inferior) as well as variable malformations of the brain (hydracephaly, porencephaly, cerebellar hypoplasia, hapoplasia of the brain stem) and of the spinal cord in lambs, kids and calves. The infection spread rapidly over large parts of North Western Europe. Belgium, Germany, France, Italy, Luxembourg, the Netherlands, Spain and the United Kingdom have been affected so far.

[0007] Therefore, SBV is a serious threat to ruminant livestock in Europe since vaccines are currently not available.

[0008] Thus, there is a strong need for vaccines and medications effecting a rapid induction of neutralizing antibodies for the prophylaxis and treatment of Schmallenberg virus infection.

SUMMARY

[0008a] In one aspect, there is provided an immunogenic composition comprising an inactivated Schmallenberg virus (SBV), wherein the SBV is inactivated by heat treatment or with an aziridine compound.

[0008b] In another aspect, there is provided a vaccine composition for use in the treatment or prevention of SBV comprising the immunogenic composition as defined herein.

[0008c] In another aspect, there is provided a vaccine composition for use in the prevention or reduction of the viremia or malformations induced by SBV comprising the immunogenic composition as defined herein.

[0008d] In another aspect, there is provided a vaccine composition for use in the prevention or reduction of the transmission of SBV, which comprises the immunogenic composition as defined herein.

[0008e] In another aspect, there is provided a method for the production of an immunogenic composition as defined herein, comprising the steps of (A) infecting cells with a SBV; (B) cultivating the infected cells; (C) harvesting the SBV produced by said cells; and (D) inactivating said viral particles by heat treatment or with a virus inactivating agent.

[0008f] In another aspect, there is provided the immunogenic composition as defined herein for use in generating an immune response to SBV in an animal.

[0008g] In another aspect, there is provided use of the immunogenic composition as defined herein in the manufacture of a medicament for the treatment, prevention or reduction of transmission of SBV in a herd of animals.

[0008h] In another aspect, there is provided use of the immunogenic composition as defined herein in the manufacture of a medicament for the treatment, reduction or prevention of viremia or malformations induced by SBV.

[0008i] In another aspect, there is provided the immunogenic composition as defined herein for use in inducing an immune response against SBV in a herd of animals.

DESCRIPTION OF THE INVENTION

[0009] The solution to the above technical problem is achieved by the description and the embodiments characterized in the claims.

[0010] Thus, the invention in its different aspects is implemented according to the claims.

[0011] In one aspect, the invention provides an immunogenic composition containing one or more antigens of the Schmallenberg virus (SBV), wherein the immunogenic composition preferably comprises the SBV.

[0012] Preferably, SBV is thus contained as the one or more antigens of SBV in the composition of the invention, or the one or more antigens of the SBV is/are preferably SBV, respectively. Hence, the immunogenic composition of the invention is in particular an immunogenic composition comprising Schmallenberg virus (SBV).

[0013] As used herein, the term "antigen" in particular refers to any molecule, moiety or entity capable of eliciting an immune response. This includes cellular and/or humoral immune responses. Depending on the intended function of the composition, one or more antigens may be included be included.

[0014] In a further preferred aspect, the antigen of SBV or the SBV contained in the immunogenic composition of the invention is inactivated.

CLAIMS

What is claimed is:

1. An immunogenic composition comprising an inactivated ~~one or more antigens of the~~ Schmallenberg virus (SBV), wherein the SBV is inactivated by heat treatment or with an aziridine compound.

~~2. The immunogenic composition according to claim 1, wherein the immunogenic composition comprises the SBV.~~

~~3. The immunogenic composition according to claim 1, wherein the antigen of SBV or the SBV is inactivated.~~

~~4.~~2. The immunogenic composition according to claim 1, wherein the SBV comprises:

- (a) a small (S) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 97.8 % sequence identity with the nucleic acid sequence of SEQ ID NO:1 or SEQ ID NO:7;
- (b) a medium (M) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 82.2 % sequence identity with the nucleic acid sequence of SEQ ID NO:2;
- (c) a large (L) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 93 % sequence identity with the nucleic acid sequence of SEQ ID NO:3; or
- (d) combinations thereof.

~~5.~~3. The immunogenic composition according to claim 1, wherein the SBV is obtainable by the inactivation of SBV comprising:

- (a) a small (S) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 97.8 % sequence identity with the nucleic acid sequence of SEQ ID NO:1 or SEQ ID NO:7;
- (b) a medium (M) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 82.2 % sequence identity with the nucleic acid sequence of SEQ ID NO:2;

- (c) a large (L) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 93 % sequence identity with the nucleic acid sequence of SEQ ID NO:3; or
- (d) combinations thereof.

~~6.~~4. The immunogenic composition according to claim 1, wherein said SBV comprises:

- (a) an S RNA segment, characterized in that the S RNA segment has a sequence having at least 97.8 % sequence identity to SEQ ID NO:4 or SEQ ID NO:8;
- (b) an M RNA segment, characterized in that the M RNA segment has a sequence having at least 82.2 % sequence identity to SEQ ID NO:5;
- (c) an L RNA segment, characterized in that the L RNA segment has a sequence having at least 93 % sequence identity to SEQ ID NO:6; or
- (d) combinations thereof.

