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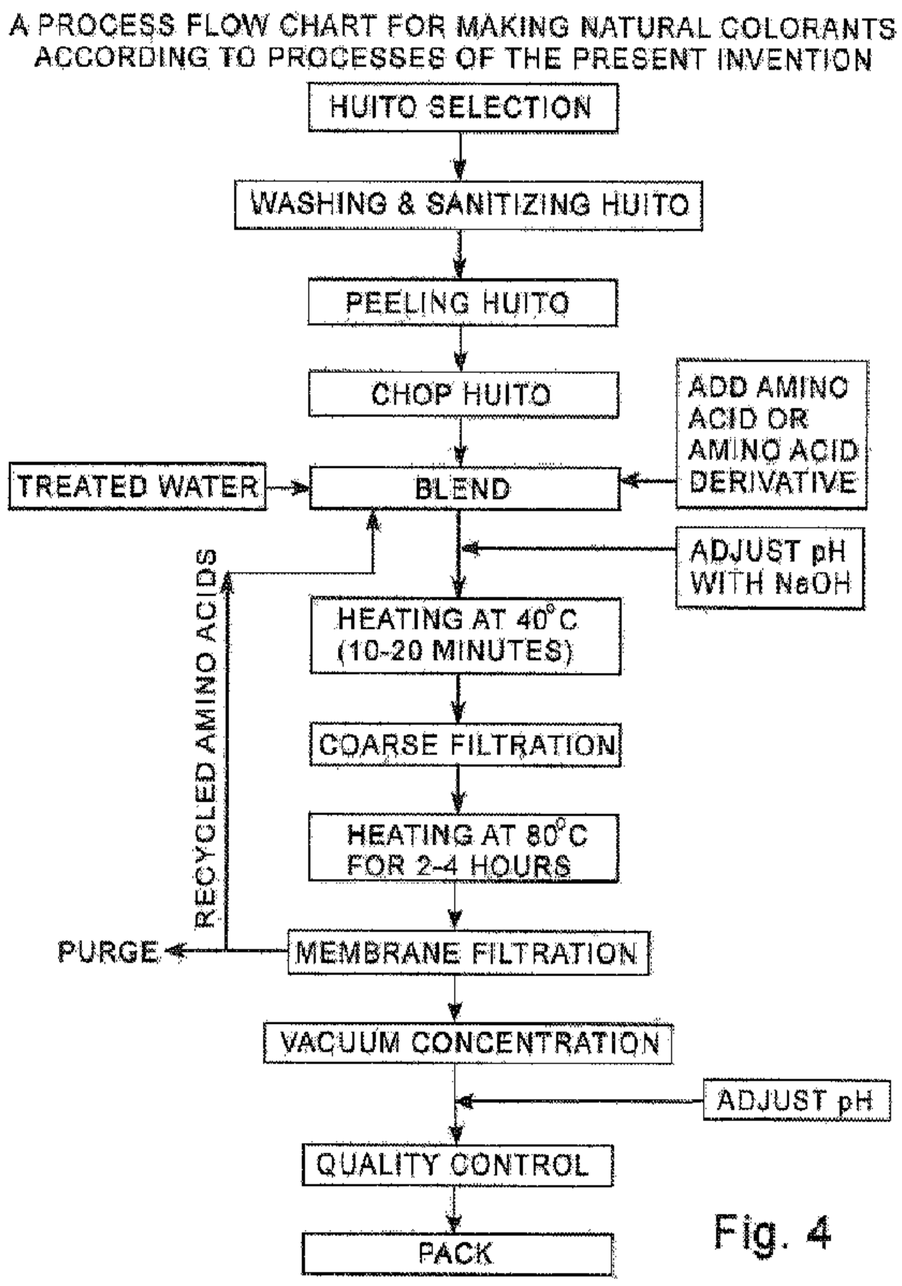


Fig. 4

(57) Abrégé/Abstract:
The present invention is directed towards natural colorants comprising a material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivitatives, a genipin-containing substance, and combinations of any thereof; and a primary amine containing compound. Processes of making natural colorants are further disclosed. Additionally, processes of producing a desired color of natural colorants are disclosed.

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(54) **Title**: NATURAL COLORANTS AND PROCESSES OF MAKING THE SAME

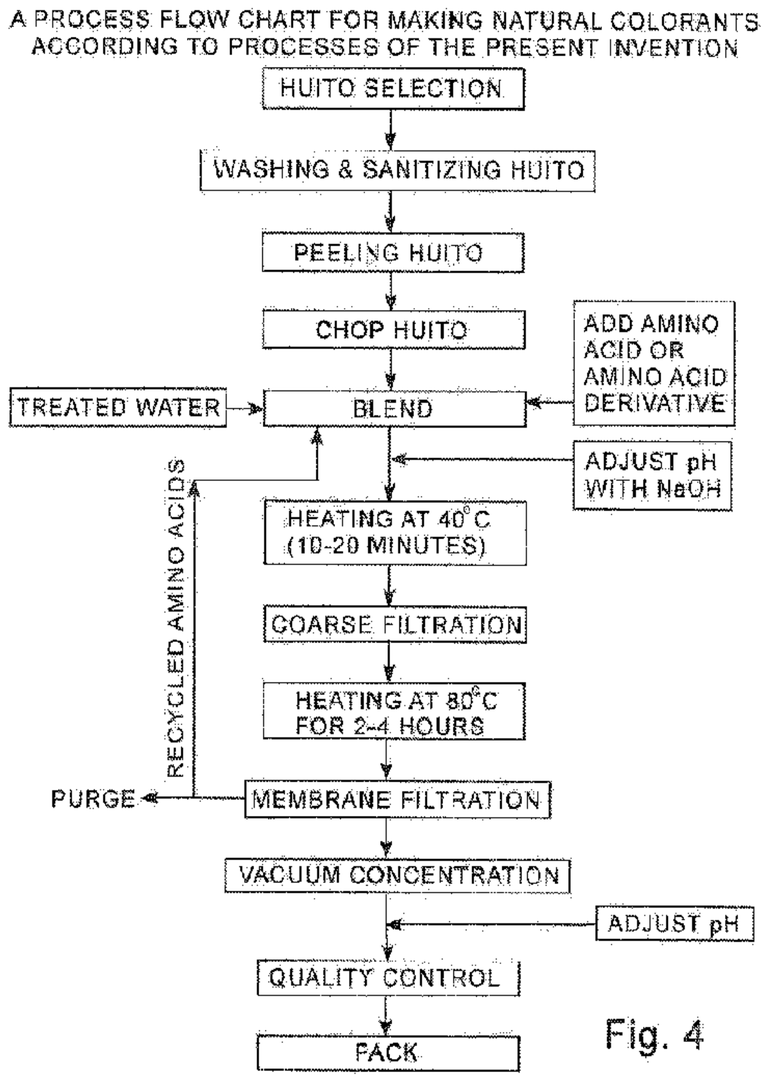


Fig. 4

(57) **Abstract**: The present invention is directed towards natural colorants comprising a material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivitatives, a genipin-containing substance, and combinations of any thereof; and a primary amine containing compound. Processes of making natural colorants are further disclosed. Additionally, processes of producing a desired color of natural colorants are disclosed.

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TITLE

NATURAL COLORANTS AND PROCESSES OF MAKING THE SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to the U.S. Provisional Patent Application No. 62/237,297, filed October 5, 2015, the contents of the entirety of which are incorporated by this reference

TECHNICAL FIELD

[0002] The present invention relates generally to natural colorants. The present disclosure is further directed to processes of making natural colorants. The present disclosure additionally is directed to processes of optimizing natural colorants.

BACKGROUND OF THE INVENTION

[0003] Currently a decreasing number of people are willing to consume food products or use cosmetic products colored synthetically, which has resulted in steady growth of the natural colorant market. As stated in US Pat. No. 8,557,319 to Wu et al., the content of which is incorporated herein by reference in its entirety, some of the first natural blue colors commercially feasible are those derived from gardenia fruits (*Gardenia jasminoides*). However, *gardenia* blue is not currently available in US and European markets and only available in some Asian markets as a safe color product for food and drug applications.

[0004] *Gardenia* fruit contains a large amount of iridoids such as geniposide, gardenoside, genipin-1-b-gentiobioside, geniposidic acid, and genipin. (Endo, T. and Taguchi, H. Chem. Pharm. Bull. 1973). Genipin is a key compound contributing to *gardenia* blue when it is reacted with specific chemicals. (US Pat. No. 4,878,921). *Gardenia* blue may be made by reacting geniposide extracted from *Gardenia* juice, purified genipin, or genipin derivatives, with certain isolated chemicals.

[0005] Genipin and other iridoid compounds, such as genipic acid, genipin gentiobioside, geniposide, and geniposidic acid are found in the fruits of *Genipa americana*, also known as genipap or huito, a wild plant of Latin America. The mature fruits of *Genipa americana* have been used in cooling drinks, jellies, sherbet, ice cream, sweet preserves, syrup, the soft drink genipapada, wine, a potent liqueur, and a tanning extract. Green or unripe fruits have been used as a color source to paint faces and bodies for adornment, to repel insects, and to dye clothing, pottery, hammocks, utensils, and basket materials a bluish-purple. The fruit and juices also have medicinal properties, for example, syrups used as cold and cough medicine. The flowers and bark of *Genipa americana* also have medicinal properties.

[0006] *Genipa americana* is also a natural source of iron, riboflavin, and anti-bacterial substances, apart from the carbohydrates, sugar, proteins, ash, and malic acid found in its fruits. The principal biochemical compounds of *Genipa americana* include: calcium, phosphorous, vitamin C, caffeine, caterine, genipic acid, genipin, gentiobioside, genipinic acid, geniposide, geniposidic acid, gardenoside, genamesides A-D, gardendiol, deacetyl asperulosidic acid methyl ester, shanzhiside, glycerides, hydantoin, mannitol, methyl esters, tannic and tartaric acid, and tannins.

[0007] Methods of preparing a genipin-rich red colorant from *Genipa americana* are known in the art. (US Pat. No. 8,945,640). Methods of preparing stable, natural colors from the juice of a fruit or plant from the *Rubiaceae* family containing genipin or derivatives of genipin, and other juice from a suitable

food-grade source, are also known in the art. (US Pat. No. 8,557,319). US Pat. App. No. 2014/0350127 discloses methods of preparing a colorant composition comprising mixing *Genipa americana* juice and a specific chemical, removing sugar from the mixture, and isolating the colorant composition. US Pat. No. 7,927,637 discloses a method of manufacturing a colorant pH-stable blue comprising peeling *Genipa americana* fruit from its skin, obtaining raw liquid juice from the *Genipa americana* fruit pulp, mixing the raw liquid juice with glycine, and warming the raw liquid juice mixed with glycine.

[0008] Additionally, while spirulina extract has been approved by the FDA as a source of blue color in candy and gum, US manufacturers have limited options when it comes to broad applications of natural blue and green colors. (Watson, E., FoodNavigator-USA, August 14, 2013, http://www.foodnavigator-usa.com/Regulation/The-wait-is-over-for-a-natural-blue!-FDA-approves-spirulina-as-food-color-in-US-as-Mars-petition-gets-green-light). Spirulina has limited use for food products since it tends to settle out in acidic beverages and is not overly heat stable. (Watson, E., FoodNavigator-USA, August 26, 2013, http://www.foodnavigator-usa.com/Suppliers2/WILD-Flavors-Our-fruit-juice-based-natural-blue-color-was-around-in-the-US-long-before-spirulina-got-the-green-light).

[0009] There remains a need for natural colorants which are pH-stable over a wide range of pH's as well as heat and light stable, so as to be used in a variety of foods and beverages.

SUMMARY OF THE INVENTION

[0010] In one embodiment, a natural colorant comprising a material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivatives, a genipin-containing substance and combinations of any thereof, reacted with a primary amine containing compound is disclosed.

