Claims

1. A thermoplastic starch composition acquired from compounding a mixture comprising

starch-containing agricultural waste in 45 to 70% by weight of total composition that the agricultural waste contains starch content less than 50% in dry weight;
thermoplastic synthetic polymer in 25 to 50% by weight of total composition;
plasticizer in 0.01 to 10% by weight of total composition; and
coupling agent in 1 to 5% by weight of total composition; wherein the compounding is performed at a first temperature which is higher than room temperature.

2. A composition of claim 1, wherein the agricultural waste is pre-treated or functionalized with a reactant having functional group selected from the group consisting of primary alkylamine, secondary alkylamine, tertiary alkylamine, stearate ester, oleate ester, ecucate ester, ethoxy, methoxy, silane, vinyl, hydroxyl or any combination thereof at a second temperature, which is higher than room temperature but lower than the first temperature, prior to compounding the mixture.

3. A composition of claim 1, wherein the agricultural waste and the plasticizer are premixed to form a first blend while the thermoplastic synthetic polymer and the coupling agent are premixed to form a second blend prior to compounding the first and second blends together to produce the thermoplastic starch composition.

4. A composition of claim 2, wherein the reactant is 0.5 to 2.0% by weight of total composition.

5. A composition of claim 1, wherein the first temperature is 140^0C to 170^0C.

14. The composition of claim 1, wherein the thermoplastic synthetic polymer is vinylpolymers which include polyvinyl alcohol, polyvinyl acetate and polyvinyl carbazols; polystyrenes which include high impact polystyrene and medium impact polystyrenes; polylactides; polyhydroxyalkanoates which include poly(hydroxybutyrate); polyacrylonitrile; poly(alkylene oxides); polyphenylene oxide; polyphenylene ether; polyimides; polyamides; polyarylethers; polycarbonates; polyesters which include polyethylene terephthalate and polybutylene terephthalate; polyolefin which includes polypropylene, polyethylene and polyisobutylene; polyacrylates; polymethacrylates; styrenic copolymers which include acrylonitrile butadiene styrene copolymers, styrene acrylonitrile copolymers, styrene ethylene butadiene copolymer and styrene ethylene butylene styrene copolymers; blends of polypropylene and polyethylene; blends of polycarbonate and polypropylene; blends of polycarbonate and acrylonitrile butadiene styrene copolymers; blends of polycarbonate and high impact polystyrene; thermoplastic elastomers which include styrenic block copolymers, polyolefin blends (TPO), elastomeric alloys, thermoplastic polyurethane, thermoplastic copolyesters and thermoplastic polyamides; ethylene vinyl acetate copolymers; ethylene vinyl alcohol copolymers; and ethylene acrylic acid copolymers.

15. A composition of claim 1 or 2, wherein the plasticizer is any one or combination of sugar alcohol, polyols, sorbitl ethoxylate, glycerol ethoxylate, pentaerythritol ethoxylate, sorbitol acetate, pentaerythritol acetate, water, urea or urea derivatives, anhydrides of sugar alcohols, phthalate esters, dimethyl and diethylsuccinate and related esters, glycerol monoacetate, glycerol diacetate, glycerol triacetate, glycerol mono acid esters, citric acid esters, adipic acid esters, stearic acid esters, oleic acid esters, copolymers of ethylene and acrylic acid, polyethylene grafted maleic acid, polybutadiene-co-acrylic acid, polybutadiene-co-maleic acid, propylene-co-acrylic acid, polypropylene-co-maleic acid and other hydrocarbon based acid, adipic acid derivatives, benzoic acid derivatives, citric acid derivatives, phosphoric acid derivatives,

sebacic acid derivatives, onoglyceride, diglycerides, acetylated monoglyceride, acetylated glycerol monostearate, acetylated glycerol monoester-12-hydroxystearic acid, esters of glycerin, glycerol monopropionate, glycerol dipropionates and tripropionates, butanoates, stearates, alkylamides, trimethylolpropane, dimethyl sulfoxide, mannitol monoacetate, and mannitol monoethyoxylate.

