

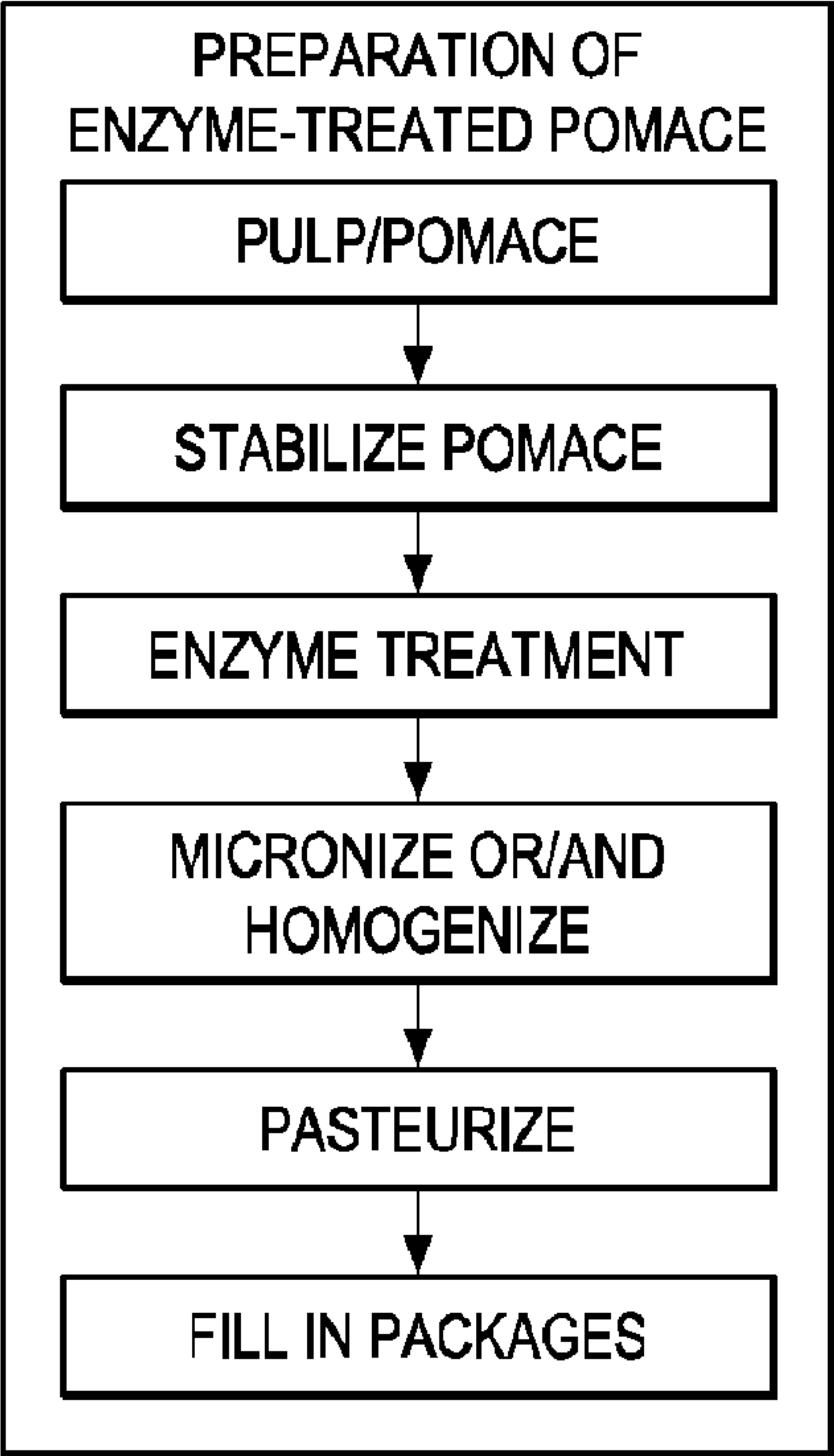


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(54) Titre : REDUCTION DE LA VISCOSITE DE BOISSONS ET D'ALIMENTS CONTENANT DES MATIERES A BASE DE FRUITS ET DE LEGUMES RICHES EN FIBRES
(54) Title: VISCOSITY REDUCTION OF BEVERAGES AND FOODS CONTAINING HIGH FIBER FRUIT AND VEGETABLE MATERIALS

FIG. 1



(57) **Abrégé/Abstract:**
A method for enzymatically treating pomace involves subjecting pomace to at least one enzyme in an amount between 0.15-1.0 wt% of the pomace. The pomace-enzyme mixture is heated to 25-57°C for 10-60 minutes before the at least one enzyme is deactivated to form the enzymatically-treated pomace. Thereafter, the enzymatically-treated pomace may be added to food and beverage products.



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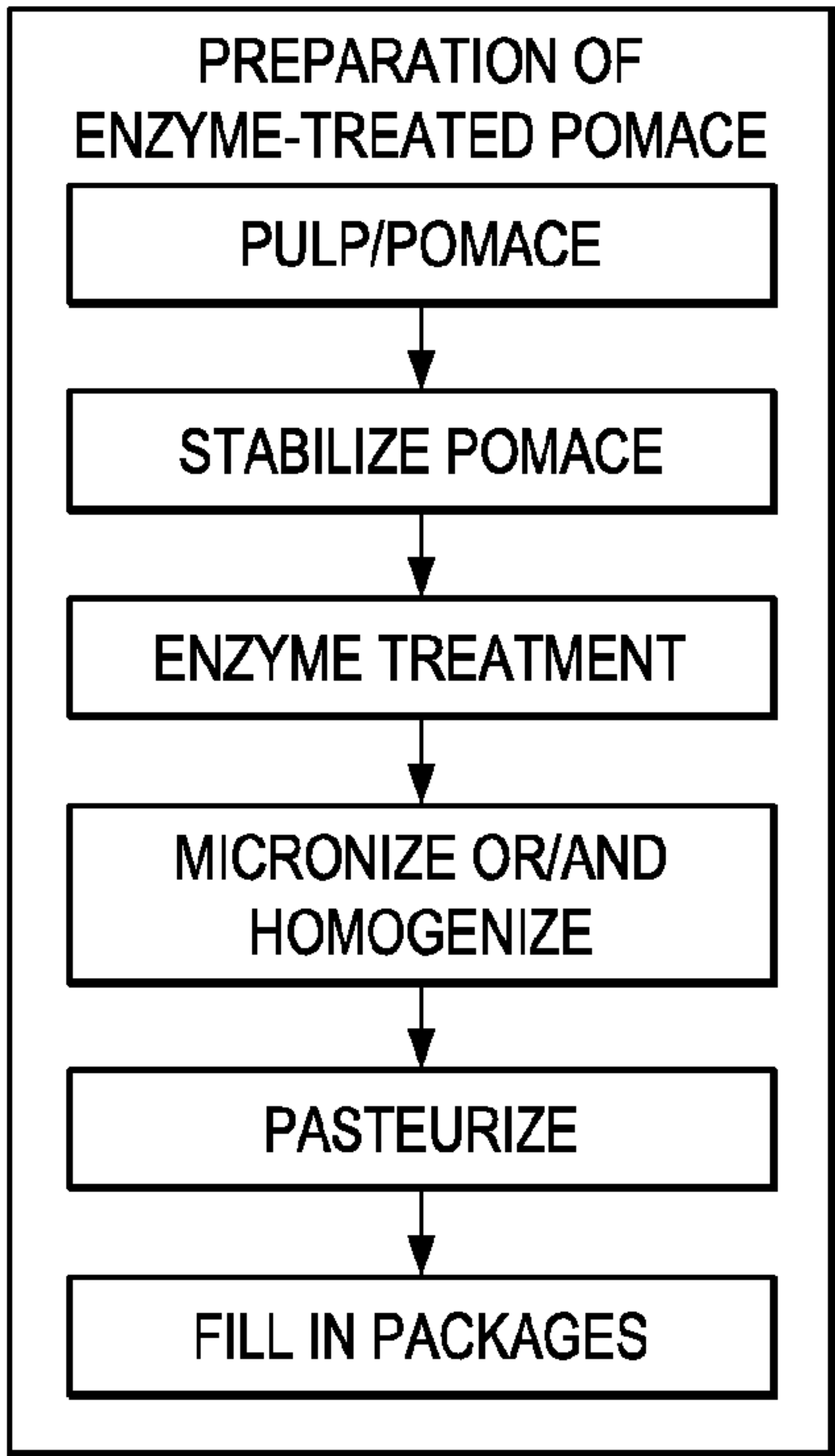
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(54) Title: VISCOSITY REDUCTION OF BEVERAGES AND FOODS CONTAINING HIGH FIBER FRUIT AND VEGETABLE MATERIALS

FIG. 1



(57) Abstract: A method for enzymatically treating pomace involves subjecting pomace to at least one enzyme in an amount between 0.15-1.0 wt % of the pomace. The pomace-enzyme mixture is heated to 25-57°C for 10-60 minutes before the at least one enzyme is deactivated to form the enzymatically-treated pomace. Thereafter, the enzymatically-treated pomace may be added to food and beverage products.

