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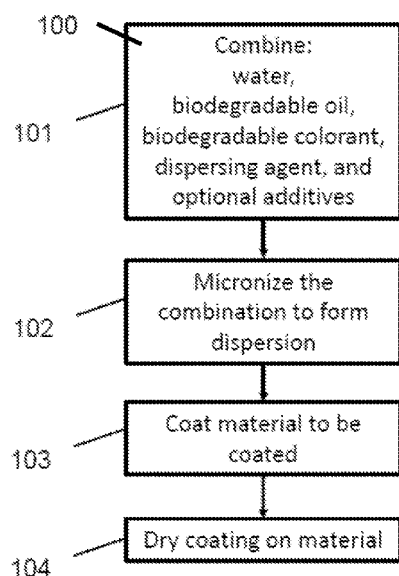


FIG. 1A

(57) Abstract: Aqueous-based biodegradable colorant coating dispersions, and methods for their use, are disclosed. The dispersions can include a colorant phase, a continuous aqueous phase, and a dispersing agent. The colorant phase can be dispersed in the continuous aqueous phase and can include a biodegradable oil and a biodegradable colorant.

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AQUEOUS-BASED BIODEGRADABLE COATING COMPOSITION

CROSS REFERENCE TO RELATED PATENT APPLICATIONS

[0001] This application claims the benefit of priority of U.S. Provisional Patent Application No. 62/513,541 filed June 1, 2017, the entire content of which is hereby
5 incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

A. Field of the Invention

[0002] The invention generally concerns an aqueous-based biodegradable colorant coating dispersion, which can be used to coat edible (*e.g.*, foods, pills, tablets, *etc.*) and non-
10 edible (*e.g.*, fertilizer particles/granules) materials. The dispersion can include a colorant phase dispersed in a continuous aqueous phase, where the colorant phase includes a biodegradable oil and a biodegradable colorant. Such a coating dispersion can produce a coating that is highly uniform in color and stable when dried on a surface.

B. Description of Related Art

15 [0003] Coating of granules, tablets, and pellets is an essential step in many applications such as those used in the food, agricultural, veterinary, pharmaceutical, crop-protections, plant growth regulator, flavoring agent, and cattle feed industries. For instance, in the cattle feed industry, various granular and pellet cattle feed formulations are coated to improve flowability, to improve visual appearance, and/or to add nutrients, vitamins, hormones,
20 medicines, antibiotics, flavors, *etc.* Fertilizers and pesticides, in either granular, pelleted, or tableted form, are coated for a variety of reasons (*e.g.*, to mask color variations between batches, to provide branding by color, to identify or distinguish quality or type by color, to help differentiate by the presence of a color the areas where the fertilizers or pesticides have been applied, to retain the integrity of the granule, pellet, or tablet during storage and
25 handling, to add additional fertilizers, nutrients, plant growth regulators, pesticides, and/or fungicides, and for the safety of those handling and applying the fertilizer and/or pesticide). Crop seeds are coated to protect against moisture, to add color to identify the quality, type, supplier, *etc.*, and to add pesticides to protect both the seed itself and the seedling that grows from the seed.

[0004] However, many commercially available colorants for use in colorant coatings are non-biodegradable, toxic, non-edible, environmentally damaging, overly intense or not intense enough in color, and/or expensive. Further, inorganic color coatings, including oxides and sulfides (*e.g.*, iron oxide, chromium oxide, titanium oxides, etc.) can be toxic, can suffer from low color strength, and/or can require high concentrations to provide an acceptable color intensity. Notably, many food colorants approved by the United States Federal Food, Drug, and Cosmetic Act (FD&C) are non-biodegradable, highly color intense, synthetic, and/or toxic to environment.

[0005] In addition, to the problems associated with current colorants, the carriers, solvents, base ingredients, and other additives of many commercial coatings are also non-biodegradable, harmful, non-edible, and/or expensive. These materials include: synthetic polymers such as hydroxypropylmethylcellulose (HPMC), polyvinylpyrrolidone (PVP), or methyl cellulose; mineral oil; petroleum products such as used fuels; and high amounts of mixtures of vegetable oil and one or more of paraffin oil, mineral oil, or synthetic derivative thereof such as esters and isocyanates. In addition, synthetic polymers, which can be expensive, can also require additional auxiliary coatings to prevent the polymers from becoming hard and cracking or chipping out over time.

[0006] There are several examples of colorant coating compositions that suffer from the above noted problems. For instance, U.S. Publication No. 2005/0187323 discloses a colorant coating for fertilizers that uses synthetic colorants in an oil base. U.S. Patent No. 5,968,222 discloses oil-based colorant coatings that contain no more than 10 wt. % of water. The use of additional water is avoided to ensure that the resulting colorant coating has an acceptable viscosity during application. U.S. Patent No. 9,090,517 and U.S. Patent No. 7,452,399 each disclose the use of a polyurethane polymer in coatings that can also contain a colorant. U.S. Patent No. 3,321,298 teaches the use of a coating that is essentially tung oil and can contain colorants. WO 1997019030 A1 discloses colorants in oils or oil containing polymers, and WO 2013096040 A1 discloses the use of colorants in a sealing coating that is water insoluble.

[0007] As illustrated above, the current colorant coating compositions are generally oil-based in that they have a continuous oil phase. While these oil-based coatings can be efficient at solubilizing lipophilic colorants, they can be costly to produce and can require the use of additional processing steps to efficiently coat materials. Further, the currently available coating compositions are not environmentally friendly, as they typically include a

significantly high amount of non-biodegradable, harmful, and/or non-edible coating materials. For example, many of the currently available coating compositions use non-biodegradable and/or toxic colorants.

SUMMARY OF THE INVENTION

5 **[0008]** A solution has been discovered to at least some of the aforementioned problems associated with currently available colorant coating compositions. The solution is premised on the development of an aqueous-based biodegradable colorant coating dispersion that contains a biodegradable oil, a biodegradable colorant, and a dispersing agent. In particular, the dispersion is structured such that a colorant phase having the biodegradable colorant and
10 the biodegradable oil is dispersed in a continuous aqueous phase. This structure allows for the solubility of the lipophilic colorant in the biodegradable oil while also taking advantage of the presence of large amounts of water in the continuous phase. Without wishing to be bound by theory, it is believed that the continuous aqueous phase can act as a penetrating agent such that the biodegradable colorant more efficiently attaches to the surface of the material by
15 having the colorant at least partially penetrate the material's surface. This can result in an evenly coated material, both on the material's surface and just beneath the surface. Even further, the use of high amounts of water in the dispersions of the present invention are believed to increase the overall volume of the dispersions such that a lower amount of biodegradable colorant is needed to coat a given surface. Ultimately, the dispersions of the
20 present invention can provide for a coating that is comparatively easier to handle and apply to materials when compared with oil-based coatings. Further, the coating compositions of the present invention, once applied to a given material to be coated and dried, results in a highly uniform color coating that can remain color stable during long term storage. Still further, the aqueous-based colorant coating dispersions of the present invention are more
25 environmentally friendly and safer to use when compared with their oil-based counterparts.

[0009] Another advantage of the presence of the continuous aqueous phase is that water soluble additives can be included in the aqueous phase, which can result in the water soluble additives being carried into the interior volume of the material. This is especially beneficial for water soluble additives that are sensitive to the processing conditions associated with
30 production of the material to be coated, such as fertilizers. For example, additives can be added after the granulation of fertilizers.