16. A composition of claim 1 or 2, wherein the coupling agent is any one or combination of ethylene vinyl acetate, ethylene vinyl alcohol, polyethylene-co-acrylic acid, polyethylene grafted maleic anhydride, maleic anhydride modified polyolefin, maleic anhydride, acrylic acid, vinyl acetate, vinyl alcohol, amino, amide or acrylate, polyvinyl-alcohol-co-vinyl acetate copolymer, ethylene/vinyl alcohol/vinyl acetate copolymers, ethylene/vinyl chloride/vinyl alcohol/vinyl acetate graft copolymers, vinyl alcohol/vinyl acetate/vinyl chloride/diacryl amide copolymers, vinyl alcohol/vinyl butyral copolymers, vinyl alcohol/styrene copolymers, poly acrylic acid-co-vinyl acetate copolymer, ethylene/acrylic acid/vinyl acetate copolymers, ethylene/vinyl chloride/acrylic acid/vinyl acetate graft copolymers, acrylic acid/acrylonitrile copolymer, ethylene/propylene/acrylic acid copolymer, styrene/acrylic acid copolymers, vinyl benzyl amino ethyl amino propyl trimethoxy silane, glycidyl methacrylate modified polymers, graft copolymers of methyl methacrylate

17. A method of producing thermoplastic starch composition comprising the steps of

compounding starch-containing agricultural waste together with a mixture of a thermoplastic synthetic polymer in 25 to 50% by weight of total composition, a plasticizer in 0.01 to 10% by weight of total composition, and a coupling agent in 1 to 5% by weight of total composition at a first temperature higher than room temperature, wherein the starch-containing agricultural waste is 45 to 70% by weight of total composition and the agricultural waste contains starch content less than 50% in dry weight.

18. A method of claim 17 further comprising the step of reacting the starch-containing agricultural waste with a reactant having functional group selected from the group consisting of primary alkylamine, secondary alkylamine, tertiary alkylamine, stearate ester, oleate ester, ecucate ester, ethoxy, methoxy, silane, vinyl, hydroxyl or any combination thereof at a second temperature, which is higher than room temperature but lower than the first emperature, prior to the compounding step.

19. A method of claim 18, wherein the reactant is 0.5 to 2.0% by weight of total composition.

20. A method of claim 17, wherein the first temperature is 140^0C to 170^0C.

Claims

1. A thermoplastic starch composition acquired from compounding a mixture comprising

starch-containing agricultural waste in 45 to 70% by weight of total composition that the agricultural waste contains starch content less than 50% in dry weight;
thermoplastic synthetic polymer in 25 to 50% by weight of total composition;
plasticizer in 1 to 10% by weight of total composition; and
coupling agent in 1 to 5% by weight of total composition; wherein the compounding is performed at a first temperature which is higher than room temperature.

2. A composition of claim 1, wherein the agricultural waste is pre-treated or functionalized with a reactant having functional group selected from the group consisting of primary alkylamine, secondary alkylamine, tertiary alkylamine, stearate ester, oleate ester, ecucate ester, ethoxy, methoxy, silane, vinyl, hydroxyl or any combination thereof at a second temperature, which is higher than room temperature but lower than the first temperature, prior to compounding the mixture.

3. A composition of claim 1, wherein the agricultural waste and the plasticizer are premixed to form a first blend while the thermoplastic synthetic polymer and the coupling agent are premixed to form a second blend prior to compounding the first and second blends together to produce the thermoplastic starch composition.

4. A composition of claim 2, wherein the reactant is 0.5 to 2.0% by weight of total composition.

5. A composition of claim 1, wherein the first temperature is 140^0C to 170^0C.

14. A composition of claim 1 or 2, wherein the thermoplastic synthetic polymer is vinylpolymer, polystyrenes, polylactic acid, polyhydroxyl adipate or polyvinyl alcohol, polyacrylonitriles, polyvinylcarbazols, poly(alkylene oxides), poly(hydroxy butyrate), polyimides, polyarylethers, poly(alkylene terephthalates), polycarbonates, polyester, polypropylene, polyethylene, and polyisobutylenes.

