Claims

1. A polypeptide that hydrolytically cleaves zearalenone and/or at least one zearalenone derivative, characterized in that the polypeptide is a hydrolase with an amino acid sequence of sequence ID numbers 1 or a functional derivative thereof, wherein a sequence identity of at least 70 % exists between the functional variants and the amino acid sequence.

2. The polypeptide according to claim 1, characterized in that the polypeptide has at least one conserved amino acid sequence segment or a functional variant thereof, wherein the functional variant of the amino acid sequence segment has a sequence identity of at least 70 %, preferably at least 84 %, more preferably at least 92 % and most preferably at least 98 %, and at least one conserved amino acid sequence segment is selected from the group of amino acid sequences +24 to +50, +52 to +77 +79 to +87, +89 to +145, +150 to +171, +177 to +193, +223 to +228, +230 to +237, +239 to +247, +249 to +255, +257 to +261, +263 to +270, +272 to +279, +297 to +301, +303 to +313, +24 to 328, +1 to +328 of the sequence having the sequence ID no. 1.

3.The polypeptide according to claim 1 or 2, characterized in that the functional variant has at least one amino acid modification selected from the group of substitution, deletion and insertion of one or more amino acids.

4. The polypeptide according to any one of claims 1, 2 or 3, characterized in that the polypeptide has a specific activity of at least 0.01 U/mg, preferably at least 0.1 U/mg, in particular at least 1 U/mg; and/or a K_M value of the hydrolytic cleavage of ZEN of at most 50 µM, preferably at most 3.5 µM, in particular at most 0.5 µM; and/or a k_{cat} value of the hydrolytic cleavage of ZEN of at least 0.05 s^{-1}, preferably at least 0.6 s^{-1}, in particular at least 5 s^{-1}; and/or a v_{max} value of the hydrolytic cleavage of ZEN of at least 0.00001 μM^{-1} s^{-1}.

5. The polypeptide according to any one of claims 1 to 4, characterized in that the polypeptide may contain an amino acid sequence selected from the group of sequence ID numbers 5, 6 and 15 or a functional variant thereof, wherein the functional variant has at least 70% sequence identity with at least one of the amino acid sequences, and the pH stability of the polypeptide at pH 5.0 amounts to at least 15 %, preferably 50 % and in particular preferably 90 %.

6. The polypeptide according to any one of claims 1 to 4, characterized in that the polypeptide contains an amino acid sequence selected from the group of sequence ID numbers 1, 5, 6 and 15 or a functional variant thereof, wherein the functional variant has at least 70 % sequence identity with at least one of the amino acid sequences, so that the polypeptide has the highest enzymatic activity in a temperature range between 30°C and 75°C, preferably between 38°C and 55°C, in particular preferably between 38°C and 52°C.

7. The polypeptide according to any one of claims 1 to 4, characterized in that the polypeptide has an amino acid sequence selected from the group of sequence ID numbers 1, 5, 6 and 15 or a functional variant thereof, wherein the functional variant has at least 70 % sequence identity with at least one of the amino acid sequences, and the polypeptide is thermally stable up to a temperature of 80°C, preferably 75°C and in particular preferably 60°C

8. The polypeptide according to any one of claims 1 to 7, characterized in that the polypeptide has at least one mutation of the amino acid sequence with respect to sequence ID no. 1 in at least one of the following positions selected from the group: 22, 23, 25, 26, 27, 29, 31, 32, 35, 37, 42, 43, 46, 51, 53, 54, 57, 60, 69, 72, 73, 78, 80, 84, 88, 95, 97, 99, 114, 118, 119, 123, 132, 141, 146, 148, 149, 154, 163, 164, 165, 169, 170, 172, 176, 180, 182, 183, 190, 191, 194, 196, 197, 198, 201, 204, 205, 206, 207, 208, 209, 210, 212, 213, 214, 216, 217, 220, 221, 222, 229, 231, 233, 238, 240, 244, 245, 246, 248, 249, 251, 254, 256, 260, 262, 263, 266, 269, 271, 277, 280, 281, 282, 283, 284, 285, 286, 287, 292, 296, 298, 302, 307, 308, 309, 311, 314, 317, 319, 321, 323, 325 and 326.

