

(54) A Sugar-Free Pectin Nutritional Gummy Base and Preparation Method Thereof

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(57) Abstract:

This innovation relates to a sugar-free pectin nutrient gummy base and a preparation method thereof, which process is shown as follows:  $\beta$ -carotene is poured into palm oil, followed by the addition of Tween 80 and water to form a mixture by agitating continuously. Then isomalt is added, afterward hydrogenation of the mixture through a high-pressure homogenize. The prepared emulsion is powdered by lyophilizer (freeze dryer), then dissolve the powder into solution which so called solution 3 at ambient temperature. Gel 1 is made by combining the powders of pectin, isomalt, and part of maltitol into water with stirring. After preparing gel 1 and solution 3, with high-speed blending firstly, solution 3 is pouring into gel 1, and addition of isomalt, and rest of maltitol is employed into the mixed gel, at this time gel 2 is created. Afterwards, adding citric acid to gel 2, vacuum degassing, heating up, moulding, and cooling. The gummy base provide by the innovation is suitable for any target market, as it is a plant-based product which is not consist of any ingredients derived from animals, as well as it does not contain any sugar, which means it does not influence blood sugar level, and not lead to obesity.

## **TITLE**

### **A Sugar-Free Pectin Nutritional Gummy Base and Preparation Method Thereof**

## **TECHNICAL FIELD**

This innovation belongs to food field, relating to a sugar-free pectin nutritional gummy base and a preparation method thereof.

## **BACKGROUND OF THE INVENTION**

Gummies are favoured by all kinds of consumers in the market. The consumer group is large, but traditional candies are low-tech with poor quality. Moreover, as the addition of lots of table sugar, coloring and other additives, the products can lead to obesity. Another adverse aspect also exists, for instance, most of them are easy to stick to teeth and low nutrient. Currently, the food trend is moving towards to low sugar and low fat. Due to the demands of some consumers who prefer to low calorie food, who are diabetes patients that have to control their sugar intake, and who are pursuing functional foods, it is necessary to develop sugar-free gummies. As the more sugar related health problems are getting severe, both government and doctors advocate people to lower sugar intake. Based on which, sugar free products are developed by many firms in food industry, especially in confectionery and snack area.

Issues with existing sugar-free gummies are:

Relatively hard and brittle mouthfeel, and breaking easily into lumps in the mouth;

Divalent cation needed, if low methoxyl pectin is employed in the formula. Generally, calcium ion is introduced for instance calcium chloride, calcium sulphate, which,

however, results in strong astringency taste.

Added more pectin generally, if high methoxyl pectin is used in the formula, which is unfavourable to the production as the rate of gelation is too fast and form harder gummy eventually after cooling;

Extremely huge amount of sugar alcohols needed, if a constant amount of high methoxyl pectin is used in the formula. For a long-term storage, however, sugar alcohol crystals will separate out of the gummy and cause floc on the surface of gummy, which not only deteriorates the taste but also impacts the appearance of the product. Moreover, the cost of the sugar alcohols is comparatively high.

## STATEMENT OF INVENTION

In order to conquer the lack of the aforementioned existing techniques, this innovation provides an approach of a sugar-free pectin nutritional gummy base and a preparation method thereof. It aims to improve the elasticity and softness of soft candy and enhance the silky mouthfeel of the product. There is no fast-gelling issue, even 10 to 15% more pectin will be added in the formula than the previous. And there is no floc separating out from the product, if a large amount of sugar alcohol is used. There is also no astringency mouthfeel, if calcium ion is introduced.

A sugar-free pectin nutritional gummy base comprising the following raw materials in part by mass of:

Pectin            20 to 25 parts;

Tween 80        0.5 to 0.7 parts;

$\beta$ -carotene      1.0 to 1.4 parts;

Palm oil         9.2 to 10 parts;

Isomalt            460 to 470 parts;

Maltitol           260 to 270 parts;

Citric acid        4 to 5 parts;

The appropriate amount of water.

The process to produce the aforesaid the sugar-free pectin nutritional gummy base includes the following steps:

1. Melting palm oil, which melting point ranges from 32 to 35°C, to liquid form for use; adding  $\beta$ -carotene into the oil with 55 to 65 RPM stirring to make mixed oil 1, and cooling and holding the temperature of the mixture to 32 to 35°C; the ratio of palm oil and  $\beta$ -carotene is 8 : 1 in order to decrease the colour of  $\beta$ -carotene and form a light-coloured mixture. Mixing at this ratio, the mixture has violet aroma without any unpleasant smell resulting from carotene.
2. Preparing Tween 80 aqueous solution which concentration is 2.8% (w/w) at 32 to 35°C;

Tween 80 is an emulsifier used in O/W emulsion, which is an amphiphilic compound. Its hydrophobic group can interact with oil phase, while the hydrophilic part is towards water phase. Through homogenization, micelles of Tween 80 are formed, which encapsulate oil and result in invisible droplets.

