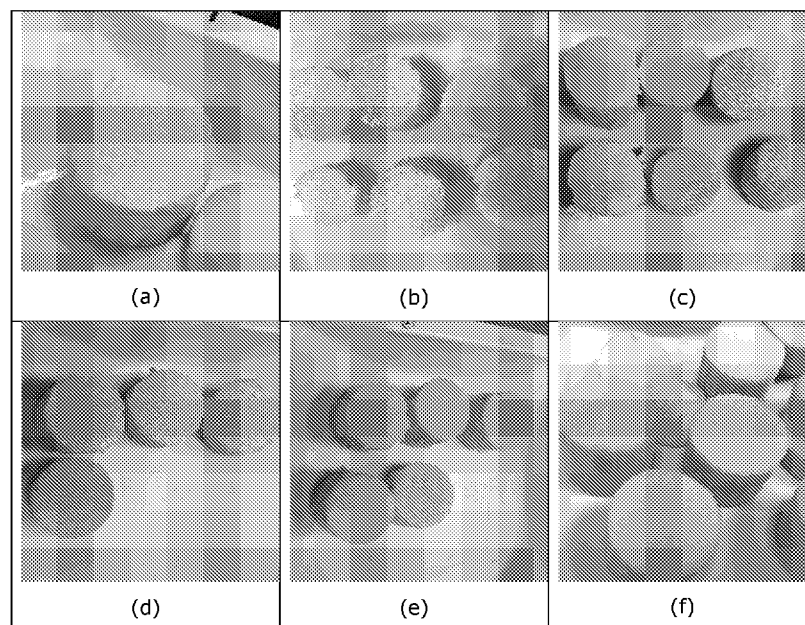


Figure 1

(57) Abstract: The present invention relates to a plant based food product, comprising plant protein at about 8 wt% to about 50 wt% relative to the plant based food product; water at about 35 wt% to about 90 wt% relative to the plant based food product; gum at about 0.01 wt% to about 2 wt% relative to the plant based food product; and cross linking agent at about 0.01 wt% to about 2 wt% relative to the plant based food product; wherein the plant based food product is free of starch.



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PLANT BASED FOOD PRODUCTS AND METHODS OF FABRICATION THEREOF

Technical Field

5 The present invention relates, in general terms, to plant based food products and their methods of fabrication thereof.

Background

10 Global meat production has increased rapidly over last 50 years, which is projected to increase by nearly 30% to \$9.8 billion in the next 30 years. Every year billions of dollars are invested into the meat industry, but due to the huge consumption, it is believed that meat production will become unsustainable by 2050. For example, there is increasing conflict between the increasing demand of meat and growing concerns associated with livestock farming, shortage of land, greenhouse gas emission, foodborne illness, and
15 animal welfare.

As meat is the primary source of proteins and many essential nutrients in developed economies, innovations in food production are urgently needed to feed the global population. Towards this end, there is a large potential market for protein alternatives.
20

Current concerns about meat consumption are raised in relation to health, social life, food behaviours, animal welfare, and natural resources exploitation. People are now more sensitive about these topics and are shifting their individual food habits in favour of a more plant-based diet. Surveys provide a concise view of the increasing percentage
25 of both vegetarians and vegans.

There is also an increasing focus in recent times on healthy living and eating.

A study published in Mayo Clinic Proceedings in 2003 found that following a starch-free
30 diet high in saturated fat for six weeks resulted in weight loss without adversely affecting cholesterol levels. Eating some starchy foods, such as potatoes in any form and refined grains, were associated with weight gain in a study published in the New England Journal of Medicine in 2011. This implies that eating fewer servings of such foods can help with weight loss. Another study found that a diet high in protein and low on the glycemc

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index may be helpful for weight loss. The glycemic index estimates how quickly foods containing carbohydrate raise blood sugar levels after you eat them.

There is however a lack of plant based food products that mimic real meat and is at the
5 same time healthy.

It would be desirable to overcome or ameliorate at least one of the above-described problems.

10 **Summary**

The invention is predicated on the understanding that a plant based food product mimic can be formulated by using plant-proteins and optionally soluble fiber as the main ingredients from grains and legumes in combination with gelling agents, lipids, and seasoning agents. The product mimic is starch-free and optionally has a high soluble
15 fiber and proteins content. The plant based food product can be made solely of natural ingredients. In particular, the plant based food product mimic can have a seafood flavour.

The present invention provides a plant based food product, comprising:

- 20 a) plant protein at about 8 wt% to about 50 wt% relative to the plant based food product;
b) water at about 35 wt% to about 90 wt% relative to the plant based food product;
c) gum at about 0.01 wt% to about 2 wt% relative to the plant based food product;
and
25 d) cross linking agent at about 0.01 wt% to about 2.0 wt% relative to the plant based food product;
wherein the plant based food product is free of starch.

As the plant based food product uses gum, it is starch free. Gum acts as a binder. It
30 provides healthier diet choice for ketogenic diet and people with high blood glucose concerns. The plant based food product is also suitable for consumers with vegetarian diet needs and can be Halal certifiable. The presence of plant protein allows for the promotion of healthy living and eating.

35 In some embodiments, the plant protein is obtained from a grain and/or a legume.

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In some embodiments, the plant protein is extracted from a grain and/or a legume.

In some embodiments, the plant protein is obtained or extracted from a grain and/or a
5 legume selected from mung bean, red lentil, yellow, pea, soya, chickpea, barley, or
wheat rice, rice, corn, sorghum, grams, millets, oat, buck wheat, sesame, palm seed
proteins, or a combination thereof.

In some embodiments, the gum is selected from carrageenan, nanocellulose, bacterial
10 cellulose, κ -carrageenan, ι -carrageenan, konjac gum, gellan gum, sodium alginate, and
locust bean gum, xanthan gum, curdlan, alginates, chitosan, inulin, galactomannans,
agar, guar gum, peach gum, gum Arabic, gellan gum, or a combination thereof.

In some embodiments, the gum comprises a mixture of κ -carrageenan and/or xanthan
15 and optionally at least one other gum.

In some embodiments, the cross linking agent is transglutaminase.

In some embodiments, the plant based food product further comprises a soluble fiber
20 at about 1 wt% to about 5 wt% relative to the plant based food product.

The presence of soluble fiber allows for the promotion of healthy living and eating.

In some embodiments, the soluble fiber is selected from nanocellulose, pectin, β -glucan,
25 mannose, arabinose, galactomannan, or a combination thereof.

In some embodiments, the plant based food product further comprises a lipid at about
0.5 wt% to about 3 wt% relative to the plant based food product.

30 In some embodiments, the lipid is selected from canola oil, camelia oil, soyabean oil,
sunflower seed oil, palm oil, coconut oil, peanut oil, rice bran oil, pumpkin seed oil,
sunflower seed oil, flaxseed oil, perilla seed oil, or a combination thereof.

In some embodiments, the plant based food product further comprises a flavouring
35 agent at about 1 wt% to about 5 wt% relative to the plant based food product.

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In some embodiments, the flavoring agent is selected from fish flavours, table salt, sugar, potassium chloride, calcium chloride, monosodium glutamate, yeast extract, nucleotides, soya sauce, vegetable sauce, or a combination thereof.

5

In some embodiments, the plant based food product further comprises a colouring agent at about 0.001 wt% to about 0.1 wt% relative to the plant based food product.

10 In some embodiments, the plant based food product further comprises a cryoprotectant at about 0.1 wt% to about 5 wt% relative to the plant based food product.

In some embodiments, the cryoprotectant is selected from antifreeze protein and peptides, sorbitol, xylitol, or a combination thereof.

15 In some embodiments, the plant based food product comprises:

a) mung bean protein at about 8 wt% to about 50 wt% relative to the plant based food product;

b) water at about 35 wt% to about 90 wt% relative to the plant based food product;

c) gum at about 0.01 wt% to about 2 wt% relative to the plant based food product;

20 and

d) transglutaminase at about 0.01 wt% to about 2.0 wt% relative to the plant based food product;

wherein the plant based food product is free of starch;

wherein the gum comprises a mixture of κ -carrageenan, guar gum and locust bean gum.

25

In some embodiments, the plant based food product is a plant based seafood product.

In some embodiments, the plant based food product is characterised by at least one of the following:

30 a) a hardness of about 400 g to about 1600 g;

b) an adhesiveness of about -12 g·sec to about 0 g·sec;

c) a springiness of about 0.5 to about 2;

d) a cohesiveness of about 0.5 to about 1;

e) a chewiness of about 350 g to about 1400 g;

35 f) a resilience of about 0.4 to about 0.9;

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- g) a breaking force of about 100 g to about 300 g;
 - h) a distance to rupture of about 0.4 cm to about 1.5 cm; or
 - i) an expressible moisture of about 1% to about 10 %.
- 5 The present invention also provides a method of fabricating a plant based food product, comprising:
- a) mixing a plant protein, gum and water in order to form a first mixture;
 - b) incorporating a cross linking agent to the first mixture in order to form a second mixture;
 - 10 c) incubating the second mixture at a temperature of about 40 °C to about 80 °C in order to form a paste; and
 - d) heating the paste to a temperature of about 80 °C to about 100 °C in order to form the plant based food product;
- wherein the plant protein at about 8 wt% to about 50 wt% relative to the plant based
- 15 food product;
- wherein water at about 35 wt% to about 90 wt% relative to the plant based food product;
- wherein the gum at about 0.01 wt% to about 2 wt% relative to the plant based food product; and
- 20 wherein cross linking agent at about 0.01 wt% to about 2 wt% relative to the plant based food product; and
- wherein the plant based food product is free of starch.

In some embodiments, the mixing step further comprises soluble fiber, lipid, flavouring
25 agent, colouring agent, cryoprotectant, or a combination thereof.

In some embodiments, the mixing step further comprises adjusting a pH to about 7.

In some embodiments, the mixing step comprises blending the plant protein, gum and
30 water.

In some embodiments, the incorporating step further comprises adjusting a pH to about
7.

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In some embodiments, the incorporating step comprises blending the first mixture and the cross linking agent.

5 In some embodiments, the incorporating step comprises blending the first mixture and the cross linking agent for at least about 1 min.

In some embodiments, the incorporating step further comprises filtering the second mixture.

10 In some embodiments, the second mixture is incubated at a temperature of about 55 °C.

In some embodiments, the second mixture is incubated for a duration of about 10 min to about 400 min.