[0010] In one aspect of the present invention, an aqueous-based biodegradable colorant coating dispersion is disclosed that contains a biodegradable oil, a biodegradable colorant, and a dispersing agent. In some instances, the colorant coating dispersion is edible. In some instances, the colorant coating dispersion comprises edible ingredients. In some instances, the colorant coating dispersion comprises food grade ingredients. The aqueous-based biodegradable colorant coating dispersion can have a biodegradable colorant homogenously dispersed in the dispersion. The biodegradable oil and the biodegradable colorant can comprise a colorant phase. The colorant phase can be homogenously dispersed in a continuous aqueous phase. The colorant phase can be dispersed as droplets. The droplets can have a mean diameter of less than 100, 50, 20, 10, 5, or 1 microns (μm). The biodegradable colorant can be homogenously dispersed in the colorant phase.

[0011] The biodegradable oil can be one or more biodegradable oil(s). The biodegradable oil can be a plant and/or animal based oil. In some instances, the biodegradable oil is a plant based oil. In a preferred embodiment, the plant based oil is a vegetable oil. In some instances, the vegetable oil is a palm kernel oil. In some instances, the biodegradable oil is edible. In some instances, the biodegradable oil is a food grade oil. In some instances, the colorant coating does not contain paraffin oil and/or mineral oil.

[0012] The biodegradable colorant can be a single colorant or a combination of different biodegradable colorants. The biodegradable colorant can be a natural colorant, derivative thereof, or a combination thereof. A natural colorant is one that can be obtained or derived from plants (*e.g.*, roots, berries, barks, leaves, woods, *etc.*), animals, insects, bacteria, protozoa, or fungus, or minerals. Non-limiting examples of such natural colorants include natural indigo blue, chlorophyll, and/or natural turmeric. In some instances, the biodegradable colorant can be keto and/or enol forms of curcumin. In some instances, the biodegradable colorant can be turmeric powder extract, (delta-2,2'-biindole)-3,3'-dione, and/or indigo carmine of the oxoindoline family/derivatives. The biodegradable colorant can be edible. In some instances, the biodegradable colorant is a food grade colorant.

[0013] The dispersing agent can be a surfactant or emulsifier or a combination of surfactants and/or emulsifiers. The dispersing agent can be biodegradable and/or ingestible/edible. In some instances, the dispersing agent is a food grade dispersing agent. In some instances, the dispersing agent can be sodium dodecyl sulfate, monoglycerides of fatty

acids, diglycerides of fatty acids, monoesters of fatty acids, diesters of fatty acids, lecithin, etc.

[0014] The aqueous-based biodegradable colorant coating dispersion of the present invention can contain additional ingredients. The additional ingredients can include a preservative, insecticide, fungicide, flavor, fragrance, micronutrient, fertilizer, plant growth agent, nutrient, secondary nutrient, trace element, plant protection agent, filler, etc., or combination thereof. In some instances, the colorant coating does not contain an additional ingredient. In some instances, the colorant coating does not contain a preservative, insecticide, fungicide, flavor, fragrance, micronutrient, fertilizer, plant growth agent, nutrient, secondary nutrient, trace element, plant protection agent, filler, etc.

[0015] The aqueous-based biodegradable colorant coating dispersion of the present invention can contain the components therein at any concentration, ratio, percent by weight, percent by volume, etc. In some instances, the colorant coating contains at least 90 wt. %, at least 95 wt. %, at least 98 wt. %, or 98 wt. %, or any range therein of water compared to the total weight of the colorant coating dispersion. In some instances, the colorant coating contains 5 to 0.001 wt. %, 3 to 0.1 wt. %, 2 to 0.5 wt. %, 2.5 to 0.01 wt. %, 2 to 0.1 wt. %, 1.5 to 0.5 wt. %, 1 wt. %, or any range therein of biodegradable oil compared to the total weight of the colorant coating dispersion. In some instances, the colorant coating contains 2.5 to 0.0001 wt. %, 2 to 0.0001 wt. %, 1 to 0.001 wt. %, 2 to 0.001 wt. %, 1 to 0.005 wt. %, 0.5 to 0.01 wt. %, 0.01 wt. %, or any range therein of a dispersing agent compared to the total weight of the colorant coating dispersion. In some instances, the colorant coating contains 2.5 to 0.0001 wt. %, 2 to 0.0001 wt. %, 1 to 0.001 wt. %, 2 to 0.001 wt. %, 1 to 0.005 wt. %, 0.5 to 0.01 wt. %, 0.5 wt. %, 0.4 wt. %, 0.3 wt. %, 0.2 wt. %, 0.1 wt. %, 0.05 wt. %, 0.01 wt. % or any range therein of the biodegradable colorant compared to the total weight of the colorant coating dispersion.

[0016] In one aspect of the present invention, the aqueous-based biodegradable colorant coating dispersion can contain: at least 95 wt. % water; 0.5 to 1.5 wt. % of the biodegradable oil, wherein the biodegradable oil is a plant based oil, preferably a vegetable oil, more preferably palm kernel oil; 0.01 to 0.75 wt. % of the biodegradable colorant, wherein the biodegradable colorant comprises a natural colorant, a derivative thereof, or a combination thereof; and 0.005 to 0.5 wt. % of the dispersing agent, wherein the dispersing agent is at least one of a biodegradable surfactant, an ingestible surfactant, or a combination thereof,

wherein the wt. % is based on the weight of the colorant coating dispersion. In some instances, the biodegradable oil and biodegradable colorant are contained in a colorant phase that is dispersed in an aqueous phase, the colorant phase being dispersed as droplets having a mean diameter of less than 20 microns (μm), preferably 1 μm to less than 20 μm .

5 **[0017]** In another aspect, a concentrated biodegradable colorant coating composition can be formulated that is capable of being added to water to form the aqueous-based biodegradable colorant coating dispersion. The concentrated biodegradable colorant coating composition can contain all of the ingredients of the aqueous-based biodegradable colorant coating dispersions of the present invention, but with a decreased amount of water. In one
10 non-limiting instance, the concentrated biodegradable colorant coating composition contains 50% of the biodegradable oil, 0.5% of the dispersion agent, and 0.5% to 25% of the biodegradable colorant by weight of the concentrated biodegradable colorant coating composition. In this instance, the concentrated biodegradable colorant coating composition can be diluted 1:50 in water to provide an aqueous-based biodegradable colorant coating
15 dispersions that can then be directly coated onto a material. The concentrated biodegradable colorant coating composition can be formulated for the purpose of being diluted at any ratio in water, including 1:1.5 to 1:100 and any range therein. The concentrations of the ingredients in the concentrated biodegradable colorant coating composition can be based on the desired amount of dilution in water and the desired concentration of the ingredients in the
20 aqueous-based biodegradable colorant coating dispersion produced by the addition of water.

[0018] In another aspect of the present invention, there is disclosed a material that has at least a portion of its surface coated with the aqueous-based biodegradable colorant coating dispersion of the present invention. The aqueous-based biodegradable colorant coating dispersion can be dried on the material. When dried, substantially all of the water has been
25 removed from the dispersion (e.g., less than 10 wt. % or less than 5 wt. %, or less than 1 wt. % or 0 wt. % water remains in the dried dispersion). The coated material can be homogeneously colored by the dried colorant coating such that the biodegradable colorant is evenly coated on the surface of the material. In some instances, the biodegradable colorant can be so evenly coated on the surface of the material that separate dried droplets are visually
30 indistinguishable from each other.

[0019] The material that is coated can be a food, seed, fertilizer, pesticide, plant growth regulator, pharmaceutical, nutraceutical, etc., or any combination thereof. The material can

be a granule, tablet, pellet, powder, pill, particle, etc. The coated material can be used in the food, agricultural, veterinary, pharmaceutical, crop-protections, plant growth regulator, flavoring agent, cattle feed industries, etc. or any combination thereof. In a preferred embodiment, the coated material is a fertilizer, pesticide, and/or plant growth regulator. In a preferred embodiment, the coated material is a food.

