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(54) **Title:** SUSHI-STYLE QUINOA

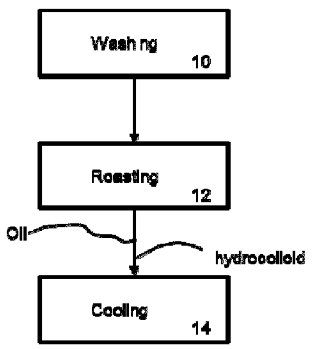

Fig. 6

(57) **Abstract:** It is provided a method of coating quinoa seeds comprising the steps of washing the quinoa seeds to remove saponins; roasting the quinoa seeds; coating said quinoa seeds with a hydrocolloid; and cooling said coated quinoa seeds. In an alternative, it is also provided that after the washing step, the seeds coated with an hydrocolloid mixture allowed to germinate (sprouted) before being roasted.

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SUSHI-STYLE QUINOA

TECHNICAL FIELD

[0001] It is provided quinoa seeds coated with edible hydrocolloids.

BACKGROUND

[0002] Quinoa (*Chenopodium quinoa* Willd.) is a nutritional food, which consists of high fatty acids, such as oleic and linoleic acids, and also high protein content, notably having a high methionine and lysine content. Quinoa seeds are considered gluten-free grains, which represent an attractive ingredient for celiac patients and also to people with wheat allergies.

[0003] Quinoa has been introduced and cultivated worldwide, such as in the United States, Canada, China, and India. Due to its great genetic diversity, it can grow in different continental soils and adapts to harsh environments such as frost, drought and even flooding. The consumable quinoa seeds are small, flat and circular-shaped. The colour of seeds can range from white, yellow, and red to black. Quinoa is claimed by Food and Agriculture Organization (FOA) as one of the crops that is a reliable source of functional food in the 21st century.

[0004] Quinoa seeds are not only utilized in animal feedstock but also in human food.

[0005] Quinoa consumption has increased, but has not reached the level of rice consumption for example. Rice is still a major ingredient in people’s diet in some countries. The essential quality of rice is its stickiness and glutinousness. Texture is a multi-parameter sensory property, with harness and stickiness as the most commonly determined parameter for cooked rice. On the contrary, the texture of quinoa is generally described as crunchy and grainy. Even though quinoa seeds have similar characteristics to rice and cereals, the mouth-feel and texture of cooked quinoa is different. The texture is described as creamy, smooth and slightly crunchy, and may be affected by the seed size, composition and cooking quality.

[0006] Regular quinoa doesn’t have adhesion to properly stick to the outside of a sushi roll or hold together in certain dishes that call for a sticky textured grain (usually rice). While whole quinoa has the ability to be substituted into many worldwide dishes that usually require rice (pilaf, paella for example), due to its relatively low levels of naturally occurring Amylopectin, quinoa cannot on its own be used for example in traditional sushi recipes that call for formed rice.

[0007] Currently, quinoa is added in small amounts to glutinous rice while cooking to take advantage of the Amylopectin in the rice. Such methodology still requires rice, especially for those people looking to avoid rice in their diets. Alternatively, quinoa is used when the sushi making is altered such to contain the quinoa on the inside of a roll or cone. Thus the use of quinoa is limited to only non-sticky applications.

[0008] There is thus a need to be provided with a way to incorporate quinoa as a substituent to rice in recipes wherein the call for sticky textured grain of rice is necessary.

SUMMARY

[0009] One aim of the present disclosure is to provide a method of coating quinoa seeds comprising the steps of washing the quinoa seeds to remove saponins; roasting said quinoa seeds; coating said quinoa seeds with an oil and a hydrocolloid; and cooling said coated quinoa seeds.

[0010] In another embodiment, it is also provided a method of coating quinoa seeds comprising the steps of washing the quinoa seeds coating said quinoa seeds with a hydrocolloid; sprouting the coated quinoa seeds; and roasting said coated quinoa seeds.

[0011] In an embodiment, the method described herien further comprises a step of cooling said coated quinoa seeds.

[0012] In an alternative embodiment, oil is added with the hydrocolloid to coat the seeds.

[0013] In another embodiment, the coated seeds are sprouted for 8-12 hours.

[0014] Another aim of the present disclosure is to provide a coated quinoa seed comprising a coating of a hydrocolloid.

[0015] In accordance with the present disclosure there is also provided a food comprising a coated quinoa seed as described herein.

[0016] In an embodiment, the oil is sunflower oil, grape seed oil, olive oil, palm oil or granola oil.

[0017] In another embodiment, the hydrocolloid is at least one of xanthan gum, gum Arabic, gum karaya, carrageenan, locust bean gum, amylopectin and carob gum.

[0018] In an additional embodiment, the quinoa seeds are roasted and coated in a tumbler.

[0019] In a particular embodiment, the quinoa seeds are roasted at a temperature of about 65°C to about 75°C, more specifically to about 73°C.

[0020] In another embodiment, the quinoa seeds are roasted with an infrared heater.

[0021] In a further embodiment, the coated quinoa seeds are cooled at a temperature of about 10°C to about 21°C, and more precisely at about 18°C.

[0022] In another embodiment, the coated quinoa seeds are fast cooled at a temperature of about 4°C.

[0023] In an additional embodiment, the quinoa seeds are coated with about 2% by weight of oil.

[0024] In another embodiment, the quinoa seeds are coated with about 0.5% by weight of hydrocolloid.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] Reference will now be made to the accompanying drawings.

[0026] Fig. 1 illustrates an histogram showing the stickiness score of samples with carrageenan, gum karaya, and locust bean gum added to the quinoa seeds as described herein.

[0027] Fig. 2 illustrates the colour acceptance score of samples with carrageenan, gum karaya, and locust bean gum coated quinoa seed.

[0028] Fig. 3 illustrates the texture acceptance score of samples with gum karaya and locust bean gum added.

[0029] Fig. 4 illustrates bitterness score of samples with gum karaya and locust bean gum added.

[0030] Fig. 5 illustrates additional questions and responses from participants.

[0031] Fig. 6 illustrates the process of coating quinoa seeds as described herein.

[0032] Fig. 7 illustrates the process of coating sporuted quinoa seeds as described herein.

DETAILED DESCRIPTION

[0033] In accordance with the present disclosure, there is provided quinoa seeds coated with edible hydrocolloids.

[0034] It is provided a sushi-style quinoa with enhanced stickiness. As described herein, raw 100% Canadian quinoa is coated with a natural additive, such as gum or other natural ingredients that acts as a binding agent.

[0035] The sushi-style quinoa provided is able to hold together during the cooking process and also at cold temperature storage while maintaining its nutritional and structural properties. It also withstands a 15-minute boiling in either a rice cooker or on a stove top without undergoing any structural change.