9. The polypeptide according to claim 8, characterized in that it has at least one mutation of the amino acid sequence with respect to sequence ID no. 1 selected from the group D22A, S23Q, S23L, N25D, I26V, F27Y, F27H, S29P, R31A, F32Y, R35K, R35Q, V37A, V42I, V43T, F46Y, S51E, S51D, D53G, N54M, N54R, L57V, L60I, S69G, P72E, V73A, A78S, N80H, F84Y, I88L, T95S, T97A, R99K, I114M, I118V, K119R, V123I, L132V, A141S, I146V, I146L, A148G, A149V, A154P, P163T, A164T, Y165C, Y165H, V169I, L170R, A172G, A176M, A176V, Y180F, D182T, F183Y, I190V, G191S, K194T, K194E, F196Y, V197C, V197R, E198R, E198S, K201D, K201G, P204S, P204A, A205S, K206P, A207M, M208A, Q209R, L210A, L210S, ΔP212, T213V, P214A, E216T, E216G, A217I, N220H, L221M, K222R, K222Q, G229A, A231V, F233W, F233Y, F233H, A238G, H240N, H240S, D244E, R245Q, M246L, S248T, S248N, S248G, Q249R, K251N, I254V, I256L,

A260M, T262D, T262G, I263T, E266D, E269H, E269N, L271V, L277E, E280A, E280L, H281R, H281Q, A282V, Q283R, D284L, D284R, I285L, I286M, R287E, R287D, R292K, R292T, Q296A, Q296E, H298V, L302S, L307Q, F308S, D309A, A311P, A314V, L317F, S319Q, S319P, S319R, S321A, S321T, T323A, P325A, A326P.

10. The polypeptide according to any one of claims 1 to 8, characterized in that it contains at least one of the following amino acid motifs selected from the group of sequence ID numbers 32 to 69 .

11. The polypeptide according to claim 9, characterized in that the polypeptide contains at least one conservative amino acid substitution in at least one position, where the conservative amino acid substitution is selected from substitutions of G to A; or A to G, S; or V to I, L, A, T, S; or I to V, L, M; or L to I, M, V; or M to L, I, V; or P to A, S, N; or F to Y, W, H; or Y to F, W, H; or W to Y, F, H; or R to K, E, D; or K to R, E, D; or H to Q, N, S; or D to N, E, K, R, Q; or E to Q, D, K, R, N; or S to T, A; or T to S, V, A; or C to S, T, A; or N to D, Q, H, S; or Q to E, N, H, K, R.

12. An additive that hydrolytically cleaves zearalenone and/or at least one zearalenone derivative to yield feed products for pigs, poultry or aquaculture, for addition to foodstuffs or to distillers dried grain and solubles, characterized in that the additive contains at least one polypeptide having an amino acid sequence of sequence ID number 1 or a functional variant thereof, wherein a sequence identity between the functional variant and the amino acid sequence amounts to at least 70 % and auxiliary substances are also present.

13. The additive according to claim 12, characterized in that at least one polypeptide according to any one of the claims 1 to 11 is contained therein.

14. The additive according to claim 12 or 13, characterized in that the auxiliary substances are selected from at least one inert carrier as well as optional additional ingredients, such as vitamins and/or minerals and/or enzymes and/or other components for detoxifying mycotoxins.

15. The additive according to claim 12, 13 or 14, characterized in that at least one polypeptide according to any one of claims 1 to 11 is present in the additive in a concentration of at most 10,000 U/g, preferably at most 1000 U/g, more preferably at most 100 U/g and most preferably at most 10 U/g.

16. The additive according to any one of claims 12 to 15, characterized in that the additive is present in encapsulated or coated form.

17. A use of one polypeptide having an amino acid sequence of sequence ID number 1 or a functional variant thereof, wherein additives containing a sequence identity between the functional variant and the amino acid sequence amounts to at least 70 %, for hydrolytic cleavage of zearalenone and/or at least one zearalenone derivative in animal feed products, in particular pigs, poultry and aquaculture, in food items or in distillers dried grain and solubles.