[0020] A coated material of the present invention can include a plurality of the coated materials. The coated material can also be a blend of the plurality of the coated materials that are mixed with other coated and/or uncoated materials. In some instances, the coated material is contained in a blended fertilizer composition. By way of example, a blended fertilizer composition of the present invention can be formulated into a quick release fertilizer. Alternatively, the blended fertilizer composition can be formulated into a slow-release fertilizer. In some instances, the blended fertilizer composition is formulated into a specialty fertilizer.

[0021] Also disclosed in the context of the present invention is a method of producing a aqueous-based biodegradable colorant coating dispersion. The method can include combining water, the at least one biodegradable oil, the at least one dispersing agent, and the at least one biodegradable colorant to form a combination. The method can further include micronizing the combination to form micronized droplets dispersed in a continuous aqueous phase, the micronized droplets comprising the at least one biodegradable oil. The method can include combining the at least one biodegradable oil and the at least one biodegradable colorant to form a colorant phase. The method can also include combining the colorant phase, the water, and the at least one dispersing agent to form a combination. The method can further include micronizing the colorant phase by homogenizing the combination at or above 6,000 rpm, 7,000 rpm, 8,000 rpm, 9,000 rpm, and/or 10,000 rpm for at least 5 minutes, 6 minutes, 7 minutes, 8 minutes, 9 minutes, and/or 10 minutes. In some instances, micronization can homogeneously disperse the biodegradable colorant, biodegradable oil, and/or colorant phase in a continuous aqueous phase. The micronization can form droplets of the biodegradable oil and/or colorant phase that have a mean diameter of less than 100, 50, 20, 10, 5, or 1 microns (μm). The processes disclosed herein may further include the step of adding one or more additional ingredients into the aqueous-based biodegradable colorant coating dispersion. The additional ingredient can be a preservative, insecticide, fungicide,

flavor, fragrance, micronutrient, fertilizer, plant growth agent, nutrient, secondary nutrient, trace element, plant protection agent, filler, etc.

[0022] Disclosed in the context of the present invention is a method of producing a coated material that is coated over at least a portion of its surface with the aqueous-based biodegradable colorant coating dispersion of the present invention and/or coated with an aqueous-based biodegradable colorant coating dispersion of the present invention that has been dried. The method can include contacting a material with a aqueous-based biodegradable colorant coating dispersion of the present invention. The method disclosed herein may further include the step of adding one or more additional ingredients into the coated material. The method disclosed herein may further include the step of drying the aqueous-based biodegradable colorant coating of the present invention onto the coated material and/or material to be coated. In one aspect of the present invention, a method of producing a fertilizer blend is disclosed. The method can include combining a fertilizer coated with the aqueous-based biodegradable colorant coating dispersion of the present invention and/or coated with a dried aqueous-based biodegradable colorant coating dispersion of the present invention with one or more of additional fertilizer(s), secondary nutrient(s), trace element(s), plant protection agent(s), and/or filler(s).

[0023] In one aspect of the present invention, disclosed is a method of fertilizing. The method can include applying a fertilizer composition comprising a fertilizer coated with an aqueous-based biodegradable colorant coating dispersion of the present invention and/or coated with a dried aqueous-based biodegradable colorant coating dispersion of the present invention to at least one of a soil, an organism, a liquid carrier, a liquid solvent, or a combination thereof.

[0024] Also disclosed are the following Embodiments 1 to 20 of the present invention. Embodiment 1 is an aqueous-based biodegradable colorant coating dispersion comprising: a colorant phase dispersed in a continuous aqueous phase, the colorant phase comprising: a biodegradable oil; and a biodegradable colorant; and a dispersing agent. Embodiment 2 is the colorant coating dispersion of Embodiment 1, wherein the colorant phase is dispersed as droplets having a mean diameter of less than 50 microns (μm), less than 20 μm , or less than 10 μm . Embodiment 3 is the colorant coating dispersion of any of Embodiments 1 to 2, comprising at least 90 wt. % of the continuous aqueous phase. Embodiment 4 is the colorant coating dispersion of any of Embodiments 1 to 3, comprising at least 90, 95, 97, or 98 wt. %

water. Embodiment 5 is the colorant coating dispersion of any of Embodiments 1 to 4, comprising 0.1 to 3, 0.5 to 2, or 0.5 to 1.5 wt. % of the biodegradable oil. Embodiment 6 is the colorant coating dispersion of any of Embodiments 1 to 5, comprising 0.001 to 2, 0.005 to 1, or 0.01 to 0.75 wt. % of the biodegradable colorant. Embodiment 7 is the colorant coating dispersion of any of Embodiments 1 to 6, comprising 0.001 to 2, 0.005 to 1, or 0.005 to 0.5 wt. % of the dispersing agent. Embodiment 8 is the colorant coating dispersion of any of Embodiments 1 to 7, wherein the biodegradable colorant comprises a natural colorant, a derivative thereof, or a combination thereof. Embodiment 9 is the colorant coating dispersion of any of Embodiments 1 to 8, wherein the biodegradable oil is a plant based oil. Embodiment 10 is the colorant coating dispersion of any of Embodiments 1 to 9, wherein the dispersing agent is at least one of a biodegradable surfactant, an ingestible surfactant, or a combination thereof. Embodiment 11 is the colorant coating dispersion of any of Embodiments 1 to 10, further comprising at least one of an insecticide, fungicide, flavor, fragrance, micronutrient, fertilizer, or a combination thereof. Embodiment 12 is the colorant coating dispersion of any of Embodiments 1 to 11, wherein the colorant coating dispersion is edible. Embodiment 13 is the colorant coating dispersion of any of Embodiments 1 to 12, comprising: at least 95 wt. % water; 0.5 to 1.5 wt. % of the biodegradable oil, wherein the biodegradable oil is a plant based oil, preferably a vegetable oil, more preferably palm kernel oil; 0.01 to 0.5 wt. % of the biodegradable colorant, wherein the biodegradable colorant comprises a natural colorant, a derivative thereof, or a combination thereof; and 0.005 to 0.5 wt. % of the dispersing agent, wherein the dispersing agent is at least one of a biodegradable surfactant, an ingestible surfactant, or a combination thereof; and wherein the colorant phase is dispersed as droplets having a mean diameter of less than 20 microns (μm). Embodiment 14 is the colorant coating dispersion of any of Embodiments 1 to 13, wherein the colorant coating dispersion does not contain paraffin oil or mineral oil. Embodiment 15 is a coated material comprising a dried colorant coating dispersion of any one of Embodiments 1 to 14. Embodiment 16 is the coated material Embodiment 15, wherein the material coated is a food, fertilizer, pesticide, or any combination thereof. Embodiment 17 is a method of coloring a material, the method comprising applying the colorant coating dispersion of any of Embodiments 1 to 14 onto the material. Embodiment 18 is the method of Embodiment 17, wherein the material is any one of a food, fertilizer, pesticide, or combination thereof. Embodiment 19 is the method of any one of Embodiments 17 to 18, further comprising drying the colored material. Embodiment 20 is the method of any of Embodiments 17 to 19,

wherein applying the colorant coating dispersion homogenously distributes the biodegradable colorant on the material.

[0025] The following includes definitions of various terms and phrases used throughout this specification.

- 5 **[0026]** The term “biodegradable” is defined as capable of being degraded by naturally occurring living organisms or through natural environmental conditions such as exposure to water, rain, sunlight, heat, cold, etc. Naturally occurring living organisms can include bacteria, fungus, plants, insects, animals, mammals, and/or humans.