[0036] Accordingly, it is described a sticky quinoa designed to have the adhesiveness similar to sticky rice. This quinoa has been developed for example as a replacement for rice in dishes that require a sticky texture, such as sushi, sticky rice, rice pudding and other applications.

[0037] In order to be sushi-rice replacement, texture modification is required to be applied on quinoa. The function of polysaccharides may influence the gelatinization of starch and may have a coating effect on quinoa.

[0038] Seed characteristics such as the size, density and seed coat influence the water binding capacity during thermal processing affecting the texture of cooked quinoa. One of the major components of quinoa granule is starch, which makes up to approximately 60% of the seed. The starch granules are small with amylose content about 4 to 25%, unlike the other grains containing an amylose proportion of around 25% - 29%. Both quinoa and rice have a similar starch structure comprised of two types of molecules, amylopectin and amylose. Amylopectin are highly branched molecules with short branches connected by both α 1-4 links and α 1-6 links, whereas amylose is a linear chain of glucose with smaller molecular weight with a few long branches linked by α 1-4 linkage. These amylose and amylopectin molecules are likely to contribute to the texture of cooked rice. The amylose content of rice was positively correlated with the hardness of cooked rice, whereas it was negatively correlated with stickiness.

[0039] The balanced essential amino acids, ranging from 8% to 22% proportion, are one of the appealing characteristics of quinoa. Cereals are major sources of dietary protein for humans but the plant proteins are often called incomplete proteins due to the small amount of essential amino acids. Quinoa consists of higher quality of amino acids than rice, especially lysine. Although high protein reduces stickiness and gives a harder texture to cooked rice, high protein content appears to contribute to a firmer, more adhesive, gummier and chewier texture of cooked quinoa.

[0040] The texture of cooked quinoa is also affected by cooking time. Cooking time positively correlates with the hardness of cooked rice. Cooking time and water uptake ratio significantly affect the texture of cooked quinoa, whereas cooking volume moderately affected hardness. When rice granules absorb water, they swell to a larger size resulting to a decrease in rice's hardness. The swelling and water solubility of quinoa increase with temperature. The swelling becomes steady and stable once it reaches the maximum swollenness, but the water solubility continues to increase as temperature increases. Quinoa starch may have a better water binding capacity at high temperatures than the other starches. Amylose acts as a strain which holds the amylopectin in granules and prevents them from bursting during swelling. The cooked quinoa, as a result, is softer, less crunchy and has a pastier texture if cooking time is prolonged leading to more volume expansion.

[0041] Quinoa starch consists of two polysaccharides: amylose and amylopectin. Generally, amylose content should be 20-30% and the amylopectin content should be 70-80%. However, the amylose content of quinoa varieties is approximately around 5 to 20%. Both amylose and amylopectin significantly affect viscosity and water binding capacity of the food product.

[0042] Currently, sold quinoa has normally been through a washing and rapid drying procedure to remove its bitter saponin content. Therefore, quinoa is usually dehulled and washed before it is sold in the market. Traditionally, the quinoa seeds are either mechanically removed or processed by rubbing and scrubbing the seeds to each other and immersed in running water to remove bitterness prior to use. It is known that saponins are soluble in water. At higher temperatures, the solubility of saponin in water increases and tissue softening is also more expeditious. When water absorption increases and moisture penetrates deeply into the coat tissue matrix, quinoa seeds allow more saponins to leach out by simple diffusion. Removing the saponin using methanol extraction changes the properties of quinoa. For instance, the water hydration capacity of quinoa increases and the fat binding capacity decreases after desaponization.

[0043] In order to deliver a product that would consistently administer the correct ratio of gum to quinoa, as well as cook the same way glutinous rice does, it is provided a solution of coating the exterior of the quinoa seed with a natural binding agent (such as for example xanthium gum) that dissolves in equal quantities when added to water and create a sticky texture when cooked.

[0044] In an embodiment, the proposed process encompassed herein firstly comprises a step of washing 10 the quinoa seeds to remove saponins (Fig. 6). The quinoa seeds are then heated/roasted 12 at a temperature for example of 73°C in a heated tumbler. Oil, such as sunflower oil, and a hydrocolloid such as for example xanthium gum is added, providing the coating to the quinoa seed, developing of a texture that binds the quinoa in a similar fashion to sushi rice. The coated quinoa seeds are then cooled rapidly 14. This method helps the quinoa absorb the oil and gum solution such that minimal residue is left over. This creates a clear coating on the outside of the quinoa seed that when added to water dissolves such that the quinoa cooks naturally in an environment that promotes a tacky texture upon completion of the cooking process.

[0045] In another embodiment, a process is proposed wherein a sprouting technique is used to coat quinoa seeds with edible hydrocolloid. Accordingly, sprouting the quinoa and soaking the seeds in water for 8-12 hours for example (with a rinsing process trialing a variation of temperatures) allows the seeds to open, providing that the gums are bonding with the seeds during the drying process. The seeds are then roadsted or dryed using for example and infrared. Sprouting leaves the quinoa seeds with even more nutritional benefits than when an ingredient is in its initial state. The quinoa will germinate, which, in turn, allows for easier digestion and absorption of nutrients. Sprouting and soaking also decrease the level of phytic acid, an enzyme inhibitor, that can block absorption of vitamins and minerals and can cause poor digestion and disruption of healthy gut bacteria. As seen in Fig. 7, it is proposed a process comprising a step of washing 10 the quinoa seeds in ambient, filtered water (for example 12°C-18°C, pH 6.5-7.5) for 8-12 hours. An hydrocolloid mixture (spray) is applied onto rinsed, wet quinoa and agitate in spiral title kettle 20. The seeds are allowed to germinate (sprouting) 22 for 8-12 hours on aluminum sheets. The seeds are then roasted 12 through an infrared heating process.

[0046] Coating the grain itself as proposed herein allows the person skilled in the art to simply measure out the volume of quinoa they would like to make and cook it using regular quinoa cooking methods (stove top, rice cooker for example). The coated quinoa as described herein provides a means to make sticky quinoa without the addition of any other ingredients or compounds.

[0047] Coating the outside of the quinoa seeds was determined to be the best outcome for both packaging, ease of preparation, shelf stability, and consistency of end product. The process described herein provides a means to deliver equal parts of the gum into the cooking process ultimately.

[0048] The use of tumbler as described herein allows coating and polishing of the outside of the quinoa seeds during the circular rotation leaving a hard smooth outer layer. Quinoa seeds are heated to 73°C and put inside a tumbler, wherein sunflower oil and xanthium gum is added until the quinoa is coated in a hard, clear, coating that dissolves when added to hot water.

