limit spread of the bacterium. However, this is largely ineffective since it is the spores rather than the bacteria that cause the disease. Therefore, burning of the hive is often the only solution to contain the disease.

[7] Thus, there is a need in the art for safe, effective measures for the control and prevention of American foulbrood disease and other related insect disease. This disclosure satisfies this need and provides related advantages as well.

SUMMARY

[7a] In one aspect, provided herein is a vaccine composition comprising whole cells or cell wall fragments of at least one dead, non-disease causing bacterial species of a bacterial genus and a carrier, wherein the at least one dead, non-disease causing bacterial species is selected from *Paenibacillus alvei, Paenibacillus dendritiformis*, or a combination thereof.

[7b] In one aspect, provided herein is use of an effective amount of the vaccine composition as described herein in the manufacture of a medicament for vaccinating or immunizing a bee queen or bee larvae against Foulbrood disease, wherein the medicament is to be administered to a bee selected from one or more of worker bees or nurse bees that feed the bee queen, bee larvae or the bee queen, thereby immunizing the queen bee or the bee larvae produced by the queen bee.

[7c] In one aspect, provided herein is use of a vaccine composition comprising whole cells or cell wall fragments of at least one dead, non-disease causing species of *Paenibacillus* in the manufacture of a medicament for preventing or vaccinating against American foulbrood in a population of bees, optionally honeybees, wherein the vaccine composition is to be administered to a bee queen, and wherein the at least one dead, non-disease causing species of *Paenibacillus* is selected from *Paenibacillus alvei, Paenibacillus dendritiformis*, or a combination thereof.

[7d] In one aspect, provided herein is a method for preparing a vaccine composition comprising isolating whole cells or cell wall fragments from at least one dead, non-disease causing bacterial species of *Paenibacillus*, wherein the at least one dead, non-disease causing bacterial species of *Paenibacillus* is selected from *Paenibacillus alvei, Paenibacillus dendritiformis*, or a combination thereof.

[7e] In one aspect, provided herein is a vaccine composition prepared by a method as described herein.

[7f] In one aspect, provided herein is a kit comprising the vaccine composition as described herein, and instructions for use.

[8] The disclosure relates to novel compositions, vaccine formulations and methods for raising an immune response to, and/or vaccinating treating and/or for the prevention foulbrood diseases caused by *Paenibacillus sp.* including American Foulbrood diseases (AFB) in bees and other insects caused by *Paenibacillus* larvae, via administration to and/or vaccination of the queen bee with dead non-disease causing *Paenibacillus sp.,* including, but not limited to *Paenibacillus alvei* (PA) and *Paenibacillus dentritiformis* (PD). In one example, the bees are honeybees.

[9] In contrast to what had been known in the art, Applicant describes administration and/or immunization by applying a stimulus from a non-disease pathogen to treat and/or prophylactically immunize the bees against diseases caused by *Paenibacillus sp.* such as Afb. Specific match between the disease pathogen and the vaccine strain is not required.

[10] Thus, in one example, this disclosure provides a method of protecting insects from disease by applying or administering an immunization stimulus derived from a pathogen other than the disease pathogen to provide broad-spectrum generalized protection.

[11] In an exemplary example, provided herein is a composition containing dead *Paenibacillus* such as PD and PA in combination or alone for the protection against infection by *Paenibacillus* larvae (PL). The composition also can contain, for example, bee feed such as honeybee feed.

[12] In other examples, the disclosure provides a method for preventing American foulbrood in a population of bees, e.g., honeybees. The method can include administering or feeding to the queen bee a vaccine formulation consisting of dead PB or PA or a combination of both. In one example, from about 1.5×10^6 to about 1.5×10^8

WHAT IS CLAIMED IS:

1. A vaccine composition comprising whole cells or cell wall fragments of at least one dead, non-disease causing bacterial species of a bacterial genus and a carrier, wherein the at least one dead, non-disease causing bacterial species is selected from *Paenibacillus alvei, Paenibacillus dendritiformis*, or a combination thereof.

2. The vaccine composition of claim 1, wherein the carrier is an insect food.

3. The vaccine composition of claim 1 or 2, wherein the dead, non-disease causing bacteria comprises *Paenibacillus dendritiformis*.