- 10 **[0027]** The term “natural” is defined as capable of being found in nature and/or not having undergone any chemical process that would not occur in nature. In some instances, a natural material is of plant or animal origin and has not undergone chemical treatment. A natural colorant is one that can be obtained or derived from nature such as plants (*e.g.*, roots, berries, barks, leaves, woods, *etc.*), animals, bacteria, protozoa, fungus, or minerals.

- 15 **[0028]** The term “food grade” is defined as a material that is suitable for ingestion by a human. The requirements for determining if a material is food grade can be determined by any industry, local, national, or international standard, such as the standards found in the Food Chemicals Codex (FCC).

- 20 **[0029]** The term “fertilizer” is defined as a material applied to soils or to plant tissues to supply one or more plant nutrients essential or beneficial to the growth of plants and/or stimulants or enhancers to increase or enhance plant growth. Non-limiting examples of fertilizers include materials having one or more of urea, ammonium nitrate, calcium ammonium nitrate, one or more superphosphates, binary NP fertilizers, binary NK fertilizers, binary PK fertilizers, NPK fertilizers, molybdenum, zinc, copper, boron, cobalt, and/or iron. In some aspects, fertilizers include agents that enhance plant growth and/or enhance the
25 ability for a plant to receive the benefit of a fertilizer, such as, but not limited to biostimulants, urease inhibitors, and nitrification inhibitors. In some particular instances, the fertilizer is urea such as urea granules.

[0030] The term “micronized” is defined as material having a mean diameter of at most 200 microns, and preferably 1 to 200 microns. In some instances, solid and/or liquid material

can be micronized. The forming of a micronized material from a larger material can be referred to herein as micronizing.

[0031] The terms “about”, “approximately”, and “substantially” are defined as being close to, as understood by one of ordinary skill in the art. In one non-limiting instance, the terms are defined to be within 10%, preferably, within 5%, more preferably, within 1%, and most preferably, within 0.5%.

[0032] The terms “wt.%,” “vol.%,” or “mol.%” refers to a weight, volume, or molar percentage of a component, respectively, based on the total weight, the total volume, or the total moles of material that includes the component. In a non-limiting example, 10 grams of a component in 100 grams of the material that includes the component is 10 wt.% of component.

[0033] The use of the words “a” or “an” when used in conjunction with any of the terms “comprising,” “including,” “containing,” or “having” in the claims or the specification may mean “one,” but it is also consistent with the meaning of “one or more,” “at least one,” and “one or more than one.”

[0034] The words “comprising” (and any form of comprising, such as “comprise” and “comprises”), “having” (and any form of having, such as “have” and “has”), “including” (and any form of including, such as “includes” and “include”), or “containing” (and any form of containing, such as “contains” and “contain”) are inclusive or open-ended and do not exclude additional, unrecited elements or method steps.

[0035] The process of the present invention can “comprise,” “consist essentially of,” or “consist of” particular ingredients, components, compositions, *etc.*, disclosed throughout the specification. With respect to the transitional phase “consisting essentially of,” in one non-limiting aspect, a basic and novel characteristic of the aqueous-based biodegradable colorant coating dispersions of the present invention are that the dispersions are water-based and can include a biodegradable oil(s) and/or colorant(s). Once dried on a material, this can result in a biodegradable coating that is highly uniform in color and is stable during storage (*e.g.*, shelf storage) for products that have been color coated with the dispersions of the present invention).

[0036] Other objects, features and advantages of the present invention will become apparent from the following figures, detailed description, and examples. It should be understood, however, that the figures, detailed description, and examples, while indicating specific embodiments of the invention, are given by way of illustration only and are not meant to be limiting. Additionally, it is contemplated that changes, combinations, and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0037] Advantages of the present invention may become apparent to those skilled in the art with the benefit of the following detailed description and upon reference to the accompanying drawings.

[0038] **FIGS. 1A-1B** – (**FIG. 1A**) is a schematic diagram depicting an exemplary method of producing a non-limiting embodiment of an aqueous-based biodegradable colorant coating dispersion and a colorant coating of the present invention. (**FIG. 1B**) is a non-limiting representation of a material coated by a colorant coating of the present invention.

[0039] **FIG. 2** – is an image of urea granules that are uncoated and that are coated with an aqueous-based dispersion of the present invention that has been dried on the granules. From left to right: uncoated urea; urea coated using an aqueous-based biodegradable colorant coating dispersion that contained 0.25 wt. % indigo by weight of the colorant coating dispersion; urea coated using an aqueous-based biodegradable colorant coating dispersion that contained 0.05% indigo + 0.05% turmeric by weight of the colorant coating dispersion; and urea coated using an aqueous-based biodegradable colorant coating dispersion that contained 0.6 turmeric by weight of the colorant coating dispersion.

[0040] While the invention is susceptible to various modifications and alternative forms, specific embodiments thereof are shown by way of example in the drawings. The drawings may not be to scale.

DETAILED DESCRIPTION OF THE INVENTION

[0041] The aqueous-based biodegradable colorant coating dispersions of the present invention provide an elegant solution to the problems associated with currently available

colorant coatings. Notably, the dispersions of the present invention can produce a homogenous, uniformly colored, and/or stable coating when dried on a given surface. In some aspects, the colorant coating is biodegradable and/or non-toxic and can be used to coat edible and non-edible material. The dispersions of the present invention can advantageously have reduced toxicity when compared to currently available coating compositions and can be produced inexpensively, easily, and on a large scale.

[0042] These and other non-limiting aspects of the present invention are discussed in further detail in the following sections with reference to the Figures.

A. Aqueous-Based Biodegradable Colorant Coating Dispersion

[0043] In one embodiment, the aqueous-based biodegradable colorant coating dispersion of the present invention can include a dispersing agent and a colorant phase dispersed in a continuous aqueous phase, the colorant phase containing a biodegradable oil and a biodegradable colorant. The components of the aqueous-based biodegradable colorant coating dispersion can be homogeneously distributed in the colorant coating dispersion. In some instances, the colorant phase is dispersed as micronized droplets in a continuous aqueous phase. Not to be bound by theory, it is believed that the micronization of the droplets may contribute to the ability of the coating composition to form a uniformly colored coating when the coating composition is dried onto a surface of a given material.

[0044] In one aspect, a majority of the aqueous-based biodegradable colorant coating dispersion is water. The water can form a continuous phase in the colorant coating dispersion. The colorant coating dispersion can contain at least 50 wt. %, at least 60 wt. %, at least 70 wt. %, at least 80 wt. %, at least 90 wt. %, at least 95 wt. %, at least 96 wt. %, at least 97 wt. %, at least 98 wt. %, at least 99 wt. %, or any range therein of water compared to the weight of the colorant coating dispersion. In some instances, the dispersion can include 80 wt. % to 99 wt. % water, preferably 90 wt. % to 99 wt. % water, or more preferably 95 wt. % to 99 wt. % water. In even more preferred embodiments, water makes up about 98 wt. % of the dispersion. The colorant phase can be dispersed in the aqueous phase. The colorant phase can be homogeneously dispersed in the aqueous phase. The colorant phase can be dispersed as micronized droplets. The micronized droplets can have a mean diameter of less than 200, less than 150, less than 100, less than 50, less than 20, less than 10, less than 5, less than 1, or less than 0.5 microns (μm) or any range therein. In preferred embodiments, the droplets have a mean diameter of less than 20 microns to 0.5 microns.