15

In some embodiments, the paste is heated to a temperature of about 90 °C.

In some embodiments, the paste is heated for a duration of about 5 min to about 120 min.

20

Brief description of the drawings

Embodiments of the present invention will now be described, by way of non-limiting example, with reference to the drawings in which:

25

Figure 1 shows examples of plant based food products.

Figure 2 shows examples of plant based food products.

Figure 3 shows images of plant based food products after the freeze-thaw cycles.

Figure 4 shows examples of plant based food products.

30 **Figure 5** shows examples of plant based food products.

Figure 6 shows examples of plant based food products.

Figure 7 shows examples of plant-based food products.

Figure 8 shows examples of plant-based food products made using commercial mung bean isolate.

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Figure 9 shows difference in appearance of ground dehulled mung bean powder before and after processing/pretreatment.

Detailed description

The present invention provides a plant based food product, comprising:

- 5 a) plant protein at about 8 wt% to about 50 wt% relative to the plant based food product;
- b) water at about 35 wt% to about 90 wt% relative to the plant based food product;
- d) gum at about 0.01 wt% to about 2 wt% relative to the plant based food product;
- and
- 10 e) cross linking agent at about 0.01 wt% to about 2 wt% relative to the plant based food product;
- wherein the plant based food product is free of starch.

As the plant based food product uses gum, it is starch free. It provides healthier diet
15 choice for ketogenic diet and people with high blood glucose concerns. The plant based food product is also suitable for consumers with vegetarian diet needs and can be Halal certifiable. The presence of plant protein allows for the promotion of healthy living and eating.

20 "Plant protein" refers to protein sourced from a plant. In some embodiments, the plant protein is about 8 wt% to about 50 wt% relative to the plant based food product. In other embodiments, the range is 10 wt% to about 50 wt%, about 10 wt% to about 45 wt%, about 10 wt% to about 40 wt%, about 10 wt% to about 35 wt%, about 10 wt% to about 30 wt%, about 10 wt% to about 25 wt%, about 15 wt% to about 25 wt%, or
25 about 15 wt% to about 20 wt%.

In some embodiments, the plant protein is obtained from a grain and/or a legume. In this regard, the grain and/or legume can be milled or crushed and dried. The grain/legume flour thus has a composition which comprises plant protein.

30

The plant may be processed before the plant protein is extracted. This can be advantageous in isolating plant protein from the other plant components and thus removing a plant smell which can be deemed un-appetizing to a consumer. For example, the plant can be processed by soaking in an aqueous medium for some time, and
35 subsequently dried, milled and the plant protein extracted. The plant protein can be

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isolated from the other plant components using any known extraction method. The extracted protein can further be calibrated to a pH of about 4.5.

5 In some embodiments, the plant protein is extracted from a plant which is pre-processed. In other embodiments, the plant is soaked in an aqueous medium for at least 1 h, 2 h or 3 h.

10 The extracted plant protein contains a lower amount of impurities as compared to a plant protein which is obtained from a grain and/or legume. The impurities such as carbohydrates, fibers, fats and amino acids can disrupt the network of the plant protein, and thus provide for a food product which is inconsistent as different methods can give different ratios of the components. It was further found that the quality and consistency of the food product can be further improved by firstly processing the plant (grain and/or legume) followed by extracting the plant protein. This ensures that the most of the
15 soluble components are removed prior to the extraction step.

In some embodiments, the plant protein further comprises carbohydrates and/or fibers. In some embodiments, the plant protein comprises carbohydrates at less than about 5%. In some embodiments, the plant protein comprises carbohydrates at less than
20 about 4%, about 3%, about 2% or about 1%. In some embodiments, the plant protein comprises fibers at less than about 5%. In some embodiments, the plant protein comprises fibers at less than about 4%, about 3%, about 2% or about 1%. Preferably, the plant protein comprises carbohydrates and/or fibers, wherein the carbohydrates and/or fibers is less than about 1%.

25 In some embodiments, the plant protein is obtained or extracted from a grain and/or a legume selected from mung bean, red lentil, yellow, pea, soya, chickpea, barley, or wheat rice, rice, corn, sorghum, grams, millets, oat, buck wheat, sesame, palm seed proteins, or a combination thereof. Tofu which is usually obtained from soya bean by
30 grinding the beans, coagulating soya milk and then pressing the resulting curds into solid white blocks of varying softness is also included.

In some embodiments, the water is about 35 wt% to about 90 wt% relative to the plant based food product. In other embodiments, the range is about 40 wt% to about 90
35 wt%, about 45 wt% to about 90 wt%, about 50 wt% to about 90 wt%, about 50 wt%

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to about 80 wt%, about 55 wt% to about 80 wt%, about 60 wt% to about 80 wt%, about 65 wt% to about 80 wt%, about 70 wt% to about 80 wt%, or about 75 wt% to about 80 wt%.

5 In some embodiments, the gum is about 0.01 wt% to about 2 wt% relative to the plant based food product. In other embodiments, the range is about 0.05 wt% to about 2 wt%, about 0.1 wt% to about 2 wt%, about 0.15 wt% to about 2 wt%, about 0.2 wt% to about 2 wt%, about 0.2 wt% to about 1.8 wt%, about 0.2 wt% to about 1.6 wt%, about 0.2 wt% to about 1.4 wt%, about 0.2 wt% to about 1.2 wt%, about 0.2 wt% to about 1 wt%, about 0.2 wt% to about 0.9 wt%, about 0.2 wt% to about 0.8 wt%, about 0.3 wt% to about 0.8 wt%, about 0.3 wt% to about 0.7 wt%, about 0.3 wt% to about 0.6 wt%, or about 0.4 wt% to about 0.6 wt%.

15 A gum can be used as a thickening agent, which is a substance that increases the viscosity of a liquid. Certain gums can impact other properties of the food product such as stabilization, emulsification and gelling. Sugar polymers including vegetable gums such as pectin from Citrus peel, guar gum from the guar bean, and locust bean gum from the carob bean can be used. Agar, algin and carrageenan are polysaccharides extracted from algae. Xanthan gum is a polysaccharide secreted by the bacterium
20 *Xanthomonas campestris* and carboxymethyl cellulose is a synthetic gum derived from cellulose.

In some embodiments, the gum is selected from carrageenan, nanocellulose, bacterial cellulose, κ-carrageenan, ι-carrageenan, konjac gum, gellan gum, sodium alginate, and
25 locust bean gum, xanthan gum, curdlan, alginates, chitosan, inulin, galactomannans, agar, guar gum, peach gum, gum Arabic, gellan gum, or a combination thereof.

In some embodiments, the gum comprises a mixture of at least two gums. It was found that using at least two gums allows for a texture which is more consistent with a fish-
30 ball like texture which is suitable for an Asian palate. For example, the gum can be a mixture of κ-carrageenan and guar gum, κ-carrageenan and locust bean gum, locust bean gum and xanthan gum, κ-carrageenan and xanthan gum, κ-carrageenan and gellan gum, κ-carrageenan and sodium alginate, xanthan and konjac, or κ-carrageenan and konjac. In other embodiments, the gum comprises a mixture of κ-carrageenan and
35 at least one other gum. In other embodiments, the gum comprises a mixture of κ-

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carrageenan and/or xanthan and optionally at least one other gum. In some embodiments, the gum comprises a mixture of k-carrageenan, guar gum and optionally at least one other gum. In some embodiments, the gum comprises a mixture of k-carrageenan, locust bean gum and optionally at least one other gum. In some
5 embodiments, the gum comprises a mixture of k-carrageenan, guar gum and locust bean gum.

In some embodiments, the cross linking agent is about 0.01 wt% to about 2 wt% relative to the plant based food product. In other embodiments, the range is about 0.05
10 wt% to about 2 wt%, about 0.1 wt% to about 2 wt%, about 0.15 wt% to about 2 wt%, about 0.2 wt% to about 2 wt%, about 0.2 wt% to about 1.8 wt%, about 0.2 wt% to about 1.6 wt%, about 0.2 wt% to about 1.4 wt%, about 0.2 wt% to about 1.2 wt%, about 0.2 wt% to about 1 wt%, about 0.2 wt% to about 0.9 wt%, about 0.2 wt% to about 0.8 wt%, about 0.3 wt% to about 0.8 wt%, about 0.3 wt% to about 0.7 wt%,
15 about 0.3 wt% to about 0.6 wt%, or about 0.4 wt% to about 0.6 wt%.

In some embodiments, the cross linking agent is transglutaminase. In other embodiments, cross linking agent is transglutaminase, glucose oxidase, tannic acid, or a combination thereof.
20

As mentioned, the plant based food product is free or void of starch. Starch or amyllum is a polymeric carbohydrate consisting of numerous glucose units joined by glycosidic bonds. This polysaccharide is produced by most green plants for energy storage. It is contained in large amounts in staple foods like potatoes, maize (corn), rice, wheat and
25 cassava (manioc). Starch is a white, tasteless and odorless powder that is insoluble in cold water or alcohol. It consists of two types of molecules: the linear and helical amylose and the branched amylopectin. Depending on the plant, starch generally contains 20 to 25% amylose and 75 to 80% amylopectin by weight. Glycogen, the glucose store of animals, is a more highly branched version of amylopectin.
30

In some embodiments, the plant based food product comprises:

- a) plant protein at about 10 wt% to about 50 wt% relative to the plant based food product;
- b) water at about 50 wt% to about 90 wt% relative to the plant based food product;

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- d) gum at about 0.01 wt% to about 2 wt% relative to the plant based food product;
and
 - e) cross linking agent at about 0.01 wt% to about 2 wt% relative to the plant based food product;
- 5 wherein the plant based food product is free of starch.

In some embodiments, the plant based food product comprises:

- a) plant protein at about 10 wt% to about 30 wt% relative to the plant based food product;
 - 10 b) water at about 50 wt% to about 90 wt% relative to the plant based food product;
 - d) gum at about 0.5 wt% to about 1 wt% relative to the plant based food product;
and
 - e) cross linking agent at about 0.01 wt% to about 2 wt% relative to the plant based food product;
- 15 wherein the plant based food product is free of starch.

In some embodiments, the plant based food product comprises:

- a) plant protein at about 10 wt% to about 30 wt% relative to the plant based food product;
 - 20 b) water at about 50 wt% to about 90 wt% relative to the plant based food product;
 - d) gum at about 0.5 wt% to about 1 wt% relative to the plant based food product;
and
 - e) cross linking agent at about 0.01 wt% to about 2 wt% relative to the plant based food product;
- 25 wherein the plant based food product is free of starch;
wherein the plant protein is extracted from a grain and/or a legume.