[0011] In another embodiment, a process of making a natural colorant comprising mixing an primary amine containing compound with a material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivatives, a genipin-containing substance and combinations of any thereof, thus forming a blend, and heating the blend, thus producing the natural colorant is disclosed. In a further embodiment, processes of the present invention further comprise filtering the blend, resulting in a permeate. In yet further embodiments, processes of the present invention comprising mixing a primary amine containing compound with a material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivatives, a genipin-containing substance, and combinations of any thereof, thus forming a blend, and heating the blend, thus producing the natural colorant further comprise mixing the permeate with the primary amine containing compound; the material selected from the genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivatives, a genipin-containing substance, and combinations of any thereof; the blend; or combinations of any thereof.

[0012] In an additional embodiment, a process of producing a desired color of a natural colorant comprising mixing a first amino acid and a second amino acid with a material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivatives, a genipin-containing substance and combinations of any thereof is disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Fig. 1 shows samples of one embodiment of a blue colorant in solution produced according to one process of the present invention.

[0014] Fig. 2 shows a comparison of samples of embodiments of natural colorants, produced according to processes of the present invention, before and after dilution.

[0015] Fig. 3 shows samples of embodiments of natural colorants, produced according to processes of the present invention, ranked in order of most intense blue color to least intense blue color. These samples are undiluted.

[0016] Fig. 4 shows a process flow chart for producing embodiments of natural colorants according to methods of the present invention.

[0017] Fig. 5 shows a comparison of samples of natural colorants made without (pictured on the left) and with (pictured on the right) recycled permeate according to processes of the present invention.

[0018] Fig. 6 shows blue colorants obtained by processes of the present invention, ranked from most vibrant blue color on the left to fainted blue color on the right, in order from left to right: colorants containing isoleucine, methionine, alanine, glutamine, phenylalanine, aspargine, arginine, serine, and proline

[0019] Fig. 7 shows a comparison of a control colorant and a purified colorant made according to processes of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0020] In one embodiment, the present invention is directed towards natural colorants comprising a material selected from the group consisting of genipin, pre-genipin compounds, iridoid compounds, genipin derivatives, genipin-containing substances, and combinations of any thereof, reacted with a primary amine containing compound. In further embodiments, the primary amine containing compound is an amino acid.

[0021] In another embodiment, the present invention is directed towards processes of making a natural colorant comprising adding a primary amine containing compound to a material selected from the group consisting of genipin, pre-genipin compounds, iridoid compounds, genipin derivatives, genipin-containing substances, and combinations of any thereof, thus forming a blend, and heating the blend, thus producing the natural colorant. In further embodiments, the primary amine containing compound is an amino acid.

[0022] In yet another embodiment, the present invention is directed towards processes of producing a desired color of a natural colorant comprising mixing a primary amine containing compound with a material selected from the group consisting of genipin, pre-genipin compounds, iridoid compounds, genipin derivatives, genipin-containing substances, and combinations of any thereof. In further embodiments, the primary amine containing compound is an amino acid. In still further embodiments, the amino acid may be a combination of two or more amino acids.

[0023] The present invention contemplates many primary amine containing compounds, including but not limited to amino acids, derivatives of amino acids, methyl amine, gamma-Aminobutryic acid, polypeptides, proteins, and combinations of any thereof. Amino acids contemplated by the present invention include but are not limited to lysine, isoleucine, alanine, phenylalanine, serine, threonine, glutamic acid, glycine, arginine, glutamine, valine, leucine, methionine, asparagine, tyrosine, aspartic acid, cysteine, histidine, proline, tryptophan, and combinations of any thereof. The amino acids may further be isolated or purified amino acids. Derivatives of amino acids contemplated by the present invention include but are not limited to carnitine, taurine, and combinations of any thereof.

[0024] The present invention contemplates many sources of primary amine containing compounds or amino acids, including but not limited to fruits, vegetables, grains, legumes, nuts, seeds, plant materials, animal materials including but not limited to milk and eggs, microbial and algal materials, by-products of any thereof, and combinations of any thereof.

[0025] In a further embodiment, the amino acid is selected from the group consisting of lysine, isoleucine, alanine, phenylalanine, serine, threonine, glutamic acid, glycine, glutamine, leucine, methionine, asparagine, tyrosine, derivatives of any thereof, and combinations of any thereof, thus forming a blue colorant. In yet a further embodiment, a first amino acid and a second amino acid are each independently selected from the group consisting of lysine,

isoleucine, alanine, phenylalanine, serine, threonine, and combinations of any thereof, thus producing a blue color. In a further embodiment, an additional amino acid selected from the group consisting of lysine, isoleucine, alanine, phenylalanine, serine, threonine, glutamic acid, glycine, arginine, glutamine, valine, leucine, methionine, asparagine, tyrosine, aspartic acid, cysteine, histidine, proline, tryptophan, derivatives of any thereof, and combinations of any thereof is mixed with the first amino acid and second amino acid.

[0026] In a further embodiment, the amino acid is selected from the group consisting of aspartic acid, glutamic acid, cysteine, and combinations of any thereof, thus forming a yellow/green colorant.

[0027] In a further embodiment, the amino acid is selected from the group consisting of proline, alanine, arginine, valine, derivatives of any thereof, and combinations of any thereof, thus forming a blue-red/purple colorant. In a further embodiment, the colorant has a bluish-red color.

[0028] In a further embodiment, the material or the genipin-containing substance is selected from the group consisting of fruits from *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof. *Genipa americana*, also referred to as huito or huito fruit, is one species within the *Genipa* genus, which falls under the *Rubiaceae* family of plants. Without restricting the scope of fruits that may be used, *Genipa americana* should be taken to include edible fruits or juices or extracts or edible parts of related plants including *Gardenia* and *Kailarsenia* and other genipin-containing plants, further including *Gardenia jasminoides* Ellis and its varieties. In preferred embodiments, the material is huito fruit.

[0029] In a further embodiment, the material is in the form selected from the group consisting of whole fruit, fruit juice, fruit puree, fruit juice concentrate, dried powder from fruit, dried powder from juice, water-insoluble parts of fruit including but not limited to seeds and sacs, derivatives of any thereof, and combinations of any thereof.

[0030] In a further embodiment, the primary amine containing compound or amino acid is present in an amount of at least 0.25% by weight relative to the weight of the material, wherein the material is selected from the group consisting of *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof. In yet a further embodiment, the primary amine containing compound or amino acid is present in an amount of about 0.25-10% by weight relative to the weight of the material, wherein the material is selected from the group consisting of *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof. In another embodiment, the primary amine containing compound or amino acid is present in an amount of about 0.5-4.0% by weight relative to the weight of the material, wherein the material is selected from the group consisting of *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof. In a preferred embodiment, the primary amine containing compound or amino acid is present in an amount of about 0.75-1.50% by weight relative to the weight of the material, wherein the material is selected from the group consisting of *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof. In further embodiments, the *Genipa americana* or fruits from close relatives of *Genipa americana* may include any part of the fruits including but not limited to a juice, an extract, an edible part, and combinations of any thereof.

[0031] In a further embodiment, the primary amine containing compound or amino acid is present in an amount of from 0.1:1 to 10:1 (molar ratio, primary amine containing compound or amino acid:material, wherein the material is genipin or purified genipin). In a further embodiment, the primary amine containing compound or amino acid is present in an amount of from 0.25:1 to 4:1 (molar ratio, primary amine containing compound or amino acid:material, wherein the material is genipin or purified genipin). In a preferred embodiment, the primary amine containing compound or amino acid is present in an amount of from 0.5:1 to 1:1 (molar ratio, primary amine

containing compound or amino acid:material, wherein the material is genipin or purified genipin). In a more preferred embodiment, the primary amine containing compound or amino acid is present in an amount of about 1:1 (molar ratio, primary amine containing compound or amino acid:material, wherein the material is genipin or purified genipin).

[0032] In a further embodiment, the amino acid is selected from the group consisting of naturally derived amino acids, amino acids derived from fermentation, synthetic amino acids, and combinations of any thereof. In yet a further embodiment, the amino acid may be the L- enantiomer. In still a further embodiment, the amino acid may be in a powder or a liquid form. In yet a further embodiment, the amino acid may be in a salt form, including a hydrochloride or monohydrochloride salt form. In still a further embodiment, the amino acid may be in a base form.

[0033] In a further embodiment, the amino acid is selected from the group consisting of isoleucine, L-isoleucine, L-lysine monohydrochloride, L-arginine base, L-glutamic acid hydrochloride (HCl), L-phenylalanine, lysine, isoleucine, alanine, phenylalanine, serine, threonine, glutamic acid, glycine, arginine, glutamine, valine, leucine, methionine, asparagine, tyrosine, aspartic acid, cysteine, histidine, proline, tryptophan, and combinations of any thereof.

[0034] In a further embodiment, the amino acid is selected from, or the first amino acid and the second amino acid are each independently selected from, the group consisting of a combination of L-isoleucine and L-lysine monohydrochloride and a combination of isoleucine and lysine. In still a further embodiment, the first amino acid is isoleucine and the second amino acid is lysine. In yet a further embodiment, increasing the amount of isoleucine produces a blue color with green notes. In yet a further embodiment, increasing the amount of lysine produces a blue color with purple notes. In still a further embodiment, the amino acid is a blend of isoleucine and lysine ranging from 60-80% isoleucine and from 20-40% lysine. In yet a further embodiment, the ratio of the first amino acid to the second amino acid is from about 60:40 to about 80:20.

In still a further embodiment, the amino acid is an about 70:30 (isoleucine:lysine) blend of isoleucine and lysine.

[0035] In yet a further embodiment, the amino acid is selected from isoleucine, alanine, and combinations of any thereof. In further embodiments, the combination of amino acids comprises 70-90% isoleucine. In yet a further embodiment, the amino acid is a blend of isoleucine and alanine ranging from 70-90% isoleucine and from 10-30% alanine. In further embodiments, the ratio of isoleucine to alanine is from about 70:30 to about 90:20. In preferred embodiments, the amino acid is an about 80:20 (isoleucine:alanine) blend of isoleucine and alanine.

[0036] In a further embodiment, the natural colorant has an L-value ranging from about 20 to about 55, an a-value ranging from about -2.0 to about 6.5, and a b-value ranging from about 1 to about -20. In a further embodiment, the natural colorant has a CV of from about 0.04 to about 55. In yet a further embodiment, concentration of the natural colorant results in a natural colorant with a CV of greater than 55.

[0037] The present invention lists measurements for the natural colorants in terms of CV, Brix, and L, a-, and b-values. CV, or color value units, are a trade designation for a measure of concentration. Brix, or degrees Brix, is a unit of measurement for the sugar (and other solids) concentration of liquids, which may be measured by both density and refractive index. L, a-, and b-values are reported for measurement using a Hunter colorimeter.

[0038] In another embodiment, the natural colorant may be used in an application selected from the group consisting of food applications, beverage applications, animal food applications, oral care applications including but not limited to toothpaste and mouthwash, personal care applications including but not limited to soap, shampoo, and fragrance, cleaning supplies, and combinations of any thereof. In a further embodiment, the natural colorant may be used in the food application. In yet a further embodiment, the natural colorant may be used in the beverage application.

[0039] In a further embodiment, the heating the blend is carried out at from about 5°C to about 65°C. In a further embodiment, the heating the blend is carried out at about 20°C to about 60°C. In yet a further embodiment, the heating the blend is carried out at about from 35°C to about 45°C.

[0040] In a further embodiment, the material is processed before adding the amino acid. In yet a further embodiment, the processing comprises an action selected from the group consisting of chopping, blending, blending with water, blending with a solvent, blending with a permeate, mashing, extracting juice, milling, filtering, pressing, heating, drying, and combinations of any thereof.