[0045] In non-limiting aspects, the colorant phase can contain at least one biodegradable oil and at least one biodegradable colorant. In some instances, the biodegradable colorant can be distributed in the biodegradable oil. The colorant can be solubilized in the biodegradable oil or can be dispersed within the oil. In preferred instances, the colorant is lipophilic and solubilized in the biodegradable oil. The colorant coating dispersion can contain less than 50 wt. %, up to 49 wt. %, up to 45 wt. %, up to 30 wt. %, up to 20 wt. %, up to 10 wt. %, up to 5 wt. %, up to 4 wt. %, up to 3 wt. %, up to 2.5 wt. %, up to 2 wt. %, up to 1.5 wt. %, up to 1 wt. %, up to 0.9 wt. %, up to 0.8 wt. %, up to 0.7 wt. %, up to 0.6 wt. %, up to 0.55 wt. %, or any range therein of the colorant phase compared to the total weight of the colorant coating dispersion.

[0046] In non-limiting aspects, the biodegradable colorant can be one or more biodegradable colorant(s). The biodegradable colorant can be edible. In some instances, the biodegradable colorant is a food grade colorant. The biodegradable colorant can be a synthetic colorant, a natural colorant, a derivative of a natural colorant, or any combination thereof. The biodegradable colorant can be a natural colorant obtained from an organism, such as a plant, bacteria, fungus, insect, or animal. The biodegradable colorant can be a plant based dye. The biodegradable colorant can be a biodegradable mineral or a biodegradable derivative of a mineral. The biodegradable colorant can be or can be obtained from chlorophyll, indigo, turmeric, logwood, madder, woad, saffron, tyrian purple, lac, murex snail, octopus ink, cuttlefish ink, catechu, gamboge tree resin, *Himalayan rubhada* root, kamala, larkspur, pomegranate, etc. In some instances, the biodegradable colorant can be keto and/or enol forms of curcumin. In some instances, the biodegradable colorant can be turmeric powder extract, (delta-2,2'-biindole)-3,3'-dione, and/or indigo carmine of the oxoindoline family/derivatives. The colorant coating dispersion can contain less than 5 wt. %, 5 wt. %, 4 wt. %, 3 wt. %, 2.5 wt. %, 2 wt. %, 1.5 wt. %, 1 wt. %, 0.5 wt. %, 0.4 wt. %, 0.3 wt. %, 0.2 wt. %, 0.1 wt. %, 0.09 wt. %, 0.08 wt. %, 0.07 wt. %, 0.06 wt. %, 0.05 wt. %, 0.04 wt. %, 0.03 wt. %, 0.02 wt. %, 0.01 wt. %, 0.005 wt. %, or any range therein of the biodegradable colorant compared to the weight of the colorant coating dispersion.

[0047] In non-limiting aspects, the biodegradable oil can be one or more biodegradable oil(s). The biodegradable oil can be a synthetic oil or a natural oil. The biodegradable oil can be a natural oil derived from a mineral, plant, animal, insect, bacteria, or fungus. The biodegradable oil can be a chemically modified oil derived from natural oil. The

biodegradable oil can be an edible oil. The biodegradable oil can be a food grade oil. In some instances, the oil is a vegetable oil. The biodegradable oil can be a palm oil, palm kernel oil, soybean oil, coconut oil, soybean oil, rapeseed oil, safflower oil, sunflower seed oil, peanut oil, corn oil, cottonseed oil, olive oil, linseed oil, acai palm oil, etc. The biodegradable oil can be a recycled or used oil. The colorant coating dispersion can contain less than 5 wt. %, 5 wt. %, 4 wt. %, 3 wt. %, 2.5 wt. %, 2 wt. %, 1.5 wt. %, 1 wt. %, 0.5 wt. %, 0.4 wt. %, 0.3 wt. %, 0.2 wt. %, 0.1 wt. %, 0.09 wt. %, 0.08 wt. %, 0.07 wt. %, 0.06 wt. %, 0.05 wt. %, 0.04 wt. %, 0.03 wt. %, 0.02 wt. %, 0.01 wt. %, 0.005 wt. %, or any range therein of the biodegradable oil compared to the weight of the colorant coating dispersion. In some instances, the colorant coating dispersion does not contain paraffin oil and/or mineral oil.

[0048] In non-limiting aspects, the aqueous-based biodegradable colorant coating dispersion contains a dispersing agent that can help facilitate and/or stabilize the dispersion of the colorant phase in the aqueous phase. The dispersing agent can be natural or synthetic dispersing agent. The dispersing agent can be a biodegradable dispersing agent or an edible dispersing agent. The dispersing agent can be or contain an emulsifier and/or a surfactant. The dispersing agent can be a nonionic, ionic, anionic, cationic, and/or zwitterionic surfactant. The dispersing agent can be a soap, alkyl sulfate, alkylsulfonate, linear alkylbenzenesulfonates, fatty alcohol ethoxylates, lignin sulfonates, alkylphenol ethoxylates, quaternary ammonium surfactants, microbial surfactants, monoglycerides of fatty acids, diglycerides of fatty acids, monoesters of fatty acids, diesters of fatty acids, etc. The dispersing agent can be sodium stearate, stearyl sulfate, dodecylsulfonates, sodium dodecyl sulfate (SDS), 4-(5-dodecyl) benzenesulfonate, octadecyl sulfates, cetrimonium bromide, cetrimonium chloride, cetrimonium stearate, lecithin, sodium phosphates, alkyl phosphates, sodium stearyl lactylate, emulsan, sophorolipids, rhamnolipids, emulsifying wax, cetaryl alcohol, polysorbate 20, cetareth 20, egg yolk, mustard, etc. The colorant coating dispersion can contain less than 2 wt. %, 2 wt. %, 1.5 wt. %, 1 wt. %, 0.5 wt. %, 0.4 wt. %, 0.3 wt. %, 0.2 wt. %, 0.1 wt. %, 0.09 wt. %, 0.08 wt. %, 0.07 wt. %, 0.06 wt. %, 0.05 wt. %, 0.04 wt. %, 0.03 wt. %, 0.02 wt. %, 0.01 wt. %, 0.009 wt. %, 0.008 wt. %, 0.007 wt. %, 0.006 wt. %, 0.005 wt. %, 0.004 wt. %, 0.003 wt. %, 0.002 wt. %, 0.001 wt. %, or any range therein of the dispersing agent compared to the weight of the colorant coating dispersion.

[0049] The aqueous-based biodegradable colorant coating dispersion can contain additional ingredients. The additional ingredients can include a preservative, insecticide, fungicide, flavor, fragrance, micronutrient, fertilizer, plant growth agent, nutrient, secondary nutrient, trace element, plant protection agent, filler, etc., or combination thereof. In some instances, the colorant coating dispersion does not contain an additional ingredient. In some instances, the colorant coating dispersion does not contain one or more of a preservative, insecticide, fungicide, flavor, fragrance, micronutrient, fertilizer, plant growth agent, nutrient, secondary nutrient, trace element, plant protection agent, filler, etc. Non-limiting examples of micronutrients include magnesium, calcium, zinc, molybdenum, boron, manganese, sulfur, iron, copper, molybdenum, zinc oxide (ZnO), boric oxide (B₂O₃), triple superphosphate (TSP), and/or magnesium oxide (MgO). In some instances, the micronutrients may be present in the form of inorganic salts. Examples of plant protection agents include, but are not limited to, insecticides, fungicides, growth regulators, nitrification inhibitors, and any mixtures of them. Examples of fillers include, but are not limited to, clay, peat, etc. Examples of other fertilizer ingredients are for example described in Ullmann's Encyclopedia of Industrial Chemistry, 5th edition, 1987, Volume A10, pages 363 to 401, DE-A-41 28 828, DE-A-19 05 834, or DE-A-196 31 764, which references are hereby incorporated by reference.

