current *Eimeria*-based vaccines produces substantial vaccine-reaction morbidity and economic losses in vaccinated flocks. Thus an effective low-virulence vaccine against *Eimeria* is needed. An effective vaccine for *Eimeria* based on conserved immunogenic targets may also prove useful as a vaccine against other apicomplexan parasites.

SUMMARY

A vaccine vector comprising a first polynucleotide sequence encoding an Apicomplexan Rhomboid polypeptide and methods of using the same are provided herein.

In one aspect, there is provided a vaccine vector comprising a first polynucleotide sequence encoding an Apicomplexan Rhomboid polypeptide expressed on the surface of the vaccine vector, wherein the Rhomboid polypeptide consists of a polypeptide selected from the group consisting of SEQ ID NO: 1, SEQ ID NO: 2, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 37, SEQ ID NO: 38, or an immunogenic fragment of SEQ ID NO: 2 comprising amino acids 1-11, 18-27, or 31-43 of SEQ ID NO: 2.

In one aspect, there is provided a pharmaceutical composition comprising the vaccine vector of as disclosed herein and a pharmaceutically acceptable carrier.

In one aspect, there is provided a use of the vaccine vector as disclosed herein or the pharmaceutical composition as disclosed herein in the manufacture of a medicament for enhancing the immune response of a subject against an Apicomplexan parasite.

In one embodiment, a vaccine vector comprising a first polynucleotide encoding an Apicomlexan Rhomboid polypeptide or an immunogenic fragment thereof and a second polypeptide sequence encoding an immunostimulatory polypeptide is disclosed. The Apicomplexan Rhomboid polypeptide and the immunostimulatory polypeptide are suitably expressed on the surface of the vaccine vector. The Apicomplexan Rhomboid polypeptide may comprise SEQ ID NO: 1, SEQ ID NO: 2, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 37, SEQ ID NO: 38, an immunogenic fragment of at least one of SEQ ID NO: 1-4, 37-38 or

CLAIMS

We claim:

1. A vaccine vector comprising a first polynucleotide sequence encoding an Apicomplexan Rhomboid polypeptide expressed on the surface of the vaccine vector, wherein the Rhomboid polypeptide consists of a polypeptide selected from the group consisting of SEQ ID NO: 1, SEQ ID NO: 2, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 37, SEQ ID NO: 38, or an immunogenic fragment of SEQ ID NO: 2 comprising amino acids 1-11, 18-27, or 31-43 of SEQ ID NO: 2.

2. The vaccine vector of claim 1 further comprising a second polynucleotide sequence encoding an immunostimulatory polypeptide, wherein the immunostimulatory polypeptide is expressed on the surface of the vaccine vector.

3. The vaccine vector of claim 2, wherein the immunostimulatory polypeptide comprises an HMGB1 polypeptide.

4. The vaccine vector of claim 3, wherein the HMGB1 polypeptide comprises a polypeptide selected from the group consisting of SEQ ID NOs: 15-23 or a polypeptide having at least 95% sequence identity to SEQ ID NOs: 15-23.

5. The vaccine vector of any one of claims 2-4, wherein the immunostimulatory polypeptide comprises a CD154 polypeptide capable of binding CD40, the CD154 polypeptide having fewer than 50 amino acids and comprising amino acids 140-149 of SEQ ID NO: 25 or a homolog thereof, or is a polypeptide selected from the group consisting of SEQ ID NO: 26, SEQ ID NO: 27, SEQ ID NO: 28, SEQ ID NO: 29, SEQ ID NO: 30 and polypeptides having at least 90% sequence identity to at least one of SEQ ID NOs: 26-30.

6. The vaccine vector of any one of claims 2-5, wherein the vector comprises more than one copy of the first polynucleotide and/or more than one copy of the second polynucleotide sequence.

7. The vaccine vector of any one of claims 2-6, wherein the first polynucleotide sequence is linked in the same reading frame to the second polynucleotide sequence.

8. The vaccine vector of claim 7, wherein the first polynucleotide and the second polynucleotide are linked via a spacer nucleotide sequence.

9. The vaccine vector of any one of claims 1-8, wherein the vaccine vector is selected from the group consisting of a virus, a bacterium, a yeast and a liposome.

10. The vaccine vector of claim 9, wherein the vaccine vector is a *Bacillus* spp.

11. The vaccine vector of any one of claims 2-10, further comprising a third polynucleotide encoding a TRAP polypeptide.

12. The vaccine vector of claim 11, wherein the TRAP polypeptide is selected from the group consisting of polypeptides having at least 95% sequence identity to SEQ ID NO: 5, SEQ ID NO: 6, SEQ ID NO: 7, SEQ ID NO: 40, an immunogenic fragment of SEQ ID NO: 5, an immunogenic fragment of SEQ ID NO: 6, an immunogenic fragment of SEQ ID NO: 7 and an immunogenic fragment of SEQ ID NO: 40.

13. The vaccine vector of claim 2, wherein the first polynucleotide and the second polynucleotide encode a polypeptide selected from the group consisting of SEQ ID NO: 32, SEQ ID NO: 34 and a polypeptide having 95% sequence identity to SEQ ID NO: 32 or SEQ ID NO: 34.

14. A pharmaceutical composition comprising the vaccine vector of any one of claims 1-13 and a pharmaceutically acceptable carrier.

15. A use of the vaccine vector of any one of claims 1-13 or the pharmaceutical composition of claim 14 in the manufacture of a medicament for enhancing the immune response of a subject against an Apicomplexan parasite.

16. The use of claim 15, wherein the enhanced immune response comprises an enhanced antibody response, an enhanced T cell response or both.

17. The use of any one of claims 15-16, wherein the vaccine vector is to be administered by an oral route.

18. The use of any one of claims 15-17, wherein the subject is a poultry species or a mammal.

19. The use of claim 18, wherein the subject is selected from the group consisting of a human, swine, chicken, turkey and cow.

20. The use of any one of claims 15-19, wherein 10^4 to 10^9 vector copies of the vaccine are to be administered to the subject.

21. The use of any one of claims 15-20, wherein the vaccine vector is killed prior to administration to the subject or is not capable of replicating in the subject.

22. The use of any one of claims 15-21, wherein the Apicomplexan parasite is *Eimeria*.

23. The vaccine vector of any one of claims 1-12, wherein the Rhomboid polypeptide consists of SEQ ID NO: 2.

24. The vaccine vector of any one of claims 1-12, wherein the Rhomboid polypeptide consists of SEQ ID NO: 1, SEQ ID NO: 2, SEQ ID NO: 3, SEQ ID NO: 4, SEQ ID NO: 37, or SEQ ID NO: 38.