[0049] The coated quinoa seeds as described herein can be incorporated in nutritious product as a substituent to rice which is high in carbohydrates and has increased levels of arsenic, without modifying the cooking process as compared with the use of white rice.

[0050] 100% Canadian golden quinoa were mixed with different hydrocolloids in various amounts then cooked and steamed in a rice cooker. Three mixtures of quinoa (with hydrocolloids carrageenan, gum karaya and locust bean gum) were produced and a sensory panel of 16 participants was asked to evaluate the visual stickiness, colour acceptance, texture as rice-replacement, and bitterness of the seeds.

[0051] 2-Way ANOVA tests were conducted on panelists' scores and showed that there is no significant difference in colour acceptance, in texture, and in bitterness score between the 3 gums added. On the other hand, the test results show a significant difference in visual stickiness (p-value 4.60E-04). Tukey's test was run and showed that the stickiness value from the gum karaya sample was significantly different from carrageenan's and locust bean gum's.

[0052] Hardness and stickiness were evaluated using texture analyzer and analyzed with 2-Way ANOVA test. With the p-value 8.63E-68, it is highly confident that there is a significant difference between all the different mixtures cooked in the experiment. After comprehending both the texture analyzer and the sensory panel results, gum karaya has the highest score in stickiness and received better ratings in general.

[0053] As encompassed herein, quinoa seeds are coated with hydrocolloids. Food additives are usually added in the food industry for quality improvement, particularly for texture modification. Choice of proper hydrocolloids source for usage depends on the characteristics, properties and functionality desired. A number of hydrocolloids characteristics are looked into and also tested through the experiment. The attributes that are important for the seeds encompassed herein are adhesiveness of gum to quinoa granules, taste or smell of gum that could affect quinoa's sensory properties, and water retention function to create the ideal chewy texture in quinoa.

[0054] In an embodiment, hydrocolloids can be xanthan gum, gum Arabic, gum karaya, carrageenan, locust bean gum or carob gum.

[0055] Xanthan gum is produced from *Xanthomonas campestrix* using biotechnological processes such as fermentation. Xanthan gum is a harmless additive that is often used for thickening, suspending or gelling purposes. It is soluble in cold or hot water which eases the blending process, and creates a viscous and cloudy solution when dissolved. One important characteristic of xanthan gum is that it is pseudoplastic, which means the more shear force applied; the less viscous it becomes. Xanthan gum is often tasteless and odourless, which makes it ideal to use as additives in food products. Any taste or smell originating from additives may easily dominate the flavor of quinoa as quinoa does not have a distinct flavor itself.

[0056] Gum Arabic is a nontoxic plant exudate from the stems and branches of Acacia sengal in the Sudan area of Africa. It is commonly used in the industry purpose as a stabilizer and thickener. In addition, it is also used to compensate for the loss of texture, mouthfeel and body in products that have low calories. Because of the properties mentioned above, gum Arabic is a suitable additive to apply to quinoa as texture modifier since it will not cover up quinoa's original flavour.

[0057] Gum karaya comprises of two natural plant exudates, *Sterculia urens* Roxb and other *Sterculia* species. Gum karaya's have long-term acid stability that provides products with high quality, long shelf-life, and organoleptic effects that cannot be achieved with other hydrocolloids. It also swells in water but it is not as soluble as most gums.

[0058] Carrageenan is a natural gum extracted from red seaweed. The most usual seaweeds for extraction of carrageenan are *Kappaphycus alvarezii* and *Eucheuma denticulatum* seaweeds. The main source of commercial carrageenan is Chondrus crispus species of seaweed. Carrageenan is a high value functional ingredient in the food industry as a stabilizer and flavour enhancer. It also acts as an oxygen barrier in meat product and as a gelling agent in milk, jam and water dessert gels.

[0059] Locust bean gum or carob gum is derived from seed endosperm of carob trees, *Ceratonia siliqua* and is cultivated in the Mediterranean area. It is partially soluble in cold water and needs to be heated at 80^{o}C for 30 minutes to reach maximum solubility. It shows that it is hot water soluble and has lesser solubility in water than other gums that are cold water soluble. The film formed using locust bean gum is translucent, thin and firmly attached on the food product. Locust bean gum is commonly used in the food industry due to its stabilizing, thickening and fat-replacing properties. In addition, it is a source of soluble fiber that can enrich the development of dietary fiber in food products and reduces the risk of heart diseases and diabetes.

[0060] Quinoa seeds coated as described herein were tested and the results were collected in three ways: researchers' evaluations, sensory score panels and texture analyzer data. There were five different hydrocolloids mixed into each quinoa batches. Each batch was prepared and cooked with different water and gum ratio to compare the visual and textural differences. ANOVA was used to statistically analyze the significant differences between each measurement. After numerous trials conducted by the researchers, the top three samples in higher textures and flavour were given to the panelist for sensory evaluations.

[0061] Accordingly, the visual and tactile stickiness of quinoa samples mixed with different types of gums were analysed. It also disclosed panelist's perception on colour, texture, and bitterness of the samples.

[0062] All visual observations are summarized in Table 1.

Table 1

Visual observations of each sample composite mixtures

Sample Compositions	Stickiness*	Visual Observations
0.5 gram Xanthan Gum in 250mL water (Stove top)	2	sticky, not mushy, whole piece quinoa present
0.5 gram Xanthan Gum in 360mL water (Stove top)	5	wet, pasty, mushy
1.0 gram Xanthan Gum in 250mL water (Stove top)	1	not wet, very elastic, slightly sticky
1.0 gram Xanthan Gum in 360mL water (Stove top)	5	stickier than other Xanthan batches, but mushy swollen shape
0.5 gram Locust Bean Gum in 250mL water	5	chunky, grainy, quinoa stays in shape (no breaking)
0.5 gram Locust Bean Gum in 300mL water	5	mushy, pasty, broken structure
1.0 gram Locust Bean Gum in 250mL water	5	sticky, mushy, broken structure
1.0 gram Locust Bean Gum in 300mL water	5	mushy, broken structure
0.5 gram Carrageenan in 250mL water	4	chewy, quinoa not deformed
0.5 gram Carrageenan in 300mL water	5	mushy, not chewy; still within acceptable appearance
1.0 gram Carrageenan in 250mL water	5	stickier than 0.5 gram with same amount of water, chewy, not mushy, very well-cooked
1.0 gram Carrageenan in 300mL water	5	soft, mushy
0.5 gram Karaya Gum in 250mL water	5	chewy, grainy, not deformed quinoa present
0.5 gram Karaya Gum in 300mL water	5	mushy, not appealing quinoa appearance
1.0 gram Karaya Gum in 250mL water	5	moist, mushy, stickier than other Karaya batches
1.0 gram Karaya Gum in 300mL water	5	mushy, soft, moist
1.0 gram Gum Arabic in 250mL water	4	sticky, quinoa pieces still present
2.0 gram Gum Arabic in 250mL water	5	extremely mushy, not acceptable stickiness, pasty

*Stickiness scale: 1 - Not sticky, 2 - Slightly sticky, 3 – Moderately sticky, 4 - Very sticky, 5 - Extremely sticky

[0063] As noted, karaya gum is the most ideal hydrocolloid given that it has the stickiness level closest to sushi rice (score=5). In addition, both the visual and textural characteristics of samples when mixed with gum karaya were also more desirable. When evaluating and describing the samples, terms such as "chewy, appealing appearance, not deformed quinoa present" were used.