B. Method of Making the Aqueous-Based Biodegradable Colorant Coating Dispersion

[0050] The aqueous-based biodegradable colorant coating dispersion can be made by combining all or some of the components of the aqueous-based biodegradable colorant coating dispersion and micronizing. With reference to FIG. 1A, the non-limiting method (100) can include combining an aqueous solution (*e.g.*, water), a dispersing agent, a biodegradable oil, and a biodegradable colorant (101). In some instances, the combination is mixed. In some instances, the biodegradable oil and biodegradable colorant are combined and mixed to form a colorant phase and the colorant phase is then combined with the water and the dispersing agent. In some instances, the biodegradable oil, biodegradable colorant, and dispersing agent are combined and mixed and then the water is combined and mixed. If additional ingredients are included, the additional ingredients can be added at any time in the production of the aqueous-based biodegradable colorant coating dispersion and/or can be added after the aqueous-based biodegradable colorant coating dispersion is formed. Mixing

can be performed by processes such as stirring, vortexing, homogenizing, shaking, pouring, etc.

[0051] An aqueous-based biodegradable colorant coating dispersion can be made by micronizing the combination of water, dispersing agent, biodegradable oil, and biodegradable colorant and optionally additional additives (102). In a preferred embodiment the biodegradable oil, biodegradable colorant, and/or colorant phase forms micronized droplets dispersed in a continuous aqueous phase. The micronized droplets can be formed by processes such as stirring, vortexing, homogenizing, shaking, precipitation, condensing, etc. In one non-limiting example, the equipment used in the Examples can be used. The formation of the droplets and the amount of time used can be an amount sufficient to obtain substantially even distribution of the droplets throughout the resulting dispersion. In a preferred embodiment, the droplets are formed by homogenizing at or above 6,000 rpm, 7,000 rpm, 8,000 rpm, 9,000 rpm, 10,000 rpm, 11,000 rpm, 12,000 rpm, or 13,000 rpm, or more. Homogenization can be performed for at least 2 minutes, 3 minutes, 4 minutes, 5 minutes, 6 minutes, 7 minutes, 8 minutes, 9 minutes, 10 minutes, 11 minutes, 12 minutes, or 13 minutes, or more. The micronization can homogeneously disperse the biodegradable colorant, biodegradable oil, and/or colorant phase in a continuous aqueous phase. The micronization can form droplets of the biodegradable oil and/or colorant phase that have a mean diameter of less than 200, 150, 100, 90, 80, 70, 60, 50, 40, 30, 20, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1, or 0.5 microns (μm).

[0052] In some aspects, the method (100) may further produce a colorant coated material. The method (100) can include coating a material with an aqueous-based biodegradable colorant coating dispersion disclosed herein (103). The material to be coated or the coated material can be a food, seed, fertilizer, pesticide, plant growth regulator, pharmaceutical, nutraceutical, etc., or any combination thereof. The material can be a granule, tablet, pellet, powder, pill, particle, etc. In a preferred embodiment, the coated material is a fertilizer, pesticide, and/or plant growth regulator. In another preferred embodiment, the coated material is a food. The aqueous-based biodegradable colorant coating dispersion can be applied to the material to be coated by a variety of methods, such as spraying, pouring, mixing, blending, etc. A fluid bed sprayer, a fluid bed coater, a liquid spray mixer, a rotating drum, spray coating at discharge point, a paddle mixer, etc. can be used. In some instances,

optionally, the aqueous-based biodegradable colorant coating dispersion is dried on the material to form a colorant coated material (104).

C. Coated Material

[0053] A material can be coated with an aqueous-based biodegradable colorant coating dispersion that has optionally been dried on the material to form a colorant coated material of the present invention. With reference to FIG. 1B, the non-limiting colorant coated material (200) can be a material (201) coated by an aqueous aqueous-based biodegradable colorant coating dispersion to form a coating layer (202) that at least partially coats the surface of the material (201). In preferred instances, at least 90%, 95 %, or 100% of the surface of the material (201) is coated with the coating layer (202). A wide variety of materials can be coated with the aqueous-based biodegradable colorant coating dispersion of the present invention. In some instances, the material coated can be a food, seed, fertilizer, pesticide, plant growth regulator, pharmaceutical, nutraceutical, etc., or any combination thereof. An aqueous-based biodegradable colorant coating dispersion can be coated onto the material by using hand mixing, spraying, pouring, mixing, blending, etc. In some instances, the aqueous-based biodegradable colorant coating dispersion is applied to a material by a fluid bed sprayer, a fluid bed coater, a liquid spray mixer, a rotating drum, spray coating at discharge point, a paddle mixer, etc. In one non-limiting instance, the equipment used in the Examples can be used. The coated material can then optionally be dried on the material. See FIG. 1A 104. The coated material can be dried by any means known, including exposure to ambient air, heated sweep gas, unheated sweep gas, radiation, heat, etc. If more than one layer is desired, the material coated can then be coated with a second, third, fourth, or more layers of aqueous-based biodegradable colorant coating dispersion before or after the first coating dries on the material (not shown). For each layer, the amount of time used to apply the colorant coating dispersion can be an amount sufficient to ensure that a substantially even layer is formed on the material and/or formed on the subsequent layer. In some instances, the application times can include 5 minutes, 10 minutes, 30 minutes, 1, hour, 2 hours, 3 hours, 4 hours, 5 hours, or more or any range therein (e.g., 5 minutes to 5 hours, 5 minutes to 1 hour, etc.).

[0054] In some embodiments, the material coated (201) is a fertilizer. The fertilizer can be in the form of particles, pellets, granules, bars, rods, etc. Fertilizers that can be used as the material that is coated and/or combined with a coated material in a blended/mixed fertilizer

can include nitrogen fertilizers, phosphate fertilizers, alkaline fertilizers, potassium and/or magnesium containing fertilizers, and/or manure, and/or secondary nutrients, and/or trace elements. Examples of nitrogen fertilizers include organic fertilizer containing nitrogen, such as urea, methylene urea, crotonylidene diurea, oxamide, melamine, substituted triazones, ethylene diurea, triuret, and any mixtures of thereof. Easily soluble nitrogen components are, for example, ammonium nitrate, ammonium sulfate, or urea. Examples of phosphate fertilizers can include single super phosphate (SSP) and triple super phosphate (TSP). Examples of potassium fertilizers can include muriate of potash (MOP). Fertilizers may contain urea, nitrogen, potassium, phosphorus, and/or magnesium in the form of inorganic salts, or mixtures thereof. Other salts that may be used are, for example, monoammonium phosphate, diammonium phosphate, potassium sulfate, potassium chloride, magnesium sulphate, calcium superphosphate, disodium hydrogen phosphate, ferric chloride, manganous chloride, calcium chloride, magnesium phosphate, ammonia, and potassium oxide. Fertilizers can contain single-nutrient, multi-nutrient, and other possible fertilizer ingredients, for example, it can contain nutrients such as nitrogen, potassium, or phosphorus, individually or in combination. In some instances, the nutrients are in the form of their salts. Examples of these are nitrogen and phosphorous fertilizers (NP), nitrogen and potassium fertilizers (NK), potassium and phosphorous fertilizers (PK), and nitrogen, phosphorus, and potassium fertilizers (NPK), lime nitrate of ammonium, ammonia sulfate, ammonia sulfa-nitrate, and urea. The coated particle can also contain plant protection agents and fillers.

D. Use of the Fertilizer Compositions

[0055] In some instances, the coated material of the present invention can be used as a fertilizer. The coated fertilizer can be used alone, in a combined fertilizer mix, or with a separate fertilizer. The coated fertilizer can be used in a method of fertilizing. The method can include applying a fertilizer composition to at least one of a soil, an organism, a liquid carrier, a liquid solvent, or a combination thereof.