In some embodiments, the plant based food product comprises:

- a) plant protein at about 10 wt% to about 30 wt% relative to the plant based food
30 product;
- b) water at about 50 wt% to about 90 wt% relative to the plant based food product;
- d) gum at about 0.5 wt% to about 1 wt% relative to the plant based food product;
and
- e) cross linking agent at about 0.01 wt% to about 2 wt% relative to the plant based
35 food product;

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wherein the plant based food product is free of starch;
wherein the plant protein is extracted from a grain and/or a legume;
wherein the gum is a mixture of κ -carrageenan and guar gum.

5 In some embodiments, the plant based food product further comprises a soluble fiber at about 1 wt% to about 5 wt% relative to the plant based food product. In other embodiments, the range is about 1.5 wt% to about 5 wt%, about 2 wt% to about 5 wt%, about 2.5 wt% to about 5 wt%, about 3 wt% to about 5 wt%, about 3.5 wt% to about 5 wt%, about 4 wt% to about 5 wt%, or about 4.5 wt% to about 5 wt%.

10

The presence of soluble fiber allows for the promotion of healthy living and eating. Soluble fiber dissolves in water. As soluble fiber dissolves, it creates a gel that may improve digestion in a number of ways. Soluble fiber may reduce blood cholesterol and sugar. It helps improve blood glucose control, which can aid in reducing risk for

15 diabetes.

15

In some embodiments, the soluble fiber is obtained from a natural source. The natural source can be from a plant or a fungus. A fungus is any member of the group of eukaryotic organisms that includes microorganisms such as yeasts and molds, as well

20 as mushrooms.

20

In some embodiments, the soluble fiber is selected from nanocellulose, pectin, β -glucan, mannose, arabinose, galactomannan, or a combination thereof.

25 In some embodiments, the plant based food product further comprises a lipid at about 0.5 wt% to about 5 wt% relative to the plant based food product. In other embodiments, the range is about 0.5 wt% to about 4 wt%, about 0.5 wt% to about 3 wt%, about 0.6 wt% to about 3 wt%, about 0.7 wt% to about 3 wt%, about 0.8 wt% to about 3 wt%, about 0.9 wt% to about 3 wt%, about 1 wt% to about 3 wt%, about 1.1 wt% to about

30 3 wt%, about 1.2 wt% to about 3 wt%, about 1.3 wt% to about 3 wt%, about 1.4 wt% to about 3 wt%, about 1.5 wt% to about 3 wt%, about 1.6 wt% to about 3 wt%, about 1.7 wt% to about 3 wt%, about 1.8 wt% to about 3 wt%, about 1.8 wt% to about 2.8 wt%, about 1.8 wt% to about 2.6 wt%, about 1.8 wt% to about 2.4 wt%, about 1.8 wt% to about 2.2 wt%, or about 1.8 wt% to about 2 wt%.

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The lipid can be plant based. The lipid can be an edible oil. The edible oil provides a mouthfeel which more closely mimics the profile of meat. In some embodiments, the lipid is selected from canola oil, camelia oil, soyabean oil, sunflower seed oil, palm oil, coconut oil, peanut oil, rice bran oil, pumpkin seed oil, sunflower seed oil, flaxseed oil, 5 perilla seed oil, corn oil, safflower oil, olive oil, sesame oil, or a combination thereof.

In some embodiments, the plant based food product further comprises a flavouring agent at about 1 wt% to about 5 wt% relative to the plant based food product. In other 10 embodiments, the range is about 1.5 wt% to about 5 wt%, about 2 wt% to about 5 wt%, about 2.5 wt% to about 5 wt%, about 3 wt% to about 5 wt%, about 3.5 wt% to about 5 wt%, about 4 wt% to about 5 wt%, or about 4.5 wt% to about 5 wt%.

In some embodiments, the flavoring agent is selected from fish flavour, table salt, sugar, potassium chloride, calcium chloride, monosodium glutamate, yeast extract, 15 nucleotides, soya sauce, vegetable sauce, or a combination thereof.

In some preferred embodiments, the flavoring agent is fish flavour or seafood flavour. Fish flavours can be provided by fish powder which are obtained by grinding dried fish, or fish sauce (liquid condiment made from fish or krill that have been coated in salt and 20 fermented for up to two years). If a vegan plant based product is desired, the savoury and salty flavour of seafood can be for example provided by algae such as seaweed, nori, or wakame.

The flavoring agent can be processed to improve the flavor profile of the plant based 25 food product. For example, if fish powder is used, the fish powder can be steeped in water or oil, which will give a different flavor profile as different aromatics and flavors can be made available.

In some embodiments, the plant based food product further comprises a colouring agent 30 at about 0.001 wt% to about 0.1 wt% relative to the plant based food product. In other embodiments, the range is about 0.005 wt% to about 0.1 wt%, about 0.01 wt% to about 0.1 wt%, about 0.02 wt% to about 0.1 wt%, about 0.03 wt% to about 0.1 wt%, about 0.04 wt% to about 0.1 wt%, about 0.05 wt% to about 0.1 wt%, about 0.06 wt% to about 0.1 wt%, about 0.07 wt% to about 0.1 wt%, or about 0.08 wt% to about 0.1 35 wt%.

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In some embodiments, the plant based food product further comprises a cryoprotectant at about 0.1 wt% to about 5 wt% relative to the plant based food product. In other embodiments, the range is about 0.5 wt% to about 5 wt%, about 1 wt% to about 5 wt%, about 1.5 wt% to about 5 wt%, about 2 wt% to about 5 wt%, about 2.5 wt% to about 5 wt%, about 3 wt% to about 5 wt%, about 3.5 wt% to about 5 wt%, or about 4 wt% to about 5 wt%.

A cryoprotectant is a substance used to protect food products from freezing damage. In some embodiments, the cryoprotectant is selected from antifreeze protein and peptides, sorbitol, xylitol, or a combination thereof.

The plant based food product can have other additives added to improve its nutritional value. Food additives are substances added to food to preserve flavor or enhance taste, appearance, or other sensory qualities. The additive can be added in any suitable amounts. For example docosahexaenoic acid (DHA), vitamins and other minerals can be added. Additives that can be added include mixed tocopherols (Vitamin E), zinc gluconate, thiamine hydrochloride (Vitamin B1), Sodium ascorbate (Vitamin C), Niacin, Pyridoxine hydrochloride (Vitamin B6), Riboflavin (Vitamin B2), Vitamin B12, Eicosapentaenoic acid, beta carotene, docosahexaenoic acid, ferrous sulfate, folic acid, turmeric extract, annatto extract, citric acid, calcium sulphate, paprika, or a combination thereof.

In some embodiments, the plant based food product comprises:

- a) mung bean protein at about 8 wt% to about 50 wt% relative to the plant based food product;
- b) water at about 35 wt% to about 90 wt% relative to the plant based food product;
- c) gum at about 0.01 wt% to about 2 wt% relative to the plant based food product;

and

- d) transglutaminase at about 0.01 wt% to about 2.0 wt% relative to the plant based food product;

wherein the plant based food product is free of starch;

wherein the gum comprises a mixture of κ -carrageenan, guar gum and locust bean gum.

In some embodiments, the plant based food product comprises:

- 15 -

- a) mung bean protein at about 8 wt% to about 20 wt% relative to the plant based food product;
- b) water at about 35 wt% to about 50 wt% relative to the plant based food product;
- c) gum at about 0.5 wt% to about 1.5 wt% relative to the plant based food product;
- 5 and
- d) transglutaminase at about 0.5 wt% to about 2.0 wt% relative to the plant based food product;
- wherein the plant based food product is free of starch;
- wherein the gum comprises a mixture of κ -carrageenan, guar gum and locust bean gum.

10

In some embodiments, the plant based food product comprises:

- a) mung bean protein at about 8 wt% to about 20 wt% relative to the plant based food product;
- b) water at about 35 wt% to about 50 wt% relative to the plant based food product;
- 15 c) gum at about 0.5 wt% to about 1.5 wt% relative to the plant based food product;
- and
- d) transglutaminase at about 0.5 wt% to about 2.0 wt% relative to the plant based food product;
- wherein the plant based food product is free of starch;
- 20 wherein the gum comprises a mixture of κ -carrageenan, guar gum and locust bean gum;
- wherein the mung bean protein is extracted from mung beans soaked in an aqueous medium for at least 3 h.

- 25 In some embodiments, the mung bean protein is about 10 wt% relative to the plant based food product. In some embodiments, the transglutaminase is about 1.6 wt% relative to the plant based food product. In some embodiments, the water is about 35 wt% to about 40 wt% relative to the plant based food product. In some embodiments, the water is about 39 wt% relative to the plant based food product.

30

- In some embodiments, the gum comprises κ -carrageenan at about 0.2 wt% to about 0.8 wt% relative to the plant based food product, guar gum at about 0.1 wt% to about 0.5 wt% relative to the plant based food product, and locust bean gum at about 0.05 wt% to about 0.5 wt% relative to the plant based food product. In other embodiments,
- 35 the gum comprises κ -carrageenan at about 0.4 wt% relative to the plant based food

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product, guar gum at about 0.2 wt% relative to the plant based food product, and locust bean gum at about 0.1 wt% relative to the plant based food product

5 In some embodiments, the plant based food product further comprises canola oil at about 1 wt% to about 10 wt% relative to the plant based food product. In some embodiments, the plant based food product further comprises canola oil at about 3 wt% relative to the plant based food product. In other embodiments, the canola oil comprises DHA.

10 In some embodiments, the plant based food product further comprises sorbitol syrup at about 5 wt% to about 10 wt% relative to the plant based food product. In some embodiments, the plant based food product further comprises sorbitol syrup at about 6 wt% relative to the plant based food product.

15 In some embodiments, the plant based food product is a plant based seafood product. In this regard, the plant based food product is flavoured with seafood or fish flavours.

Food hardness is a texture term used to describe the food by a textural or a mechanical property respectively. It is the maximum force achieved at the first bite. Food firmness
20 is used as an alternative term to food hardness. It can be measured using an isometric Kistler force transducer.