[0041] In a further embodiment, an enzyme is added to the blend. In yet a further embodiment, the enzyme is β-glucosidase.

[0042] In a further embodiment, the blend or the natural colorant is filtered. Various types of filtration are contemplated by the present invention, including but not limited to nanofiltration and ultrafiltration. Nanofiltration generally refers to filtration using a membrane with a molecular weight cutoff of less than 5,000 Daltons. Nanofiltration may also refer to filtration using a membrane with a molecular weight cutoff of 200-2,000 Daltons. In some embodiments of the present invention, the membrane has a molecular weight cutoff of about 5,000 Daltons or less. In further embodiments of the present invention, the membrane has a molecular weight cutoff of about 3,000 Daltons or less. In other embodiments of the present invention, the membrane has a molecular weight cutoff of about 1,000 Daltons or less. It was found that using the membrane with the molecular weight cutoff of about 1,000 Daltons or less provided better retention of color body.

[0043] In further embodiments, the blend is filtered, resulting in the permeate. In still further embodiments, the permeate is recycled in processes according to the present invention. In yet further embodiments, processes of making a natural colorant comprising mixing a primary amine containing compound to a material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivatives,

genipin-containing substances, and combinations of any thereof, thus forming a blend, and heating the blend, thus producing the natural colorant further comprise mixing the permeate with the primary amine containing compound; the material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivatives, genipin-containing substances, and combinations of any thereof; the blend; or combinations of any thereof. In a further embodiment, the permeate is a source of all or some of the primary amine containing compound or the amino acid for processes of the present invention.

[0044] In yet a further embodiment, the natural colorant is heated. In still a further embodiment, the heating the natural colorant is carried out at a temperature of from about 10°C to about 100°C. In a preferred embodiment, the heating the natural colorant is carried out at a temperature of about 80°C.

[0045] In a further embodiment, the natural colorant is concentrated. In yet a further embodiment, water is added to the group consisting of the amino acid, the material, the natural colorant, and combinations of any thereof.

[0046] In still a further embodiment, the pH of the natural colorant is adjusted. In yet a further embodiment, the pH of the natural colorant is adjusted by adding a base to the natural colorant. In preferred embodiments, the base is sodium hydroxide. In still another embodiment, the pH of the natural colorant is adjusted by adding an acid to the natural colorant. In further embodiments, the acid is selected from the group consisting of hydrogen chloride, citric acid, and combinations of any thereof. In a preferred embodiment, the acid is citric acid. In still further embodiments, the pH of the natural colorant may be adjusted after addition of an amino acid to a material selected from the group consisting of genipin, pre-genipin compounds, iridoid compounds, genipin derivatives, and combinations of any thereof, including but not limited to huito fruit, but before an initial heating. In further embodiments, the pH of the natural colorant may be adjusted after the initial heating and before a secondary heating. In yet further embodiments, the pH of the natural colorant is adjusted

to about 4-9. In preferred embodiments, the pH of the natural colorant is adjusted to around 7.0. In still further embodiments, the pH of the natural colorant or the blend may be adjusted continuously throughout processes of the present invention. In yet further embodiments, the pH of the natural colorant or the blend may be adjusted to optimize the color value of the natural colorant.

[0047] In a further embodiment, a ratio of the first amino acid to the second amino acid is adjusted to achieve the desired color. In yet a further embodiment, more than 2 amino acids are combined.

[0048] In yet another embodiment, the processes of the present invention may be carried out aerobically. In preferred embodiments, the processes of the present invention for producing a blue natural colorant are carried out aerobically.

[0049] The invention is further explained by the following examples.

[0050] Example 1: Preparation of Natural Blue Colorant. Huito fruit was peeled, chopped, and blended with water (ratio of 1:2.5, huito:water). The resulting mixture was heated at 40°C for 10 minutes while adding 4% by weight (relative to the huito fruit weight) of an amino acid solution (isoleucine:lysine, 70:30). The resulting blend was filtered by vacuum filtration, and the filtrate was heated at 80°C for 3 hours and concentrated.

[0051] It was found that adjusting the ratio of isoleucine:lysine produced variations in color. Increasing the amount of isoleucine produced greener colors, while increasing the amount of lysine produced more purple notes. The 70:30 isoleucine:lysine ratio produced a vibrant blue color. However, given natural discrepancies inherent in the fruit, specific ratios may need to be adjusted to achieve a desired shade of the natural colorant.

[0052] Color values (CV) as well as L, a, and b-values were measured before concentration. These values were measured at 2 separate facilities, giving the following results, summarized in Tables 1 and 2 below.

[0053] Fig. 1 shows four natural colorants prepared according to processes of the present invention. The colorant furthest to the left is a shade of

blue with almost no green or purple notes. The colorant second from the left has slightly more purple notes than the colorant furthest to the left. The colorant third from the left has more purple notes than the colorant second from the left. The colorant on the right is a deeper/darker shade of blue than the colorant furthest to left.

[0054] Table 1: Color Values of Natural Blue Colorant Measured at Location 1

Trial	**CV**	**Brix**	**L**	**a**	**b**
1	3.51	8.1	35.75	1.96	-7.21
2	5.58	12.9	36.11	1.51	-7.12
3	3.09	7.8	41.55	2.51	-8.99
4	3.35	7.6	41.11	1.69	-7.55
5	4.87	11.2	41.18	0.73	-7.80
6	4.46	12.1	40.96	1.79	-9.02
7	4.35	11.9	39.87	2.18	-8.22

[0055] Table 2: Color Values of Natural Blue Colorant Measured at Location 2

Trial	**CV**	**Brix**	**L**	**a**	**b**
4	3.33	---	42.12	1.42	-8.48
6	4.46	---	43.24	1.36	-9.71
7	4.30	---	41.84	1.86	-9.27

[0056] The small differences in values between Table 1 and Table 2 can be explained by differences in equipment used for the testing.

[0057] Concentration may increase the CV values from 3 to 55 or higher. A natural blue colorant with a higher CV, for example a CV of 55, would be beneficial by allowing for a lower inclusion rate and improved cost in use

(CIU), as compared to natural blue colorants with much lower CV values which require a high usage rate.

[0058] The natural blue colorants have a low, positive a-value and a high, negative b-value.

[0059] The natural blue colorants produced were found to be light stable, heat stable, and acid stable.

[0060] Example 2: Preparation of Natural Colorants. The pulp/seeds/sac of huito fruit (Genipa americana) was removed from the raw fruit (unripe), dried, and ground into a powder. To the huito powder (10.0 g), deionized water (90.0 g) was added. The huito powder was mixed with the water and soaked for 30 minutes. To the huito powder and water was added β-glucosidase (0.15 g). After 30 minutes, the mixture was filtered to remove insoluble matter. The pH of the filtrate was adjusted to 6.80 by adding a 10% sodium hydroxide (NaOH) solution. The resulting solution was divided into 5.00 g samples.

[0061] Different amino acids were added to each sample, with a total of 0.05 g amino acids added to each sample. The samples were left for 15 hours. After 15 hours, the color changes were observed (Fig. 2). Fig. 2 shows the test tubes containing the samples before dilution on the left and after dilution on the right. Descriptions of the variations in colors and intensities are in the following paragraph, and summarized in the Table 3 below.

[0062] The sample containing lysine produced the darkest blue color. The intensity of the blue colors of the samples, listed from strongest to weakest (identified by the amino acid added) was: lysine > alanine > phenylalanine > serine > threonine. The sample containing threonine produced approximately the same intensity of blue color as the control sample. The samples containing cysteine and glutamic acid produced yellow/green colors. The sample containing aspartic acid produced a greener color than the samples containing cysteine and glutamic acid. The sample containing proline produced a blue/red color. All the samples were diluted (10-times) with deionized water (Fig. 2). The

undiluted samples settled for an additional day. The colors of the samples, ranked by intensity/color spectrum and identified by the amino acid added was: lysine (navy blue) > alanine (navy blue) > phenylalanine (light blue) > serine (greyish) > control (red purple, with more blue) > threonine (greenish) > proline (red purple) > aspartic acid (slightly greenish grey) > glutamic acid ≈ cysteine (yellow/green). The results are summarized in Table 3 below and shown in Fig. 3. Fig. 3 shows samples of natural colorants ranked in order of most intense blue color (1) to least intense blue color (10).

[0063] Table 3: Preparation of Natural Colorants

Sample	**Amino Acid (0.05 g)**	**Color; blue intensity (1 = most intense)**	**Color; blue intensity (1= most intense) – after 10x dilution with deionized water + standing for 1 day**
1	L-Lysine HCl natural	Blue; 1	Navy blue; 1
2	L-Phenylalanine natural	Blue; 3	Light blue; 3
3	L-Alanine-natural	Blue; 2	Navy blue; 2
4	L-Proline natural	Blue/red	Red purple; 7
5	L-Aspartic acid natural	Green	Slightly greenish grey; 8
6	L-Glutamic acid HCl natural	Yellow/green	Yellow/green; 9
7	L-serine	Blue; 4	Greyish; 4
8	L-Threonine natural	Blue; 5	Greenish; 6
9	L-cysteine HCl natural	Yellow/green	Yellow/green; 10
10	None (control)	Blue; 5	Red purple with more blue; 5

[0064] Example 3: Methods of Preparing Natural Colorants. Fig. 4 shows a process flow chart for making natural colorants. Huito fruit is selected, washed and sanitized, peeled, chopped, and blended with treated water and at

least one amino acid. For example, 1.0% isoleucine (by weight of the huito fruit) or 0.75% alanine (by weight of the huito fruit) may be used. The pH is adjusted to 7.0 with a sodium hydroxide solution, resulting in a pH-adjusted mixture. The pH-adjusted mixture is heated at 40°C for 10-20 minutes, coarse filtered, heated at 80°C for 2-4 hours, and filtered using a membrane having 3,000 Dalton or less molecular weight cutoff, resulting in permeate and colorant. The permeate may either be discarded, or recycled and used in place of the treated water and/or the at least one amino acid. The colorant is vacuum concentrated and pH-adjusted to 4.2. The colorant may be subjected to quality control. The colorant may be packed.

[0065] Example 4: Effect of Recycling Permeate on Methods of Preparing Natural Colorants. A natural colorant was made (the control), and the permeate from making the control was used to make another natural colorant (the test). The color values were measured for both the control and the test to determine the effects of using recycled permeate in making natural colorants.

[0066] The control was prepared by peeling and chopping huito fruit into small pieces. A ratio of 2 parts deionized water to 1 part huito fruit was blended with high sheer. Isoleucine was added (0.75% of the huito fruit, by weight). The pH was adjusted to 8.0 with a sodium hydroxide solution, resulting in a pH-adjusted mixture. The pH-adjusted mixture was heated at 40°C for 20 minutes, coarse filtered, heated at 80°C for 4 hours, and membrane filtered (resulting in a permeate), and optionally concentrated, thus resulting in the control. The pH was adjusted to 4.2 with a citric acid solution for microbiological stability. The color of the control was measured.

[0067] The test was prepared by peeling and chopping huito fruit into small pieces. A ratio of 2 parts permeate (the permeate from making the control) to 1 part huito fruit was blended with high sheer, producing a mixture. The permeate was obtained by membrane filtration using a membrane with a molecular weight cutoff of 3,000 Daltons or less (Hydracore 7410). A spiral wound membrane module (comprising layers of membranes separated by

spacers) was used. The filtration is most effective when an appropriate spacer thickness is selected for the spiral wound membrane module. The spacer thickness may be in the range of from about 35 mil (1 mil = 1/1000 of an inch) to about 120 mil. Permeation using a 45 mil spacer was compared to permeation using a 65 mil spacer, with the 45 mil spacer offering a better permeation rate than the 65 mil spacer. Isoleucine was added (total 0.75% of the huito fruit, by weight; with 0.576% from isoleucine powder and 0.174% from the permeate). The permeate contained 0.087% isoleucine. The pH of the mixture was adjusted to 8.0 with a sodium hydroxide solution, resulting in a pH-adjusted mixture. The pH-adjusted mixture was heated at 40°C for 20 minutes, coarse filtered, and heated at 80°C for 4 hours, resulting in the test. The pH was adjusted to 4.2 with a citric acid solution for microbiological stability. The color of the test was measured.

