homology or structural similarity; and thaumatin shares extensive similarity at the protein sequence level with certain non-sweet proteins found in other plants.

[0007] International patent application PCT/US2020/012955, filed 01/09/2020, published as WO2020/146650 on 07/16/2020 relates to a sweeting composition comprising (i) mycelia of an ascomycete or an aqueous extract thereof or (ii) an aqueous extract of a fruiting body of an ascomycete and use of such composition to provide improve flavor to a product for oral administration. The application also relates to compositions comprising combinations of sweetening compositions and a product for oral administration.

[0008] International patent application PCT/US2021/039176, filed June 25, 2021, published as WO2021/263158 on December 30, 2021, relates to newly identified fungal sweet-taste modifying proteins and the cDNA encoding the proteins. The application further relates to Myd proteins active in sweet taste activation and the cDNA encoding the same and methods for isolating such cDNA and for isolating and expressing such proteins. The application also relates to a sweetening composition which includes the proteins and methods to provide improved flavor to a product for oral administration.

[0009] Thus, a need still remains for new low or zero calorie sweeteners with improved taste from natural sources, particularly from ascomycetes fungal species. A need also remains for producing fungally-derived low or zero calorie sweeteners with improved taste and methods of using such.

SUMMARY OF THE INVENTION

[0010] The present invention meets these and other needs by providing the newly identified first fungally-derived sweet-tasting protein identified herein as Myd1, and more generally as the Myd family of proteins, as well as the genes and cDNA encoding such proteins, and methods of using such proteins, genes, and cDNA in the modulation of the taste of foods. The invention provides, in particular, DNA sequences, herein identified as *MYD1*, encoding the corresponding sweet polypeptide Myd1 (also referred to as mycodulcein, and Honey Truffle Sweetener (HTS)), the first sweet-tasting protein identified from fungi. The polypeptides of the invention modulate sweet taste and perception, either alone, or in combination with food, beverage, dietary supplement, or pharmaceuticals. Myd1 reduces the sourness, bitterness or astringency of foods and drinks; and Myd1 also has an activity to enhance the taste of foods and drinks, namely a taste-modifying activity.

[0010a] In a first aspect, the present disclosure provides a polynucleotide encoding a polypeptide selected from the group consisting of:

(a) a polypeptide of sequence selected from the group consisting of SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137 and SEQ ID NO:140;

(b) a polypeptide having at least 95% sequence identity to the polypeptide sequence selected from the group consisting of SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137 and SEQ ID NO:140; and

(c) a polypeptide of sequence modified from the polypeptide sequence selected from the group consisting of SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137 and SEQ ID NO:140 by deletion, insertion, substitution, or addition of no more than 6 amino acids,

wherein the encoded polypeptide has a sweet-taste modulation activity and is not the polypeptide of SEQ ID NO:3

[0010b] In a second aspect, the present disclosure provides an expression cassette comprising the polynucleotide of the disclosure.

[0010c] In a third aspect, the present disclosure provides a vector comprising the polynucleotide of the disclosure.

[0010d] In a fourth aspect, the present disclosure provides a host cell transformed with an expression cassette or a vector comprising the polynucleotide of the disclosure.

[0010e] In a fifth aspect, the present disclosure provides a host cell expressing the polynucleotide of the disclosure.

[0010f] In a sixth aspect, the present disclosure provides a method of producing a protein having sweet-taste modulation activity comprising:

culturing the host cell of the fourth or fifth aspects in a medium under conditions for protein expression.

[0010g] In a seventh aspect, the present disclosure provides a polypeptide having sweet-taste modulation activity comprising:

(a) a polypeptide sequence selected from the group consisting of SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137 and SEQ ID NO:140;

(b) a polypeptide having at least 95% sequence identity to the polypeptide sequence selected from the group consisting of SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137 and SEQ ID NO:140 (c) a polypeptide of sequence modified from the polypeptide sequence selected from the group consisting of SEQ ID NO:3, 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:15, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137, and SEQ ID NO:140SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137 and SEQ ID NO:140

by deletion, insertion, substitution, or addition of no more than 6 amino acids, and wherein

the polypeptide is not the polypeptide of SEQ ID NO:3.

[0010h] In an eighth aspect, the present disclosure provides a composition, comprising:

(a) a product for oral administration, wherein the product differs from *Mattirolomyces terfezioides* truffle, and

(b) a sweetening composition comprising a polypeptide of the disclosure,

wherein the combination has enhanced sweet taste compared to the product for oral administration.

[0010i] In a ninth aspect, the present disclosure provides a method for modulating the taste of a product for oral administration, comprising:

combining a product for oral administration with an effective amount of a sweetening composition comprising a polypeptide of the disclosure,

wherein the product for oral administration differs from *Mattirolomyces terfezioides* truffle and the combination has enhanced sweet taste compared to the product for oral administration.