[0056] Non-limiting examples of plants that can benefit from the fertilizer of the present invention include vines, trees, shrubs, stalked plants, ferns, etc. The plants may include orchard crops, vines, ornamental plants, food crops, timber, and harvested plants. The plants may include Gymnosperms, Angiosperms, and/or Pteridophytes. The Gymnosperms may include plants from the Araucariaceae, Cupressaceae, Pinaceae, Podocarpaceae, Sciadopitaceae, Taxaceae, Cycadaceae, and Ginkgoaceae families. The Angiosperms may

include plants from the Aceraceae, Agavaceae, Anacardiaceae, Annonaceae, Apocynaceae, Aquifoliaceae, Araliaceae, Arecaceae, Asphodelaceae, Asteraceae, Berberidaceae, Betulaceae, Bignoniaceae, Bombacaceae, Boraginaceae, Burseraceae, Buxaceae, Canellaceae, Cannabaceae, Capparidaceae, Caprifoliaceae, Caricaceae, Casuarinaceae, 5 Celastraceae, Cercidiphyllaceae, Chrysobalanaceae, Clusiaceae, Combretaceae, Cornaceae, Cyrillaceae, Davidsoniaceae, Ebenaceae, Elaeagnaceae, Ericaceae, Euphorbiaceae, Fabaceae, Fagaceae, Grossulariaceae, Hamamelidaceae, Hippocastanaceae, Illiciaceae, Juglandaceae, Lauraceae, Lecythidaceae, Lythraceae, Magnoliaceae, Malpighiaceae, Malvaceae, Melastomataceae, Meliaceae, Moraceae, Moringaceae, Muntingiaceae, Myoporaceae, 10 Myricaceae, Myrsinaceae, Myrtaceae, Nothofagaceae, Nyctaginaceae, Nyssaceae, Olacaceae, Oleaceae, Oxalidaceae, Pandanaceae, Papaveraceae, Phyllanthaceae, Pittosporaceae, Platanaceae, Poaceae, Polygonaceae, Proteaceae, Punicaceae, Rhamnaceae, Rhizophoraceae, Rosaceae, Rubiaceae, Rutaceae, Salicaceae, Sapindaceae, Sapotaceae, Simaroubaceae, Solanaceae, Staphyleaceae, Sterculiaceae, Strelitziaceae, Styracaceae, Surianaceae, 15 Symplocaceae, Tamaricaceae, Theaceae, Theophrastaceae, Thymelaeaceae, Tiliaceae, Ulmaceae, Verbenaceae, and/or Vitaceae family.

EXAMPLES

[0057] The present invention will be described in greater detail by way of specific examples. The following examples are offered for illustrative purposes only, and are not 20 intended to limit the invention in any manner. Those of skill in the art will readily recognize a variety of noncritical parameters, which can be changed or modified to yield essentially the same results.

Example 1

(Production of Fertilizer Coated with an Aqueous-Based Biodegradable Colorant 25 Coating)

[0058] Described below are non-limiting examples of production of a coating on a fertilizer. Fertilizer granules were coated with an aqueous-based biodegradable colorant coating dispersion containing different concentrations of biodegradable colorants.

[0059] Briefly, the colorant coating dispersions were produced in a 500 ml plastic bottle 30 by charging 200 ml water, 0.02 g SDS, and biodegradable colorants with or without 2 g of palm kernel oil. See Table 1. The combination of ingredients were either mixed without

homogenization or were micronized by homogenization for 10 minutes at 10,000 rpm using a IKA T50 digital ULTRA TURRAX homogenizer. Uniform dispersion of the colorants were obtained in the micronized colorant coating dispersions containing palm kernel oil.

[0060] The colorant coating dispersions were applied onto urea granules in a fluid bed granulator (manufactured by BOSCH). Briefly, 1 kg of urea granules containing nitrogen inhibitors were charged and preheated at 50° C with hot air flow (250 m³/hr) for 15 min. The color coating dispersion was pumped in to the fluid bed granulator using peristaltic pump at a rate of 10 ml/min through spray nozzles to coat the urea granules (microclimate air pressure: 0.07 bar; spray air pressure: 0.14 bar maintained till the spraying was finished).

[0061] After completion of coating process, the coated granules were subjected to drying in the same equipment at 50-55° C for 20-25 min. The granules were then discharged from the granulator, cooled, and stored in a polythene bag.

Table 1

No.	Substrate to be coated		Coating Ingredient 1		Coating Ingredient 2		Coating Ingredient 3	
	Name	Qty. in gram	Name	Quantity in gram (% of coating solution)	Name	Quantity in gram (% of coating solution)	Name	Quantity in gram (% of coating solution)
1	Urea	1000	(delta-2,2'-biindole)-3,3'-dione	2.5 (1.25%)	-	-	-	-
2	Urea	1000	Curcumin (keto/enol forms)	12 (6%)	-	-	-	-
3	Micronutrient coated Urea	1000	(delta-2,2'-biindole)-3,3'-dione	0.5 (0.25%)	Curcumin (keto/enol forms)	0.5 (0.25%)	-	-
4	Urea	1000	(delta-2,2'-biindole)-3,3'-dione	0.5 (0.25%)	Curcumin (keto/enol forms)	0.5 (0.25%)	Palm Oil	2g (1%)
5	Urea	1000	Curcumin (keto/enol forms)	1.2 (0.6%)	-	-	Palm Oil	2g (1%)
6	Urea	1000	(delta-2,2'-biindole)-3,3'-dione	0.5 (0.25%)	-	-	Palm Oil	2g (1%)
7	Urea	1000	(delta-2,2'-biindole)-3,3'-dione	0.1 (0.05%)	Curcumin (keto/enol forms)	0.1 (0.05%)	Palm Oil	2g (1%)

Example 2**(Characterization of Fertilizer Coated with an Aqueous-Based
Biodegradable Colorant Coating)**

[0062] Fertilizer granules coated with micronized or non-micronized coatings of Example
5 1 and uncoated urea granules containing nitrogen inhibitors (control) were evaluated for
stability and homogeneity of color distribution on the coated granules.

[0063] Briefly, coated and control samples were stored in airtight plastic containers at
ambient temperature for more than 6 months. The samples were visually evaluated for
uniformity of color and color degradation at the time of production and every two weeks
10 during storage.