15. A composition of claim 1 or 2, wherein the plasticizer is any one or combination of sugar alcohol, polyols, sorbitl ethoxylate, glycerol ethoxylate, pentaerythritol ethoxylate, sorbitol acetate, pentaerythritol acetate, water, urea or urea derivatives, anhydrides of sugar alcohols, phthalate esters, dimethyl and diethylsuccinate and related esters, glycerol monoacetate, glycerol diacetate, glycerol triacetate, glycerol mono acid esters, citric acid esters, adipic acid esters, stearic acid esters, oleic acid esters, copolymers of ethylene and acrylic acid, polyethylene grafted maleic acid, polybutadiene-co-acrylic acid, polybutadiene-co-maleic acid, propylene-co-acrylic acid, polypropylene-co-maleic acid and other hydrocarbon based acid, adipic acid derivatives, benzoic acid derivatives, citric acid derivatives, phosphoric acid derivatives, sebacic acid derivatives, onoglyceride, diglycerides, acetylated monoglyceride, acetylated glycerol monostearate, acetylated glycerol monoester-12-hydroxystearic acid, esters of glycerin, glycerol monopropionate, glycerol dipropionates and tripropionates, butanoates, stearates, alkylamides, trimethylolpropane, dimethyl sulfoxide, mannitol monoacetate, and mannitol monoethyoxylate.

16. A composition of claim 1 or 2, wherein the coupling agent is any one or combination of ethylene vinyl acetate, ethylene vinyl alcohol, polyethylene-co-acrylic acid, polyethylene grafted maleic anhydride, maleic anhydride modified polyolefin, maleic anhydride, acrylic acid, vinyl acetate, vinyl alcohol, amino, amide or acrylate, polyvinyl-alcohol-co-vinyl acetate copolymer, ethylene/vinyl alcohol/vinyl acetate copolymers, ethylene/vinyl

chloride/vinyl alcohol/vinyl acetate graft copolymers, vinyl alcohol/vinyl acetate/vinyl chloride/diacryl amide copolymers, vinyl alcohol/vinyl butyral copolymers, vinyl alcohol/styrene copolymers, poly acrylic acid-co-vinyl acetate copolymer, ethylene/acrylic acid/vinyl acetate copolymers, ethylene/vinyl chloride/acrylic acid/vinyl acetate graft copolymers, acrylic acid/acrylonitrile copolymer, ethylene/propylene/acrylic acid copolymer, styrene/acrylic acid copolymers, vinyl benzyl amino ethyl amino propyl trimethoxy silane, glycidyl methacrylate modified polymers, graft copolymers of methyl methacrylate

17. A method of producing thermoplastic starch composition comprising the steps of

compounding starch-containing agricultural waste together with a mixture of a thermoplastic synthetic polymer in 25 to 50% by weight of total composition, a plasticizer in 1 to 10% by weight of total composition, and a coupling agent in 1 to 5% by weight of total composition at a first temperature higher than room temperature, wherein the starch-containing agricultural waste is 45 to 70% by weight of total composition and the agricultural waste contains starch content less than 50% in dry weight.

18. A method of claim 17 further comprising the step of reacting the starch-containing agricultural waste with a reactant having functional group selected from the group consisting of primary alkylamine, secondary alkylamine, tertiary alkylamine, stearate ester, oleate ester, ecucate ester, ethoxy, methoxy, silane, vinyl, hydroxyl or any combination thereof at a second temperature, which is higher than room temperature but lower than the first emperature, prior to the compounding step.

19. A method of claim 18, wherein the reactant is 0.5 to 2.0% by weight of total composition.

20. A method of claim 17, wherein the first temperature is 140^0C to 170^0C.