18. The method for hydrolytic cleavage of zearalenone and/or at least one zearalenone derivative, characterized in that the zearalenone and/or at least one zearalenone derivative is/are hydrolyzed by a polypeptide having an amino acid sequence of sequence ID numbers 1 or a functional variant thereof, wherein the sequence identity between the functional variant and at least one of the amino acid sequences is at least 70 %.

19. The method according to claim 18, characterized in that the polypeptide is used in an additive according to any one of claims 13 to 16.

20. The method according to claim 19, characterized in that the polypeptide or the additive is mixed with a foodstuff or animal feed product contaminated with zearalenone and/or with at least one zearalenone derivative; the contaminated foodstuff or animal feed product is brought in contact with moisture, and the polypeptide or the additive hydrolyzes the zearalenone and/or at least one zearalenone derivative present in contaminated foodstuff or animal feed product.

21. The method according to any one of claims 18 to 20, characterized in that at least 70 %, preferably at least 80 %, in particular at least 90 % of the zearalenone and/or at least one zearalenone derivative is/are hydrolyzed.

Patent Claims

1. A polypeptide that hydrolytically cleaves zearalenone and/or at least one zearalenone derivative, characterized in that the polypeptide is a hydrolase with an amino acid sequence selected from the group of sequence ID numbers 1 to 15 or a functional derivative thereof, wherein a sequence identity of at least 70 % exists between the functional variants and at least one of the amino acid sequences.

2. The polypeptide according to claim 1, characterized in that the polypeptide has at least one conserved amino acid sequence segment or a functional variant thereof, wherein the functional variant of the amino acid sequence segment has a sequence identity of at least 70 %, preferably at least 84 %, more preferably at least 92 % and most preferably at least 98 %, and at least one conserved amino acid sequence segment is selected from the group of amino acid sequences +24 to +50, +52 to +77 +79 to +87, +89 to +145, +150 to +171, +177 to +193, +223 to +228, +230 to +237, +239 to +247, +249 to +255, +257 to +261, +263 to +270, +272 to +279, +297 to +301, +303 to +313, +24 to 328, +1 to +328 of the sequence having the sequence ID no. 1.

3. The polypeptide according to claim 1 or 2, characterized in that the polypeptide has at least one mutation of the amino acid sequence with respect to sequence ID no. 1 in at least one of the following positions selected from the group: 22, 23, 25, 26, 27, 29, 31, 32, 35, 37, 42, 43, 46, 51, 53, 54, 57, 60, 69, 72, 73, 78, 80, 84, 88, 95, 97, 99, 114, 118, 119, 123, 132, 141, 146, 148, 149, 154, 163, 164, 165, 169, 170, 172, 176, 180, 182, 183, 190, 191, 194, 196, 197, 198, 201, 204, 205, 206, 207, 208, 209, 210, 212, 213, 214, 216, 217, 220, 221, 222, 229, 231, 233, 238, 240, 244, 245, 246, 248, 249, 251, 254, 256, 260, 262, 263, 266, 269, 271, 277, 280, 281, 282, 283, 284, 285, 286, 287, 292, 296, 298, 302, 307, 308, 309, 311, 314, 317, 319, 321, 323, 325 and 326.

4. The polypeptide according to any one of claims 1, 2 or 3, characterized in that it has at least one mutation of the amino acid sequence with respect to sequence ID no. 1 selected from the group D22A, S23Q, S23L, N25D, I26V, F27Y, F27H, S29P, R31A, F32Y, R35K, R35Q, V37A, V42I, V43T, F46Y, S51E, S51D, D53G, N54M, N54R, L57V, L60I, S69G, P72E, V73A, A78S, N80H, F84Y, I88L, T95S, T97A, R99K, I114M, I118V, K119R, V123I, L132V, A141S, I146V, I146L, A148G, A149V, A154P, P163T, A164T, Y165C, Y165H, V169I, L170R, A172G, A176M, A176V, Y180F, D182T, F183Y, I190V, G191S, K194T, K194E, F196Y, V197C, V197R, E198R, E198S, K201D, K201G, P204S, P204A, A205S,

K206P, A207M, M208A, Q209R, L210A, L210S, ΔP212, T213V, P214A, E216T, E216G, A217I, N220H, L221M, K222R, K222Q, G229A, A231V, F233W, F233Y, F233H, A238G, H240N, H240S, D244E, R245Q, M246L, S248T, S248N, S248G, Q249R, K251N, I254V, I256L, A260M, T262D, T262G, I263T, E266D, E269H, E269N, L271V, L277E, E280A, E280L, H281R, H281Q, A282V, Q283R, D284L, D284R, I285L, I286M, R287E, R287D, R292K, R292T, Q296A, Q296E, H298V, L302S, L307Q, F308S, D309A, A311P, A314V, L317F, S319Q, S319P, S319R, S321A, S321T, T323A, P325A, A326P.