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VISCOSITY REDUCTION OF BEVERAGES AND FOODS CONTAINING HIGH FIBER FRUIT AND VEGETABLE MATERIALS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of provisional U.S. Application No. 62/378,953 entitled “Viscosity Reduction of Beverages and Foods Containing High Fiber Fruit and Vegetable Materials” filed August 24, 2016, provisional U.S. Application No. 62/346,077 entitled “Viscosity Reduction of Beverages and Foods Containing High Fiber Fruit and Vegetable Materials” filed June 6, 2016, and provisional U.S. Application No. 62/210,261 entitled “Viscosity Reduction of Beverages and Foods Containing High Fiber Fruit and Vegetable Materials” filed August 26, 2015, the technical disclosures of which are hereby incorporated by reference in their entirety.

FIELD OF THE INVENTION

[0002] The present invention relates generally to beverage and food products containing enzymatically-treated high fiber fruit and vegetable materials, such as pomace. The beverage products exhibit a significantly reduced viscosity when compared to beverage products containing non-enzymatically-treated high fiber fruit and vegetable materials, and the fiber content of the high fiber fruit and vegetable materials remains the same pre and post enzymatic treatment.

BACKGROUND

[0003] Fruit and vegetable based products, especially juices and beverages, are popular among consumers as a healthy comestible and a means to meet their daily recommended amounts of fruits and vegetables. However, some food and vegetable based products lack the nutrients contained in the whole fruit or vegetable. For example, due to the juice extraction process, portions of the whole fruit or vegetable, such as cellulosic materials, membranes, pulp, etc., are excluded from the juice that would otherwise be consumed if the fruit or vegetable were eaten whole.

[0004] Various attempts have been made to supplement fruit and vegetable juices to incorporate these lost nutrients back into the fruit and/or vegetable product. For instance, various fiber powders obtained from edible and/or typically inedible portions of foods are commercially

available; however, such powders tend to impart an undesirable flavor to the juice. Moreover, they may dissolve so thoroughly that a consumer has difficulty believing that the juice does in fact contain the added fiber. Efforts to incorporate large pieces of insoluble fibers into juice have generally resulted in the inclusion of undesired color, flavor, and fibrous textures to the juice product. In addition, this takes longer time for hydration to be incorporated into juice or beverage. The thickness or viscosity of the juice, coupled with the appearance and mouthfeel associated with incorporating a substantial amount of the fibrous/solid materials into the product, pose the most problems from a consumer acceptability standpoint as well as a product processing standpoint.

[0005] The application of nutritious and fibrous components to finished products has been limited due primarily to the consumer's perception of the finished products containing the fibrous components as something other than juice (such as a smoothie or some other product containing a thick consistency).

[0006] Others in the industry have tried numerous methods to reduce the viscosity of beverages containing high-fiber fruit or vegetable materials. Exemplary methods include chemical hydrolysis and mechanical technologies. Although these methodologies reduce the viscosity of the high fiber fruit or vegetable materials, they are disadvantageous in the food and beverage industry for a variety of reasons. For instance, chemical hydrolysis subjects high fiber fruit or vegetable materials to chemicals, such as formic acid and hydrochloric acid, resulting in non-specific reactions whereby the chemicals react with glycosidic bonds in fiber and thus the fiber and sugar identities are not retained. Moreover, few food-grade chemicals are candidates for such use. A stigma is also attached to chemically-treated products as not being fresh or natural and such products may even be considered unhealthy.

[0007] Mechanical technologies to reduce the viscosity of the pomace, such as homogenization and micronization, cannot break down the fiber into a smaller chain size. Although the fibers may be pulverized or micronized, the chain length of the fibers remain intact, and thus, this method cannot deliver the same amount of fiber nor can it reduce viscosity of the fiber-containing pomace to the point where it is not detectable by the consumer.

BRIEF SUMMARY

[0008] Aspects of the disclosure relate to a low viscosity beverage comprising juice and pomace or other high fiber by-products from fruits or vegetables (hereinafter collectively “pomace”). The beverage contains enzymatically-treated pomace in an amount to provide high fiber content, yet the beverage maintains a low viscosity despite the significant amount of pomace. The beverage contains at least 1 wt% of pomace. In one embodiment, the viscosity of the final beverage product is about 60-250 cP measured at 20 °C with a Brookfield viscometer (spindle #1, 20 rpm). If the beverage is a reduced calorie beverage or a beverage containing less than 100% juice, the viscosity may be as low as 25 cP, e.g. 25 to 150 cP measured at 20 °C with a Brookfield viscometer (spindle #1, 20 rpm). However, in another embodiment, the reduced calorie beverage or the beverage containing less than 100% juice may have a viscosity comparable with a full-calorie beverage or a beverage containing 100% juice.

[0009] In another aspect, the viscosity of the beverage varies based upon the amount of enzymatically-treated pomace included in the beverage. For example, in one embodiment the viscosity of the beverage may be in the range between 20–270 centipoise, and more specifically between 25–250 centipoise, when the enzymatically-treated pomace is included in an amount between 1–20 wt% of the beverage. In another embodiment, the viscosity of the beverage incorporating the enzymatically-treated pomace is between 230–1800 centipoise, and more specifically between 250 and 1780 centipoise, when the enzymatically-treated pomace is included in an amount between 20–40 wt% of the beverage. In yet another embodiment, the beverage comprises enzymatically-treated pomace in an amount between 1–40 wt%, with a corresponding viscosity between 1–1800 centipoise, and more specifically between 5–1780 centipoise.

[0010] In another aspect, the viscosity of the beverage varies based upon the amount of enzymatically-treated pomace, but also the presence of other viscous ingredients and/or viscosity-building ingredients. A viscous ingredient is a non-solid ingredient that has a viscosity that is greater than that of the enzymatically-treated pomace, and may include fruit and/or vegetable purees and juice concentrates. A viscosity-building ingredient is an ingredient, such as carrageenan, pectin, gellan gum, or flour, etc., which is added to a beverage product and increases the viscosity of the beverage product. For example, in one embodiment, a beverage

product having enzymatically-treated pomace in the range of 1–40 wt%, and also fruit and/or vegetable purees in an amount between 1–40 wt%, has a viscosity in the range of 2000–4000 cP.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] Figure 1 is a flowchart depicting one aspect of the present disclosure, including steps taken in preparing of enzyme-treated pomace.

[0012] Figure 2 is a graph depicting the effect of water activity of orange pomace based on added solutes.

DETAILED DESCRIPTION

[0013] Some embodiments of the present disclosure is directed to a beverage product containing at least 1 wt% fiber in order to provide a high fiber beverage but with a low viscosity. As used herein, a low viscosity corresponds to a viscosity that is less than 250 cP at 20°C. In certain aspects of the invention, a significant amount of pomace may be used, for example 10 to 15 wt% or more of enzymatically-treated pomace. In some embodiments, the enzyme-treated pomace may be included in an amount between 1 – 40 wt%. For example, a beverage may be prepared having 25 wt% or more of the enzymatically-treated pomace. Another exemplary beverage product may be prepared with 36 wt% enzyme-treated pomace to form a beverage product with a high fiber content. “High fiber” or “high fiber content” as used in the present disclosure shall mean a fiber content of at least 1 wt%.