[0064] Fig. 1 shows the perception of panelists towards the stickiness of quinoa samples when they were given the samples to touch and feel. Panelists were also provided a reference samples made of sushi rice. Gum karaya received 4 responses stating it is "extremely sticky" and 8 responses of "very sticky". The 12 responses that fell in the two most ideal categories of description support that gum karaya is most capable of generating results with a high stickiness level that is similar to sushi rice.

[0065] A 2-way ANOVA was conducted on the visual stickiness of the quinoa samples. The results are tabulated in Table 2.

Table 2

2-Way ANOVA results when comparing stickiness score of samples with various gum added

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	14.58333	15	0.972222	1.258993	0.286012	2.014804
Columns	15.5	2	7.75	10.03597	4.60E-04	3.31583
Error	23.16667	30	0.772222			
Total	53.25	47				

[0066] The p-value of the food additives is 0.0004, which is less than 0.05. It shows that there is a significant difference on the visual stickiness between the quinoa samples with different food additives used. Tukey's test was performed on the average stickiness values of each gum and is summarized in Table 3.

Table 3

Tukey's test of various gums' average stickiness scores from sensory panelists

	Carrageenan	Locust Bean Gum	Gum Karaya
Stickiness (g)	2.500[a]	3.000[a]	3.875[b]

[0067] The result states that the visual stickiness of karaya gum is significantly different from the other two gums.

[0068] Fig. 2 illustrates the results from how well the panelists accept the colour of each quinoa sample. Both gum karaya and locust bean gum received "like very much" responses while only locust bean gum received 2 "like extremely" responses. Locust bean gum is the best candidate to mix with quinoa in terms of colour acceptance.

[0069] The colour acceptance was also analyzed using a 2-way ANOVA test (Table 4). The result indicates that there is no significant difference on the colour of quinoa samples with different hydrocolloids added. The p-value is 0.190844, which is higher than 0.05.

Table 4

2-Way ANOVA results when comparing colour acceptance score of samples with various gums added

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	87.88889	11	7.989899	9.8875	3.58E-06	2.258518
Columns	2.888889	2	1.444444	1.7875	0.190844	3.443357
Error	17.77778	22	0.808081			
Total	108.5556	35				

[0070] Texture sensory made by the researchers are summarized in Table 5. From the researchers' subjective view, the most ideal mouthfeel ratio of the batch is 0.5 gram of gum with 1 cup of water used. When each gum and water ratio increases, the quinoa loses the stickiness and chewiness resulting in mushy and watery batches. In contrast, there is little bitterness present when there is an increment on gums and water. Both karaya gum and locust bean gum scored the highest on sticky mouthfeel similar to sushi rice, which is corresponding to the score 5 as extremely sticky. Both samples are grainy, sticky, and chewy without structural destruction of quinoa pieces. Besides the same texture, they both have similar taste with little bitterness comparing to the other gums. They both are considered the ideal additives to modify the quinoa texture.

Table 5

Texture observation of each sample composite mixtures

Sample Compositions	Stickiness	Texture Observation
0.5 gram Xanthan Gum in 250mL water (Stove top)	2	chewy, popping, grainy, not mushy, bitter
0.5 gram Xanthan Gum in 360mL water (Stove top)	5	less chewy, mushy mouthfeel
1.0 gram Xanthan Gum in 250mL water (Stove top)	1	chewier than 0.5g batch with 250 mL water, elastic, can feel individual grain, not mushy
1.0 gram Xanthan Gum in 360mL water (Stove top)	5	overall chunky, texture is stickier and pastier
0.5 gram Locust Bean Gum in 250mL water	5	grainy, can feel individual grain present, sticky
0.5 gram Locust Bean Gum in 300mL water	5	better taste than 1.0g Locust Bean Gum with 300mL water, not mushy
1.0 gram Locust Bean Gum in 250mL water	5	mushy, pasty mouthfeel
1.0 gram Locust Bean Gum in 300mL water	5	different taste, no grainy texture, mushy, aftertaste is bitter
0.5 gram Carrageenan in 250mL water	4	chewy, grainy mouthfeel
0.5 gram Carrageenan in 300mL water	5	bitter
1.0 gram Carrageenan in 250mL water	5	less bitter compared with the 0.5 g Carrageenan with 250mL water
1.0 gram Carrageenan in 300mL water	5	not bitter, no grainy, chewy mouthfeel
0.5 gram Karaya Gum in 250mL water	5	mushy texture, chewy, grainy mouthfeel, not bitter
0.5 gram Karaya Gum in 300mL water	5	stick together, mushy texture, not bitter
1.0 gram Karaya Gum in 250mL water	5	grainy texture even though it's mushy, bitter taste
1.0 gram Karaya Gum in 300mL water	5	bitter taste, mushy, sticky texture
0.5 gram Gum Arabic in 250mL water	3	grainy, chewy texture, slightly bitter taste
1.0 gram Gum Arabic in 250mL water	4	chewy, grainy texture, more bitterness than 0.5 gram Gum Arabic
2.0 gram Gum Arabic in 250mL water	> 5	too mushy, cannot feel the quinoa, not chewy/grainy mouthfeel, deformed quinoa shape, slightly bitter

*Stickiness scale: 1 - Not sticky, 2 - Slightly sticky, 3 - Moderately sticky, 4 - Very sticky, 5 - Extremely sticky

[0071] Carrageenan is another option to use since it also gives quinoa stickiness when 0.5 grams and 1 cup of water was used. Unlike gum karaya and locust bean gum, it only received a score of 4, which is equivalent to “very sticky”. Lastly, lower stickiness scores were given to xanthan gum and gum Arabic.