Pouring mixed oil 1 is poured into Tween 80 solution, then adding warm water (32 to 35°C) that weighed 6.5 times as much as the mixed oil at 32 to 35°C with 120-130 RPM stirring to form mixed liquid 1;

The ratio used here is most appropriate condition of freeze-drying for mixed liquid 1.

3. Homogenizing mixed liquid 1 under 35,000 to 38,000 psi for generating nano-droplets which diameters are in the range of 85 to 100 nm;

The droplet size should range from 85 to 100 nm. Although the number could be smaller, more energy and higher pressure are consumed and needed. Too large size would cause droplets aggregation, which would further lead to coalescence and form visible oil droplets.

After high-pressure homogenization, even at room temperate, there is no suspended solid or oil that can be seen in the solution.

Zeta sizer can be applied to evaluate the oil droplet size, if it too large, one more hydrogenation should be employed to form the desired solution 1.

4. Adding isomalt to solution 1 to form solution 2 which contains 1.4% of isomalt;

The use of isomalt is a cryoprotectant for the process of freeze drying

Freeze-drying solution 2;

Through freeze drying, solution 2 loses most moisture and flakes is formed on the tray in dryer finally. Grind flakes into fine powder which should pass through 80 mesh sieve and comprises of moisture about 5 to 8%. Dissolve the powder 1 at ambient temperature to prepare solution 3 for use;

5. Mixing pectin powder, 1/2 parts isomalt and 1/2 parts maltitol, then adding water (60 to 65 °C) which is 15 times the weight of pectin. Stirring the mixture around 10 to 15 minutes with 130 to 150 RPM to fully dissolve the powders to form gel 1;
6. Pouring solution 3 into gel 1 with 10 to 15 minutes relatively higher agitation (220-230 RPM) at 60 to 65 °C; Then adding the rest of isomalt and maltitol with 5 to 10 minutes relatively higher speed mixing (220-230 RPM) at 60 to 65 °C to

make gel 2;

7. Preparing citric acid solution and putting it into gel solution 2 with evenly mixing through 10 minutes stirring (130-150 RMP) at 60 to 65 °C;
8. Vacuum degassing the gel to generate a bubble-free, usable soft gummy base;
9. heating it to 90 to 95 °C, then transfer gel to molding machine, and cooling molds or trays fully filled with gel in cooling room.

$\beta$ -carotene an oily substance, which is a natural nutrient that has the ability to provide a smooth mouthfeel. Palm oil is a natural ingredient with slightly sweet taste and pleasant violet aroma. Either  $\beta$ -carotene or palm oil is water insoluble, and not dissolve in water. This innovation applies emulsification technology, which uses emulsifier to form micelles to encapsulate oil and form oil droplets with certain constant size. It can greatly improve water solubility of oil (oil can dissolve in water). With the help of emulsion system, oil would be evenly dispersed in gel system, and further consistently distributed in gummies. Due to homo-disperse of invisible oil droplet, the gummy is tasted softer and silkier. The embedded oil droplets in the network structure of pectin gel not only improve water holding capacity of the gel but enhance its elasticity, as gel structure are not so tight as before. It also reduces the chance of cross-linking between pectin molecules, which further protect moisture migration from the inside of the gummy to its surface, as water molecules would be squeezed out resulting from cross-linking of molecules side chain. Furthermore, more water would be evaporated as the migration of water to the gummy surface due to side chain cross-linking, which lead to precipitation of sugar alcohol and other soluble solids out of the product. The cross-linking of pectin side chain and water lose eventually cause rubber texture of gummies. Therefore, the application of innovation retards separation of sugar alcohol and prevents the mouthfeel deterioration of the candy.

### **Beneficial effects of the innovation**

The base provided by this innovation does not contain any sugar, hence, the produce will neither influence blood sugar level nor lead to obesity. The base is plant based, it does not consist of any ingredients derived from animals, therefore it is suitable for all kind of consumers, no matter who is vegetarian, kosher or halal.

There is no special smell of the base from animals like gelatin, but it has faint fragrance from plant extracts.

The base is used to make sugar-free plant-based gummies, which can add bio-active ingredients, as well as adjust flavor and color according to requirements.

