METHODS AND RELATED COMPOSITIONS FOR MANUFACTURING FOOD AND FEED

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to U.S. Provisional Application No. 62/450,038, filed on January 24, 2017, and U.S. Provisional Application No. 62/584,011, filed on November 9, 2017, the contents of which are hereby incorporated herein by reference in their entireties.

BACKGROUND

Arthropods, such as crickets, cicadas, grasshoppers, ants, insect larvae, caterpillars, and scorpions, have many traditional and potential new uses in the production of food and feed for humans and animals, respectively. Insects as food and feed emerge as an especially relevant issue due to the rising cost of animal protein, food and feed insecurity, environmental pressures, population growth, and increasing demand for affordable and sustainable sources of nutrients for humans and animals (e.g., livestock). To cultivate beneficial arthropods for use in the food and feed industries, there is a need in the art for ways to promote the growth and fitness of such arthropods.

SUMMARY

Disclosed herein are compositions and methods for modulating the fitness of insects for food and feed manufacturing. The composition includes an agent that alters a level, activity, or metabolism of one or more microorganisms resident in a host, the alteration resulting in a modulation in the host's fitness.

In one aspect, the present disclosure refers to a method, comprising delivering to a host insect a composition comprising an amino acid-producing bacterium in an amount effective for increasing a nutritional profile of the host insect, wherein the amino-acid-producing bacteria is a *Corynebacterium* species.

In one aspect, the present disclosure refers to a method, comprising altering a host insect's microbiota wherein the host has a nutritional profile and wherein altering comprises delivering directly or indirectly into the host a composition comprising an amino acid-producing bacterium in an amount effective for increasing the nutritional profile of the host insect, wherein the amino-acid-producing bacteria is a *Corynebacterium* species.

In one example, provided herein is a method for increasing a nutritional profile of an insect, the method including delivering an effective amount of methionine-producing bacteria to the insect.

In some examples, the insect is a cricket, a grasshopper, or a locust.

In some examples, the insect may be developmentally an embryo, larva, pupa, or adult.

In some examples, the delivery may include delivering the composition to at least one habitat where the insect grows, lives, reproduces, or feeds.

In some examples, the methionine-producing bacteria may be delivered in an insect comestible composition for ingestion by the insect.

In some examples, the methionine-producing bacteria may be formulated with an agriculturally acceptable carrier as a liquid, a solid, an aerosol, a paste, a gel, or a gas composition.

In some examples, the carrier may be a seed coating.

In a second example, provided herein is a modified insect comprising exogenous methionine-producing bacteria resident in the insect.

In some examples, the insect is developmentally an embryo, a larva, a pupa, or an adult.

In some examples, the methionine-producing bacteria alters microbiota in a gut and/or haemocoel of the insect.

In yet another example, the composition includes an agent that alters a level, activity, or metabolism of one or more microorganisms resident in an insect host, the alteration resulting in an increase in the insect host's fitness.

CLAIMS

1. A method, comprising delivering to a host insect a composition comprising an amino acid-producing bacterium in an amount effective for increasing a nutritional profile of the host insect, wherein the amino-acid-producing bacteria is a *Corynebacterium* species.

2. A method, comprising altering a host insect's microbiota wherein the host has a nutritional profile and wherein altering comprises delivering directly or indirectly into the host a composition comprising an amino acid-producing bacterium in an amount effective for increasing the nutritional profile of the host insect, wherein the amino-acid-producing bacteria is a *Corynebacterium* species.

3. A method according to claim 1 or 2, wherein the amino acid-producing bacterium produces the amino acid at a concentration of at least 0.1 mg/mL in a culture.

4. A method of making an animal or human food product, the method comprising:

(a) delivering to a plurality of host insects a composition comprising an amino acid-producing bacteria formulated with an insect comestible carrier; and

(b) processing the plurality of host insects into a food, food additive, or food supplement after at least a portion of the plurality of host insects have ingested the composition.

5. The method of any one of claims 1-3, wherein increasing the nutritional profile is determined by observing that production of the amino acid in the host insect to which the composition was delivered is greater than production of the amino acid in a host insect to which the same composition but without the amino acid-producing bacteria is delivered.

6. The method of any one of claims 1-3, wherein increasing the nutritional profile is determined by observing an increase in body mass of the host insect relative a host insect to which the same composition but without the amino acid-producing bacteria is delivered.

7. The method of any one of claims 1-6, wherein the amino acid-producing bacteria is a methionine-producing bacteria.

8. The method of any one of claims 1-6, wherein the amino acid-producing bacteria is a glutamate-producing bacteria.

9. A method of making an animal or human food product, the method comprising:

(a) providing a plurality of host insects, wherein at least a portion of the plurality of host insects comprise a target entomopathogenic bacterium;

(b) delivering to the plurality of host insects a composition comprising a phage that targets the entomopathogenic bacterium and an insect comestible carrier in an amount effective for increasing the fitness of the plurality of host insects; and

(c) processing the plurality of host insects into a food, food additive, or food supplement.

10. The method of claim 9, wherein the phage is chosen from Myoviridae, Siphoviridae, Podoviridae, Lipothrixviridae, Rudiviridae, Ampullaviridae, Bicaudaviridae, Clavaviridae, Corticoviridae, Cystoviridae, Fuselloviridae, Glubuloviridae, Guttaviridae, Inoviridae, Leviviridae, Microviridae, Plasmaviridae, and Tectiviridae.

11. The method of claim 9 or 10, wherein fitness is measured as mobility, body weight, survival, reproduction, or metabolism.

12. The method of any one of claims 1-11, wherein the host insect is a cricket, a grasshopper, or a locust.

13. The method of any one of claims 1-11, wherein the host insect is a dipteran insect.

14. The method of claim 13, wherein the dipteran insect is a black soldier fly.

15. The method of any one of claims 1-11, wherein the host insect is a lesser mealworm.

16. The method of any one of claims 1-15, wherein the host insect is developmentally an embryo, larva, pupa, or adult.

17. The method of any one of claims 1-16, wherein delivering comprises delivering the composition to at least one habitat where the host insect grows, lives, reproduces, or feeds.

18. The method of any one of claims 1-17, wherein the composition is a liquid, a solid, an aerosol, a paste, a gel, or a gas.

19. The method of any one of claims 1-18, wherein the *Corynebacterium* species is *Corynebacterium glutamicum.*