[0072] As seen in Fig. 3, liking of texture scores from panelists fell between “very unacceptable” to “slightly acceptable.” It showed that most of the panelists could not accept the texture of quinoa as sushi-rice replacement. The quinoa with locust bean gum added showed higher unacceptance in texture since 6 panelists scored it as “very unacceptable” and “slightly unacceptable” was rated by 5 panelists. The rest of the panelists gave it 3 out of 5, which means that the texture was “moderately acceptable” to them. Furthermore, quinoa with gum karaya had similar results to the locust bean gum. Comparing the two hydrocolloids from Fig. 3, gum karaya had an overall higher acceptance as texture modifier.

[0073] A statistical way was used to analyze the texture using a 2-way ANOVA (Table 6). It shows that there is a significant difference between the panelists as the p-value is 0.00109 which is less than the threshold of 0.05. In contrast, there was no difference between the samples with different gum additions since the p-value is 0.21625, which is more than 0.05.

<u>Table 6</u>

2-Way ANOVA results when comparing texture score of samples with gum karaya and locust bean gum added

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	24.5	15	1.633333	5.444444	0.001095	2.403447
Columns	0.5	1	0.5	1.666667	0.216248	4.543077
Error	4.5	15	0.3			
Total	29.5	31				

[0074] Bitterness of the quinoa samples was scored between “slightly not bitter” to “extremely bitter.” Both food additives, gum karaya and locust bean gum, had similar scores. Looking at Fig. 4, there were 8 out of 16 panelists who scored it “very much bitter” on locust bean gum samples. However, other 8 panelists scored evenly between “slightly not bitter” and “moderately bitter”. None of them scored locust bean gum sample as “extremely bitter.” Gum karaya scored the highest bitterness compared to locust bean gum batches. There was also a tendency that panelists scored its bitterness from slightly bitter to extremely bitter. Overall, only one panelist scored gum karaya “slightly not bitter.” Due to incomparable responses on bitterness from the panelists, a 2-way AVONA (Table 7) was conducted and concluded that there was no significant difference in bitterness between the two samples. The p-value for the bitterness between two samples is 0.3714, which is above 0.05.

Table 7

2-Way ANOVA results when comparing bitterness score of samples with gum karaya and locust bean gum added

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	34.875	15	2.325	1.754717	0.14364	2.403447
Columns	1.125	1	1.125	0.849057	0.371403	4.543077
Error	19.875	15	1.325			
Total	55.875	31				

[0075] There were additional questions given to 16 panelists and answered in a “yes/no” manner during the sensory evaluation. The responses were organized into a clustered graph, shown in Fig. 5. Most of the panelists gave positive responses, such as the pleasant smell or presence of gum flavor. There was a 100% of participants who described the quinoa samples as staying in shape when they pressed quinoa in their hands. Furthermore, there were two questions with similar responses: if panelists’ were willing to order and spend extra money on modified quinoa in a sushi restaurant. The scores were 6/10 as yes/no, respectively.

[0076] For all kinds of quinoa samples studied, both hardness and stickiness were analyzed using a texture analyzer (TA.XT2i). The average score of hardness and stickiness was summarized in Table 8 and analyzed using 2-way ANOVA test (Table 9). There was a significant difference between samples, hardness/stickiness and also interactions since all three p-values were less than 0.05. Even though there were significant differences, it was difficult to further carry out the least significance difference (LSD) test because there was a significant interaction present.

Table 8

Result of hardness and stickiness of each sample using Texture Analyzer

Samples with gum and water	Hardness (g)	Stickiness (g)
Xanthan Gum 0.5g 1 cup water (stove)	926.8	-77.22
Xanthan Gum 1g 1 cup water (stove)	893.6	-67.56
Xanthan Gum 1g 1 cup water	386.7	-81.06
locust bean gum 0.5g 1 cup water	365.5	-91.554
locust bean gum 0.5g 1.25 cup water	181.0	-65.358
locust bean gum 1g 1 cup water	243.7	-79.9
locust bean gum 1g 1.25 cup water	300.1	-73.86
carrageenan 0.5g 1 cup water	376.6	-70.204
carrageenan 0.5g 1.25 cup water	208.0	-57.906
carrageenan 1g 1 cup water	319.8	-64.59
carrageenan 1g 1.25 cup water	232.8	-54.244
gum karaya 0.5g 1 cup water	396.2	-68.278
gum karaya 0.5g 1.25 cup water	191.9	-65.392
gum karaya 1g 1 cup water	277.1	-67.524
gum karaya 1g 1.25 cup water	296.7	-76.14
gum arabic 0.5g 1 cup water	188.8	-26.244
gum arabic 1g 1 cup water	189.2	-37.986
control 1 cup water	223.4	-43.034
control 1.25 cup water	384.1	-79.36
sushi rice 1.5 cup water	3098.9	-211.22

Table 9

2-Way ANOVA results for stickiness and hardness of multiple quinoa samples from Texture Analyzer

ANOVA						
Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Sample	18037223.35	18	1002068	79.5456	8.6327E-68	1.6721
Columns	14984723.72	1	14984724	1189.5096	9.1000E-74	3.9034
Interaction	22081798.28	18	1226767	97.3825	8.0263E-74	1.6721
Within	1914804.291	152	12597.4			
Total	57018549.65	189				

[0077] The properties of hydrocolloids had an impact on quinoa such as visual stickiness, colour, texture qualities and bitterness. Carrageenan, gum karaya and locust bean gum are shown to be the potential texture modifiers when dry mixed with quinoa before cooking. Among the three food additives, gum karaya scores the highest on different tested parameters, such as stickiness sensation and visual colour acceptance. However, sensory evaluation of modified quinoa showed that the majority of panelists could taste the bitterness of the samples. It is thus described how to produce sticky quinoa as a rice-replacement using edible hydrocolloids. The enclosed results confirmed the usage of food polysaccharides to enhance the texture of quinoa.

EXAMPLE I
Quinoa seeds coating protocol and testing

[0078] The quinoa variety used was Golden Quinoa, light brown, flat, circular-shaped seeds with a diameter of 1.0 to 2.0 mm. It was cultivated and processed by Canadian Northern Quinoa Corporation located in Saskatoon, Saskatchewan. The Golden Quinoa was obtained by Blair Bullus, the President of Top Tier Foods. Different types of natural gums were supplied by Pacific Blends and Colony Gums Inc.

[0079] The rice cooker was provided by BCIT. It is a 16 cup rice cooker made by RIVAL with serial number RC 165-CN. The rice cooker has simple settings with only cook and keep warm functions.