### **Detailed implementation of the innovation**

The present invention is now illustrated in greater detail by way of Examples. It should be noted that, on the premise of non-conflict, the various examples described below, or each technical feature can be combined arbitrarily to form new embodiment.

#### **Example 1**

A sugar-free pectin nutritional gummy base, all the presents are by weight:

Pectin            23 parts;

Tween 80        0.6 parts;

$\beta$ -carotene      1.2 parts;

Palm oil         9.6 parts;

Isomalt         467 parts;

Maltitol            267 parts;

Citric acid        4.3 parts;

The appropriate amount of water.

The process to produce the sugar-free pectin nutritional gummy base includes the following steps:

1. Melting palm oil to liquid form for use; adding  $\beta$ -carotene into the oil with 65 RPM stirring to make mixed oil 1, cooling and holding the temperature of the mixture to 35°C;
2. Preparing Tween 80 aqueous solution which concentration is 2.8% (w/w) at 35°C;

Pouring mixed oil 1 is poured into Tween 80 solution, then adding warm water (32 to 35°C) that weighed 6.5 times as much as the mixed oil at 35°C with 120-130 RPM stirring to form mixed liquid 1;

3. Homogenizing mixed solution 1 under 38,000 psi for generating nanodroplets which diameters are in the range of 85 to 100 nm;
4. Adding isomalt to solution 1 to form solution 2 which contains 1.4% of isomalt; freeze-drying solution 2;

Grind and sieve these flakes obtained by drying solution 2 to make fine powder which should pass through 80 mesh sieve and comprises of moisture about 8%. Dissolve the powder 1 at ambient temperature to obtain solution 3;

5. Mixing pectin powder, 1/2 parts of isomalt and 1/2 parts of maltitol, then adding water (60°C) which is 15 times the weight of pectin. Stirring the mixture around 10 minutes with 150 RPM to fully dissolve the powders to form gel 1;

6. Pouring solution 3 into gel 1 with 10 minutes relatively higher agitation (230 RPM) at 65 °C; Then adding the rest of isomalt and maltitol with 5 minutes relatively higher speed mixing (230 RPM) at 65 °C to make gel 2;
7. Preparing citric acid solution and putting it into gel 2 with evenly mixing through 10 minutes stirring (130 RMP) at 65 °C;
8. Vacuum degassing gel to generate a bubble-free, usable gummy base;
9. heating it to 95 °C , transferring gel to molding machine, then transferring molds or trays to cooling room

#### Example 2

A sugar-free pectin nutritional gummy base, all the presents are by weight:

Pectin            25 parts;

Tween 80        0.5 parts;

β-carotene      1.4 parts;

Palm oil         9.2 parts;

Isomalt         470 parts;

Maltitol         270 parts;

Citric acid      4 parts;

The Appropriate amount of water.

The process to produce the sugar-free pectin nutritional gummy base includes the following steps:

1. Melting palm oil to liquid form for use; adding  $\beta$ -carotene into the oil with 55 to 65 RPM stirring to make mixed oil 1, holding the temperature of the mixture to 32°C;

2. Preparing Tween 80 aqueous solution which concentration is 2.8% (w/w) at 32°C;

Pouring mixed oil 1 is poured into Tween 80 solution, then adding warm water (32°C) that weighed 6.5 times as much as the mixed oil at 32°C with 120-130 RPM stirring to form mixed liquid 1;

3. Homogenizing mixed solution 1 under 35,000 psi for generating nanodroplets which diameters are in the range of 85 to 100 nm;

4. Adding isomalt to solution 1 to form solution 2 which contains 1.4% of isomalt; Freeze-drying solution 2;

Grind and sieve these flakes obtained by drying solution 2 to make fine powder which should pass through 80 mesh sieve and comprises of moisture about 5%. Dissolving the powder 1 at ambient temperature to prepare solution 3;

5. Mixing pectin powder, 1/2 parts of isomalt and 1/2 parts of maltitol, then adding water (60°C) which is 15 times the weight of pectin. Stirring the mixture around 10 minutes with 130 RPM to fully dissolve the powders to form gel 1;

6. Pouring solution 3 into gel 1 with 15 minutes relatively higher agitation (220 RPM) at 60 °C; Then adding the rest of isomalt and maltitol with 10 minutes relatively higher speed mixing (220 RPM) at 60 °C to make gel solution 2;

7. Preparing citric acid solution and putting it into gel 2 with evenly mixing through 10 minutes stirring (150 RMP) at 60 °C;

8. Vacuum degassing gel to generate a bubble-free, usable gummy base;

9. heating it to 90°C, transferring gel to molding machine, then transferring molds or trays to cooling room

### Example 3

A sugar-free pectin nutritional gummy base, all the presents are by weight:

Pectin            20 parts;

Tween 80        0.5 parts;

β-carotene      1.0 parts;

Palm oil        10 parts;

Isomalt        460 parts;

Maltitol        260 parts;

Citric acid     4 parts;

The appropriate amount of water.