[0014] In other embodiments, the present disclosure describes a beverage product having at least 1 wt% fiber to provide a high fiber beverage with a high viscosity. As used herein, a high viscosity corresponds to a viscosity that is greater than 250 cP at 20°C. In these embodiments, the viscosity is also attributable to the presence of viscous ingredients, viscosity-building ingredients, and/or the amount of enzymatically-treated pomace included therein. For example, enzymatically-treated pomace in the range of 1-40 wt% may be added to viscous ingredients also in the range of 1-40 wt%, and more particularly between 20–40 wt% to create a beverage with a viscosity that is between 2000–4000 cP at 20°C.

[0015] It was discovered that fruit or vegetable pomace subjected to certain conditions and certain combinations of enzymes, exhibits no fiber loss, yet beverages containing the enzymatically-treated pomace may have a substantially lower viscosity than beverages containing non-enzymatically-treated pomace. As used herein, non-enzymatically-treated pomace may also be referred to as “untreated pomace.” These results were unexpected because although enzymatic hydrolysis is commonly used in the industry to reduce viscosity, such hydrolysis usually destroys the structure of the fiber and negatively impacts sensory attributes, including, for instance, cooked notes, of the product to which it is incorporated, and thus its nutritional value. Without being bound by theory, the inventors believe that under certain reaction conditions, a partial hydrolysis of the native fiber contained in the pomace occurs, whereby the chain length of the native fiber—including pectin, hemicellulose and cellulose—is reduced, without reaching the point of complete hydrolysis (i.e., breaking down the fiber chain

into sugar components). Chain length reduction occurs by endo-scission due to the presence of endo-acting enzymes. Moreover, chain length is reduced to an extent that fiber maintains its standard of identity as determined by the analytical fiber assays. The enzymatic treatment discussed herein was found to control molecular weight reduction. Although the molecular weight of the fiber changes following enzymatic treatment, both the pre and post treatment fiber can be classified as fiber. According to certain aspects of the disclosure, the beverage comprises pomace.

[0016] As used herein, the term “pomace” refers to the by-product remaining after fruit or vegetable juice pressing processes, wine crush operations, puree and concentrate operations, canning processes, and other food manufacturing processes. The pomace is typically discarded in the waste stream during processing. Pomace may include, for example, skins, peel, pulp, seeds, cellulosic material, and edible part of stems of the fruit and vegetable such as apples or carrots. Pomace generally contains more than a single item, for example, pomace may contain at least skin and pulp. In some cases the pomace can derive from or contain other parts of the fruit and vegetable such as pod, stalk, flower, root, leaves and tuber. Pomace resulting from juice extraction is typically in the form of a part of a press cake. Depending on the specific fruit or vegetable, pomace may contain portions of the fruit or vegetable which are inedible. Pomace differs from pulp. Pulp is the soft mass of fruit or vegetable matter from which most of the water has been extracted via pressure. For example, orange pomace includes membrane, but orange pulp does not. Further, apple pomace can contain skin, but apple pulp does not.

[0017] By-products from paste and purée processes such as tomato skins and seeds from tomato ketchup and paste processing are also included in the pomace even though they are not the by-products from juice extracts. Fruit skins from cannery processes are also edible by-products. Hereafter, pomace includes all by-products from fruit and vegetable juice, paste, puree and canning processes.

[0018] Wet pomace, which generally has a moisture content in the range between 70–85 wt%, generally contains high dietary fiber content, and varying amounts of essential vitamins, minerals and phytonutrients (depending on the types of fruit/vegetable and process applied). For example, cranberry pomace remains after the squeezing the juice for cranberry juices and concentrates. The pomace used in accordance with this invention may be derived from the same fruits and/or vegetables as the juice. In alternative embodiments, the pomace may

be derived from fruits and/or vegetables that are different from the fruits and/or vegetables from which the juice is derived. In other embodiments the pomace is derived from fruits, vegetables or a combination of fruits and vegetables.

[0019] The pomace contains natural nutrients (such as Vitamin A, vitamin C, vitamin E, phytonutrients such as polyphenols and antioxidants), flavors, colors of the original fruits and vegetables and large amount of a natural (e.g., un-processed fibers. Most juice extraction by-product contains over 40% by weight (dry basis) of dietary fiber. The use of pomace in food products will fortify fiber and naturally existing nutrients such as vitamins and phytochemicals. The use of pomace will also enable the addition of fruit and vegetable fiber to foods which will fortify the food products with fiber and with naturally existing nutrients such as vitamins and phytochemicals.

[0020] In accordance with aspects of the invention, the pomace is enzymatically-treated. As used herein “enzymatically-treated” means adding an enzyme to the pomace to reduce the chain length of the fibrous material. The enzyme may be any enzyme that reduces the chain length of the targeted fiber to lower its molecular weight without releasing sugars. In this manner, the total fiber content of the starting pomace material prior to enzymatic treatment is maintained. In certain implementations, the enzyme used to treat the pomace may include pectinase, hemicellulase, cellulase, or any combination of the aforementioned enzymes. In one embodiment, the enzyme may be added to wet pomace in an amount of between 0.30 to 1 wt%, or between 0.15 to 1 wt%, but in some embodiments, an amount that is at least between 0.15 to 0.75 wt% of the pomace.

[0021] The enzymatic treatment takes place under certain conditions in order to achieve pomace that provides a substantial amount of fiber, yet provides a beverage product with a low viscosity. For instance, the mixture of wet pomace and enzyme may be heated, agitated, and/or mixed during enzymatic treatment. In one embodiment, the enzymes are combined with the pomace and the mixture of enzyme(s) and pomace is preheated to at least about 25 °C, for example, to about 25–60°C. The mixture is then allowed to react at the heated temperature. The mixture may be agitated or mixed while preheating and/or during the reaction. In general, the enzyme / pomace mixture is allowed to react for about 10 minutes to about one hour. The reaction time and temperature are monitored and controlled to achieve this goal.

[0022] In aspects of the invention, the target viscosity is 60-250 cP in a juice or beverage measured at 20 °C with a Brookfield viscometer (spindle #1, 20 rpm) when the enzymatically-treated pomace is applied into juice or beverage. In aspects of the invention, the target viscosity is 25–150 cP in juice/beverage measured at 20 °C with a Brookfield viscometer (spindle #1, 20 rpm) when the enzymatically-treated pomace is applied into a reduced calorie beverage or a beverage having less than 100% juice. However, depending upon the type of reduced calorie beverage or beverage having less than 100% juice, the target viscosity may be the same as the full calorie beverage or beverage having 100% juice when mixed with enzymatically-treated pomace.

[0023] In one embodiment, the viscosity of a beverage incorporating the enzymatically-treated pomace is between 20–270 centipoise, and more specifically between 25–250 centipoise, when the enzymatically-treated pomace is included in an amount between 1–20 wt% of the beverage. In another embodiment, the viscosity of the beverage incorporating the enzymatically-treated pomace is between 230–1800 centipoise, and more specifically between 250 and 1780 centipoise, when the enzymatically-treated pomace is included in an amount between 20–40 wt% of the beverage. In yet another embodiment, the beverage comprises enzymatically-treated pomace in an amount between 1 – 40 wt%, with a corresponding viscosity between 1–1800 centipoise, and more specifically between 5–1780 centipoise. In some embodiments, these viscosities may correspond to the stated range of enzymatically-treated pomace regardless of whether the beverage is full calorie, reduced calorie, or whether the beverage is 100% juice or a juice drink that is less than 100% juice.

[0024] Following enzymatic treatment, the enzyme is deactivated. The enzyme may be deactivated using any method sufficient to deactivate the enzyme, including, without limitation, sterilization, pasteurization or otherwise subjecting the mixture to high temperature, short time (HTST) or ultra-high temperature (UHT) for a short time. For example, the enzyme is deactivated by heating to 75 °C to 107 °C for a period of time between 6 seconds to 600 seconds.

[0025] The enzymatically-treated pomace prepared in accordance with the present disclosure has the same fiber content as untreated pomace, but with shorter chain lengths. Thus, the overall fiber content is maintained during processing, as illustrated in Table 1, comparing the nutritional compositions of untreated pomace and enzyme-treated orange pomace.