[0080] 87.5 grams of Golden quinoa were dry mixed with different level of gums, either 0.5g or 1.0g. Consequently, 1 cup and 1.5 cup of water were combined with 0.5g or 1.0g of gum to create 4 different combinations of mixtures. The mixtures were then cooked individually in an automatic rice cooker until automatically stopped and boiled for 30 minutes on stove top. Batches made with the rice cooker are left inside to be steamed for 15 minutes after cooking is stopped.

[0081] Halfway through the experiment, some variables were changed to reduce run time of each batch. Firstly, only 1.25 cup and 1 cup of water were used with 0.5g or 1.0g of gum. Secondly, only the rice cooker was used because of more even heating and more consistent results. Steaming time was also reduced to 10 minutes to avoid quinoa being too soft and mushy. After a few trials, water was reduced further to only 1 cup as it always gave a more ideal texture in terms of stickiness and hardness.

[0082] When preparing for the large amount of samples, the weight of quinoa and gum were multiplied by 4 times, while the amount of water was 1.5 cup to achieve the same texture as previous results.

[0083] After cooling to 18^{o}C, 5 pieces of subsample were selected randomly from the cooked quinoa batch. A one-cycle, force-versus-distance compression program was used to measure and calculate using a TA.XT2i Texture Analyzer with a 50 mm cylindrical probe attachment. The quinoa sample was compressed at a constant speed of 10 mm/s. For each cooking replicate, texture measurements were conducted 5 times. The results were recorded as hardness, which was defined by the height of the positive force peak, and as stickiness, which was defined by the height of the negative force peak.

[0084] The results containing stickiness and hardness score of quinoa samples from the texture analyzer were analyzed using two-way ANOVA. A p-value of 0.05 is considered as the level of statistical significance unless otherwise specified.

[0085] Following 9 weeks of experiment with various gums, 3 best batches were selected and used as samples on the sensory evaluation. Sensory tests were conducted in an environment with minimal noise and each panelist was separated by setting booths in the classroom to avoid disturbances.

[0086] 16 participants were recruited from the Food Technology Program at British Columbia of Technology Institution (BCIT) and were evaluated from the pre-screening questionnaire if they were qualified to be part of the sensory panel. Only people who consumed sushi previously were invited to be panelists. All participants provided a voluntary written consent form after receiving verbal and written information about the study.

[0087] After filling out the participation consent form, participants completed the sensory questionnaires at week 14. Sensory questionnaires were only designed to collect information about the study of sushi-style quinoa consumed at the last week of the experiment. Participants were asked to evaluate the 3 quinoa samples made with addition of gum.

[0088] In the first part of the sensory form, panelists were given a reference sample along with the 3 quinoa samples to touch and feel. Researchers asked the panelists to rate the samples' stickiness and colour acceptance level without tasting. Afterwards, researchers took away the carrageenan sample because of its less desirable taste, and had panelists taste the quinoa sample with locust bean gum and gum karaya added. Participants were then asked to rate the texture as a rice-replacement as well as the bitterness inside their mouth.

[0089] On the last part of questionnaire, participants were given the opportunity to comment on what they liked and disliked about the quinoa samples. The open-ended section of the sensory questionnaire captured unstructured feedback on participants' opinions that provided insights on the feasibility of sushi quinoa becoming a new product for both restaurants and household consumers.

[0090] Liking of the study was examined using a 9-point hedonic scale for colour acceptance and textural stickiness, and a 5-point scale for visual stickiness and bitterness taste. Similar to texture analyzer results, the different characteristics scores of quinoa samples from the sensory panel were analyzed using two-way ANOVA. A p-value of 0.05 is considered as the level of statistical significance unless otherwise specified.

[0091] While the present disclosure has been described in connection with specific embodiments thereof, it will be understood that it is capable of further modifications and this application is intended to cover any variations, uses, or adaptations, including such departures from the present disclosure as come within known or customary practice within the art and as may be applied to the essential features hereinbefore set forth, and as follows in the scope of the appended claims.

WHAT IS CLAIMED IS:

1. A method of coating quinoa seeds comprising the steps of:

   a) washing the quinoa seeds to remove saponins;

   b) roasting said quinoa seeds;

   c) coating said quinoa seeds with an oil and a hydrocolloid; and

   d) cooling said coated quinoa seeds.

2. A method of coating quinoa seeds comprising the steps of:

   a) washing the quinoa seeds;

   b) coating said quinoa seeds with a hydrocolloid;

   c) sprouting the coated quinoa seeds; and

   d) roasting said coated quinoa seeds.

3. The method of claim 2, further comprising a step of cooling said coated quinoa seeds.

4. The method of claim 2 or 3, further comprising the step of adding oil with the hydrocolloid.

5. The method of any one of claims 2-4, wherein said coated seeds are sprouted for 8-12 hours.

6. The method of claim 1 or 4, wherein said oil is sunflower oil, grape seed oil, olive oil, palm oil or granola oil.

7. The method of any one of claims 1-6, wherein said hydrocolloid is at least one of xanthan gum, gum Arabic, gum karaya, carrageenan, locust bean gum, amylopectin and carob gum.

8. The method of any one of claims 1-7, wherein said quinoa seeds are roasted and coated in a tumbler.

9. The method of any one of claims 1-8, wherein said quinoa seeds are roasted at a temperature of about 65°C to about 75°C.

10. The method of any one of claims 1-9, wherein said quinoa seeds are roasted at a temperature of about 73°C.

11. The method of any one of claims 1-9, wherein said quinoa seeds are roasted with an infrared heater.

12. The method of claim 1 and 3, wherein said coated quinoa seeds are cooled at a temperature of about 10°C to about 21°C.

13. The method of claim 1-12, wherein said coated quinoa seeds are cooled at a temperature of about 18°C.

14. The method of claims 1 and 3, wherein said coated quinoa seeds are fast cooled at a temperature of about 4°C.

15. The method of any one of claims 1-14, wherein said quinoa seeds are coated with about 2% by weight of oil.

16. The method of any one of claims 1-15, wherein said quinoa seeds are coated with about 0.5% by weight of hydrocolloid.