[0068] Table 4, below, shows the conditions used to make the test and the control

[0069] Table 4: Conditions for the Control and the Test

	Control	**Test**
Huito fruit weight (g)	85.83	100
Permeate obtained from filtration using a Hydracore 7410 membrane, spiral wound; 2x concentrated (volume concentration factor); (g)	0	200 (contained 0.174 g isoleucine)
Deionized water (g)	171.66	0
Isoleucine (g) (0.75% of the huito fruit, by weight)	0.64	0.576
Weight after filtration (g)	165.49	191.17
Initial sample taken out (g)	15.8	15.09
Sample taken out at 2	15.85	15.56

hours (g)		
Final weight (at 4 hours) (g)	133.84	160.52

[0070] The color value (CV), a measurement of strength of color, was the same between the control and the test. The color hue, as measured by the Hunter L, a, and b values, was very similar and not substantially different between the control and the test. The ΔE was less than 5, indicating that consumers would find it difficult to perceive any color differences. ΔE quantifies changes in color, with a ΔE value greater than 5 representing a color change which may be readily observed by consumers. ΔE is calculated by the equation: $\Delta E = \text{square root of } \{(L_0-L)^2 + (a_0-a)^2 + (b_0-b)^2\}$. Fig. 5 shows the control on the left and the test on the right, confirming that both colorants are visually the same. Table 5, below, shows the detailed results of pH and color testing the control and the test.

[0071] Table 5: Results of pH and Color Testing the Control and the Test

	lambda max (nm)	**abs (Absorbance of lambda max)**	**Color value (CV)**	**L (0.5 CV)**	**a (0.5 CV)**	**b (0.5 CV)**
Control (at 4 hours)	595.07	0.36	1.86	41.25	-1.08	-8.01
Test (at 4 hours)	595.09	0.36	1.89	41.57	-1	-7.91

[0072] As can be seen in Table 5, the CV and Hunter L, a, and b values are very similar for both the control and the test. Recycling the permeate provides virtually the same color while reducing the fresh water requirement of

methods of preparing natural colorants and reducing the purified amino acid requirement of methods of preparing natural colorants.

[0073] Example 5: Effect of pH Adjustment of Natural Colorants. Natural colorants (colorant A and colorant B) were prepared. For both colorant A and colorant B, a ratio of huito fruit to water of 1:3.6 was used. Isoleucine was added to both colorants at a rate of 1.5% by weight of huito fruit. The pH of both colorants was adjusted to a pH of 8 with a sodium hydroxide solution. Both colorants were heated for 10 minutes at 40°C in a hot water bath, and both colorants were filtered. Colorant B was readjusted to a pH of 8, while colorant A had no further pH adjustments. Both colorants were heated for 3 hours at 80°C in a hot water bath. Both colorants were adjusted to a pH of 4.2 with citric acid. The results of pH and color testing of colorant A and colorant B are summarized below in Table 6 and Table 7.

[0074] Table 6: Colorant A pH and Color Testing Results

Process Step	**Time (hours:minutes)**	**CV**	**L**	**a**	**b**	**Genipin (ppm)**	**pH**
Before amino acid added	n/a	n/a	n/a	n/a	n/a	n/a	4.26
After amino acid added & NaOH addition	n/a	n/a	n/a	n/a	n/a	n/a	8.00
After heating at 40°C	0:10	n/a	n/a	n/a	n/a	n/a	6.3
After heating	3:00	0.63	22.41	-0.52	-1.17	428	5.61

at 80°C							

[0075] Table 7: Colorant B pH and Color Testing Results

Process Step	Time (hours:minutes)	CV	L	a	b	Genipin (ppm)	pH
Before amino acid added	n/a	n/a	n/a	n/a	n/a	n/a	4.26
After amino acid added & NaOH addition	n/a	n/a	n/a	n/a	n/a	n/a	8.00
After heating at 40°C	0:10	n/a	n/a	n/a	n/a	n/a	6.28
After readjusting pH with NaOH	n/a	n/a	n/a	n/a	n/a	n/a	8.00
After heating at 80°C	3:00	0.91	22.92	-0.85	-1.97	84	6.3

[0076] As can be seen by comparing the data in Table 6 and Table 7, colorant A, which only had the pH adjusted to 8.0 once (after the addition of the amino acid), had a color value (CV) of 0.63 after heating at 80°C for 3 hours. However, colorant B, which had the pH adjusted to 8.0 twice (after the addition of the amino acid and after filtering after the initial heating at 40°C), had a CV of 0.91, almost 45% higher than colorant A, giving colorant B a stronger color. This improvement in CV translates to a tremendous amount of cost savings. Such

cost savings are achievable since a higher color value means that less of the colorant with the higher color value will be needed in an application, for example a food or beverage application, to achieve a desired color. Essentially, a higher color value equates to an improved yield of the colorant. Further savings could be achieved by continuously adjusting the pH throughout preparation of natural colorants.

[0077] Example 6: Preparation of Improved Natural Blue Colorant. Natural colorants prepared by reacting huito fruit with various amino acids were compared. A general procedure was followed. The general procedure involved combining huito fruit with water in a 1:3.6 (huito fruit:water) ratio, adding the various amino acids at various rates, adjusting the pH to 7 with a sodium hydroxide solution, heating for 20 minutes at 40°C with constant stirring, filtering, heating for 4 hours at 80°C with constant stirring and while adding water about every 30 minutes to account for evaporation, and adjusting the pH to 4.2.

[0078] For Test A, the amino acid used was isoleucine at a rate of 0.75% by weight of the huito fruit weight. For Test B, the amino acid used was alanine at a rate of 0.75% by weight of the huito fruit weight. For Test C, the amino acid used was a combination of isoleucine and alanine, with the isoleucine at a rate of 0.6% by weight of the huito fruit weight and with the alanine at a rate of 0.15% by weight of the huito fruit weight. The results of Test A, Test B, and Test C, and the analysis of a combination of the Test A colorant and the Test B colorant (80% Test A, 20% Test B) are summarized below.

[0079] Table 8: Test A Analysis

Process	**Time (hours:minutes)**	**CV**	**L**	**a**	**b**
Reaction at 80°C	4:00	0.517	42.93	-1.07	-7.18

[0080] Table 9: Test B Analysis

Process	Time (hours:minutes)	CV	L	a	b
Reaction at 80°C	4:00	0.795	42.56	0.18	-8.97

[0081] Table 10: Test C Analysis

Process	Time (hours:minutes)	CV	L	a	b
Reaction at 80°C	4:00	0.595	42.45	-0.71	-7.9

[0082] Table 11: Analysis of the Combination of Test A and Test B

	CV	L	a	b
80:20 blend (Test A:TestB)	0.576	42.8	-0.83	-7.52

[0083] Overall, the combination of isoleucine and alanine reacted with huito fruit results in an improved natural colorant with a better color having less green and more red (higher a-value) as compared to a colorant resulting from a mixture of huito fruit and isoleucine alone, and no observed precipitate. Similar results were observed by reacting amino acids separately with huito fruit and then blending the resultant colorants (as compared to mixing 2 or more amino acids with the huito fruit). The natural colorant produced by using alanine had a blue-red/purple color.

[0084] Example 7: Natural Colorants from Various Amino Acids. Processes substantially according to the previous process examples were used to make natural colorants using various amino acids (mixing huito fruit with water in about a ratio of 1:3.6 huito fruit:water, weight:weight; mixing various amino acids at a rate of about 1.5% by weight of the huito fruit weight,

adjusting the pH with sodium hydroxide, heating for 20 minutes at 40°C, coarse filtering, heating for 2 hours at 80°C, and adjusting the pH with citric acid). For colorants (not concentrated) obtained from an aerobic process using huito fruit, the results are summarized in Table 12 below. Fig. 6 shows the varying colors of the blue colorants as summarized in Table 12 below. Fig. 6 shows colorants obtained by methods of the present invention, ranked from most vibrant blue color on the left to fainted blue color on the right, in order from left to right: colorants containing isoleucine, methionine, alanine, glutamine, phenylalanine, aspargine, arginine, serine, and proline. For colorants obtained from an aerobic process using a genipin extract, the results are summarized in Table 17 below. For additional colorants obtained from an aerobic process using a genipin extract, the results are summarized in Table 18 below.

[0085] The process of obtaining the genipin extract comprises washing, peeling, and cutting huito fruit; blending a ratio of 1.5:1 (water:huito fruit, weight:weight) water and huito fruit, and filtering to produce a huito juice. Genipin is extracted from the huito juice using buytl acetate (1:2 butyl acetate:huito juice, weight:weight). The extraction using butyl acetate is repeated. The butyl acetate is evaporated, resulting in a genipin extract which may be dried to a powder. To obtain the colorants as summarized in Table 13 and Table 14, the dried, genipin extract powder was dissolved in a mixture of water and ethanol and mixed with the amino acid, and heated for 2 hours.

[0086] Table 12: Natural Colorants from Aerobic Reaction of Huito Fruit with Various Amino Acids

Amino Acid	Color (primary color/undertone)	L	a	b	CV
Alanine	Blue/red	22.9	-0.58	-2.39	0.51
Arginine	Blue/red	22.82	-0.81	-2.15	0.54
Asparagine	Blue/green	22.73	-0.69	-1.91	0.56
Glutamine	Blue/green	22.87	-0.7	-2.05	0.51
Isoleucine	Blue/green	23.25	-1.01	-2.32	0.44
Methionine	Blue/green	23.05	-0.99	-2.14	0.49
Phenylalanine	Blue/green	22.97	-1.08	-1.91	0.51

Proline	Light blue/grey	23.63	-0.65	-1	0.11
Serine	Light blue/purple	23.32	-0.76	-2.5	0.37

[0087] Table 13: Natural, Concentrated Colorants from Aerobic Reaction of Huito Fruit with Various Amino Acids

Amino Acid	**L**	**a**	**b**
Taurine	43.17	1.06	-11.19
Lysine	43.65	1.35	-10.91
Alanine	43.85	0.29	-10.77
Arginine	44.61	-1.06	-10.19

[0088] Table 14: Natural Colorants from Aerobic Reaction of Genipin Extract with Various Amino Acids

Amino Acid	**Color**	**L**	**a**	**b**
Isoleucine	Green	87.47	-3.42	-0.77
Threonine	Green	79.12	-5.91	-2.42
Histidine	Blue	71.13	-7.82	-17.46
Tryptophan	Yellow/green	n/a	n/a	n/a
Phenylalanine	Deep green	n/a	n/a	n/a

[0089] Example 8: Natural Colorants using Isoleucine or Alanine. Processes substantially according to the previous process examples were used to make natural colorants using isoleucine or alanine. The results of analysis of these natural colorants are summarized below.