Table 1

	no-enzyme treatment	enzyme treatment 1	enzyme treatment 2	enzyme treatment 3
Fat (%)	0.1	0.1	0.1	0.11
Protein (%)	1.16	1.25	1.3	1.35
Total Sugars (%)	9	8.7	8.9	8.9
Aarabinose (%)	0.4	0.5	0.5	0.4
Xylose (%)	BQL	BQL	BQL	BQL
Rhamnose (%)	BQL	BQL	BQL	BQL
Galactose (%)	BQL	BQL	BQL	BQL
Fructose (%)	2.6	2.7	2.8	2.9
Glucose (%)	2.2	2.3	2.4	2.5
Sucrose (%)	4.2	3.7	3.7	3.5
Maltose (%)	BQL	BQL	BQL	BQL
Lactose (%)	BQL	BQL	BQL	BQL
Total Dietary Fiber (%)	3.5	2.9	3.1	3
Viscosity (cp)	14620	3040	2120	2170
Vitamin C (mg/100g)	24.07	24.38	23.64	21.38

BQL: Below Quantification Limit

[0026] The enzymatically-treated pomace may then be added to a liquid to form a beverage product. Typically this is done at temperatures of between about 4° to 25°C. The beverage may be pasteurized before or after the addition of the enzymatically-treated pomace. The beverage product may undergo batch processing or continuous processing.

[0027] The liquid contained in the beverage product may be juice. The juice may be derived from any fruits, vegetables or a combination of fruits and vegetables. For instance, the juice may be derived from orange, pineapple, apple, mango, cranberry, grapefruit, blueberry, acai, strawberry, grape, passion fruit, tomato, cucumber, kale, spinach, broccoli, carrot, lemons, limes, tangerine, mandarin orange, tangelo, pomelo, celery, beets, lettuce, spinach, cabbage, artichoke, broccoli, beet, Brussels sprouts, cauliflower, watercress, peas, beans, lentils, asparagus, radish, peach, banana, pear, guava, apricot, watermelon, pomegranate, blackberry, papaya, lychee, plum, prune, fig or any combinations thereof. Moreover, the juice may be 100% juice or a juice drink that is less than 100% juice. The juice may be not-from-concentrate or from concentrate.

[0028] The liquid of the beverage product may also include water, such as coconut water or flavored water, nectars, serums, or carbonated water. In other embodiments, the liquid of the beverage product may be a dairy product such as milk or cream. The liquid may also be a combination of the above-mentioned liquids. For example, the liquid may be a mixture of both milk and juice, or juice and water.

[0029] In certain embodiments, the beverage product comprises between about 1-30 wt% of enzymatically-treated pomace, or between about 5-27 wt%, or between 10-15 wt% all based on total weight of the beverage product. In other embodiments, the beverage product includes between 1–20 wt% of the enzymatically-treated pomace, or between 20–40 wt% enzymatically-treated pomace. In a particular embodiment, the beverage product may include about 36 wt% of the enzymatically-treated pomace, and when in the absence of a viscous ingredient or a viscosity-building ingredient, such an amount would form a beverage product having a smoothie-like or spoonable consistency.

[0030] Beverage products containing the enzymatically-treated pomace exhibit a reduced viscosity compared to a beverage product that contains non-enzymatically-treated pomace. For instance, the viscosity in the beverage product containing the enzymatically-treated pomace may be at least 50% for example, up to about 90% less than the viscosity of a beverage product containing non-enzymatically-treated pomace. In additional embodiments, the viscosity is reduced anywhere in a range of about 50-90% compared to the same beverage product containing non-enzymatically-treated pomace. In certain aspects, the viscosity of the beverage products containing enzymatically-treated pomace is about 60-250 cP. In certain aspects the viscosity of the beverage product is about 100-150 cP. If the beverage is a low calorie beverage or one that does not contain 100% juice, then the viscosity can be as low as 25 cp, e.g. 25 to 150 cp. The viscosity measurements discussed herein were taken with a Brookfield viscometer at 20 rpm with spindle #1 at 20°C. In other aspects, the viscosity of the beverage product incorporating enzymatically-treated pomace may vary based upon the amount of the enzymatically-treated pomace that is added.

[0031] Various additional components may be added to the beverage product in aspects of this disclosure. These components may include, without limitation, flavors, flavorings, sweeteners, food-grade acidulants, such as citric acid, vitamins and minerals, grains, and proteins. Non-limiting examples of grains may include rice, wheat, and oats. Sweeteners may be nutritive and/or non-nutritive. In alternative aspects of the disclosure, carbon dioxide can be used to provide effervescence to the beverages. Any of the techniques and carbonating equipment known in the art for carbonating beverages can be employed. Typical embodiments may have, for instance, from about 0.5 to 5.0 volumes of carbon dioxide.

[0032] As previously mentioned, other components may take the form of viscous ingredients such as fruit and/or vegetable purees, and viscosity-building ingredients, such as cereal flour, carrageenan, pectin, gellan gum, etc. These ingredients may be included in a beverage to create a beverage product having a thicker, smoothie-like or spoonable consistency. The utilization of enzymatically-treated pomace in these thicker, more viscous beverage products enables the creation of a beverage that has a higher amount of fiber, but without further increasing the viscosity to levels that may be unexpected or undesirable for consumers. As used herein, these high viscosity beverage products may also referred to herein as “spoonable”.

[0033] The beverage product may be full calorie, reduced calorie, or low calorie. As used herein, “reduced calorie beverage” means a beverage having at least a 25% reduction in calories per 8 oz. serving of beverage as compared to the full calorie version, typically a previously commercialized full-calorie version. As used herein, a “low-calorie beverage” has fewer than 40 calories per 8 oz. serving of beverage. The correlative meaning applies to beverage concentrates and other beverage products disclosed here. In certain exemplary embodiments, the reduced calorie beverage may be low calorie beverage. The reduced calorie beverage may be sweetened entirely with one or more non-nutritive sweeteners or with a combination of nutritive and non-nutritive sweeteners.

[0034] Figure 1 is a method for creating enzymatically-treated pomace in accordance with an illustrative embodiment. As illustrated in Figure 1, in an aspect of the present disclosure, the pulp/pomace is obtained, then stabilized by treating with heat (preheating). The preheated pomace is subsequently subjected to enzyme treatment. In one embodiment, the enzyme treatment step involves combining the enzymes with the pomace to form an enzyme-pomace mixture, which is then heated to at least about 25 °C, for example, to about 25–60°C. The mixture may be agitated or mixed during the reaction, which may last between 10–60 minutes. After the enzyme treatment step, the enzyme is deactivated, for example, by heating the mixture to 75 °C to 107 °C for 6-600 seconds. The particle size of the enzymatically-treated pomace may be reduced via micronization, homogenization, or a combination of these processes. The enzymatically-treated pomace is then added to a fruit and/or vegetable juice, pasteurized and filled in packages. Pasteurization may take place under standard conditions, such as HTST.

[0035] In addition to the benefits, including viscosity reduction and fiber retention, the mouthfeel of the beverage products according to non-limiting embodiments described herein is

acceptable to consumers. In particular, juices containing untreated pomace tend to have a higher viscosity and a thicker mouthfeel, i.e., more like a smoothie than a pulp-free juice. Testing was performed to identify what range of orange juice viscosities is most acceptable to consumers. Based on this testing, the inventors found that consumers preferred the thinnest product, i.e., the product with the lowest viscosity. Moreover, with respect to juices and acceptability, consumers prefer a juice that is not much thicker than a regular orange juice. The inventors also found that as long as the product was not too thick, consumer who prefers “no-pulp” products are willing to accept some viscosity for a more nutritious product.

[0036] Table 2 illustrates responses relating to consumer liking and mouthfeel for 100% orange juice containing various viscosity and pulp density measurements (beverages that did not contain floating pulp have a density of 0. The letters a, b, c, d, e, and f are used herein to denote significant differences at $p=0.10$). In accordance with conventional use, if two numbers share the same letter, they are not significantly different from each other. If they do not share a common letter, then they are significantly different from each other. For example, if a number is labelled “a”, then it is significantly different than numbers labelled with b, c, d, e, or f as well as numbers labeled with bcd or edf or bc, but it is not significantly different from other numbers labelled with an “a” such as abc or adf or abd or abdf.