In some embodiments, the plant based food product is characterised by a hardness of about 400 g to about 1600 g. In other embodiments, the hardness is about 400 g to
25 about 1550 g, about 400 g to about 1500 g, about 450 g to about 1500 g, about 500 g to about 1500 g, about 550 g to about 1500 g, about 600 g to about 1500 g, about 650 g to about 1500 g, about 700 g to about 1500 g, about 750 g to about 1500 g, about 800 g to about 1500 g, about 850 g to about 1500 g, about 900 g to about 1500 g, about 1000 g to about 1500 g, about 1050 g to about 1500 g, about 1100 g to about
30 1500 g, about 1150 g to about 1500 g, about 1200 g to about 1500 g, about 1250 g to about 1500 g, or about 1300 g to about 1500 g.

Adhesiveness is defined as the work required to remove food that adheres to the mouth (generally the palate) during the normal swallowing process. It is the work needed to
35 overcome the attractive forces between the surface of the product and the surface of

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the material (the probe) with which the product comes in contact.

In other embodiments, the plant based food product is characterised by an adhesiveness of about -12 g·sec to about 0 g·sec. In other embodiments, the adhesiveness is about
5 -11 g·sec to about 0 g·sec, about -10 g·sec to about 0 g·sec, about -10 g·sec to about -1 g·sec, about -10 g·sec to about -2 g·sec, about -10 g·sec to about -3 g·sec, about -10 g·sec to about -4 g·sec, about -10 g·sec to about -5 g·sec, about -10 g·sec to about -6 g·sec, about -10 g·sec to about -7 g·sec, or about -10 g·sec to about -8 g·sec.

10 Springiness is the rate at which a deformed material goes back to its undeformed condition after deforming force is removed. It is a measurement of elastic recovery. It is the degree to which the food returns to its original height after being compressed. It is calculated as a ratio of the original and deformed length.

15 In other embodiments, the plant based food product is characterised by a springiness of about 0.5 to about 2. In other embodiments, the springiness is about 0.6 to about 2, about 0.7 to about 2, about 0.8 to about 2, about 0.9 to about 2, about 1 to about 2, about 1.2 to about 2, about 1.4 to about 2, about 1.6 to about 2, or about 1.8 to about 2.

20 Cohesiveness means the strength of internal bonds making up the body of the food. It is how well the food withstands the second deformation relative to its resistance under the first deformation. In other words, it's the extent to which the food deforms when compressed. Cohesiveness is calculated as a ratio of the original and deformed areas.

25 In other embodiments, the plant based food product is characterised by a cohesiveness of about 0.5 to about 1. In other embodiments, the cohesiveness is about 0.6 to about 1, about 0.7 to about 1, about 0.8 to about 1, or about 0.9 to about 1.

30 Chewiness is the energy required to chew a solid food until it is ready for swallowing and is given by the relationship: hardness × cohesiveness × elasticity.

In other embodiments, the plant based food product is characterised by a chewiness of about 350 g to about 1400 g. In other embodiments, the chewiness is about 400 g to
35 about 1400 g, about 450 g to about 1400 g, about 500 g to about 1400g , about 550 g

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to about 1400 g, about 600 g to about 1400 g, about 650 g to about 1400 g, about 700 g to about 1400 g, about 7500 g to about 1400 g, about 800 g to about 1400 g, about 850 g to about 1400 g, about 900 g to about 1400 g, or about 1000 g to about 1400 g.

5 Resilience is an indicator of how a sample recovers from deformation, including both speed and strength. It is defined as the ratio of the area before the deformation target to the area after the deformation target when the first depression is applied.

In other embodiments, the plant based food product is characterised by a resilience of
10 about 0.4 to about 0.9. In other embodiments, the resilience is about 0.5 to about 0.9, about 0.5 to about 0.8, about 0.5 to about 0.7, or about 0.6 to about 0.8.

In other embodiments, the plant based food product is characterised by a breaking force
15 of about 100 g to about 300 g. In other embodiments, the breaking force is about 100 g to about 290 g, about 100 g to about 280 g, about 100 g to about 270 g, about 100 g to about 260 g, about 100 g to about 250 g, about 110 g to about 250 g, about 120 g to about 250 g, about 130 g to about 250 g, about 140 g to about 250 g, about 150 g to about 250 g, about 160 g to about 250 g, about 170 g to about 250 g, about 180 g to about 250 g, about 190 g to about 250 g, or about 200 g to about 250 g.

20 In other embodiments, the plant based food product is characterised by a distance to rupture of about 0.4 cm to about 1.5 cm. In other embodiments, the distance to rupture is about 0.5 cm to about 1.5 cm, about 0.6 cm to about 1.5 cm, about 0.6 cm to about 1.4 cm, about 0.6 cm to about 1.3 cm, about 0.6 cm to about 1.2 cm, about 0.6 cm to
25 about 1.1 cm, or about 0.6 cm to about 1 cm.

Expressible moisture refers to the amount of liquid forced out from a food system by the application of force and measures the amount of free water released under the measurement conditions. Expressible moisture reflects the water holding capacity of the
30 product. High expressible moisture reflects a bad water holding capacity, which means under pressure, the product will have moisture expressed.

In other embodiments, the plant based food product is characterised by an expressible
35 moisture of about 1% to about 10 %. In other embodiments, the expressible moisture is about 1% to about 9 %, about 1% to about 8 %, about 1% to about 7 %, about 1%

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to about 6 %, about 2% to about 6 %, about 3% to about 6 %, or about 4% to about 6 %.

The present invention also provides a method of fabricating a plant based food product,
5 comprising:

- a) mixing a plant protein, gum and water in order to form a first mixture;
 - b) incorporating a cross linking agent to the first mixture in order to form a second mixture;
 - d) incubating the second mixture at a temperature of about 40 °C to about 80 °C
10 in order to form a paste; and
 - e) heating the paste to a temperature of about 80 °C to about 100 °C in order to form the plant based food product;
- wherein the plant protein at about 8 wt% to about 50 wt% relative to the plant based food product;
- 15 wherein water at about 35 wt% to about 90 wt% relative to the plant based food product;
- wherein the gum at about 0.01 wt% to about 2 wt% relative to the plant based food product; and
- wherein cross linking agent at about 0.01 wt% to about 2 wt% relative to the plant
20 based food product; and
- wherein the plant based food product is free of starch.

In some embodiments, the method of fabricating a plant based food product comprises:

- a) mixing a plant protein, gum and water in order to form a first mixture;
 - 25 b) incorporating a cross linking agent to the first mixture in order to form a second mixture;
 - d) incubating the second mixture at a temperature of about 40 °C to about 80 °C in order to form a paste; and
 - e) heating the paste to a temperature of about 80 °C to about 100 °C in order to
30 form the plant based food product;
- wherein the plant protein at about 10 wt% to about 50 wt% relative to the plant based food product;
- wherein water at about 50 wt% to about 90 wt% relative to the plant based food product;

- 20 -

wherein the gum at about 0.01 wt% to about 2 wt% relative to the plant based food product; and

wherein cross linking agent at about 0.01 wt% to about 2 wt% relative to the plant based food product; and

5 wherein the plant based food product is free of starch.

In some embodiments, the plant protein is extracted from a plant. The plant protein can be extracted from a plant which is processed by soaking the plant in an aqueous medium for at least 1 h, 2 h or 3 h. In other embodiments, the extracted plant protein is washed
10 using an aqueous medium at pH 4.5.

In some embodiments, the mixing step further comprises a soluble fiber, a lipid, a flavouring agent, a colouring agent, a cryoprotectant, or a combination thereof.

15 It was found that when the plant based food product is a seafood product, the fish flavour can be enhanced by performing certain steps. For example, the grain and/or a legume can be pre-soaked in an aqueous medium such as water for a predetermined duration. The duration can be about 1 h to about 48 h, about 1 h to about 44 h, about
20 1 h to about 40 h, about 1 h to about 36 h, about 1 h to about 32 h, about 1 h to about 28 h, about 1 h to about 24 h, about 1 h to about 20 h, about 1 h to about 16 h, about 1 h to about 12 h, about 1 h to about 8 h, about 1 h to about 7 h, about 1 h to about 6 h, about 1 h to about 5 h, about 1 h to about 4 h, or about 1 h to about 3 h. After which, the plant protein can be dried, milled and sieved before plant protein extraction. This advantageously removes most (if not all) of the grain and/or a legume taste and/or
25 smell. The plant protein can be subjected to an acid wash. This ionises the volatiles within the plant protein such that they can be extracted and hence removes the grain and/or a legume taste and/or smell. Alternatively or in addition, the fish flavours such as fish powder can be pre-soaked in a medium such as water or oil to more completely extract the flavours. The pre-soak can be performed at ambient temperature (about 10
30 °C to about 40 °C) or under an elevated temperature such as about 40 °C to about 100 °C. The duration can be about 1 h to about 48 h, about 1 h to about 44 h, about 1 h to about 40 h, about 1 h to about 36 h, about 1 h to about 32 h, about 1 h to about 28 h, about 1 h to about 24 h, about 1 h to about 20 h, about 1 h to about 16 h, about 1 h to about 12 h, about 1 h to about 8 h, about 1 h to about 7 h, about 1 h to about 6 h,
35 about 1 h to about 5 h, about 1 h to about 4 h, or about 1 h to about 3 h.

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In some embodiments, the mixing step further comprises adjusting a pH to about 7.

In some embodiments, the mixing step comprises blending the plant protein, gum and
5 water. In other embodiments, the blending is for at least about 1 min, about 2 min,
about 4 min, about 5 min, about 10 min, about 15 min, about 20 min, or about 30 min.
The blending can be performed using a blender, such as a hand blender or a stand
blender. This depends on the scale of fabrication.

10 In some embodiments, the incorporating step further comprises adjusting a pH to about
7.

In some embodiments, the incorporating step comprises blending the first mixture and
the cross linking agent.

15

In some embodiments, the incorporating step comprises blending the first mixture and
the cross linking agent for at least about 1 min. In other embodiments, the duration is
at least about 2 min, about 4 min, about 5 min, about 10 min, about 15 min, about 20
20 min, or about 30 min. In some embodiments, the incorporating step comprises blending
the first mixture and the cross linking agent for at least about 5 min.

In some embodiments, the incorporating step further comprises filtering the second
mixture. Filtering helps to ensure that a consistent mouthfeel can be obtained.

25 In some embodiments, the second mixture is incubated at a temperature of about 40
°C to about 75 °C, about 40 °C to about 70 °C, about 40 °C to about 65 °C, about 40
°C to about 60 °C, about 40 °C to about 55 °C, about 45 °C to about 55 °C, or about
50 °C to about 55 °C. A water bath or oven can be used for heating the samples at the
set temperature. The humidity of oven can range from 50% to 100%.

