CLAIMS

What is claimed is:

1. An engineered phytase polypeptide or a fragment thereof comprising phytase activity having at least 82% sequence identity with the amino acid sequence set forth in SEQ ID NO:1.

2. The engineered phytase polypeptide or fragment thereof of claim 1, wherein the amino acid sequence of the engineered phytase polypeptide or fragment thereof has a Hidden Markov Model (HMM) score of at least about 1200 as set forth in Table 11 for the high Tm phytase clade polypeptides.

3. An engineered phytase polypeptide or core domain fragment thereof having at least 78% sequence identity with amino acid positions 14-325 corresponding to the amino acid sequence set forth in SEQ ID NO:1.

4. The engineered phytase polypeptide or fragment thereof of any one of claims 1-3, wherein the polypeptide or fragment has an in-feed pelleting recovery of at least about 50% when applied in mixer liquid application (MLA) at 95°C for 30 seconds, using a standard in-feed pelleting recovery test as described in Example 5.

5. The engineered phytase polypeptide or fragment thereof of any one of claims 1-4, wherein the polypeptide or fragment has a ratio of in-feed pelleting recoveries of at least about 0.7 when applied in MLA at 95°C for 30 seconds as compared to application in MLA at 80°C for 30 seconds, using a standard in-feed pelleting recovery test as described in Example 5.

6. The engineered phytase polypeptide or fragment thereof of any one of claims 1-5 wherein said polypeptide or fragment thereof comprises a Tm temperature of at least about 92.5° C using differential scanning calorimetric assay conditions described in Example 3.

7. The engineered phytase polypeptide or fragment thereof of claim 6 wherein said polypeptide or fragment thereof comprises a specific activity of at least about 100 U/mg at pH 3.5 under assay conditions described in Example 3.

8. The engineered phytase polypeptide or fragment thereof of any one of claims 1-2 or 4-7, wherein said phytase polypeptide comprises an amino acid sequence selected from the group consisting of SEQ ID NO:2, SEQ ID NO:3, SEQ ID NO:4, SEQ ID NO:5, SEQ ID NO:6, SEQ ID NO:7, SEQ ID NO:8, SEQ ID NO:9, SEQ ID NO:10, SEQ ID NO:11, SEQ ID NO:12, SEQ ID NO:13, SEQ ID NO:14, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:18, SEQ ID NO:19, SEQ ID NO:20, SEQ ID NO:21, SEQ ID NO:22, SEQ ID NO:23, SEQ ID NO:24, SEQ ID NO:25, SEQ ID NO:26, SEQ ID NO:27, SEQ ID NO:28, SEQ ID NO:29, SEQ ID NO:30, SEQ ID NO:31, SEQ ID NO:32, SEQ ID:NO:33, SEQ ID NO:34, SEQ ID NO:35, SEQ ID NO:36, SEQ ID NO:37, and SEQ ID NO:64.

9. The engineered phytase polypeptide or fragment thereof of any one of claims 1-2 or 4-7, wherein said phytase polypeptide comprises an amino acid sequence selected from the group consisting of SEQ ID NO:67, SEQ ID NO:68, SEQ ID NO:69, SEQ ID NO:70, SEQ ID NO:71, SEQ ID NO:72, SEQ ID NO:73, SEQ ID NO:74, SEQ ID NO:75, SEQ ID NO:76, SEQ ID NO:77, SEQ ID NO:78, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:81, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:84, SEQ ID NO:85, SEQ ID NO:86, and SEQ ID NO:87.

10. An animal feed, feedstuff, feed additive composition or premix comprising the engineered phytase polypeptide or fragment thereof of any one of claims 1-9, wherein the engineered phytase polypeptide or fragment thereof may be used (i) alone or (ii) in combination with a direct fed microbial comprising at least one bacterial strain or (iii) with at least one other enzyme or (iv) in combination with a direct fed microbial comprising at least one bacterial strain and at least one other enzyme, or (v) any of (i), (ii), (iii) or (iv) further comprising at least one other feed additive component and, optionally, the engineered phytase polypeptide or fragment thereof is present in an amount of at least about 0.1g /ton feed.