[0090] Table 15: Natural Colorant using Isoleucine

% amino acid (relative to weight of huito	**Huito fruit to water ratio (weight/weight)**	CV	**Brix**	L	**a**	**b**

fruit)						
1.00	1:3.0	23.61	55.3	38.57	1.55	-8.38
1.00	1:2.8	23.33	57.6	38.23	1.46	-9.66

[0091] Table 16: Natural Colorant using Alanine

% amino acid (relative to weight of huito fruit)	Huito fruit to water ratio (weight/weight)	CV	Brix	L	a	b
0.75	1:2.48	19.46	49.1	38.51	4.03	-8.55
0.75	1:2.8	18.61	57.9	38.88	5	-9.75

[0092] Example 9: Purified Colorant Trials. A general procedure of mixing huito fruit with water at a ratio of 1:3.6 huito fruit:water, weight:weight, heating at 40°C, and coarse filtering, resulting in a fruit extract, was used to prepare the colorants of this example. For the control colorant, isoleucine was added to the fruit extract at 1% by weight of the huito fruit weight and heated for 4 hours. For the purified colorant, the fruit extract was treated with 95% ethanol at a ratio of 1:2 fruit extract:ethanol, weight:weight, filtered, ethanol evaporated off, and mixed with isoleucine at a rate of 1% by weight of the huito fruit weight, and heated for 4 hours. Fig. 7 shows a comparison of the control and purified colorants. Results are summarized below.

[0093] Table 17: Comparison of Control and Purified Colorants

Sample	Reaction Time (hours)	pH	Brix	Weight (g) in 100 mL	lambda max (nm)	abs (Absorbance)	CV	L	a	b
Control	4	5.59	3.34	0.1883	590.99	0.27	1.44	42.78	0.71	-10.78
Purified	4	5.42	3.05	0.2068	591.86	0.23	1.10	42.87	0.49	-10.2

[0094] Example 10: Reduction of Residual Unreactive Amino Acids and Genipin. Processes substantially according to previous examples involving membrane filtration were followed. The samples were concentrated 2 times and passed through diafiltration. The results summarized below show that the amino acid (isoleucine) was reduced by 49% after the 2x concentration and reduced by 92% after diafiltration. Reduction of residual unreactive amino acids provide the benefit of allowing for a cleaner label on the final colorant product. The 2x concentration and diafiltration also remove all remaining unreacted genipin in the colorants.

[0095] Table 18: Analysis of Reduction of Residual Unreactive Amino Acids and Genipin

Membrane	Molecular Weight cutoff	Sample	Genipin	Isoleucine	CV	L	a	b
Hydracore 7410	3000	Initial	65.11	0.0644%	0.50	42.09	0.70	-8.91
		2x Filtration Concentrate	83.09	0.1060%	1.61	42.12	0.61	-8.76
		Adjust to equal CV		0.0329%				
		% Reduction		48.8831%				
		Diafiltration Concentrate	Not Detected	0.0142%	1.43	41.28	0.95	-8.71
		Adjust to equal CV		0.0050%				
		% Reduction		92.2903%				

[0096] The present invention has been described with reference to certain examples. However, it will be recognized by those of ordinary skill in the art that various substitutions, modifications, or combinations of any of the examples may be made without departing from the spirit and scope of the invention. Thus, the invention is not limited by the description of the examples, but rather by the appended claims as originally filed.

CLAIMS

What is claimed is:

1. A natural colorant comprising:

a material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivitatives, a genipin-containing substance and combinations of any thereof, reacted with a primary amine containing compound.

2. The natural colorant of claim 1, wherein the primary amine containing compound is selected from the group consisting of amino acids, derivatives of amino acids, methyl amine, gamma-Aminobutryic acid, polypeptides, proteins, and combinations of any thereof.

3. The natural colorant of claim 1 or claim 2, wherein the natural colorant further comprises a second primary amine containing compound.

4. The natural colorant of claim 2, wherein the amino acid is selected from the group consisting of lysine, isoleucine, alanine, phenylalanine, serine, threonine, glutamic acid, glycine, arginine, glutamine, valine, leucine, methionine, asparagine, tyrosine, aspartic acid, cysteine, histidine, proline, tryptophan, and combinations of any thereof.

5. The natural colorant of claim 2 or claim 3, wherein the amino acid is isolated.

6. The natural colorant of claim 2 or claim 3, wherein the amino acid is purified.

7. The natural colorant of claim 2, wherein the derivative of the amino acid is selected from the group consisting of carnitine, taurine, and combinations of any thereof.

8. The natural colorant of claim 2, wherein the material is reacted with the amino acid selected from the group consisting of lysine, isoleucine, alanine, phenylalanine, serine, threonine, glutamic acid, glycine, arginine, glutamine, valine, leucine, methionine, asparagine, tyrosine, carnitine, taurine and combinations of any thereof, thus forming a blue colorant.

9. The natural colorant of claim 2, wherein the material is reacted with the amino acid selected from the group consisting of aspartic acid, glutamic acid, cysteine, and combinations of any thereof, thus forming a yellow/green colorant.

10. The natural colorant of claim 2, wherein the material is reacted with proline, thus forming a red/purple colorant.

11. The natural colorant of claim 1 or claim 2, wherein the material is selected from the group consisting of *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof.

12. The natural colorant of claim 1 or claim 11, wherein the material is in the form selected from the group consisting of whole fruit, fruit juice, fruit puree, fruit juice concentrate, dried powder from fruit, dried powder from juice, water-insoluble parts of fruit, derivatives of any thereof, and combinations of any thereof.

13. The natural colorant of claim 1 or claim 2, wherein the material is selected from the group consisting of genipin, purified genipin, and combinations of any thereof.

14. The natural colorant of claim 2, wherein the amino acid is present in an amount of at least 0.25% by weight relative to the weight of the material, wherein the material is selected from the group consisting of *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof.

15. The natural colorant of claim 14, wherein the amino acid is present in an amount of about 0.25-10% by weight relative to the weight of the material, wherein the material is selected from the group consisting of *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof.

16. The natural colorant of claim 14, wherein the amino acid is present in an amount of about 0.5-4.0% by weight relative to the weight of the material, wherein the material is selected from the group consisting of *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof.

17. The natural colorant of claim 2, wherein the amino acid is present in an amount of about 0.75-1.50% by weight relative to the weight of the material, wherein the material is huito fruit.

18. The natural colorant of claim 2, wherein the amino acid is present in an amount of from 0.25:1.0 to 4:1 molar ratio of the amino acid to the material, wherein the material is selected from the group consisting of genipin, purified genipin, and combinations of any thereof.

19. The natural colorant of claim 2, wherein the amino acid is selected from the group consisting of naturally derived amino acids, amino acids

derived from fermentation, synthetic amino acids, and combinations of any thereof.

20. The natural colorant of claim 2, wherein the amino acid is selected from the group consisting of isoleucine, L-isoleucine, lysine, L-lysine monohydrochloride, arginine, L-arginine base, glutamic acid, L-glutamic acid HCl, phenylalanine, L-phenylalanine, alanine, serine, glycine, arginine, glutamine, valine, leucine, methionine, asparagine, tyrosine, carnitine, taurine, and combinations of any thereof.

21. The natural colorant of claim 2, wherein the amino acid is selected from the group consisting of a combination of L-isoleucine and L-lysine monohydrochloride, a combination of isoleucine and lysine, and a combination of isoleucine and alanine.

22. The natural colorant of claim 21, wherein the amino acid is a blend of isoleucine and lysine ranging from 60-80% isoleucine and from 20-40% lysine.

23. The natural colorant of claim 21, wherein the amino acid is an about 70:30 (isoleucine:lysine) blend of isoleucine and lysine.

24. The natural colorant of claim 21, wherein the amino acid is a blend of isoleucine and alanine ranging from 70-90% isoleucine and from 10-30% alanine.

25. The natural colorant of claim 1 or claim 2, wherein the natural colorant has an L-value ranging from about 20 to about 55, an a-value ranging from about -2.0 to about 6.5, and a b-value ranging from about -20 to about 1, as measured using a Hunter colorimeter.

26. The natural colorant of claim 1 or claim 2, wherein the natural colorant has a CV of from about 0.04 to about 55.

27. The use of the natural colorant of claim 1 or claim 2 in an application selected from the group consisting of a food application, a beverage application, an animal food application, an oral care application including but not limited to toothpaste and mouthwash, a personal care application including but not limited to soap, shampoo, and fragrance, a cleaning supply application, and combinations of any thereof.

28. A process of making a natural colorant comprising:

mixing a primary amine containing compound to a material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivitatives, a genipin-containing compound, and combinations of any thereof, thus forming a blend; and

heating the blend, thus producing the natural colorant.

29. The process of making a natural colorant of claim 28, wherein the primary amine containing compound is selected from the group consisting of amino acids, derivatives of amino acids, methyl amine, gamma-Aminobutryic acid, polypeptides, proteins, and combinations of any thereof.

30. The process of claim 28, wherein the genipin-containing compound is selected from the group consisting of *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof.

31. The process of claim 28 or claim 29, wherein the material is in the form selected from the group consisting of whole fruit, fruit juice, fruit puree, fruit juice concentrate, dried powder from fruit, dried powder from juice, water-

insoluble parts of fruit, derivatives of any thereof, and combinations of any thereof.

32. The process of claim 29, wherein the amino acid is selected from the group consisting of isoleucine, L-isoleucine, lysine, L-lysine monohydrochloride, arginine, L-arginine base, glutamic acid, L-glutamic acid HCl, phenylalanine, L-phenylalanine, alanine, serine, glycine, arginine, glutamine, valine, leucine, methionine, asparagine, tyrosine, carnitine, taurine, and combinations of any thereof.

33. The process of claim 29, wherein the amino acid is the combination of amino acids selected from the group consisting of isoleucine and lysine, and isoleucine and alanine.

34. The process of claim 33, wherein the combination of amino acids comprises 60-80% isoleucine.

35. The process of claim 29, wherein the amino acid is present in an amount of at least 0.25% by weight relative to the weight of the material, wherein the material is selected from the group consisting of *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof.

36. The process of claim 29, wherein the amino acid is present in an amount of about 0.25-10% by weight relative to the weight of the material, wherein the material is selected from the group consisting of *Genipa americana*, fruits from close relatives of *Genipa americana*, and combinations of any thereof.

37. The process of claim 29, wherein the amino acid is present in an amount of about 0.75-1.50% by weight relative to the weight of the material, wherein the material is huito fruit.

38. The process of claim 29, wherein the amino acid is present in an amount of from 0.25:1 to 4:1 molar ratio of the amino acid to the material, wherein the material is selected from the group consisting of genipin, purified genipin, and combinations of any thereof.

39. The process of claim 28 or claim 29, wherein the heating the blend is carried out at about 20°C to about 60°C.

40. The process of claim 28 or claim 29, wherein the heating the blend is carried out at about 35°C to about 45°C.

41. The process of claim 28 or claim 29, further comprising processing the material before adding the amino acid.

42. The process of claim 41, wherein the processing the material further comprises an action selected from the group consisting of chopping, blending, blending with water, mashing, extracting juice, milling, filtering, pressing, heating, drying, and combinations of any thereof.

43. The process of claim 28 or claim 29, further comprising filtering the blend, resulting in a permeate.

44. The process of claim 43, wherein the filtering the blend further comprises passing the blend through a membrane with a molecular weight cutoff of 5,000 Daltons or less.

45. The process of claim 28 or claim 29, further comprising heating the blend a second time.

46. The process of claim 45, wherein the heating the blend a second time is carried out at a temperature of from about 10°C to about 100°C.

47. The process of claim 45, wherein the heating the blend a second time is carried out at a temperature of about 50-80°C.

48. The process of claim 28 or claim 29, further comprising concentrating the natural colorant.

49. The process of claim 28 or claim 29, further comprising adding water to the group consisting of the amino acid, the material, the natural colorant, and combinations of any thereof.

50. The process of claim 28 or claim 29, further comprising adding an enzyme to the blend.

51. The process of claim 50, wherein the enzyme is β-glucosidase.

52. The process of claim 28 or claim 29, further comprising adjusting the pH of the natural colorant.

53. The process of claim 52, wherein the adjusting the pH of the natural colorant is achieved by adding a compound selected from the group consisting of a base, an acid, and combinations of any thereof to the natural colorant.