30 In some embodiments, the second mixture is incubated at a temperature of about 55
°C. This allows the cross linking reaction to occur.

In some embodiments, the second mixture is incubated for a duration of about 10 min
to about 400 min. In other embodiments, the duration is about 10 min to about 360
35 min, about 10 min to about 320 min, about 10 min to about 280 min, about 10 min to

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about 240 min, about 10 min to about 200 min, about 10 min to about 180 min, about 10 min to about 160 min, about 10 min to about 140 min, about 10 min to about 120 min, about 10 min to about 100 min, about 10 min to about 80 min, about 10 min to about 60 min, about 10 min to about 40 min, or about 10 min to about 20 min. In some
5 embodiments, the second mixture is incubated for a duration of about 20 min to about 200 min.

In some embodiments, the method further comprises a step after the incubation step of moulding the paste. The paste can be moulded into any shape, for example, a ball or
10 a patty.

In some embodiments, the paste is heated to a temperature of more than about 80 °C to about 100 °C, about 85 °C to about 100 °C, about 90 °C to about 100 °C, or about 95 °C to about 100 °C, or about 90 °C to about 95 °C. A water bath or oven can be
15 used for heating the samples at the set temperature. The humidity of oven can range from 50% to 100%.

In some embodiments, the paste is heated to a temperature of about 90 °C. The paste can for example be steamed, or cooked in heated water.
20

In some embodiments, the paste is heated for a duration of about 5 min to about 120 min. In other embodiments, the duration is about 5 min to about 110 min, about 5 min to about 100 min, about 5 min to about 90 min, about 5 min to about 80 min, about 5 min to about 70 min, about 5 min to about 60 min, about 5 min to about 50 min, about
25 5 min to about 40 min, about 5 min to about 30 min, about 5 min to about 20 min, or about 5 min to about 10 min. In some embodiments, the paste is heated for a duration of about 10 min to about 60 min.

It would be understand that after the paste is heated, while the plant based food product
30 is ready for consumption, the plant based food product can be further processed to alter its texture and/or mouthfeel. For example, the plant based food product can be deep-fried in oil, pan fried or oven baked.

In some embodiments, method further comprises freeze-thawing the plant based food
35 product for at least one cycle.

Examples**Benchmarking with real fish product**

Use the real fishball data, the following benchmark was applied to gauge our product.

5

Table 1. Suggested benchmarks for the textural profiles of the vegetarian surimi.

Textural property	Suggested range
Hardness (g)	443.6 – 1470.3
Adhesiveness (g·sec)	-10.3 – 0
Springiness	0.9 – 1.4
Cohesiveness	0.8 – 0.9
Chewiness	368.2 – 1329.8
Resilience	0.5 – 0.7
Breaking force (g)	118.2 – 248.7
Distance to rupture (cm)	0.6 – 1.1
Expressible moisture (%) *	3.00 – 5.50 *

*: The calculation of the expressible moisture is closely related to the sample weight, and this benchmark only applies to the sample weight within 4 – 6 g.

10

Method of fabricating plant based food products

The processing methods and conditions used are summarised below:

1. Blending of all the ingredients with a hand-held blender
2. Adjust to pH = 7.0
- 15 3. Filtration of the blended mixture with a test sieve
4. Incubation of the mixture at 55 °C
5. Cooking of the mixture at 90 °C

Formulations of plant based food products

20 Some formulations that match the textural properties of the commercial seafood ball products, of which the main ingredients are summarised below:

1. 18.3% mung bean protein, 1.6% transglutaminase, 0.2% κ-carrageenan, 0.1% guar gum

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2. 20% mung bean protein, 1.6% transglutaminase, 0.4% κ -carrageenan, 0.27% gellan gum
3. 20% mung bean protein, 1.6% transglutaminase, 0.4% gellan gum
4. 20% mung bean protein, 1.6% transglutaminase, 0.2% κ -carrageenan, 0.13% locust bean gum
5. 20% mung bean protein, 1.6% transglutaminase, 0.2% locust bean gum, 0.2% xanthan gum
6. 18% mung bean protein, 1.6% transglutaminase, 0.4% κ -carrageenan, 0.2% xanthan gum

10

Figure 1 and 2 shows images of the food product samples. They can be processed using moulds of different sizes and shapes. For example, a round-shaped mould can be used to form a ball shape similar to current commercial products.

- 15 Figure 1 shows images of the cooked plant based food products. (a) – (f) indicate the fish balls (plant based food products) made according to formulation 1 – 6. The colour differences were due to the lighting, no additional colouring was added.

Figure 2 shows additional images of plant based food products. (a) formulation 1 product;
20 (b) formulation 4 product.

Freezer stability of plant based food products

The freeze stability of the products was tested. Sorbitol was selected as the cryoprotectant. The formulations and the product stability were listed as below:

25

7. 18% mung bean protein, 1.6% transglutaminase, 0.4% κ -carrageenan, 0.27% gellan gum, 4% sorbitol
8. 18% mung bean protein, 1.6% transglutaminase, 0.2% κ -carrageenan, 0.13% Locust bean gum, 4% sorbitol

30

Before and after one or two cycles of -18 °C freezing, all samples had texture profiles meet the designated benchmark. The time length for the freezing was 3 days for both cycles, when thawing, the samples were put in tap water at room temperature for 2 h before proceeding to other tests.

35

- 25 -

Figure 3 shows images of plant based food products after the freeze-thaw cycles. (a) formulation 7 products, after one freeze-thaw cycle; (b) formulation 8 products, after one freeze-thaw cycle; (c) formulation 8 products, after two freeze-thaw cycle. The colour differences were due to the lighting, no additional colouring was added.

5

Other formulations of plant based food products

Other formulations that match the textural properties of commercial seafood ball products are summarised below, the main ingredients of which include:

- 10 9. 20% mung bean protein, 1.6% transglutaminase, 0.2% κ-carrageenan, 0.2% sodium alginate
10. 20% mung bean protein, 1.6% transglutaminase, 0.2% κ-carrageenan, 0.13% gellan gum
11. 20% mung bean protein, 1% transglutaminase, 0.2% κ-carrageenan, 0.13% gellan gum
- 15 12. 20% mung bean protein, 1.6% transglutaminase, 0.15% κ-carrageenan, 0.1% gellan gum
13. 15% mung bean protein, 1.6% transglutaminase, 0.2% κ-carrageenan, 0.13% locust bean gum
- 20 14. 18% mung bean protein, 1.6% transglutaminase, 0.2% κ-carrageenan, 0.13% guar gum
15. 20% mung bean protein, 1.6% transglutaminase, 0.4% κ-carrageenan, 0.27% locust bean gum

- 25 Figure 4 shows images of the food product samples. They will be processed using moulds of different sizes and shapes. For example, a round-shaped mould can be used to form a ball shape similar to current commercial products.

- 30 Figure 4 shows images of the plant based food products samples. (a) – (g) indicate the food product made according to formulation 9 – 15. Any colour differences were due to the lighting, no additional colouring was added.

Other formulations of plant based food products

- 35 There are several formulations that match the textural properties of the commercial seafood ball products, the key ingredients are summarised below:

- 26 -

16. 15.38% mung bean protein, 1.54% transglutaminase, 0.15% xanthan, 0.23% konjac
17. 15.38% mung bean protein, 1.54% transglutaminase, 0.15% k-carrageenan, 0.15% konjac
- 5 18. 15.38% mung bean protein, 1.54% transglutaminase, 0.15% k-carrageenan, 0.15% Gellan
19. 20% mung bean protein, 1.6% transglutaminase, 0.75% κ -carrageenan, 0.5% Gellan gum

10 Figure 5 shows images of the food product samples. They will be processed using moulds of different sizes and shapes. For example, a round-shaped mould can be used to form a ball shape similar to current commercial products.

15 Figure 5 shows images of plant based food product samples. (a) – (d) indicate the food product made according to formulation 16 – 19.

20. 13.4% mung bean protein, 0.2% transglutaminase, 1.6% κ -carrageenan, 1% Guar gum
21. 32.9% mung bean protein, 0.2% transglutaminase, 1.45% κ -carrageenan, 0.72% Guar gum
- 20 22. 32.9% mung bean protein, 0% transglutaminase, 1.45% κ -carrageenan, 0.72% Guar gum

Flavour of plant based food products

25 The flavour of the above plant based food products can be improved with the introduction of certain pre-processing steps, addition of fish flavour, or a combination thereof. There are several methods that can reduce undesirable beany off-flavours and impart fish flavours to improve the overall flavour of the products as summarized below:

- 30 a) Mung beans are soaked in excess water for at least 1 hour, dried, milled and passed through a sieve before proceeding to protein extraction. Soaking mung beans for 1 hour noticeably reduces beany odour and yellowness of the mung bean flour (Figure 9). This gives the final plant based food product a more desirable coloration and appeal.

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- b) Protein isolated from mung beans is washed with water adjusted to pH 4.5 several times. This removes the undesirable colouration and smell.
- c) Fish powder is steeped in water to prepare a 20 wt% solution
- d) Fish powder is steeped in vegetable oil to prepare a 30 wt% solution
- 5 e) After preparation of food product and removal from the moulds, the food product can be kept in chiller at 4°C for 15-18 hrs followed by steeping in boiling water (100°C) for 1 minute before serving. This allows the food product to be prepared in bulk and stored if they are not consumed immediately. Overnight storage in the chiller can cause the food product to become more rubbery/tough. It was
10 observed that if the food product is steeped in hot boiling water for at least 3 min, it restores the bouncy/soft texture and further reduces the beany aroma.

There are formulations with improved flavour that match the textural properties of the commercial seafood ball products, the key ingredients are summarised below:

- 15 23. 18% mung bean protein pre-processed according to method a), 1.6% transglutaminase, 0.4% κ -carrageenan, 0.2% guar gum, 4% sorbitol, 45% of solution prepared according to method c), 3% of solution prepared according to method d)
- 20 24. 18% mung bean protein pre-processed according to method a), 1.6% transglutaminase, 0.2% κ -carrageenan, 0.13% locust bean gum, 49% of solution prepared according to method c), 3% of solution prepared according to method d)
- 25 Figure 6 shows images of the food product samples. They will be processed using moulds of different sizes and shapes. For example, a round-shaped mould can be used to form a ball shape similar to current commercial products.