Table 2

	All Participants (n=206)											
	100% OJ (Viscosity 20 Density 0)	100% OJ (Viscosity 85 Density 0)	100% OJ (Viscosity 100 Density 0)	100% OJ (Viscosity 150 Density 0)	100% OJ (Viscosity 20 Density 15)	100% OJ (Viscosity 85 Density 15)	100% OJ (Viscosity 150 Density 15)	100% OJ (Viscosity 20 Density 30)	100% OJ (Viscosity 85 Density 30)	100% OJ (Viscosity 100 Density 30)	100% OJ (Viscosity 150 Density 30)	100% OJ (Viscosity 20 Density 30)
100% OJ Viscosity Density												
Overall Appearance Liking	306.9 a	301.3 ab	288.5 ab	287.3 ab	293.6 ab	284.6 b	291.1 ab	283.1 b	286.1 b	283.1 b	285.2 b	
Color Liking	314.7	309.5	307.4	302.6	312.5	301.1	308.6	306.4	304.6	301.2	304.3	
Mouthfeel Liking	292.3 a	266.8 abcd	238.7 def	217.0 f	268.0 abc	254.6 bcde	239.1 def	274.9 ab	254.5 bcde	244.5 cdef	233.8 ef	
Thickness Liking	271.6 a	256.6 abc	231.2 cde	202.3 f	265.6 ab	243.5 abcde	226.9 def	261.6 ab	250.5 abcd	237.7 bcde	221.5 ef	
Bits of Orange Liking (Removed Non- Detectors)	221.7 ab (n=85)	221.7 ab (n=101)	198.8 b (n=107)	199.6 b (n=110)	243.2 a (n=180)	232.0 ab (n=186)	224.5 ab (n=183)	246.1 a (n=194)	239.8 a (n=185)	237.8 a (n=195)	230.5 ab (n=195)	
Bits of Orange Amount (Removed Non- Detectors)	137.6 d (n=87)	140.4 d (n=101)	133.6 d (n=106)	137.0 d (n=100)	184.4 c (n=183)	201.6 bc (n=184)	184.6 c (n=185)	213.3 ab (n=194)	218.3 ab (n=189)	211.6 ab (n=193)	226.7 a (n=191)	
Aftertaste Liking	262.9 a	251.3 ab	226.3 bc	215.1 c	255.3 a	246.3 ab	238.3 abc	265.8 a	255.7 a	244.9 ab	240.0 abc	

[0037] In addition to providing desirable mouthfeel, the inclusion of enzyme-treated pomace has been shown to provide beverage products with an improved taste profile, particularly in the presence of beverage ingredients that may cause the taste to differ from a beverage product that utilizes all natural ingredients, or only 100% juice ingredients. For example, low calorie beverages sweetened in whole or in part by a non-nutritive sweetener typically have a distinctive taste. The inclusion of enzyme-treated pomace to a low calorie beverage in the amount between 1–40 wt% has been shown to mask the taste attributable to the non-nutritive sweetener. As a result, the low calorie beverage has a more natural taste.

[0038] Example 1

[0039] Orange pomace is enzymatically-treated by adding about 0.15 to 1 wt% of an enzyme mixture containing pectinase alone or in combination with hemicellulase and/or cellulase based on wt% of fiber in orange pomace and heating to at least about 25°C. The enzymatically-treated pomace can be micronized /homogenized for consistency of ingredients and deactivated.

[0040] The enzymatically-treated pomace is added to a food-safe liquid, for example, 100% not-from concentration (NFC) orange juice in the amounts identified in Table 3 below. The mixture is agitated for 10 minutes. The resulting fiber content (wt% based on total weight of the pomace) and viscosity values of the resulting beverage product are included in Table 3. From the data included in Table 3, a beverage can be formulated with enzymatically-treated pomace in an amount between 1–40 wt% of the beverage, with a corresponding viscosity between 1–1800 centipoise, and more specifically between 5–1780 centipoise. At higher viscosities, the beverage has a smoothie-like consistency. For example, with enzymatically-treated pomace in an amount of around 36 wt%, the beverage has a viscosity between 1300–1500 centipoise, and more specifically about 1400 centipoise.

Table 3

Ingredient	NFC OJ with enzyme treated pomace							
NFC OJ (%)	95.7	88.3	85	85	75	70	64	60
Orange Pomace (%)	4.3	11.7	15	21.7	25	30	36	40
Fiber (%)	0.5	0.85	1	1.32	1.475	1.7	2	2.18
Viscosity (cP)	32	80	100	278	714*	956*	1400*	1776*

Viscosity values identified with a single asterisk (*) were measured with spindle #2 of a Brookfield viscometer. The remaining values were measured with spindle #1. All samples were measured at 20 RPM and 20 degrees C.

[0041] In contrast, NFC orange juice combined with the same pomace that was not enzymatically-treated contained the same amount of fiber as the beverage product containing enzymatically-treated pomace; however, the viscosity of the beverage product containing the enzymatically-treated pomace was significantly lower than the beverage product containing non-enzymatically-treated pomace. Results of the non-enzymatically-treated orange juice are provided in Table 4 for comparison.

Table 4

Ingredient	NFC OJ with untreated pomace							
NFC OJ (%)	95.7	88.3	85	85	75	70	64	60
Orange Pomace (%)	4.3	11.7	15	21.7	25	30	36	40
Fiber (%)	0.5	0.85	1	1.32	1.475	1.7	2	2.18
Viscosity (cP)	55	265	463	1300*	1340*	2140**	3880**	5400**

Viscosity values identified with a single asterisk (*) were measured with spindle #2 of Brookfield. Those marked with a double asterisk (**) were measured with spindle #5. All remaining values were measured with spindle #1.

[0042] Example 2

[0043] Orange pomace is enzymatically-treated by adding about 0.15 to 1 wt% of an enzyme mixture containing pectinase alone or in combination with hemicellulase and/or cellulase based on wt% of fiber in orange pomace and heating to at least about 25°C. The

enzymatically-treated pomace can be micronized/homogenized for consistency of ingredients and deactivated.

[0044] The enzymatically-treated pomace is combined with puree and juice to form a spoonable beverage product having a viscosity that is greater than 3000 cP, as measured by a Brookfield rotary viscometer at 20°C. More specifically, between 30–40 wt% of the pomace is added to an equal amount of fruit and/or vegetable puree, the remainder of the beverage product formed from a fruit and/or vegetable juice to create a beverage product having a viscosity that is greater than 3000 cP, and more particularly between 3000 – 4000 cP. Even more specifically, 35.98 wt% orange pomace is added with an equal amount of mango puree, and 29.98 wt% apple juice, as shown in Table 5 below, to create a beverage product having a viscosity of 3425 cP.

[0045] Table 5.

SPOONABLE FORMULATION #1	
Ingredients	Weight %
Orange Pomace	35.98
Mango Puree	35.98
Apple Juice	29.98
Mango Citrus Flavor	0.05
Total (%)	100.00
Viscosity	3425 cP

[0046] Example 3

[0047] Orange pomace is enzymatically-treated by adding about 0.15 to 1 wt% of an enzyme mixture containing pectinase alone or in combination with hemicellulase and/or cellulase based on wt% of fiber in orange pomace and heating to at least about 25°C. The enzymatically-treated pomace can be micronized/homogenized for consistency of ingredients and deactivated.

[0048] In this illustrative example, the pomace is combined with puree and juice, and a viscosity-building ingredient to create a spoonable beverage product having a viscosity that is greater than 2000 cP, as measured by a Brookfield rotary viscometer at 20°C. More specifically, between 10–20 wt% of pomace may be added to a fruit and/or vegetable puree in an amount between 30–40 wt%, including an amount of a viscosity-building ingredient that ranges between 1–5 wt%. Juice is also added in an amount between 40–54 wt%, yielding a beverage having a

viscosity that is between 2000–3000 cP. In a more specific example, as shown in Table 6, about 15 wt% orange pomace is added to about 22 wt% carrot puree and about 12 wt% apple puree. The beverage product also includes about 12 wt% apple juice and about 35 wt% orange juice, and about 3.2 wt% oat flour. About 0.05 wt% of citric acid is also added. The beverage product has a viscosity that is about 2510 cP, as measured by a Brookfield rotary viscometer at 20°C.