The process to produce the sugar-free pectin nutritional gummy base includes the following steps:

1. Melting palm oil to liquid form for use; adding β-carotene into the oil with 55 to 65 RPM stirring to make mixed oil 1, cooling and holding the temperature of the mixture to 35°C;
2. Preparing Tween 80 aqueous solution (aq) which concentration is 2.8% (w/w) at 35°C;

Pouring mixed oil 1 is poured into Tween 80 (aq), then adding warm water (35°C)

that weighed 6.5 times as much as the mixed oil at 35°C with 130 RPM stirring to form mixed solution 1;

3. Homogenizing mixed solution 1 under 36,000 psi for generating nanodroplets which dosimeters are range from 85 to 95 nm;
4. Adding isomalt to solution 1 to form solution 2 which contains 1.4% of isomalt; Freeze-drying solution 2;

Grind and sieve these flakes obtained by drying solution 2 to make fine powder which should pass through 80 mesh sieve and comprises of moisture about 6%. Dissolving the powder 1 at ambient temperature to prepare solution 3;

5. Mixing pectin powder, 1/2 parts of isomalt and 1/2 parts of maltitol, then adding water (65°C) which is 15 times the weight of pectin. Stirring the mixture around 15 minutes with 150 RPM to fully dissolve the powders to form gel 1;
6. Pouring solution 3 into gel 1 with 10 to 15 minutes relatively higher agitation (230 RPM) at 60 to 65°C; Then adding the rest of isomalt and maltitol with 10 minutes relatively higher speed mixing (220 RPM) at 60 °C to make gel 2;
7. Preparing citric acid solution and putting it into gel 2 with evenly mixing through 10 minutes stirring (150 RMP) at 60 °C;
8. Vacuum degassing gel to generate a bubble-free, usable gummy base;
9. Heating it to 95 °C , transferring gel to molding machine, then transferring molds or trays to cooling room

#### Example 4

On the basis of Example 1, in step (7), 5 parts of calcium lactate powder and 0.5 parts of edible flavouring are added to obtain high-calcium gummy.

#### Example 5

On the basis of Example 2, in step (7), 5 parts of calcium lactate powder and 0.5 parts of edible flavouring are added to obtain high-calcium gummy.

#### Example 6

On the basis of Example 3, in step (7), 5 parts of calcium lactate powder and 0.5 parts of edible flavouring are added to obtain high-calcium gummy.

#### Comparison 1

The differences from Example 4 were significant at 2.2 parts of  $\beta$ -carotene and 8.6 parts of palm oil, which resulted in a dark colour of oil, strong carrot smell, and loss of aroma.

#### Comparison 2

The difference from Example 5 was significant at cutting the half of Tween 80 used, which resulted in the dried powder was not fully dissolve, cannot form clear solution, and some small oil droplet can be detected.

#### Comparison 3

The differences from Example 6 were in step (7) by increasing the ratio between water and the mixed oil 1 from 6.5:1 to 10:1, which resulted in extending the time and energy cost of freeze drying, and a higher the moisture content of the final powder; once decrease the ratio to 3.5:1, dissolution rate would slow down, due to a higher oil content of the powder.

#### Comparison 4

The differences from Example 4 were in step (3) by reducing pressure of

hydrogenation, resulting in larger droplet sizes (> 130 nm) and further impact the freeze-dried powder. Powder can not fully dissolve in water, what's worse, with stirring large visible droplet formed (aggregation of oil droplets occurred).

#### Comparison 5

The differences from Example 5 were in step (4) by cutting a half of isomalt. due to lack of cryoprotectant for freeze-drying process. Cryoprotectant is used to reduce the likelihood of particles/droplets interaction during freezing. It aims to prevent droplets aggregation in this process. The powder was hardly soluble in water.

#### Comparison 6

The differences from Example 6 were in step (5) by adding pectin, isomalt and maltitol all together at the same time, which led to inconsistent mouthfeel of gummies. Because it is difficult to mix it evenly at routine process under set conditions, much more time and energy (electricity) are required. Moreover, it is risk that powder form clots in gel system.

Table 1 compared stability among Example 4 to 6. The stability test was conducted under conditions of 30 °C and 65% relative humidity for 3 months.