17. A coated quinoa seed comprising a coating of a hydrocolloid.

18. The coated quinoa seeds of claim 17, further comprising an oil in said coating.

19. The coated quinoa seeds of claim 18, wherein said oil is sunflower oil or granola oil.

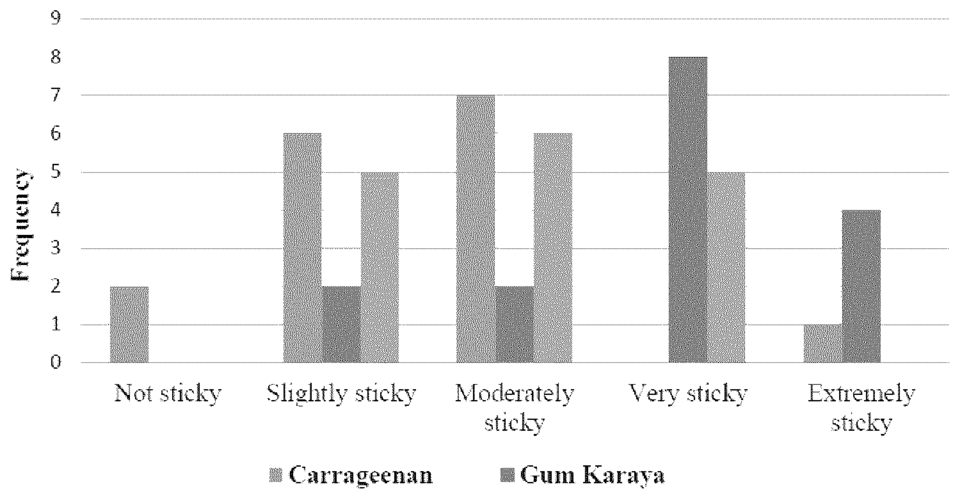
20. The coated quinoa seeds of any one of claims 17-19, wherein said hydrocolloid is at least one of xanthan gum, gum Arabic, gum karaya, carrageenan, locust bean gum, amylopectin and carob gum.

21. The coated quinoa seeds of any one of claims 17-20, wherein said quinoa seeds are coated with about 2% by weight of oil.

22. The coated quinoa seeds of claims 17-21, wherein said quinoa seeds are coated with about 0.5% by weight of hydrocolloid.

23. The coated seeds of any one of claims 17-22, wherien said seeds are further sprouted.

24. A food comprising the coated quinoa seed of any one of claims 17-23.


9
8
7
6
5
4
3
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1
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Frequency
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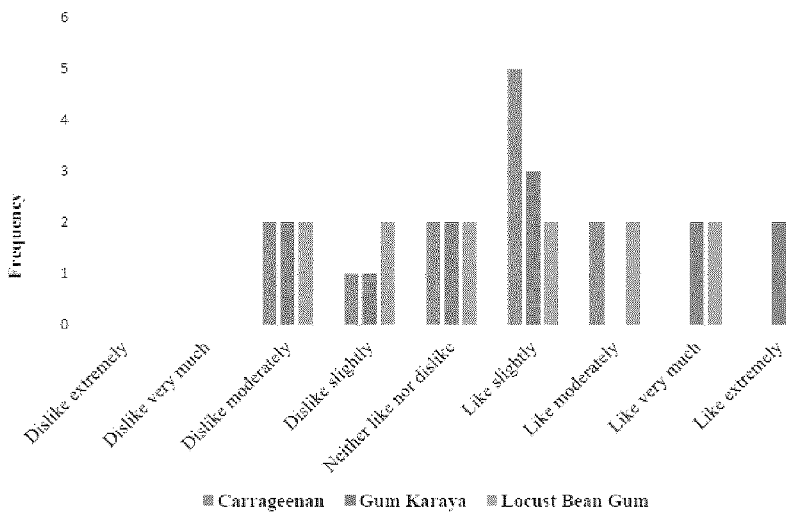
Slightly sticky
Moderately sticky
Very sticky
Extremely sticky
Carrageenan
Gum Karaya

Fig. 1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5
4
3
2
1
0
Frequency
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Dislike moderately
Dislike slightly
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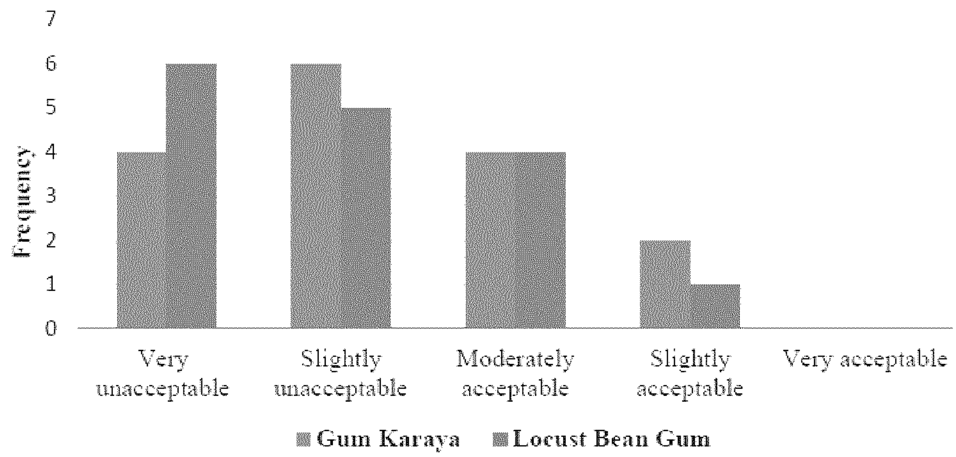
Like slightly
Like moderately
Like very much
Like extremely
Carrageenan
Gum Karaya
Locust Bean Gum

Fig. 2


Frequency
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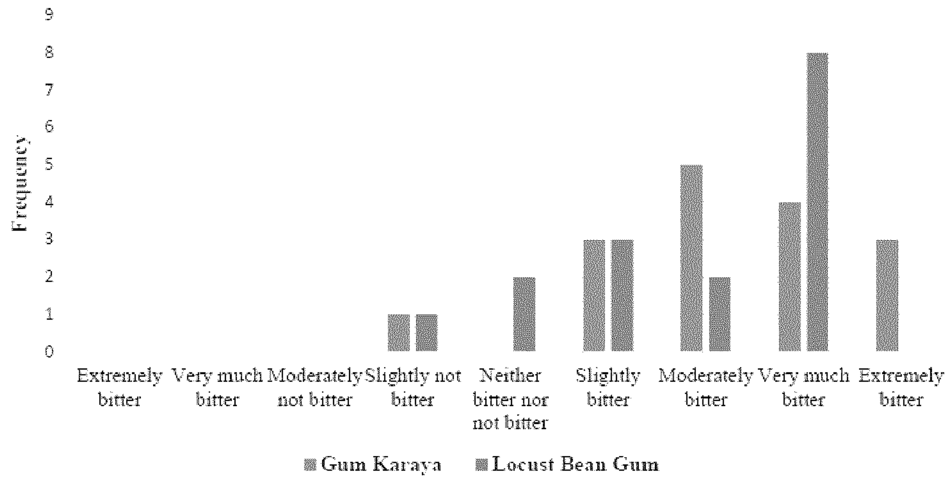
1
2
3
4
5
6
7
Very unacceptable
Slightly unacceptable
Moderately acceptable
Slightly acceptable
Very acceptable
Gum Karaya
Locust Bean Gum