30 Figure 6 shows images of plant based food product samples. (a) – (f) indicate the food product made according to method a-d and formulation 23 and 24.

The flavour and mouthfeel of the plant-based food product can be improved by modifying the processing steps and inclusion of key ingredients such as:

- 28 -

25. 18% mung bean protein pre-processed according to method (a), 1.6% transglutaminase, 0.4% κ -carrageenan, 0.2% guar gum, 4% sorbitol, 45% of solution prepared according to method (c), 3% of solution prepared according to method (d). The final plant-based seafood thus prepared after incubation and boiling is processed according to method (e) before consumption.

26. 10% mung bean protein pre-processed according to method (a), 1.6% transglutaminase, 0.4% κ -carrageenan, 0.2% guar gum, 6.06% sorbitol syrup, 38.77% of water, 3% canola oil with DHA, Locust bean gum 0.1%.
10 The final plant-based seafood thus prepared after incubation and boiling is processed according to method (e) before consumption.

27. 15% mung bean protein pre-processed according to method (a), 1.6% transglutaminase, 0.4% κ -carrageenan, 0.2% guar gum, 6.06% sorbitol syrup, 38.77% of water, 3% canola oil with DHA, Locust bean gum 0.1%.
15 The final plant-based seafood thus prepared after incubation and boiling is processed according to method (e) before consumption.

Figure 7 shows images of plant-based food product samples. (a) – (d) indicate the food product made according formulations 25 (Figure 7 (a) and 7 (b)) and 26 (Figure 7 (c) and 7 (d)).

Comparison

Plant based food product made using formulations 23-27 were evaluated for its sensory properties by a panel of at least 4 members against plant based food product made using formulations 1-22. The formulations which were processed according to method a) was found to exhibited bouncier texture, which was comparable to real fishballs. Plant based food product made using formulations 23-27 was also tested to have a lesser beany flavour compared to formulations 1-22.

Formulation 26 (0.1% Locust bean gum) was compared against Formulation 15 (0.27% locust bean gum) in a taste test. Formulation 26 was tested to have a more bouncy texture, while formulation 15 had an almost brittle texture when bitten. Formulation 26 is preferred by the taste testers.

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Formulation 26 (1.6% transglutaminase, 0.4% κ -carrageenan, 0.2% guar gum, 0.1% Locust bean gum) was compared against Formulation 20-22 in a taste test. Formulation 26 was found to have a firmness that is acceptable and close to a processed fish food product, while formulations 20-22 are softer. Formulation 26 is preferred by the taste
5 testers.

In lieu of using the mung bean protein isolates that is made and purified by the inventors, commercial mung bean protein isolates were also tested in the formulations of plant-based food products (formulation 26). Figure 8 a) shows the consistency of
10 commercial mung bean protein isolate when dissolved in water. It could be observed that the solution thickened immediately into a paste after stirring and this made the solubilization of remaining ingredients into the formulation more difficult. Further, Figure 8 b) shows the food products formulated using commercial mung bean protein isolate. The sensory evaluation by 4 panelists of these food products made using commercial
15 mung bean protein indicated that the food product exhibited a starchy mouthfeel with no gel-like or real fishball-like characteristics from texture or mouthfeel point of view. It is believed that the purity of the commercial mung bean protein isolate is low and possibly also contain other plant extracts such as starch and fiber.

20 It will be appreciated that many further modifications and permutations of various aspects of the described embodiments are possible. Accordingly, the described aspects are intended to embrace all such alterations, modifications, and variations that fall within the spirit and scope of the appended claims.

25 Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", and variations such as "comprises" and "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

30 Throughout this specification and the claims which follow, unless the context requires otherwise, the phrase "consisting essentially of", and variations such as "consists essentially of" will be understood to indicate that the recited element(s) is/are essential i.e. necessary elements of the invention. The phrase allows for the presence of other non-recited elements which do not materially affect the characteristics of the invention

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but excludes additional unspecified elements which would affect the basic and novel characteristics of the method defined.

5 The reference in this specification to any prior publication (or information derived from it), or to any matter which is known, is not, and should not be taken as an acknowledgment or admission or any form of suggestion that that prior publication (or information derived from it) or known matter forms part of the common general knowledge in the field of endeavour to which this specification relates.

10

Claims

1. A plant based food product, comprising:
 - a) plant protein at about 8 wt% to about 50 wt% relative to the plant based food
5 product;
 - b) water at about 35 wt% to about 90 wt% relative to the plant based food product;
 - c) gum at about 0.01 wt% to about 2 wt% relative to the plant based food product;
and
 - d) cross linking agent at about 0.01 wt% to about 2 wt% relative to the plant based
10 food product;wherein the plant based food product is free of starch.
2. The plant based food product according to claim 1, wherein the plant protein is
15 obtained or extracted from a grain and/or a legume.
3. The plant based food product according to claim 1 or 2, wherein the plant protein
is obtained or extracted from a grain and/or a legume selected from mung bean, red
lentil, yellow, pea, soya, chickpea, barley, or wheat rice, rice, corn, sorghum, grams,
20 millets, oat, buck wheat, sesame, palm seed proteins, or a combination thereof.
4. The plant based food product according to any one of claims 1 to 3, wherein the
gum is selected from carrageenan, cellulose, bacterial cellulose, κ -carrageenan, ι -
carrageenan, konjac gum, gellan gum, sodium alginate, and locust bean gum, xanthan
25 gum, curdlan, alginates, chitosan, inulin, galactomannans, agar, guar gum, peach gum,
gum Arabic, gellan gum, or a combination thereof.
5. The plant based food product according to any one of claims 1 to 4, wherein the
gum comprises a mixture of κ -carrageenan and/or xanthan and optionally at least one
30 other gum.
6. The plant based food product according to any one of claims 1 to 5, wherein the
cross linking agent is transglutaminase.

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7. The plant based food product according to any one of claims 1 to 6, wherein the plant based food product further comprises a soluble fiber at about 1 wt% to about 5 wt% relative to the plant based food product.
- 5 8. The plant based food product according to claim 7, wherein the soluble fiber is selected from nanocellulose, pectin, β -glucan, mannose, arabinose, galactomannan, or a combination thereof.
9. The plant based food product according to any one of claims 1 to 8, wherein the
10 plant based food product further comprises a lipid at about 0.5 wt% to about 3 wt% relative to the plant based food product.
10. The plant based food product according to claim 9, wherein the lipid is selected
15 from canola oil, camelia oil, soyabean oil, sunflower seed oil, palm oil, coconut oil, peanut oil, rice bran oil, pumpkin seed oil, sunflower seed oil, flaxseed oil, perilla seed oil, or a combination thereof.
11. The plant based food product according to any one of claims 1 to 10, wherein
20 the plant based food product further comprises a flavouring agent at about 1 wt% to about 5 wt% relative to the plant based food product.
12. The plant based food product according to claim 11, wherein the flavoring agent
25 is selected from fish flavours, table salt, sugar, potassium chloride, calcium chloride, monosodium glutamate, yeast extract, nucleotides, soya sauce, vegetable sauce, or a combination thereof.
13. The plant based food product according to any one of claims 1 to 12, wherein
30 the plant based food product further comprises a colouring agent at about 0.001 wt% to about 0.1 wt% relative to the plant based food product.
14. The plant based food product according to any one of claims 1 to 13, wherein
the plant based food product further comprises a cryoprotectant at about 0.1 wt% to
about 5 wt% relative to the plant based food product.
- 35 15. The plant based food product according to claim 14, wherein the cryoprotectant

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is selected from antifreeze protein and peptides, sorbitol, xylitol, or a combination thereof.

16. The plant based food product according to any one of claims 1 to 15, comprising:
- 5 a) mung bean protein at about 8 wt% to about 50 wt% relative to the plant based food product;
- b) water at about 35 wt% to about 90 wt% relative to the plant based food product;
- c) gum at about 0.01 wt% to about 2 wt% relative to the plant based food product;
- and
- 10 d) transglutaminase at about 0.01 wt% to about 2.0 wt% relative to the plant based food product;
- wherein the plant based food product is free of starch;
- wherein the gum comprises a mixture of κ -carrageenan, guar gum and locust bean gum.
- 15 17. The plant based food product according to any one of claims 1 to 16, wherein the plant based food product is a plant based seafood product.
18. The plant based food product according to any one of claims 1 to 17, wherein the plant based food product is characterised by at least one of the following:
- 20 a) a hardness of about 400 g to about 1600 g;
- b) an adhesiveness of about -12 g·sec to about 0 g·sec;
- c) a springiness of about 0.5 to about 2;
- d) a cohesiveness of about 0.5 to about 1;
- e) a chewiness of about 350 g to about 1400 g;
- 25 f) a resilience of about 0.4 to about 0.9;
- g) a breaking force of about 100 g to about 300 g;
- h) a distance to rupture of about 0.4 cm to about 1.5 cm; or
- i) an expressible moisture of about 1% to about 10 %.
- 30 19. A method of fabricating a plant based food product, comprising:
- a) mixing a plant protein, gum and water in order to form a first mixture;
- b) incorporating a cross linking agent to the first mixture in order to form a second mixture;
- c) incubating the second mixture at a temperature of about 40 °C to about 80 °C
- 35 in order to form a paste; and

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- d) heating the paste to a temperature of about 80 °C to about 100 °C in order to form the plant based food product;
wherein the plant protein at about 8 wt% to about 50 wt% relative to the plant based food product;
- 5 wherein water at about 35 wt% to about 90 wt% relative to the plant based food product;
wherein the gum at about 0.01 wt% to about 2 wt% relative to the plant based food product; and
wherein cross linking agent at about 0.01 wt% to about 2 wt% relative to the plant
- 10 based food product; and
wherein the plant based food product is free of starch.
20. The method according to claim 19, wherein the mixing step further comprises soluble fiber, lipid, flavouring agent, colouring agent, cryoprotectant, or a combination
- 15 thereof.
21. The method according to claim 19 or 20, wherein the mixing step further comprises adjusting a pH to about 7.
- 20 22. The method according to any one of claims 19 to 21, wherein the mixing step comprises blending the plant protein, gum and water.
23. The method according to any one of claims 19 to 22, wherein the incorporating
- 25 step further comprises adjusting a pH to about 7.
24. The method according to any one of claims 19 to 23, wherein the incorporating
- step comprises blending the first mixture and the cross linking agent.
25. The method according to any one of claims 19 to 24, wherein the incorporating
- 30 step comprises blending the first mixture and the cross linking agent for at least about 1 min.
26. The method according to any one of claims 19 to 25, wherein the incorporating
- 35 step further comprises filtering the second mixture.