11. An animal feed, feedstuff, feed additive composition or premix comprising the engineered phytase polypeptide or fragment thereof of any one of claims 6-9, wherein the engineered phytase polypeptide or fragment thereof may be used (i) alone or (ii) in combination with a direct fed microbial comprising at least one bacterial strain or (iii) with at least one other enzyme or (iv) in combination with a direct fed microbial comprising at least one bacterial strain and at least one other enzyme, or (v) any of (i), (ii), (iii) or (iv) further comprising at least one

~~other feed additive component and, optionally, the engineered phytase polypeptide or fragment thereof is present in an amount of at least about 0.1g /ton feed.~~

~~12. A recombinant construct comprising a regulatory sequence functional in a production host operably linked to a nucleotide sequence encoding the engineered phytase polypeptide or fragment thereof of any one of claims 1-9.~~

~~13. A recombinant construct comprising a regulatory sequence functional in a production host operably linked to a nucleotide sequence encoding the engineered phytase polypeptide or fragment thereof of any one of claims 6-9.~~

~~14. The recombinant construct of claim 12, wherein the production host is selected from the group consisting of bacterial, fungi, yeast, plants and algae.~~

~~15. The recombinant construct of claim 13, wherein the production host is selected from the group consisting of bacterial, fungi, yeast, plants, and algae.~~

~~16. A method for producing an engineered phytase polypeptide or fragment thereof comprising:~~

~~(a) transforming a production host with the recombinant construct of claim 12; and~~

~~(b) culturing the production host of step (a) under conditions whereby the engineered phytase polypeptide or fragment thereof is produced.~~

~~17. A method for producing an engineered phytase polypeptide or fragment thereof comprising:~~

~~(c) transforming a production host with the recombinant construct of claim 13; and~~

~~(d) culturing the production host of step (a) under conditions whereby the engineered phytase polypeptide or fragment thereof is produced.~~

~~18. The method according to claim 16 or 17, wherein the engineered phytase polypeptide or fragment thereof is optionally recovered from the production host.~~

~~19. A phytase-containing culture supernatant obtained by the method of claim 16 or 17.~~

~~20. A phytase-containing culture supernatant obtained by the method of claim 18.~~

~~21. A polynucleotide sequence encoding the engineered phytase polypeptide or fragment thereof of any one of claims 1-9.~~

~~22. A polynucleotide sequence encoding the engineered phytase polypeptide or fragment thereof having phytase activity of any one of claims 6-9.~~

~~23. A dried enzyme composition for use in animal feed comprising the engineered phytase polypeptide or fragment thereof of any one of claims 1–9.~~

~~24. A dried enzyme composition for use in animal feed comprising the engineered phytase polypeptide or fragment thereof of any one of claims 6-9.~~

~~25. The dried enzyme composition of claim 23 wherein the dried enzyme composition is a granulated feed additive composition.~~

~~26. The dried enzyme composition of claim 24 wherein the dried enzyme composition is a granulated feed additive composition.~~

~~27. A liquid enzyme composition for use in animal feed comprising the engineered phytase polypeptide or fragment thereof of any one of claims 1–9.~~

~~28~~1. A liquid enzyme composition for use in animal feed comprising an engineered phytase polypeptide or a fragment thereof comprising phytase activity having at least 82% sequence identity with the amino acid sequence set forth in SEQ ID NO:1 wherein said polypeptide or fragment thereof comprises a Tm temperature of at least about 92.5° C using differential scanning calorimetric assay conditions described in Example 3~~the engineered phytase polypeptide or fragment thereof of any one of claims 6–9~~.

~~29. A method for improving the nutritional value of an animal feed, wherein the engineered phytase or fragment thereof of any one of claims 1–9, is added to animal feed.~~

~~30. A method for improving the nutritional value of an animal feed, wherein the engineered phytase or fragment thereof of any one of claims 6-9 is added to animal feed.~~

~~31. A method for improving animal performance on one or more metrics comprising administering an effective amount of the engineered phytase polypeptide of any one of claims 1-9 or the animal feed, feedstuff, feed additive composition or premix of claim 10 or claim 11 to the animal.~~

~~32. The method of claim 31, wherein the one or more metrics is selected from the group consisting of increased feed efficiency, increased weight gain, reduced feed conversion ratio, improved digestibility of nutrients or energy in a feed, improved nitrogen retention, improved ability to avoid the negative effects of necrotic enteritis, and improved immune response.~~

~~33. The method of claim 31 or claim 32, wherein the animal is a monogastric animal selected from the group consisting of swine and poultry.~~

~~34. The method of claim 33, wherein the swine is selected from the group consisting of piglets, growing pigs, and sows.~~

~~35. The method of claim 33, wherein the poultry is selected from the group consisting of turkeys, ducks, chickens, broiler chicks, layers, geese, pheasants, quail, and emus.~~

~~36. The method of claim 31 or claim 32, wherein the animal is a ruminant animal selected from the group consisting of cattle, young calves, goats, sheep, giraffes, bison, moose, elk, yaks, water buffalo, deer, reindeer, caribou, camels, alpacas, llamas, antelope, pronghorn and nilgai.~~