[0049] Table 6.

SPOONABLE FORMULATION #2	
Ingredients	Weight %
Orange Pomace	14.99
Carrot Puree	21.99
Apple Puree	12.39
Apple Juice	12.39
Oat Flour	3.2
Orange Juice	34.98
Citric Acid	0.05
Total (%)	100.00
Viscosity	2510 cP

[0050] Carrageenan is a commonly used viscosity-building ingredient or gelling agent that is extracted from red edible seaweeds. Carrageenan may be added to a beverage product to cause gelling, which increases the viscosity of the beverage to which it is added. In the two examples that follow, varying amounts of carrageenan have been added to a beverage product that also includes enzymatically-treated pomace.

[0051] Example 4

[0052] Orange pomace is enzymatically-treated by adding about 0.15 to 1 wt% of an enzyme mixture containing pectinase alone or in combination with hemicellulase and/or cellulase based on wt% of fiber in orange pomace and heating to at least about 25°C. The enzymatically-treated pomace can be micronized/homogenized for consistency of ingredients and deactivated. The pomace, a viscous ingredient, and a viscosity-building ingredient are mixed with water and some other flavorants. More specifically, between 30–40 wt% of orange pomace is combined with 10–20 wt% of a viscosity-building ingredient, such as carrageenan, and 1–5 wt% orange concentrate. Between 7–17 wt% water is added, along with flavorants. In a more specific example, as shown in Table 7, about 35 wt% orange pomace is mixed with about

15 wt% carrageenan, 3.2 wt% orange concentrate, and about 12.4 wt% water. The remaining ingredients include sodium citrate, sugar, and flavor.

[0053] Table 7.

SPOONABLE FORMULATION #3	
Ingredients	Weight %
Carrageenan	14.99
Sodium Citrate	21.99
Sugar	12.39
Water	12.39
Orange Concentrate	3.2
Orange Pomace	34.98
Flavor	0.05
Total (%)	100.00

[0054] Example 5

[0055] Orange pomace is enzymatically-treated by adding about 0.15 to 1 wt% of an enzyme mixture containing pectinase alone or in combination with hemicellulase and/or cellulase based on wt% of fiber in orange pomace and heating to at least about 25°C. The enzymatically-treated pomace can be micronized /homogenized for consistency of ingredients and deactivated.

[0056] The enzymatically-treated pomace is combined with viscous ingredients, viscosity-building ingredients, flavorants, and water to form spoonable beverage product. More specifically, between 10–20 wt% of the pomace mixed with 20–30 wt% viscous ingredients, which may include yogurt, blueberry puree, and black currant concentrate. Also mixed with the pomace are viscosity-building ingredients, such as carrageenan and oat flour, in an amount between 1–5 wt%. About 40–60 wt% liquids, such as water and juice, along with 2–10 wt% flavorants and citric acid. A more specific example of the formulation is provided in Table 8 below.

[0057] Table 8.

SPOONABLE FORMULATION #4	
Ingredients	Weight %
Carrageenan	0.35
Sodium Citrate	0.2
Sugar	5

Water	43.035
Oat Flour	3.2
FC Orange Juice	6.9
Orange Pomace	15
Citric Acid	0.1
Yogurt	22.4
Blueberry Puree	3.165
Black Currant Concentrate	0.5
Mixed Berry Flavor	0.15
Total (%)	100.00

[0058] Example 6

[0059] Orange pomace is enzymatically-treated by adding about 0.15 to 1 wt% of an enzyme mixture containing pectinase alone or in combination with hemicellulase and/or cellulase based on wt% of fiber in orange pomace and heating to at least about 25°C. The enzymatically-treated pomace can be micronized /homogenized for consistency of ingredients and deactivated.

[0060] The orange pomace is mixed with a liquid formed from a mixture of milk and juice, a viscosity-building ingredient, edible acids, and flavorants to create a beverage product with a viscosity greater than 300 cP. More specifically, between 10–20 wt% orange pomace is added to 75–85 wt% of a liquid mixture formed from milk and juice to form a beverage product with a viscosity between 300–400 cP. Between 1–5 wt% oat flour is added, along with between 0.1–0.04 wt% edible acid, and between 0.1–0.5 wt% flavorant. A more specific example is provided in Table 8 below, which has a viscosity of about 350 cP.

[0061] Table 8.

JUICE AND DAIRY FORMULATION	
Ingredients	Weight %
Skim Milk	21
Orange Juice	60
Orange Pomace	15
Oat Flour	3.4
Malic Acid	0.16
Citric Acid	0.13
Orange Flavor	0.31
Total	100

Viscosity	350 cP
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[0062] By maintaining the amount of fiber throughout processing, fiber-related health claims may be made with respect to the beverage products containing the enzymatically-treated pomace. Moreover, because the fiber content in the pomace remains unaltered by the enzymatic treatment, the beverage products provided herein provide the same nutritional benefits as beverage products containing non-enzymatically-treated pomace.

[0063] Enzymatically-treated pomace may be combined with fruit juices or fruit juice concentrates for water activity reduction. This combination of pomace and fruit juice enables the addition of concentrated fruit or vegetable products to foods. This addition of whole fruit and vegetable products to shelf stable foods increases the nutritional value of the food as previously described for beverage products.

[0064] Food products may also be produced with enzyme treated high fiber fruit and vegetable materials, such as pomace. In food products, enzymatically-treated pomace, prepared in accordance with aspects of this disclosure, can be combined with soluble solids such as sugars, sugar alcohols and salts to reduce the water activity of the pomace. For example, the starting water activity of the orange pomace is 0.987. The ending water activity can be adjusted to a desired water activity which depends on the amount of solutes added. For microstability, with the use of potassium sorbate, it is desired to reduce the water activity to below 0.83. See Table 9 below and Figure 2.

Table 9

Effect on Water Activity of a Model Solute Blend

	%	%	%	%	%	%	%	%
Orange Pomace	0.00	70.0	65.00	60.00	55.00	50.00	45.00	40.00
Solute Blend								
Glycerine, 99% USP	56.67	16.71	19.48	22.27	25.04	27.83	30.63	33.40
Fructose, crystalline	19.08	5.72	6.68	7.63	8.59	9.54	10.49	11.45
Honey	19.08	5.72	6.68	7.63	8.59	9.54	10.49	11.45
Milk permeate powder	6.17	1.85	2.16	2.47	2.78	3.09	3.39	3.70
Solute Blend Total (%)	100.00	30.00	35.00	40.00	45.00	50.00	55.00	60.00
Total %	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Water Activity		0.904	0.896	0.866	0.838	0.805	0.776	0.743

[0065] This reduced water activity pomace may be incorporating as a filling, topping, binder or inclusion in shelf-stable food products. In addition, water activity reduced pomace may be formulated as a dip, spread, or topping that can be used for dipping, spreading or topping on fruits, vegetables, breads, crackers or chips. For food products, the viscosity reduction of pomace facilitates processing.

[0066] For example, pomace may be dehydrated using either heat to remove moisture or heat and vacuum to remove moisture under lower temperature conditions. This dehydration of pomace is facilitated by the viscosity reduction of the enzymatically-treated pomace. Generally, in dehydration processes, the maximum dehydration is limited by the increase in viscosity corresponding to the increase in solids content. Enzyme treated pomace allows for a greater concentration of the pomace (greater solids concentration and corresponding lower moisture content) to be incorporated into a food product. Further, with the lower moisture content of the pomace of the present disclosure, greater water activity reduction can be achieved. This water activity reduction is important for imparting microbiological shelf stability of the food products. In addition, as the pomace is concentrated, less soluble solids are required for lowering the water activity, which allows an equivalent water activity reduction with the addition of less sugars, sugar alcohols and salts.

[0067] Example 7

[0068] An orange pomace filling is made by combining orange pomace with filling ingredients. The water activity of this orange pomace filling is 0.77.