Fig. 3


Frequency
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2
3
4
5
6
7
8
9
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Very much bitter
Moderately not bitter
Slightly not bitter
Neither bitter nor not bitter
Slightly bitter
Moderately bitter
Very much bitter
Extremely bitter
Gum Karaya
Locust Bean Gum

Fig. 4

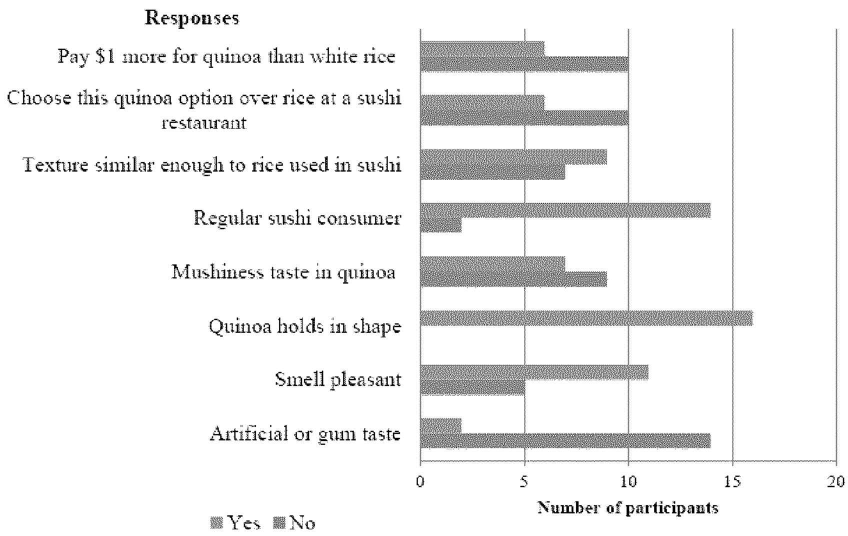
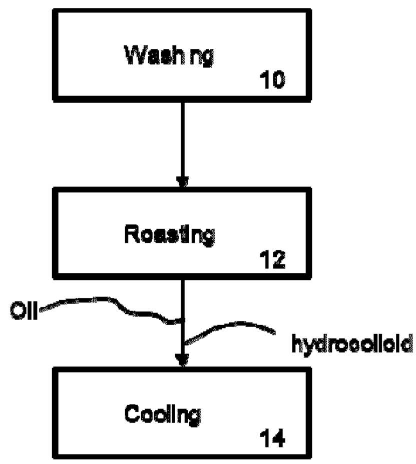

Responses
Pay $1 more for quinoa than white rice
Choose this quinoa option over rice at a sushi restaurant
Texture similar enough to rice used in sushi
Regular sushi consumer
Mushiness taste in quinoa
Quinoa holds in shape
Smell pleasant
Artificial or gum taste
0
5
10
15
20
Number of participants
Yes
No

Fig. 5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Roasting
12
Oil
hydrocolloid
Cooling
14

Fig. 6

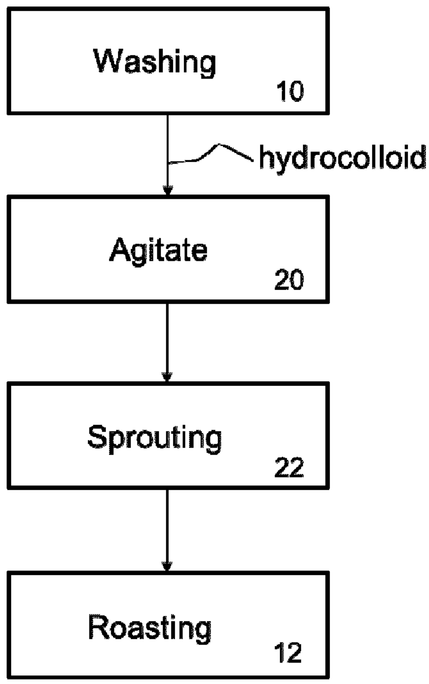
Washing
10
hydrocolloid
Agitate
20
Sprouting
22
Roasting
12

Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2018/051484

A. CLASSIFICATION OF SUBJECT MATTER
IPC: ***A23L 25/00*** (2016.01) , ***A23L 5/00*** (2016.01) , ***A23P 20/10*** (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)
Keywords used across the whole IPC

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

Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used)
Databases: Questel-Orbit, CIPO Library Discovery Tool, Google Patents, Google
Keywords: quinoa, seeds, rice, grain, sushi, hydrocolloid, colloid, xanthan, arabic, karaya, carrageenan, locust, amylo*, carob, roast, toast, wash, sprout, germinat*, coat,

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	WO 2015/196061A1 (TREECE et al.) 23 December 2015 (23-12-2015) * paragraphs 0012, 0016, 0017, 0024; Table 2; claim 1 *	17-22, 24 1-24
X	WO 2009/085511A1 (MCARDLE et al.) 09 July 2009 (09-07-2009) * paragraphs 005, 008, 072 *	17, 18, 20, 24
X	WO 00/78161A2 (CHRISTENSEN et al.) 28 December 2000 (28-12-2000) * page 7, lines 18-29; page 9, lines 9-11 *	17, 20, 24
X	WO 2004/100678A2 (ASHMEAD et al.) 25 November 2004 (25-11-2004) * page 10, lines 4-14 *	17, 20, 24

☑ Further documents are listed in the continuation of Box C.

☑ See patent family annex.

*	Special categories of cited documents:
"A"	document defining the general state of the art which is not considered to be of particular relevance
"E"	earlier application or patent but published on or after the international filing date
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O"	document referring to an oral disclosure, use, exhibition or other means
"P"	document published prior to the international filing date but later than the priority date claimed
"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&"	document member of the same patent family

Date of the actual completion of the international search
31 January 2019 (31-01-2019)

Date of mailing of the international search report
05 February 2019 (05-02-2019)

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Facsimile No.: 819-953-2476

Authorized officer

Cara-Lynn Baas (819) 639-8420

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	SUÁRES-ESTRELLA et al. *Quinoa bitterness: causes and solutions for improving product acceptability*. Journal of the Science of Food and Agriculture, Volume 98, Issue 11, pages 4033-4041, 2018. * abstract; Table 3; page 98 *	1-16, 23, 24
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Y	US 2010/0196569A1 (SCANLIN et al.) 05 August 2010 (05-08-2010) * paragraphs 0041-0044, 0060]	1-16, 23, 24

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		AU2015276896B2	08 November 2018 (08-11-2018)
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		EP3157353A4	16 August 2017 (16-08-2017)
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