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27. The method according to any one of claims 19 to 26, wherein the second mixture is incubated at a temperature of about 55 °C.
28. The method according to any one of claims 19 to 27, wherein the second mixture
5 is incubated for a duration of about 10 min to about 400 min.
29. The method according to any one of claims 19 to 28, wherein the paste is heated to a temperature of about 90 °C.
- 10 30. The method according to any one of claims 19 to 29, wherein the paste is heated for a duration of about 5 min to about 120 min.

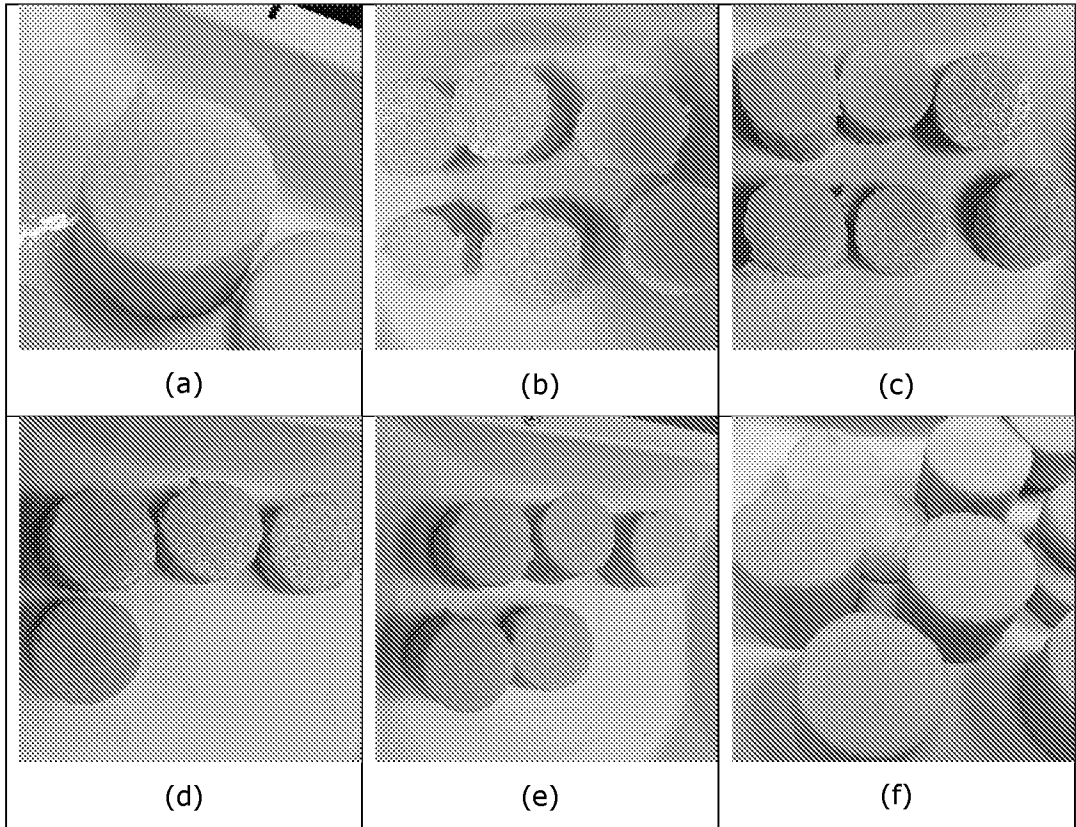


Figure 1

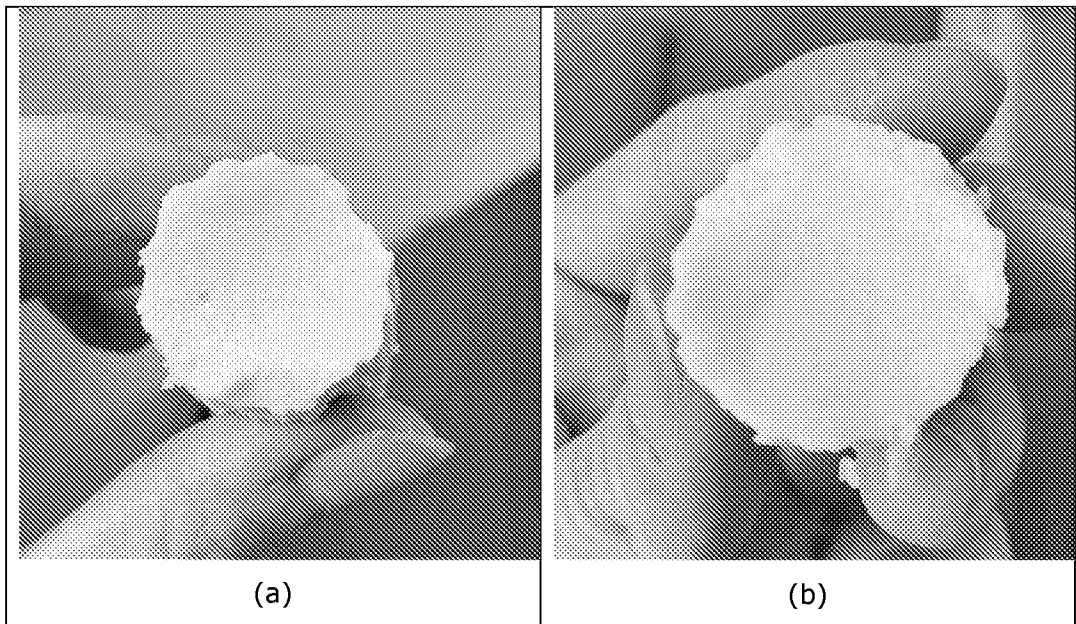


Figure 2

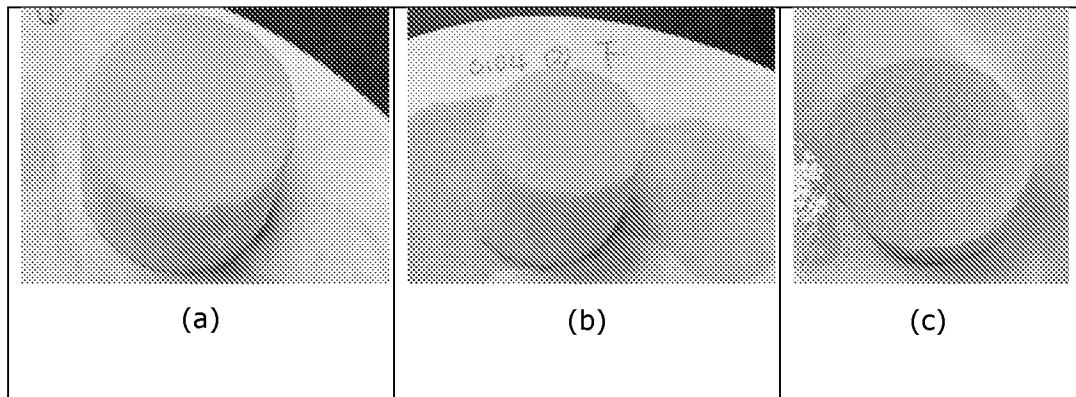
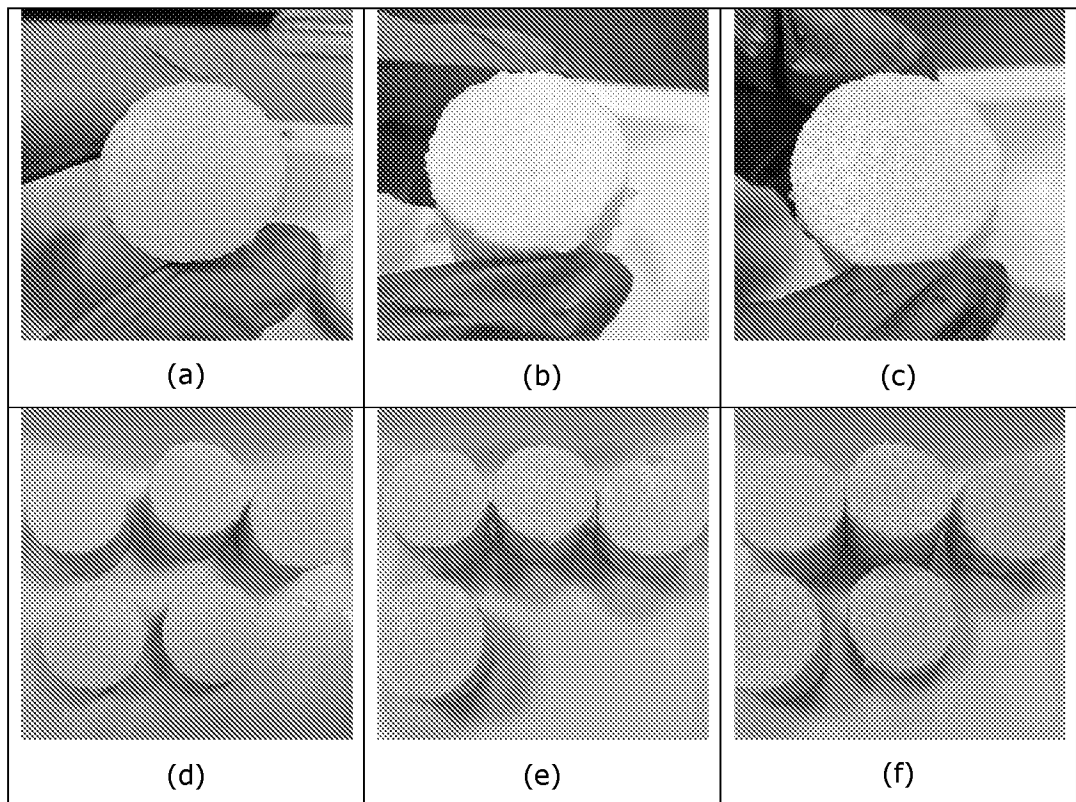