<u>Orange Pomace Filling</u>	
<u>Ingredients</u>	<u>Formula (%)</u>
Orange Pomace	33.30
Potassium Sorbate	0.09
Glycerine, 99%, USP	9.04
Dextrose (Glucose)	14.28
Fructose, crystalline	14.15
Invert Sugar Syrup	12.39
Sugar (sucrose), bulk fine	10.53
Starch, Mira-thik 468	0.94
Starch, Mira-gel 463	0.94
Starch, Lo-temp 588	1.51
Microcrystalline Cellulose	<u>2.83</u>
Total (%)	100.00

[0069] The orange pomace filling is then combined with cereal based dough (50/50 ratio by weight) and then baked at 325°F for 8 minutes.

<u>Cereal Based Dough</u>	
<u>Ingredients</u>	<u>Formula (%)</u>
Wheat flour, soft, unbleached	35.27
Dextrose (Glucose)	1.91
Molasses	0.96
Vanilla flavor	0.12
Salt	0.51
Baking Powder	0.51
Water	14.00
Sunflower Oil, high oleic	13.73
Invert Sugar syrup	1.98
Potassium sorbate	0.25
Oat flakes, old fashioned	15.38
Oat flakes, baby size	<u>15.38</u>
Total (%)	100.00

[0070] The product is cut into orange pomace topped bars containing about 16% pomace and having water activity a_w of 0.75.

[0071] The invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The foregoing embodiments, therefore, are to be considered in all respects illustrative rather than limited to the invention described herein. Scope of the invention is thus indicated by the appended claims, rather than by the foreign description, and all changes that come within the meaning and range of equivalency of the claims are intended to be embraced therein.

AMENDED CLAIMS**received by the International Bureau on 18 January 2017 (18.01.2017)**

We claim:

1. A beverage product comprising:
liquid; and
about 1-40 wt% enzymatically-treated pomace, wherein the enzymatically-treated pomace is derived from pomace selected from a group consisting of at least one fruit, at least one vegetable, or combinations thereof; and
wherein the enzymatically-treated pomace comprises an amount of fiber that is the same before and after enzymatic treatment, and wherein a total fiber content of the enzymatically-treated pomace prior to enzymatic treatment is maintained in the beverage product.
2. The beverage product of claim 1, wherein the beverage product has a viscosity between 20–4000 cP at 20 °C.
3. The beverage product of claim 1, wherein the enzymatically-treated pomace is between 1-30 wt%, and wherein the beverage product has a viscosity between 60–250 cP at 20 °C.
4. The beverage product of claim 1, wherein the enzymatically-treated pomace is between 25-40 wt%, and wherein the beverage product has a viscosity between 700–1800 cP at 20 °C.
5. The beverage product of claim 1, wherein the enzymatically-treated pomace is about 36 wt%, and wherein the viscosity is between 1300–1500 cP at 20 °C.
6. The beverage product of claim 1, further comprising:
between 20–40 wt% of a viscous ingredient; and
wherein the viscosity of the beverage product is between 2000–4000 cP at 20°C.
7. The beverage product of claim 1, further comprising:
between 1–20 wt% of a viscosity-building ingredient.

8. The beverage product of claim 1 wherein the liquid comprises a juice selected from a group comprising orange, pineapple, apple, mango, cranberry, grapefruit, blueberry, acai, strawberry, grape, passion fruit, tomato, cucumber, kale, spinach, broccoli, carrot, lemons, limes, tangerine, mandarin orange, tangelo, pomelo, celery, beets, lettuce, spinach, cabbage, artichoke, broccoli, Brussels sprouts, cauliflower, watercress, peas, beans, lentils, asparagus, radish, peach, banana, pear, guava, apricot, watermelon, pomegranate, blackberry, papaya, lychee, plum, prune, fig and combinations thereof.
9. The beverage product of claim 1 wherein the pomace is derived from at least one fruit or vegetable selected from the group comprising orange, pineapple, apple, mango, cranberry, grapefruit, blueberry, acai, strawberry, grape, passion fruit, tomato, lemon, lime, tangerine, mandarin orange, tangelo, pomelo, peach, banana, pear, guava, apricot, watermelon, pomegranate, blackberry, papaya, lychee, plum, prune, fig, cucumber, kale, spinach, broccoli, carrot, celery, beets, lettuce, spinach, cabbage, artichoke, coconut, broccoli, Brussels sprouts, cauliflower, watercress, peas, beans, lentils, asparagus, radish, wheat grass and combinations thereof.
10. The beverage product of claim 1 wherein the enzymatically-treated pomace is obtained by treating the pomace with enzymes selected from the group consisting of pectinase, cellulase, hemicellulase or combinations thereof.
11. The beverage product of claim 1, wherein the fiber in the enzymatically-treated pomace has a shorter chain length than native fiber in the pomace before the enzymatic treatment.
12. The beverage product of claim 1, wherein the beverage product is a reduced calorie beverage comprising a non-nutritive sweetener, and wherein a taste profile of the reduced calorie beverage product is similar to a full-calorie beverage lacking the non-nutritive sweetener.
13. The beverage product of claim 8, wherein the beverage product further comprises at least one grain.

14. The beverage product of claim 13, wherein the liquid further comprises dairy.
15. The beverage product of claim 1, wherein the liquid comprises dairy, and wherein the beverage product further comprises a viscosity-building ingredient.

16. A food product comprising:
- about 1–40 wt% enzymatically-treated pomace, wherein the pomace is derived from the group consisting of at least one fruit, at least one vegetable, or combinations thereof;
 - wherein the amount of fiber in the pomace remains the same before and after enzymatic treatment, and wherein a total fiber content of the enzymatically-treated pomace prior to enzymatic treatment is maintained in the beverage product; and
 - wherein the food product exhibits a microbial shelf stability of 6 months.
17. The food product of claim 16 wherein the pomace is derived from at least one fruit or vegetable selected from the group comprising orange, pineapple, apple, mango, cranberry, grapefruit, blueberry, acai, strawberry, grape, passion fruit, tomato, lemons, limes, tangerine, mandarin orange, tangelo, pomelo, peach, banana, pear, guava, apricot, watermelon, pomegranate, blackberry, papaya, lychee, plum, prune, fig, cucumber, kale, spinach, broccoli, carrot, celery, beets, lettuce, spinach, cabbage, artichoke, coconut, broccoli, Brussels sprouts, cauliflower, watercress, peas, beans, lentils, asparagus, radish, wheat grass and combinations thereof.

18. A method comprising:
- subjecting pomace to at least one enzyme to form a pomace-enzyme mixture, wherein the pomace comprises fiber and the pomace-enzyme mixture comprises the at least one enzyme in an amount between 0.15–1.0 wt% of the pomace;
 - heating the pomace-enzyme mixture to 25–57°C for 10–60 minutes; and
 - deactivating the at least one enzyme to form the enzymatically-treated pomace.
19. The method of claim 18 wherein the range of the at least one enzyme is between 0.15–0.75 wt% of the pomace.
20. The method of claim 18 wherein the pomace contains a fiber content of between 3–8 wt%, and wherein the fiber content is the same before and after enzyme treatment.
21. The method of claim 18, further comprising:
- deactivating the enzyme by heating the pomace-enzyme mixture to 75–107°C for 6–600 seconds.
22. The method of claim 18 wherein the enzyme is pectinase, hemicellulase, cellulase, or any combination thereof.
23. The method of claim 18, further comprising:
- reducing a particle size of the enzymatically-treated pomace.
24. The method of claim 23, wherein the particle size of the enzyme-treated pomace is reduced by processes selected from the group consisting of micronization, homogenization, or combinations thereof.
25. The method of claim 19, further comprising:
- agitating the pomace-enzyme mixture during the heating step.