5. The polypeptide according to any one of claims 1 to 4, characterized in that it contains at least one of the following amino acid motifs selected from the group of sequence ID numbers 32 to 69 .

6. An isolated polynucleotide having a nucleotide sequence that codes for a polypeptide, wherein the polypeptide has the property of hydrolyzing zearalenone and/or at least one zearalenone derivative, characterized in that the nucleotide sequence codes from at least one polypeptide according to any one of claims 1 to 5 and/or the nucleotide sequence has a degree of sequence identity of at least 70 % for a nucleotide sequence selected from the group having sequence ID numbers 16 to 31 and/or the nucleotide sequence hydrolyzes under moderate stringency conditions with at least one nucleotide sequence, selected from the group of sequence ID numbers 16 to 31 and/or with a subsequence thereof having at least 200 nucleotides, in particular at least 100 nucleotides and/or a complementary strand of the nucleotide sequence or the subsequence thereof.

7. An additive that hydrolytically cleaves zearalenone and/or at least one zearalenone derivative to yield feed products for pigs, poultry or aquaculture, for addition to foodstuffs or to distillers dried grain and solubles, characterized in that the additive contains at least one polypeptide having an amino acid sequence selected from the group of sequence ID numbers 1 to 15 or a functional variant thereof, wherein a sequence identity between the functional variant and at least one of the amino acid sequences amounts to at least 70 % and auxiliary substances are also present.

8. The additive according to claim 7, characterized in that at least one polypeptide according to any one of the claims 1 to 5 is contained therein.

9. The additive according to claim 7 or 8, characterized in that the auxiliary substances are selected from at least one inert carrier as well as optional additional ingredients, such

as vitamins and/or minerals and/or enzymes and/or other components for detoxifying mycotoxins.

10. The additive according to claim 7, 8 or 9, characterized in that at least one whreuponconcentration of at most 10,000 U/g, preferably at most 1000 U/g, more preferably at most 100 U/g and most preferably at most 10 U/g.

11. The additive according to any one of claims 7 to 10, characterized in that the additive is present in encapsulated or coated form.

12. A use of at least one polypeptide having an amino acid sequence selected from the group of sequence ID numbers 1 to 15 or a functional variant thereof, wherein additives containing a sequence identity between the functional variant and at least one of the amino acid sequences amounts to at least 70 %, for hydrolytic cleavage of zearalenone and/or at least one zearalenone derivative in animal feed products, in particular pigs, poultry and aquaculture, in food items or in distillers dried grain and solubles.

13. The method for hydrolytic cleavage of zearalenone and/or at least one zearalenone derivative, characterized in that the zearalenone and/or at least one zearalenone derivative is/are hydrolyzed by a polypeptide having an amino acid sequence selected from the group of sequence ID numbers 1 to 15 or a functional variant thereof, wherein the sequence identity between the functional variant and at least one of the amino acid sequences is at least 70 %.

14. The method according to claim 13, characterized in that the polypeptide is used in an additive according to any one of claims 6 to 10.

15. The method according to claim 14, characterized in that the polypeptide or the additive is mixed with a foodstuff or animal feed product contaminated with zearalenone and/or with at least one zearalenone derivative; the contaminated foodstuff or animal feed product is brought in contact with moisture, and the polypeptide or the additive hydrolyzes the zearalenone and/or at least one zearalenone derivative present in contaminated foodstuff or animal feed product.

16. The method according to any one of claims 13 to 15, characterized in that at least 70 %, preferably at least 80 %, in particular at least 90 % of the zearalenone and/or at least one zearalenone derivative is/are hydrolyzed.