Figure 3



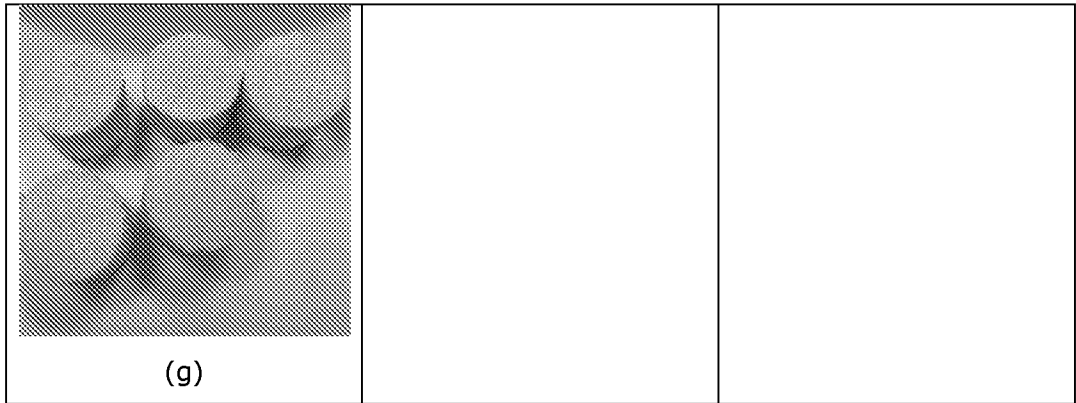


Figure 4

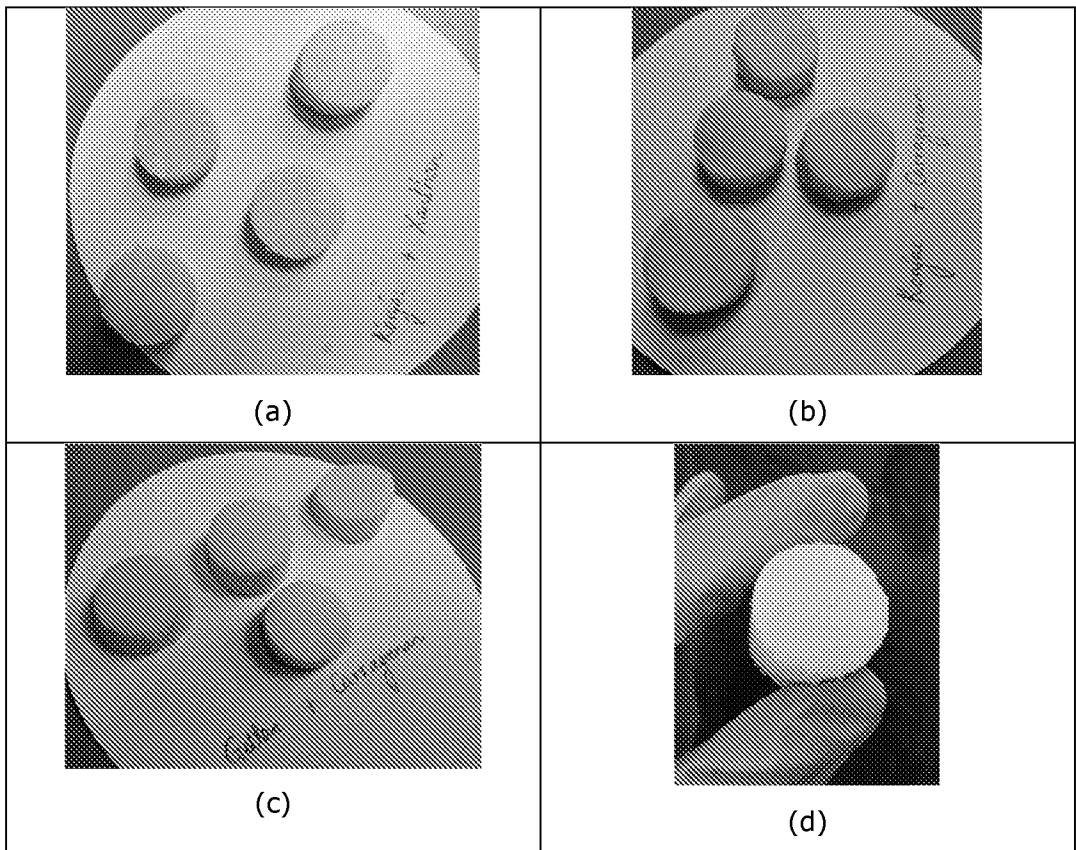


Figure 5

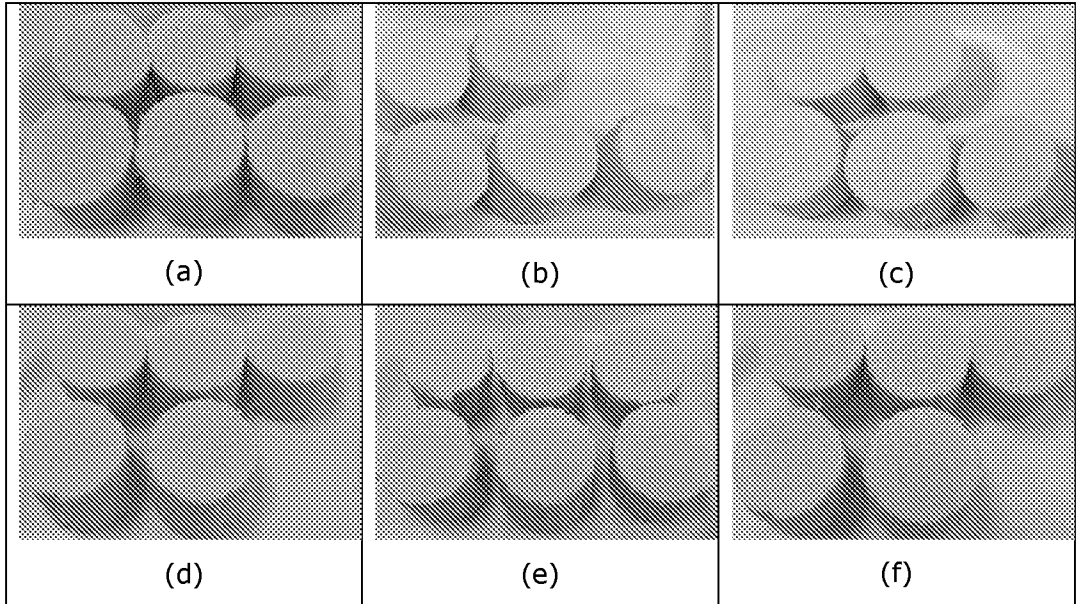


Figure 6

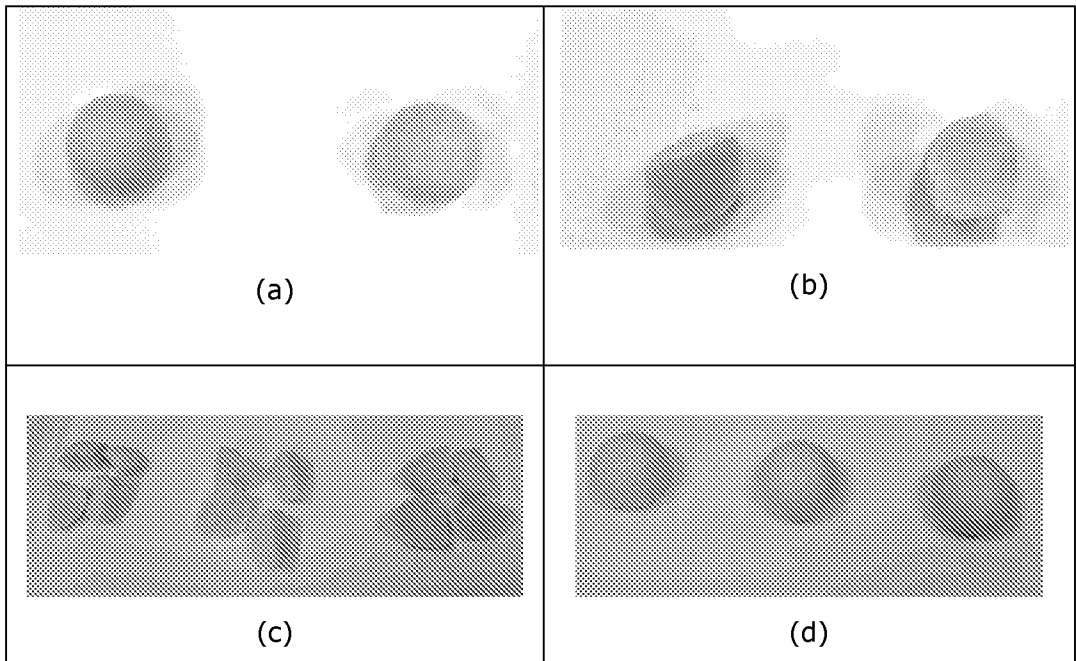


Figure 7

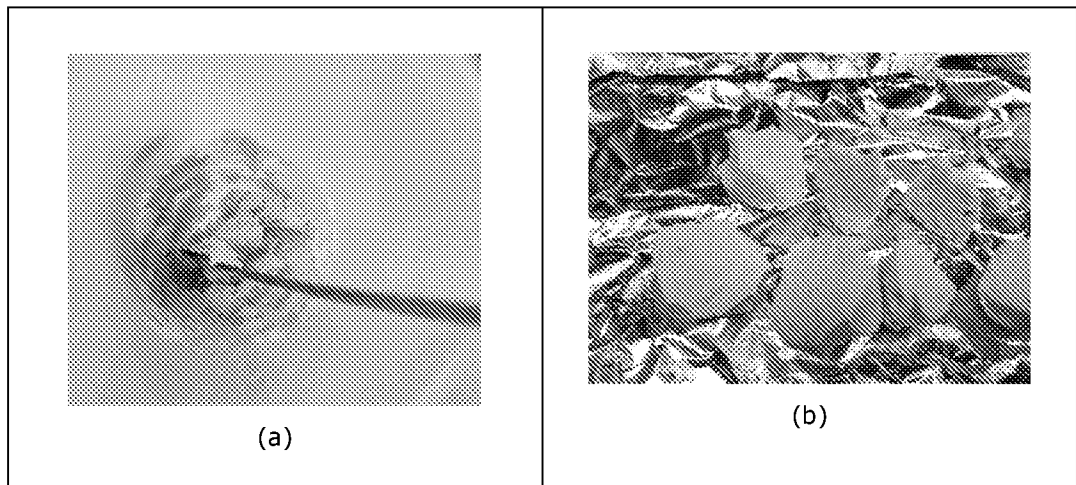


Figure 8



Figure 9