54. The process of claim 52, wherein the adjusting the pH of the natural colorant occurs at a time selected from the group consisting of after the amino acid is added, after heating, and combinations of any thereof.

55. The process of claim 52, wherein the adjusting the pH of the natural colorant occurs continuously throughout the process.

56. The process of claim 43, wherein the permeate is mixed with a component selected from the group consisting of the material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivitatives, the genipin-containing compound; the primary amine containing compound; the blend; and combinations of any thereof.

57. The process of claim 28 or claim 29, wherein the process is performed in aerobic conditions.

58. A process of producing a desired color of a natural colorant comprising:

mixing a first amino acid and a second amino acid with a material selected from the group consisting of genipin, purified genipin, pre-genipin compounds, iridoid compounds, genipin derivitatives, a genipin-containing substance, and combinations of any thereof.

59. The process of claim 58, further comprising adjusting a ratio of the first amino acid to the second amino acid to achieve the desired color.

60. The process of claim 58, wherein the first amino acid and the second amino acid are each independently selected from the group consisting of isoleucine, L-isoleucine, lysine, L-lysine monohydrochloride, arginine, L-arginine base, glutamic acid, L-glutamic acid HCl, phenylalanine, L-phenylalanine, alanine, serine, glycine, arginine, glutamine, valine, leucine, methionine, asparagine, tyrosine, carnitine, taurine, and combinations of any thereof.

61. The process of claim 58, wherein the first amino acid and the second amino acid are each independently selected from group consisting of lysine, isoleucine, alanine, phenylalanine, serine, threonine, and combinations of any thereof, thus producing a blue color.

62. The process of claim 58, wherein the first amino acid is isoleucine and the second amino acid is lysine.

63. The process of claim 62, wherein increasing the amount of isoleucine produces a blue color with green notes.

64. The process of claim 62, wherein increasing the amount of lysine produces a blue color with purple notes.

65. The process of claim 58, wherein the ratio of the first amino acid to the second amino acid is from about 70:30 to about 90:10.

66. The process of claim 62, wherein the ratio of isoleucine to lysine is about 70:30 (isoleucine:lysine).

67. The process of claim 65, wherein the first amino acid is isoleucine and the second amino acid is alanine.

68. The process of claim 58, wherein an additional amino acid is mixed with the first amino acid and the second amino acid.

69. The process of claim 68, wherein the additional amino acid is selected from the group consisting of lysine, isoleucine, alanine, phenylalanine, serine, threonine, glutamic acid, glycine, arginine, glutamine, valine, leucine,

methionine, asparagine, tyrosine, aspartic acid, cysteine, histidine, proline, tryptophan, derivatives of any thereof, and combinations of any thereof.

70. A product produced by the process of claim 28 or claim 58.

71. A process of reducing a compound selected from the group consisting of a primary amine containing compound, an amino acid, genipin, and combinations of any thereof in a natural colorant comprising: the process of claim 43; concentrating the permeate; and passing the permeate through diafiltration, thus resulting in a colorant substantially free of unreacted primary amino containing compounds and genipin.

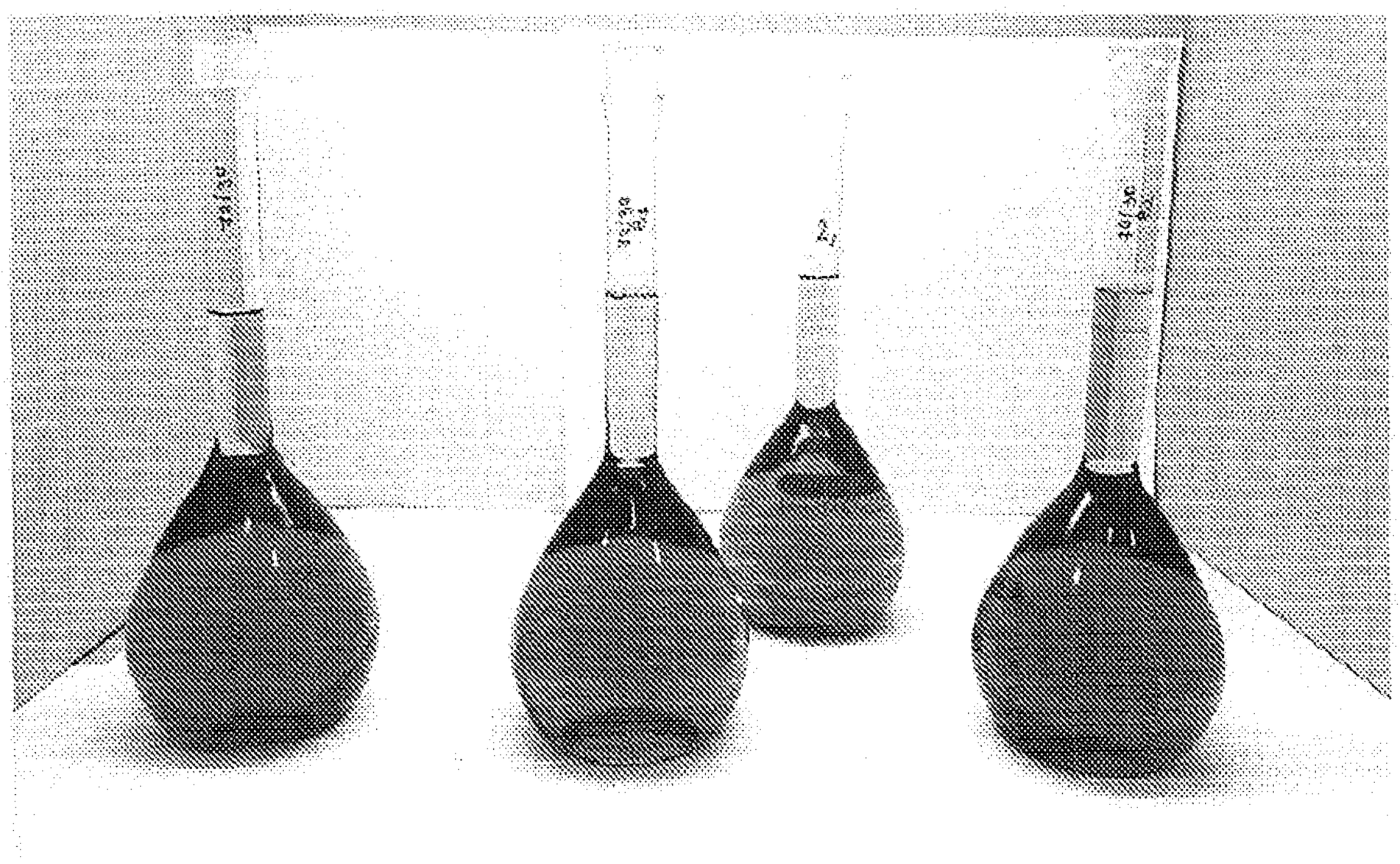


Fig. 1

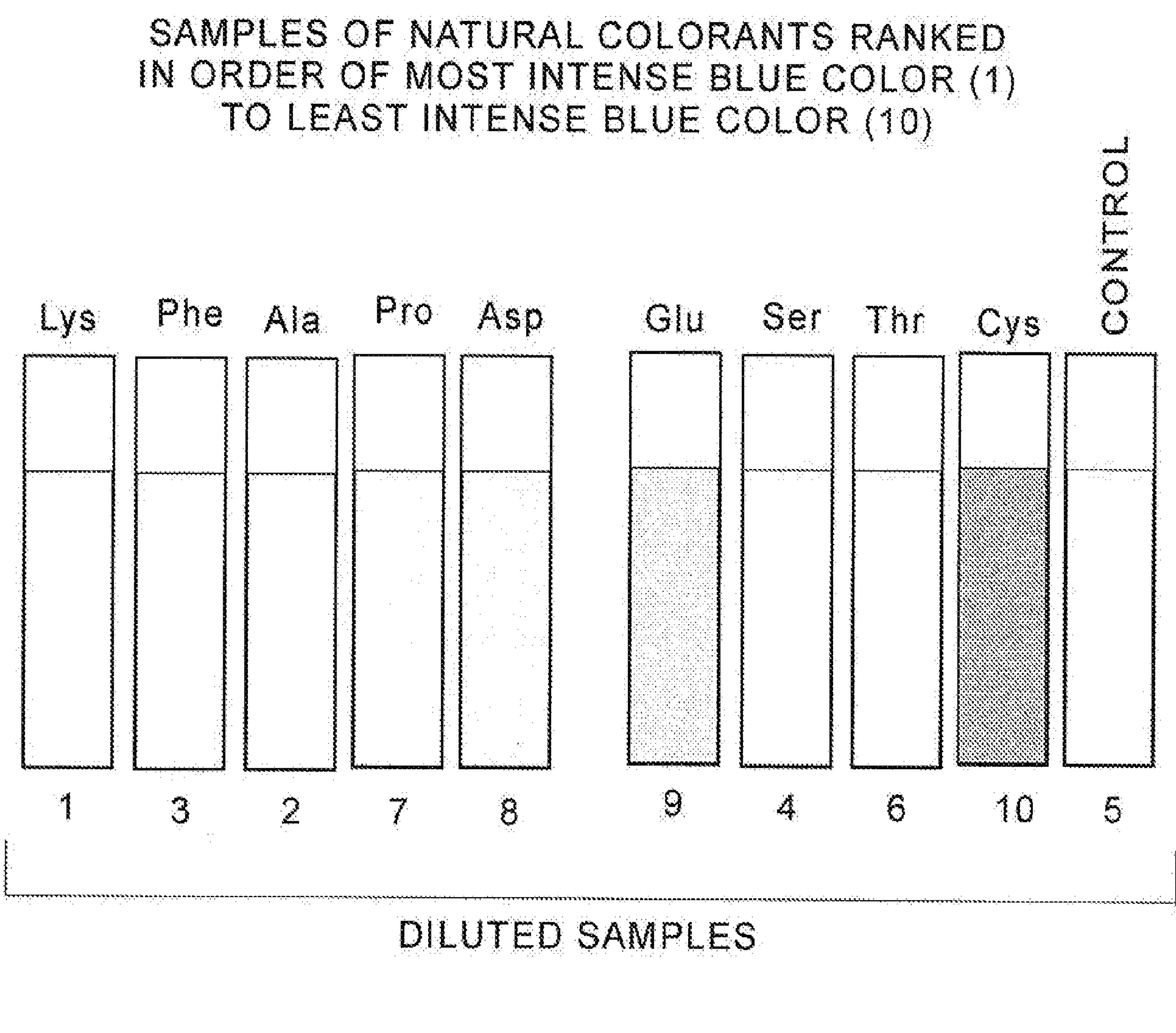

SAMPLES OF NATURAL COLORANTS RANKED
IN ORDER OF MOST INTENSE BLUE COLOR (1)
TO LEAST INTENSE BLUE COLOR (10)
Lys
Phe
Ala
Pro
Asp
Glu
Ser
Thr
Cys
CONTROL
1
3
2
7
8
9
4
6
10
5
DILUTED SAMPLES