~~7. The immunogenic composition according to claim 3, wherein SBV is inactivated by heat treatment or with a virus inactivating agent.~~

~~8. The immunogenic composition according to claim 7, wherein virus inactivating agents is an aziridine compound.~~

~~9.~~5. The immunogenic composition according to claim ~~8~~1, wherein the aziridine compound is binary ethyleneimine (BEI).

~~10.~~6. The immunogenic composition according to claim ~~2~~1, comprising an amount of SBV which is equivalent to a virus titer of at least about 10^5 $TCID_{50}$/mL per dose

~~11.~~7. The immunogenic composition according to claim ~~2~~1, wherein the SBV has a pre-inactivation titer of at least about 10^6 SBV particles per milliliter.

~~12.~~8. The immunogenic composition according to claim 1, further containing one or more pharmaceutically acceptable carriers or excipients.

~~13.~~9. The immunogenic composition according to claim ~~12~~8, wherein said one or more pharmaceutically acceptable carriers or excipients are selected from the group consisting

of solvents, dispersion media, adjuvants, stabilizing agents, diluents, preservatives, antibacterial and antifungal agents, isotonic agents, and adsorption delaying agents.

~~14.~~10. The immunogenic composition according to claim 1, further comprising aluminum hydroxide, saponin or combinations thereof.

~~15.~~11. A vaccine composition for use in the treatment or prevention ~~according to~~ of SBV comprising the immunogenic composition according to claim 1.

~~16.~~12. A vaccine composition for use in the prevention or reduction of the viremia or malformations induced by SBV comprising the immunogenic composition according to claim 1.

~~17.~~13. A vaccine composition for use in the prevention or reduction of the transmission of SBV, which comprises the immunogenic composition according to claim 1.

~~18. A method for the production of SBV, comprising the steps of:~~

~~(a) infecting cells with a SBV;~~

~~(b) cultivating the infected cells; and~~

~~(c) harvesting the SBV produced by said cells.~~

~~19. The method for the production of SBV according to claim 18, wherein the SBV is passaged alternately between insect cells and mammalian cells, and wherein the method further comprises the steps of~~

~~(a) infecting insect cells with a SBV;~~

~~(b) cultivating the infected cells of step (a);~~

~~(c) harvesting the SBV produced by said cells in step (b);~~

~~(d) infecting mammalian cells with the viral particles harvested in step (c);~~

~~(e) cultivating the infected cells of step (d); and~~

~~(f) harvesting the SBV produced by said cells in step (e).~~

~~20. The method for production of SBV according to claim 19, wherein the method further comprises the steps of:~~

~~(d) infecting mammalian cells with a SBV;~~

~~(e) cultivating the infected cells of step (d);~~

~~(f) harvesting the SBV produced by said cells in step (e);~~

~~(g) infecting insect cells with the viral particles harvested in step (f);~~

~~(h) cultivating the infected cells of step (g); and~~

~~(i) harvesting the SBV produced by said cells in step (h).~~

~~21. The method according to claim 18, comprising the steps of~~

~~(a) infecting insect cells with a SBV;~~

~~(b) cultivating the infected cells of step (a);~~

~~(c) harvesting the SBV produced by said cells in step (b);~~

~~(d) infecting mammalian cells with the SBV harvested in step (c);~~

~~(e) cultivating the infected cells of step (d);~~

~~(f) harvesting the SBV produced by said cells in step (e);~~

~~(g) infecting insect cells with the SBV harvested in step (f);~~

~~(h) cultivating the infected cells of step (g); and~~

~~(i) harvesting the SBV produced by said cells in step (h).~~

~~22. The method according to claim 21, further comprising the steps of:~~

~~(j) infecting mammalian cells with the SBV harvested in step (i);~~

~~(k) cultivating the infected cells of step (j); and~~

~~(l) harvesting the SBV produced by said cells in step (k).~~

~~23. The method according to claim 30, further comprising the steps of:~~

~~(m) infecting insect cells with the SBV harvested in step (l);~~

~~(n) cultivating the infected cells of step (m); and~~

~~(o) harvesting the SBV produced by said cells in step (n).~~

~~24. The method according to claim 19, wherein the insect cells are KC cells and the mammalian cells are BHK cells.~~

~~25. The method according to claim 24, wherein the mammalian cells are BHK-21 cells.~~

~~26~~14. A method for the production of ~~inactivated SBV or of~~ an immunogenic composition according to claim ~~3~~1, comprising the steps of

(A) infecting cells with a SBV;

(B) cultivating the infected cells;

(C) harvesting the SBV produced by said cells; and

(D) inactivating said viral particles by heat treatment or with a virus inactivating agent.

~~27~~15. The method according to claim ~~26~~14, wherein the cells are monkey kidney cells or BHK cells.