Table 1. Comparison of Stability

Samples	Initially (g/100g)	1 <sup>st</sup> month (g/100g)	2 <sup>nd</sup> month (g/100g)	3 <sup>rd</sup> month (g/100g)	Degradation rate
Example 4	5.21	5.14	5.01	4.93	5.4%
Example 5	5.24	5.13	4.98	4.92	6.1%
Example 6	5.22	5.15	5.03	4.90	6.1%

Comparison 6	5.20	4.23	3.16	3.06	41.2%
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Table 2 compared texture of the products made among Example 4 to 6 and Comparison 1. Texture analysis was conducted by the use of TPA (Texture Analyzer Profile) on a texture analyzer. Results were averaged from 10 replicates.

Samples	Hardness	Springiness	Cohesiveness	Chewiness	Resilience
Example 4	30861	0.84	0.73	19681	0.33
Example 5	31633	0.83	0.75	16787	0.34
Example 6	30957	0.81	0.73	18563	0.41
Comparison 6	43138	0.31	0.67	8386	0.13

Finally, it should be noted that the above embodiments illustrate the technical solutions of the utility model, rather than limit the scope of protection of the utility model. Although the utility model is described in detail with reference to the preferred embodiments, technical people or food technologists should understand that the technical solution of the utility model can be modified or equivalently replaced without departing from the essence and scope of the technical solution of the utility model.

## WHAT WE CLAIM IS

1. A sugar-free pectin nutritional gummy base, characterized in comprising the following raw materials in part by mass of:

Pectin            20 to 25 parts;

Tween 80        0.5 to 0.7 parts;

$\beta$ -carotene      1.0 to 1.4 parts;

Palm oil         9.2 to 10 parts;

Isomalt         460 to 470 parts;

Maltitol         260 to 270 parts;

Citric acid      4 to 5 parts;

the appropriate amount of water.

2. A method of preparing sugar-free pectin nutritional gummy base, characterized in wherein comprising the steps of:

(i) Melting palm oil and adding  $\beta$ -carotene with agitating to form mixed oil 1;

(ii) Preparing Tween 80 solution with concentration 2.8% (w/w) followed by pouring the mixed oil 1 into; adding water and blending to make mixed liquid 1;

(iii) Homogenizing the mixed liquid 1 through high-pressure homogenization under 35,000 to 38,000 psi to generate droplets with particle size ranging from 85 to 100 nm (nanometre), which is solution 1.

- (iv) Adding isomalt to solution 1 to form solution 2 , said amount is: the concentration of isomalt is 1.4% w/w; freeze drying solution 2 to make powder 1, which contains 5-8% of moisture and 90% can pass 80 mesh sieves; Take amount of powder 1 required for production, dissolve it at ambient temperature to get solution 3;
  - (v) Pectin powder, part of isomalt and part of maltitol dissolve into water with stirring to form gel 1.
  - (vi) Mixing solution 3 with gel 1 with blending, which is 220 to 230 RPM; adding the rest of isomalt and maltitol through high-agitating to form gel 2;
  - (vii) Pouring prepared citric acid solution in to gel 2, and mixing evenly;
  - (viii) Vacuum degassing to get a bubble-free, usable gummy base;
  - (ix) heating up, moulding and cooling.
3. The preparation method of a sugar-free pectin nutritional gummy base according to claim 2, characterized in that, wherein the stirring condition said in process (i) is 55 to 65 RPM at 32-35°C.
  4. The preparation method of a sugar-free pectin nutritional gummy base according to claim 2, characterized in that, in Tween 80 solution in process (ii) is 2.8% w/w at 32-35°C.
  5. The preparation method of a sugar-free pectin nutritional gummy base according to claim 2, characterized in that, the proportion among isomalt, maltitol, pectin and water added in process (v) is 0.5:0.5:1:15 with 10 to 15 minutes stirring (130 to 150 RPM) at a temperature of from 60 to 65°C.
  6. The preparation method of a sugar-free pectin nutritional gummy base according

to claim 2, characterized in that, the conditions for preparing the mixture of solution 3 and gel 1 in process (vi) is pouring solution 3 to gel 1 with 10 to 15 minutes stirring 220 to 230 RPM at a temperature of from 60 to 65°C.

7. The preparation method of a sugar-free pectin nutritional gummy base according to claim 2, characterized in that, the conditions mentioned in process (vii) is adding citric acid solution into gel 2 with 10 minute 130 to 150 RPM stirring at a temperature of from 60 to 65°C.
8. The process claimed in Claim 2, wherein the heating temperatures mentioned step ix is at a temperature of from 90 to 95°C.