Fig. 2

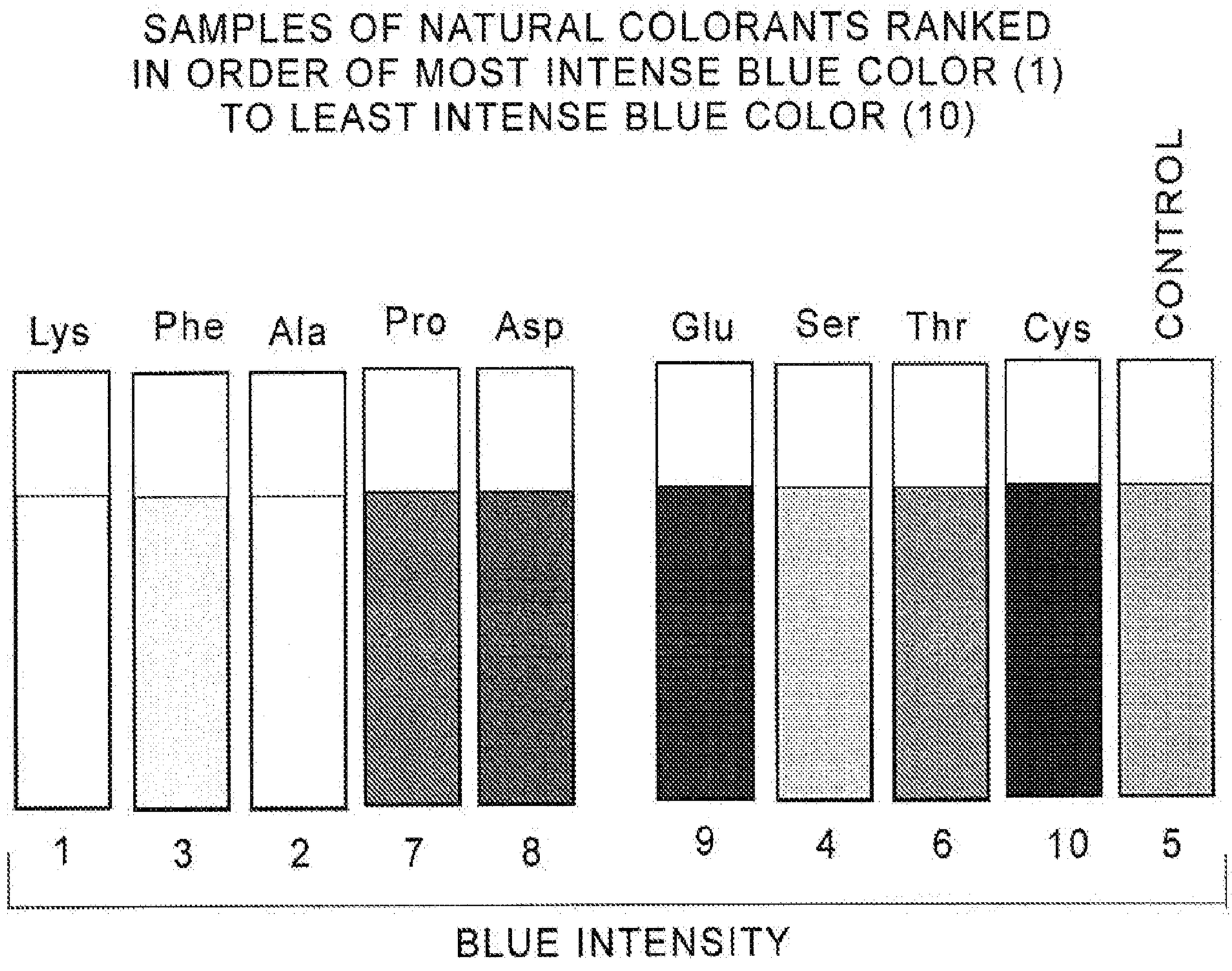

SAMPLES OF NATURAL COLORANTS RANKED
IN ORDER OF MOST INTENSE BLUE COLOR (1)
TO LEAST INTENSE BLUE COLOR (10)
Lys
Phe
Ala
Pro
Asp
Glu
Ser
Thr
Cys
CONTROL
1
3
2
7
8
9
4
6
10
5
BLUE INTENSITY

Fig. 3

A PROCESS FLOW CHART FOR MAKING NATURAL COLORANTS ACCORDING TO PROCESSES OF THE PRESENT INVENTION

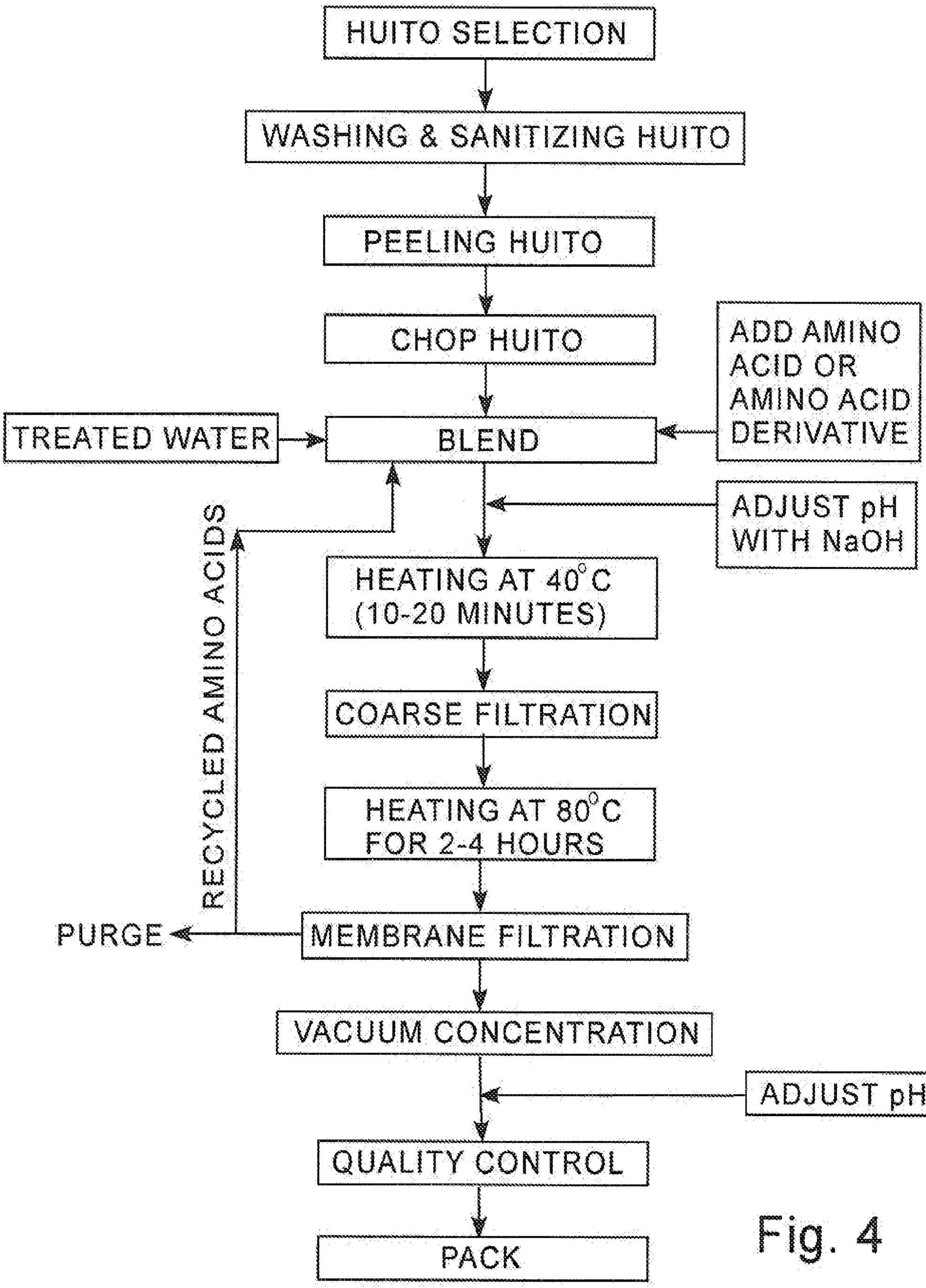


Fig. 4

COMPARISON OF SAMPLES OF NATURAL COLORANTS MADE WITHOUT AND WITH RECYCLED PERMEATE

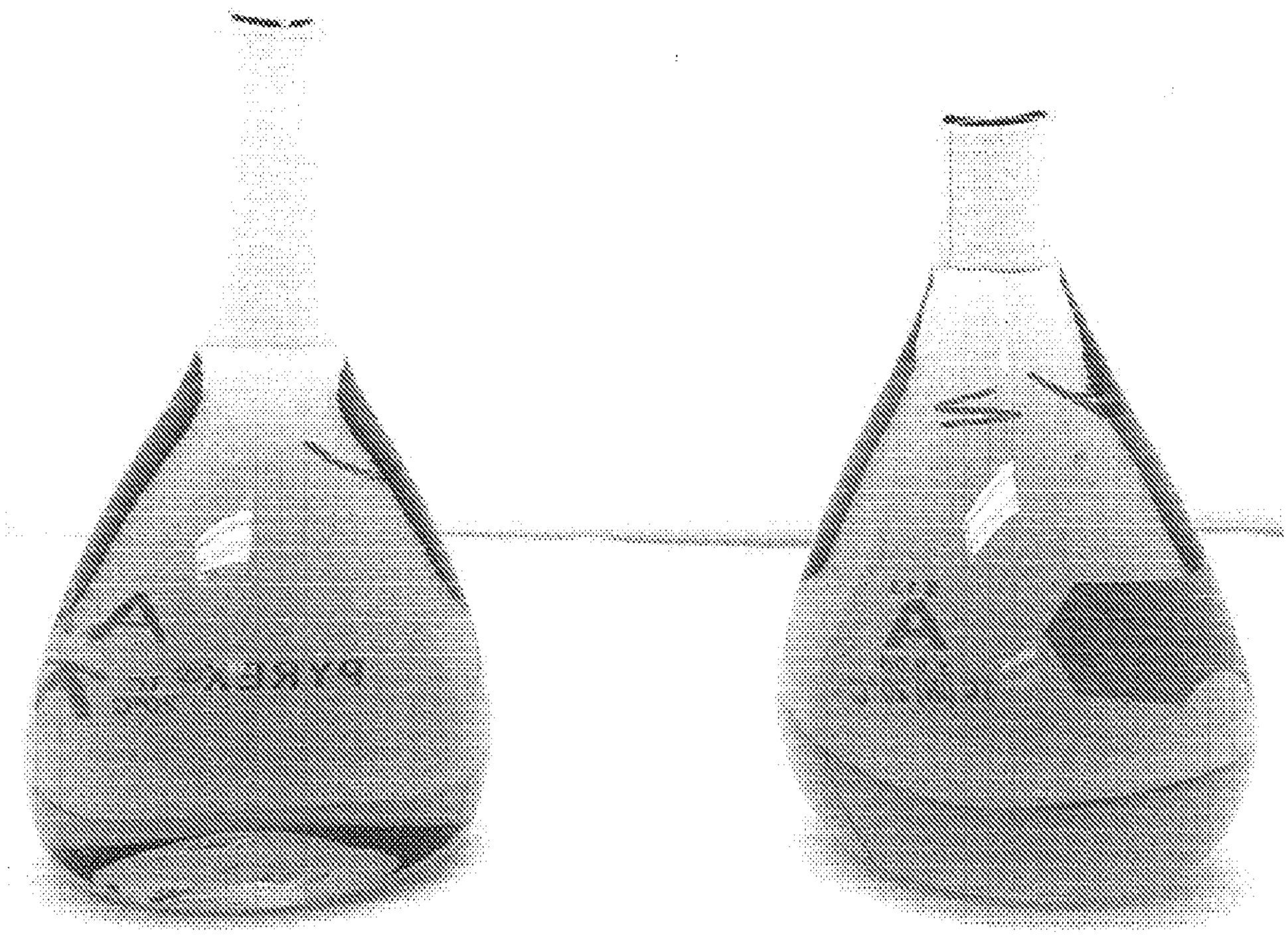


Fig.5

BLUE COLORANTS OBTAINED BY METHODS OF THE PRESENT INVENTION, RANKED FROM MOST VIBRANT BLUE COLOR ON THE RIGHT, IN ORDER FROM LEFT TO RIGHT: COLORANTS CONTAINING ISOLEUCINE, METHIONE, ALANINE, GLUTAMINE, PHENYLALANINE, ASPARGINE, SERINE, AND PROLINE