~~28~~16. The method according to claim ~~27~~15, wherein the monkey kidney cells are Ma104 cells or Ma104-AK cells, and the BHK cells are BHK-21 cells.

~~29~~17. The method according to claim 1~~4~~26, wherein the cells are infected with SBV at an MOI of 0.00001 – 0.01.

~~30~~18. The method according to claim 1~~4~~26, wherein the cells are infected with SBV at an MOI of 0.0001 – 0.001.

~~31~~19. The method according to claim 1~~4~~26, wherein the cells are cultivated in a medium comprising about 0 % FCS.

~~32~~20. The method according to claim 1~~4~~26, wherein the cells are cultivated in a medium comprising about 1-10 % FCS.

~~33~~21. The method according to claim 1~~4~~26, wherein the cells are cultivated in a medium comprising about 2-6 % FCS.

~~34~~22. The method according to claim 1~~4~~26, wherein the cells are cultivated at a temperature of 25-38°C.

~~35~~23. The method according to claim 1~~4~~26, wherein the SBV comprises:

- (a) a small (S) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 97.8 % sequence identity with the nucleic acid sequence of SEQ ID NO:1 or SEQ ID NO:7;

- (b) a medium (M) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 82.2 % sequence identity with the nucleic acid sequence of SEQ ID NO:2;
- (c) a large (L) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 93 % sequence identity with the nucleic acid sequence of SEQ ID NO:3; or
- (d) combinations thereof.

~~36~~24. The method according to claim 1~~426~~, wherein said SBV comprises:

- (a) an S RNA segment, characterized in that the S RNA segment has a sequence having at least 97.8 % sequence identity to SEQ ID NO:4 or SEQ ID NO:8;
- (b) an M RNA segment, characterized in that the M RNA segment has a sequence having at least 82.2 % sequence identity to SEQ ID NO:5;
- (c) an L RNA segment, characterized in that the L RNA segment has a sequence having at least 93 % sequence identity to SEQ ID NO:6; or
- (d) combinations thereof.

~~37. A SBV comprising:~~

~~(a) a small (S) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 97.8 % sequence identity with the nucleic acid sequence of SEQ ID NO:1 or SEQ ID NO:7;~~

~~(b) a medium (M) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 82.2 % sequence identity with the nucleic acid sequence of SEQ ID NO:2;~~

~~(c) a large (L) RNA segment having a sequence that is inverse complementary to a nucleic acid sequence having at least 93 % sequence identity with the nucleic acid sequence of SEQ ID NO:3; or~~

~~(d) combinations thereof.~~

~~38. A SBV comprising:~~

~~(a) an S RNA segment, characterized in that the S RNA segment has a sequence having at least 97.8 % sequence identity to SEQ ID NO:4 or SEQ ID NO:8;~~

~~(b) an M RNA segment, characterized in that the M RNA segment has a sequence having at least 82.2 % sequence identity to SEQ ID NO:5;~~

~~(c) an L RNA segment, characterized in that the L RNA segment has a sequence having at least 93 % sequence identity to SEQ ID NO:6; or~~

~~(d) combinations thereof.~~

~~39. A composition of matter obtainable by the method according to claim 26.~~

~~40. The composition according to claim 39, wherein the composition is an immunogenic composition.~~

~~41. The composition according to claim 39, wherein the composition is a vaccine.~~

4225. The immunogenic composition according to claim 1 for use in generating an immune response to SBV in an animal.

4326. Use of the immunogenic composition according to claim 1 in the manufacture of a medicament for the treatment, ~~or~~ prevention or reduction of transmission of SBV in a herd of animals.

4427. Use of the immunogenic composition according to claim 1 in the manufacture of a medicament for the treatment, reduction or prevention of viremia or malformations induced by SBV.

4528. The immunogenic composition according to claim 1 for use in inducing an immune response against SBV in a herd of animals.

~~46. Use of the immunogenic composition according to claim 1 in the manufacture of a medicament for the treatment or reduction of viremia or malformations induced by SBV in a herd of animals.~~

~~47. Use of the immunogenic composition according to claim 1 in the manufacture of a medicament for the prevention or reduction of transmission of SBV in a herd of animals.~~

~~48~~29. The immunogenic composition according to claim ~~42~~25 or 28, wherein the immunogenic composition is formulated for administration in a single dose or in two doses.

~~49~~30. The use according to claim ~~43~~26 or 27 wherein the immunogenic composition is formulated for administration in a single dose or in two doses.

~~50. The use according to claim 44, wherein the immunogenic composition is formulated for administration in a single dose or in two doses.~~

~~51. The immunogenic composition according to claim 45, wherein the immunogenic composition is formulated for administration in a single dose or in two doses.~~

~~52. The use according to claim 46 wherein the immunogenic composition is formulated for administration in a single dose or in two doses.~~

~~53. The use according to claim 47, wherein the immunogenic composition is formulated for administration in a single dose or in two doses.~~