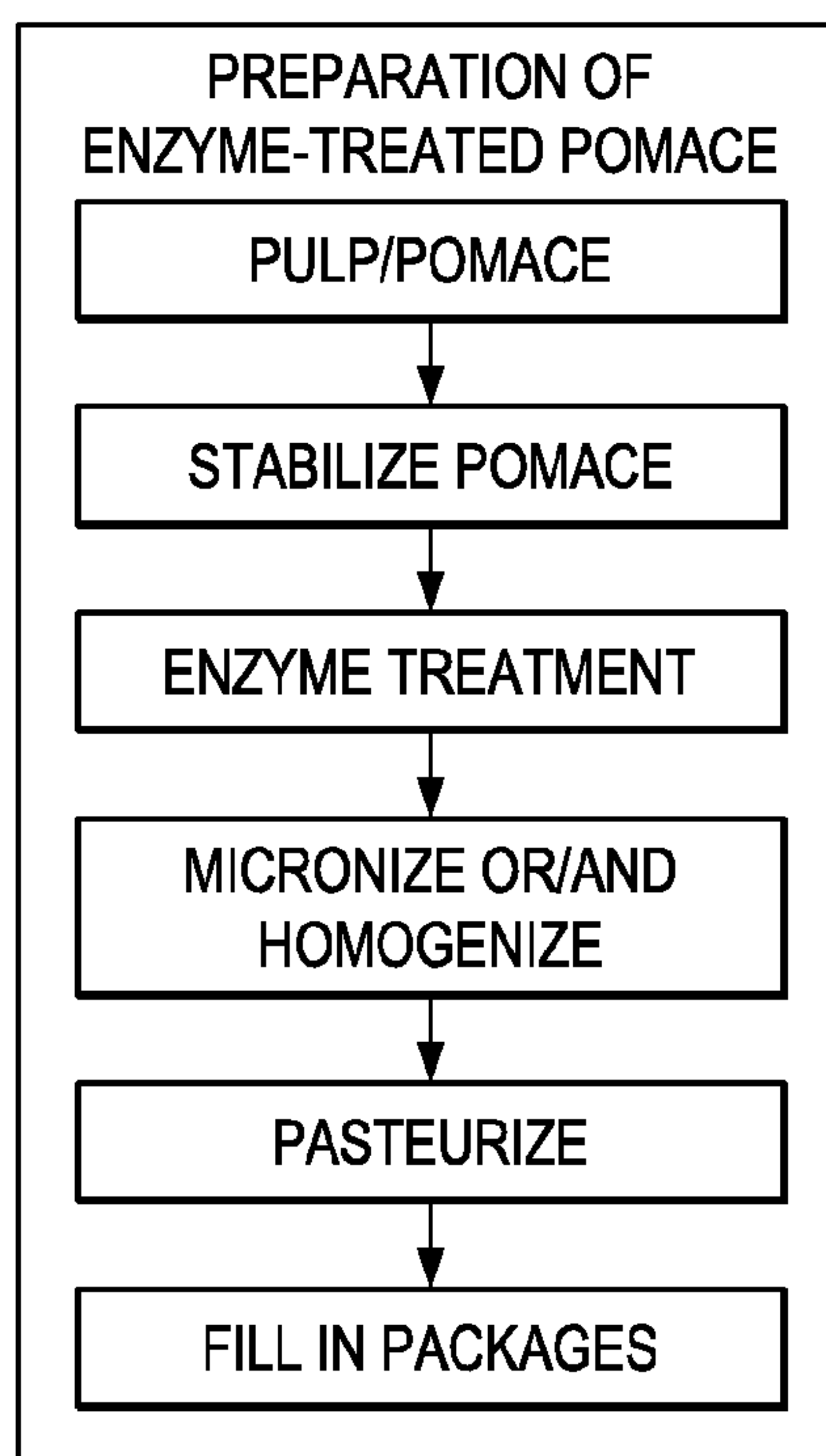
26. The method of claim 18, further comprising:

adding the enzymatically-treated pomace to juice to form a high fiber beverage product, wherein the enzymatically-treated pomace is added in an amount between 1–40 wt% of the high fiber beverage product, and wherein a viscosity of the high fiber beverage product has a viscosity of 20–4000 cP measured at 20°C.

27. The method of claim 26, wherein the amount of enzymatically-treated pomace is 36 wt% of the high fiber beverage product, and wherein the viscosity of the high fiber beverage product is between 1300–1500 cP at 20°C.

28. The method of claim 18, further comprising:

adding the enzymatically-treated pomace to food to form a high fiber food product, wherein the food product exhibits a microbial shelf stability of 6 months.

*1/2***FIG. 1**

2/2

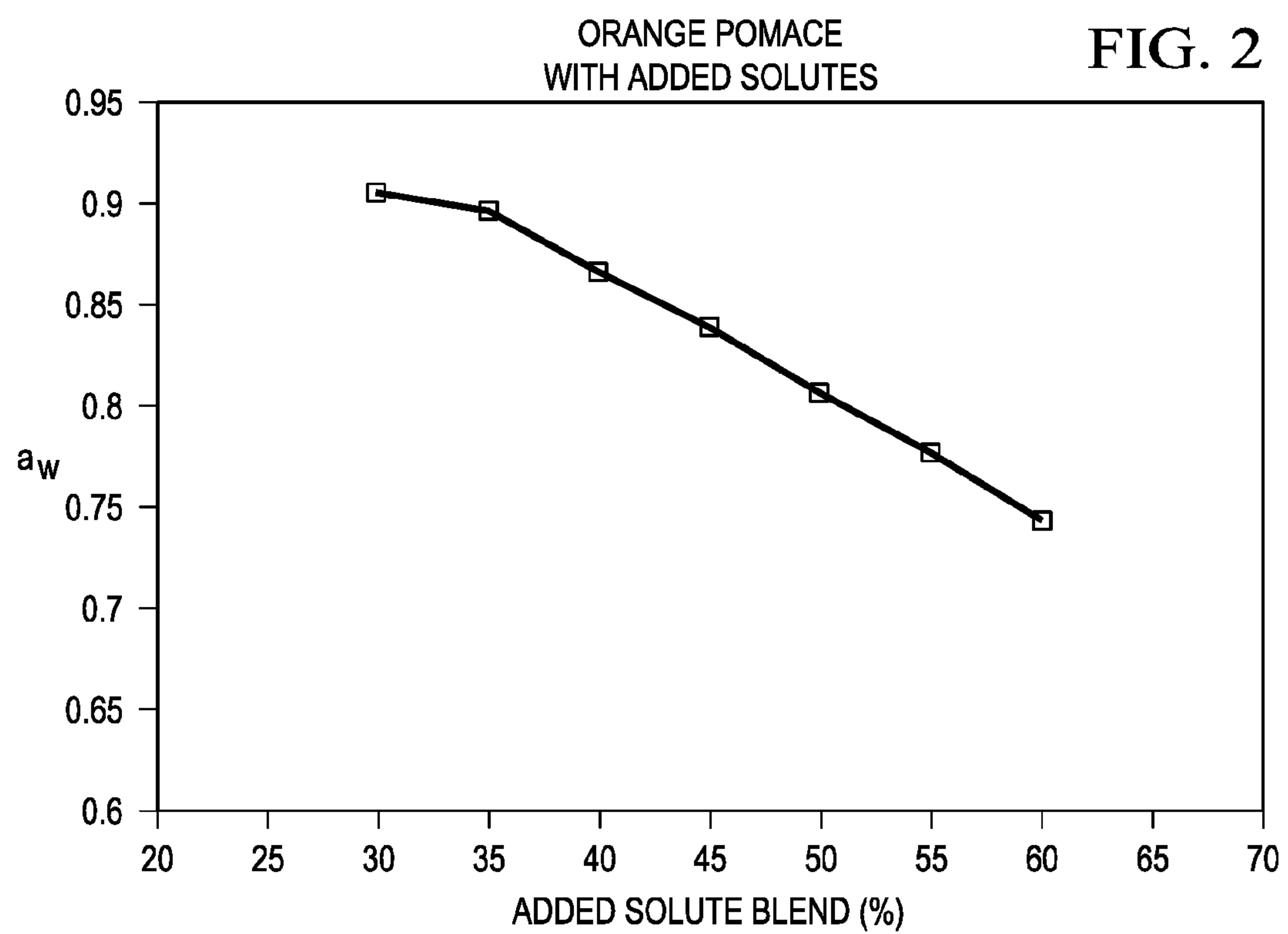


FIG. 1