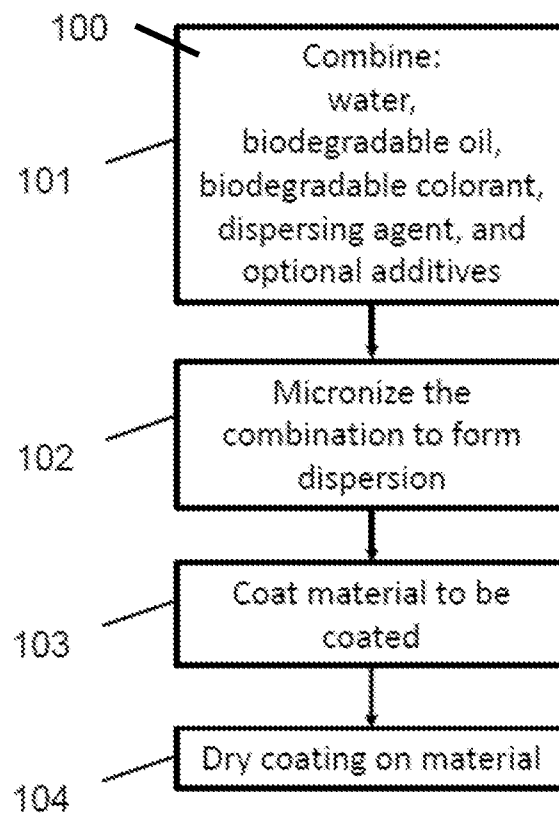
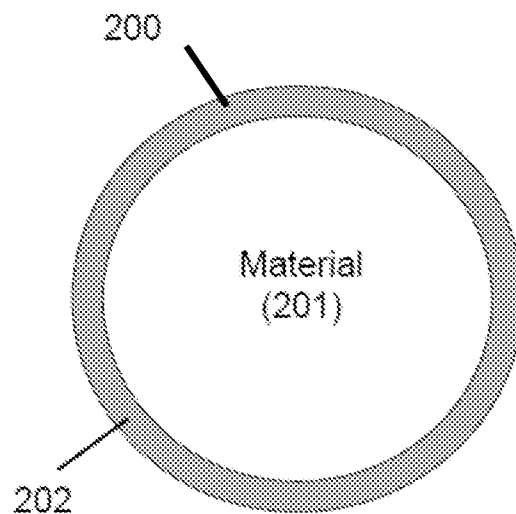
[0064] It was found that the fertilizer granules coated with micronized aqueous-based
biodegradable colorant coatings that contained 1% of a biodegradable oil (palm oil) were
very uniformly colored (see FIG. 2) and were highly stable during long term storage of the
coated granules. Color uniformity for the micronized coatings that contained 1% of a
15 biodegradable oil were noticeably more uniform than those without the biodegradable oil and
the coatings that were not micronized. Specifically, color patches were observed in the non-
micronized coatings and color patches as well as uneven color distribution was observed in
coatings that did not contain biodegradable oil. Further, fertilizers coated with micronized
coatings containing a biodegradable oil remained uniformly colored during long term storage.

CLAIMS

1. An aqueous-based biodegradable colorant coating dispersion comprising:
a colorant phase dispersed in a continuous aqueous phase, the colorant phase comprising:
a biodegradable oil; and
a biodegradable colorant; and
a dispersing agent.
2. The colorant coating dispersion of claim 1, wherein the colorant phase is dispersed as droplets having a mean diameter of less than 50 microns (μm), less than 20 μm , or less than 10 μm .
3. The colorant coating dispersion of claim 1, comprising at least 90 wt. % of the continuous aqueous phase.
4. The colorant coating dispersion of claim 1, comprising at least 90, 95, 97, or 98 wt. % water.
5. The colorant coating dispersion of claim 1, comprising 0.1 to 3, 0.5 to 2, or 0.5 to 1.5 wt. % of the biodegradable oil.
6. The colorant coating dispersion of claim 1, comprising 0.001 to 2, 0.005 to 1, or 0.01 to 0.75 wt. % of the biodegradable colorant.
7. The colorant coating dispersion of claim 1, comprising 0.001 to 2, 0.005 to 1, or 0.005 to 0.5 wt. % of the dispersing agent.
8. The colorant coating dispersion of claim 1, wherein the biodegradable colorant comprises a natural colorant, a derivative thereof, or a combination thereof.
9. The colorant coating dispersion of claim 1, wherein the biodegradable oil is a plant based oil.
10. The colorant coating dispersion of claim 1, wherein the dispersing agent is at least one of a biodegradable surfactant, an ingestible surfactant, or a combination thereof.

11. The colorant coating dispersion of claim 1, further comprising at least one of an insecticide, fungicide, flavor, fragrance, micronutrient, fertilizer, or a combination thereof.
12. The colorant coating dispersion of claim 1, wherein the colorant coating dispersion is edible.
13. The colorant coating dispersion of claim 1, comprising:
 - at least 95 wt. % water;
 - 0.5 to 1.5 wt. % of the biodegradable oil, wherein the biodegradable oil is a plant based oil, preferably a vegetable oil, more preferably palm kernel oil;
 - 0.01 to 0.5 wt. % of the biodegradable colorant, wherein the biodegradable colorant comprises a natural colorant, a derivative thereof, or a combination thereof; and
 - 0.005 to 0.5 wt. % of the dispersing agent, wherein the dispersing agent is at least one of a biodegradable surfactant, an ingestible surfactant, or a combination thereof; andwherein the colorant phase is dispersed as droplets having a mean diameter of less than 20 microns (μm).
14. The colorant coating dispersion of claim 1, wherein the colorant coating dispersion does not contain paraffin oil or mineral oil.
15. A coated material comprising a dried colorant coating dispersion of claim 1.
16. The coated material claim 15, wherein the material coated is a food, fertilizer, pesticide, or any combination thereof.
17. A method of coloring a material, the method comprising applying the colorant coating dispersion of claim 1 onto the material.
18. The method of claim 17, wherein the material is any one of a food, fertilizer, pesticide, or combination thereof.
19. The method of claim 17, further comprising drying the colored material.

20. The method of claim 17, wherein applying the colorant coating dispersion homogenously distributes the biodegradable colorant on the material.

*FIG. 1A**FIG. 1B*

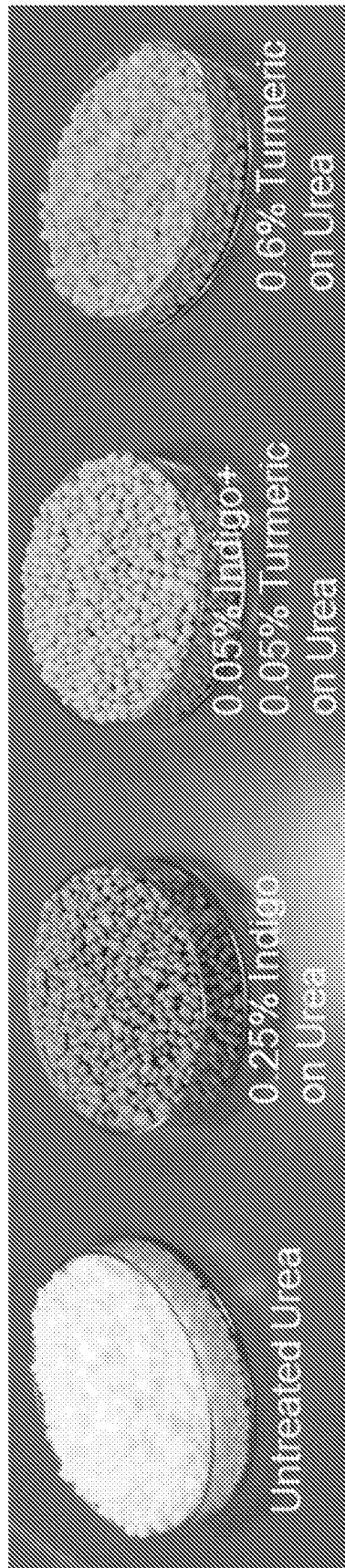


FIG. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2018/053890

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23P20/10 B01J2/00 A23L5/43
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A23P B01J A23L

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 594 258 A1 (FRIESLAND FRICO DOMO COOP [NL]) 27 April 1994 (1994-04-27) column 3, line 54 - column 4, line 4; claims 1,5,7,8,13,14,17,18 -----	1-20
X	WO 2012/059590 A1 (CHR HANSEN AS [DK]; MASON SARAH LOUISE [DK]; BONNET MARIE [FR]) 10 May 2012 (2012-05-10) page 9, line 1 - page 11, line 31; claims 1,2,4,5,10; example 2 page 15, line 26 - page 16, line 5 -----	1
X	WO 2016/174004 A1 (CHR HANSEN NATURAL COLORS AS [DK]) 3 November 2016 (2016-11-03) paragraph [0035] - paragraph [0036]; claims 1,11 ----- -/--	1-20



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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INTERNATIONAL SEARCH REPORT

International application No

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