4. The vaccine composition of any of claims 1-3, wherein the composition comprises from 1.5×10^7 to 1.5×10^{11} whole cells or cell wall fragments per gram of insect food or carrier.

5. Use of an effective amount of the vaccine composition of any of claims 1 to 4 in the manufacture of a medicament for vaccinating or immunizing a bee queen or bee larvae against Foulbrood disease, wherein the medicament is to be administered to a bee selected from one or more of worker bees or nurse bees that feed the bee queen, bee larvae or the bee queen, thereby immunizing the queen bee or the bee larvae produced by the queen bee.

6. The use of claim 5, wherein the Foulbrood disease is caused by a species of *Paenibacillus.*

7. The use of claim 6, wherein the Foulbrood disease is American Foulbrood disease.

8. The use of claim 7, wherein the Foulbrood disease is American Foulbrood disease and is caused by *P. larvae*.

9. The use of any one of claims 5 to 8, wherein the one or more of the queen bee, worker bees, nurse bees or the larvae are to be administered from 1.5×10^7 to 1.5×10^{11} whole cells or cell wall fragments per dose.

10. The use of claim 9, wherein the one or more of the queen bee, worker bees, nurse bees or larvae are to be administered at least one, or at least two, or at least three, or at least four, or at least five, or at least six, or at least seven, or at least eight, or at least nine, or at least 10 dose(s)

of from 1.5 x10^7 to 1.5 x 10^{11} whole cells or cell wall fragments of the dead, non-disease causing species of *Paenibacillus*.

11. Use of a vaccine composition comprising whole cells or cell wall fragments of at least one dead, non-disease causing species of *Paenibacillus* in the manufacture of a medicament for preventing or vaccinating against American foulbrood in a population of bees, optionally honeybees, wherein the vaccine composition is to be administered to a bee queen, and wherein the at least one dead, non-disease causing species of *Paenibacillus* is selected from *Paenibacillus alvei, Paenibacillus dendritiformis*, or a combination thereof.

12. The use of claim 11, wherein the dead non-disease causing species of *Paenibacillus* is *Paenibacillus dendritiformis*.

13. The use of claim 11 or 12, wherein the administration comprises feeding one or more of the queen bee, worker bees, nurse bees or larvae a suitable amount of queen feed comprising from 1.5 x 10^7 to 1.5 x 10^{11} whole cells or cell wall fragments per dose of at least one dead non-disease causing species of *Paenibacillus*.

14. The use of claim 13, wherein the Foulbrood disease is American Foulbrood and is caused by *P. larvae*.

15. The use of any one of claims 11 to 14, wherein the composition comprises or consists essentially of *Paenibacillus dendritiformis.*

16. The use of any one of claims 11 to 15, wherein the one or more of the queen bee, worker bees, nurse bees or the larvae are to be administered from 1.5 x 10^7 to 1.5 x 10^{11} whole cells or cell wall fragments per dose.

17. The use of claim 16, wherein the one or more of the queen bee, worker bees, nurse bees or larvae are to be administered at least one, or at least two, or at least three, or at least four, or at least five, or at least six, or at least seven, or at least eight, or at least nine, or at least 10 dose(s) of from 1.5 x 10^7 to 1.5 x 10^{11} whole cells or cell wall fragments.

18. A method for preparing a vaccine composition comprising isolating whole cells or cell wall fragments from at least one dead, non-disease causing bacterial species of *Paenibacillus*, wherein the at least one dead, non-disease causing bacterial species of *Paenibacillus* is selected from *Paenibacillus alvei, Paenibacillus dendritiformis*, or a combination thereof.

19. The method of claim 18, further comprising admixing the isolated whole cells or cell wall fragments with an insect food.

20. The method of claim 19, wherein the insect food is selected from a queen bee wafer, a sugar eater, a spirulina supplement, queen candy in the shipping container, a queen cell, an insect supplement.

21. The method of claim 20, wherein the at least one dead, non-disease causing bacterial species is *Paenibacillus dendritiformis*.

22. The method of any one of claims 18-21, further comprising formulating the isolated whole cells or cell wall fragments to provide from 1.5×10^7 to 1.5×10^{11} whole cells or cell wall fragments per dose.

23. A vaccine composition prepared by a method of any one of claims 18 to 22.

24. A kit comprising the vaccine composition of any one of claims 1-4, and instructions for use.