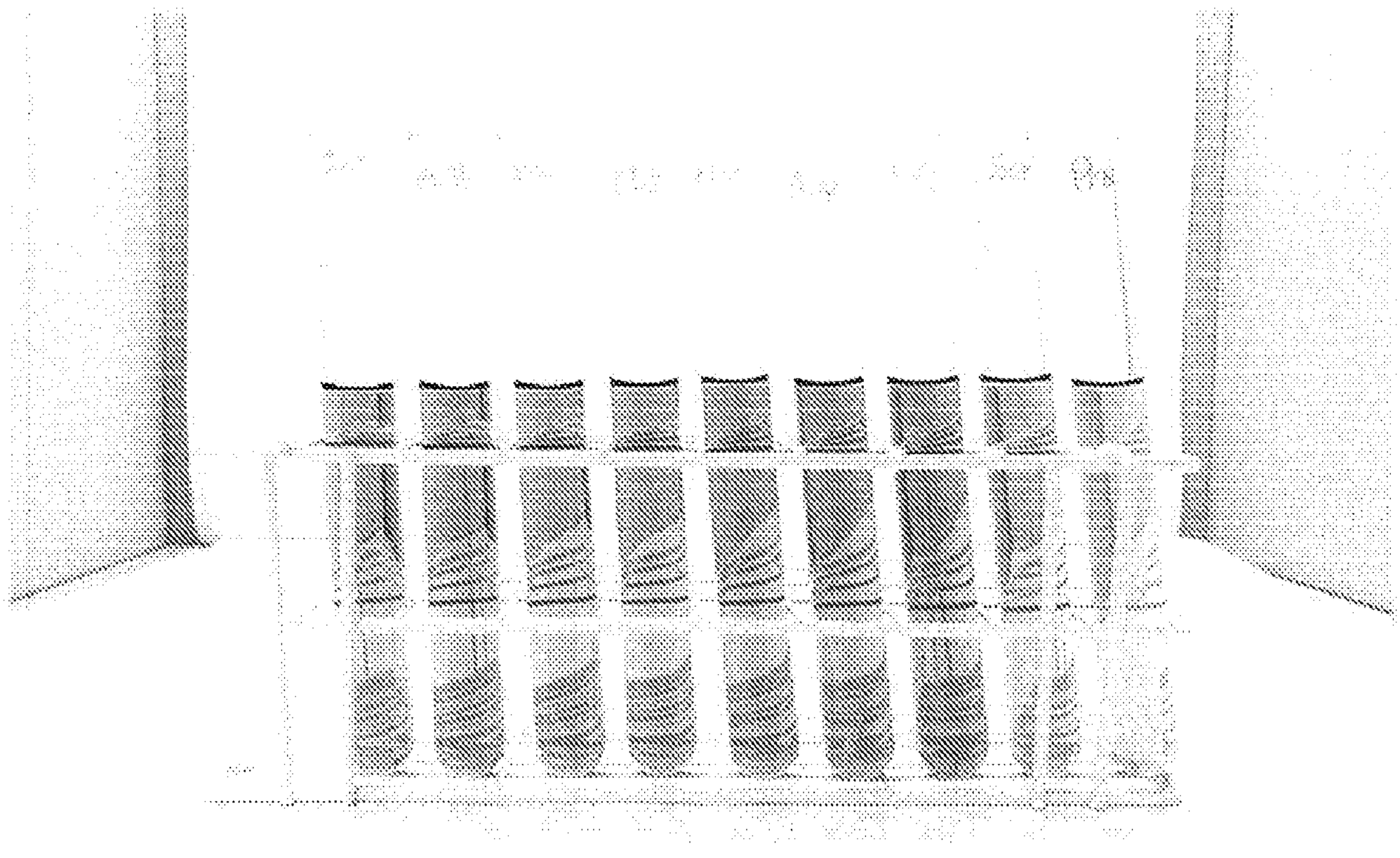


Fig. 6

COMPARISON OF CONTROL AND PURIFIED COLORANTS

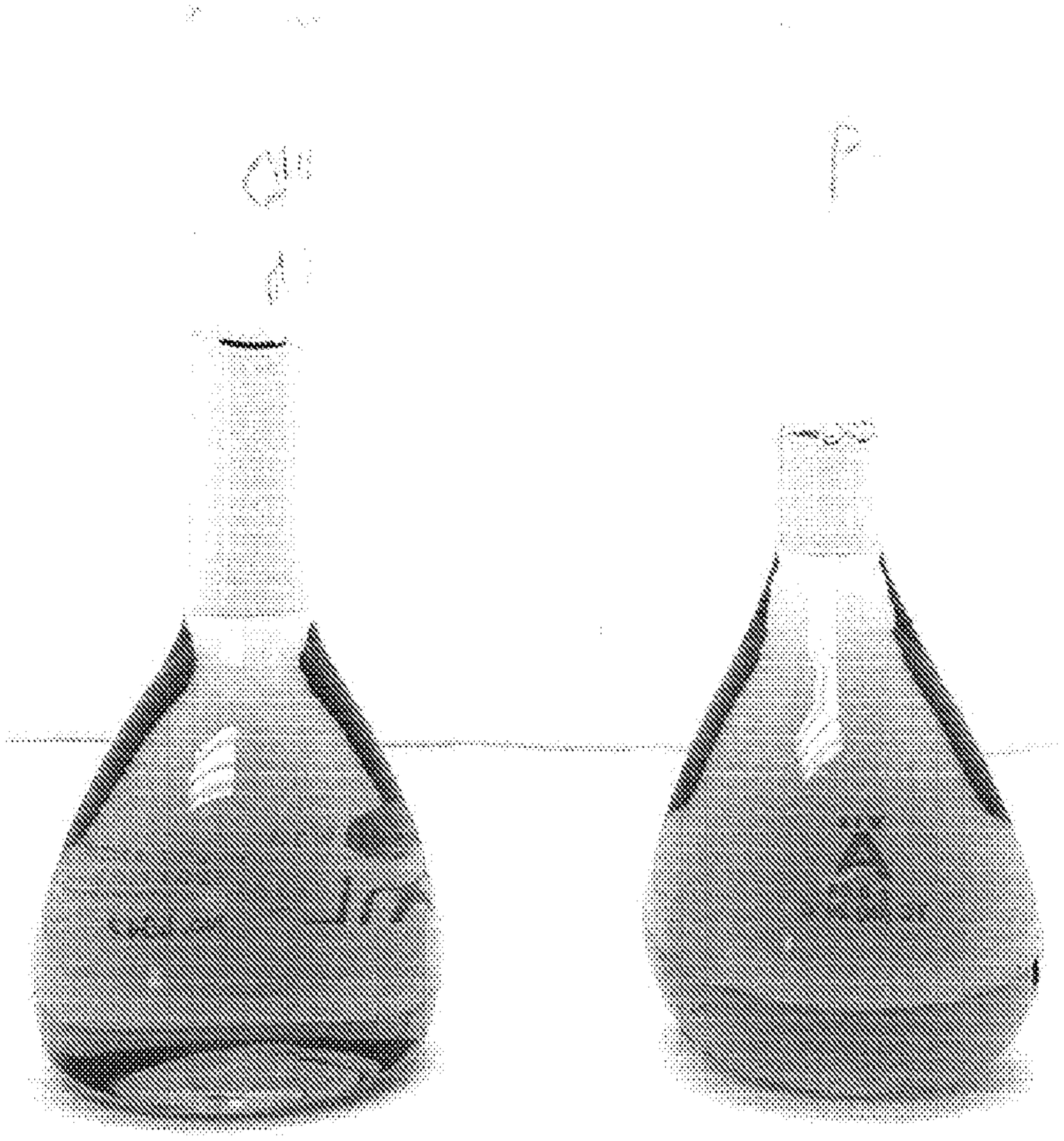


Fig. 7

A PROCESS FLOW CHART FOR MAKING NATURAL COLORANTS ACCORDING TO PROCESSES OF THE PRESENT INVENTION

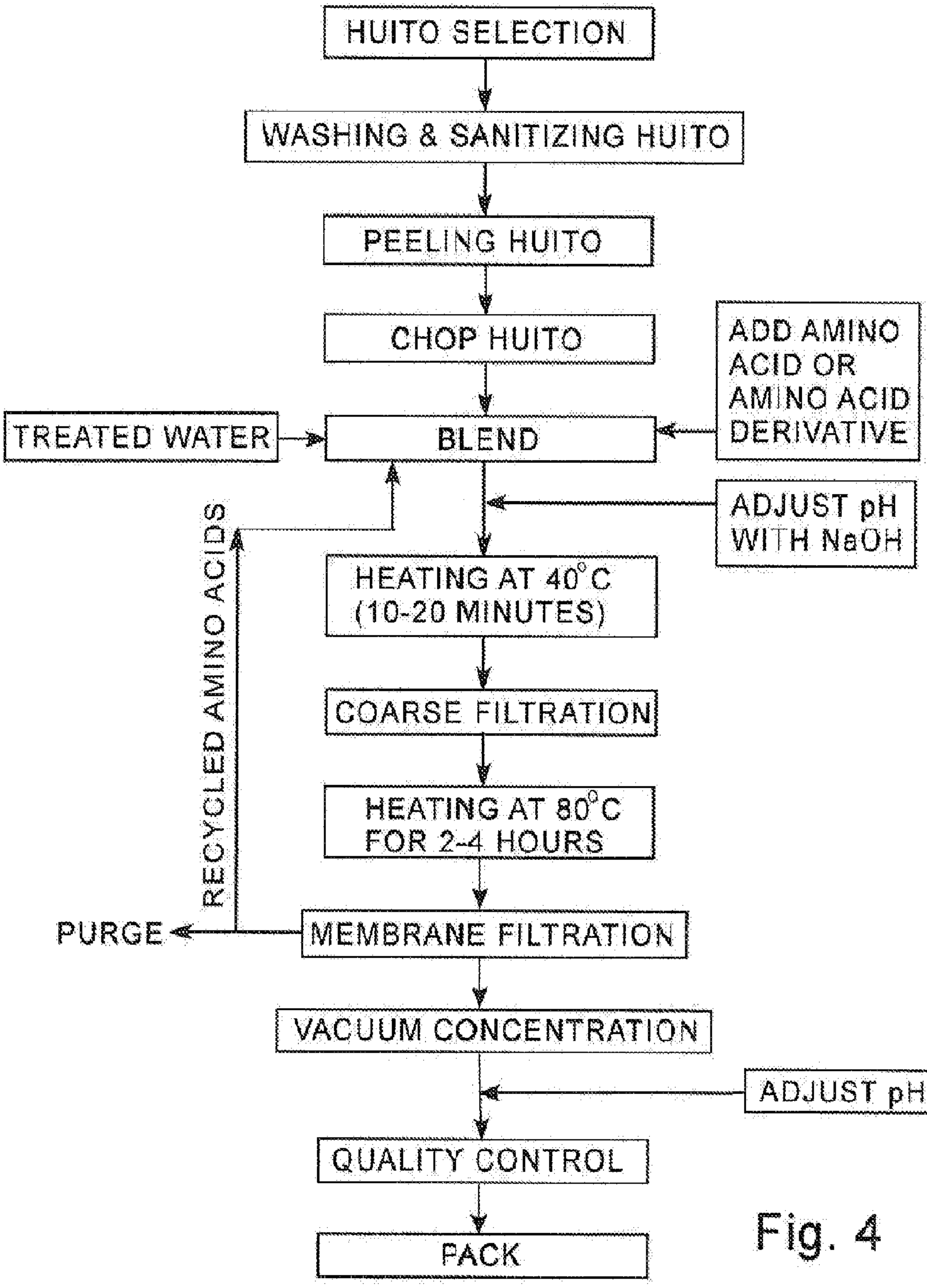


Fig. 4