[0011] Accordingly, one example of the invention provides a polynucleotide (e.g., isolated polynucleotide) encoding a polypeptide, wherein the encoded polypeptide has a sweet-taste modulation activity and optionally different in amino acid sequence from polypeptide SEQ ID

NO:3. In embodiments, the encoded polypeptide is selected from the group consisting of (a) a polypeptide sequence selected from the group consisting of 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:15, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:71, SEQ ID NO:72, SEQ ID NO:73, SEQ ID NO:74, SEQ ID NO:75, SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137, SEQ ID NO:140 and SEQ ID NO:141; (b) a polypeptide having at least 80% sequence identity to a polypeptide sequence selected from the group consisting of SEQ ID NO:3, 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:15, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137, and SEQ ID NO:140; and (c) a polypeptide sequence modified from the polypeptide sequence selected from the group consisting of SEQ ID NO:3, 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:15, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137, and SEQ ID NO:140 by deletion, insertion, substitution, or addition of no more than 24 amino acids and wherein the polypeptide sequence is optionally different from that of SEQ ID NO:3.

[0012] Another example of the invention provides a polynucleotide (e.g., isolated polynucleotide) encoding a polypeptide having sweet-taste modulation activity. The polynucleotide is selected from the group consisting of: (a) a polynucleotide comprising SEQ ID NO:2 optionally with at least one modification; (b) a polynucleotide comprising a nucleic acid sequence having at least 80% sequence identity to SEQ ID NO:2 and optionally different from SEQ ID NO:2, (c) a polynucleotide comprising (i) SEQ ID NO:2 and (ii) a nucleotide sequence encoding a histidine tag. In an embodiment, the polynucleotide encoding a polypeptide having sweet-taste modulation activity is a polynucleotide other than that of SEQ ID NO:2.

[0013] Another example of the invention provides a polynucleotide (e.g., isolated polynucleotide) encoding a polypeptide having sweet-taste modulation activity. The polynucleotide is selected from the group consisting of: (a) a polynucleotide comprising the nucleotide of SEQ ID NO:76, SEQ ID NO:77, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:85,

NO:125, SEQ ID NO:126, SEQ ID NO:128, SEQ ID NO:129, SEQ ID NO:130, SEQ ID NO:131, SEQ ID NO:133, SEQ ID NO:134, SEQ ID NO:135, SEQ ID NO:136, SEQ ID NO:138, or SEQ ID NO:139 excluding the sequences in each of the listed SEQ ID NOs which encode the histidine tag; and (e) a polynucleotide comprising a nucleic acid sequence having at least 80% sequence identity to the nucleotide of SEQ ID NO:76, SEQ ID NO:77, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:85, SEQ ID NO:86, SEQ ID NO:88, SEQ ID NO:89, SEQ ID NO:90, SEQ ID NO:91, SEQ ID NO:93, SEQ ID NO:94, SEQ ID NO:96, SEQ ID NO:97, SEQ ID NO:99, SEQ ID NO:100, SEQ ID NO:102, SEQ ID NO:103, SEQ ID NO:104, SEQ ID NO:105, SEQ ID NO:107, SEQ ID NO:108, SEQ ID NO:110, SEQ ID NO:111, SEQ ID NO:112, SEQ ID NO:113, SEQ ID NO:115, SEQ ID NO:116, SEQ ID NO:117, SEQ ID NO:118, SEQ ID NO:120, SEQ ID NO:121, SEQ ID NO:122, SEQ ID NO:123, SEQ ID NO:125, SEQ ID NO:126, SEQ ID NO:128, SEQ ID NO:129, SEQ ID NO:130, SEQ ID NO:131, SEQ ID NO:133, SEQ ID NO:134, SEQ ID NO:135, SEQ ID NO:136, SEQ ID NO:138, or SEQ ID NO:139 excluding the sequences in each of the listed SEQ ID NOs which encode the histidine tag.

[0014] In other examples, the polynucleotide encoding the polypeptide having sweet-taste modulation activity is optionally operably linked to a heterologous regulatory element. Additionally or alternatively, the polynucleotide sequence further encodes a protein tag or label. The protein tag is optionally an affinity tag. The protein tag is optionally a histidine tag. In specific examples, the polynucleotide encoding the polypeptide having sweet-taste modulation activity is the nucleotide of SEQ ID NO:2 further encodes a protein tag or label. In specific examples, the polynucleotide encoding the polypeptide having sweet-taste modulation activity is the nucleotide of SEQ ID NO:2 optionally operably linked to a heterologous regulatory element. Additionally or alternatively, the nucleotide of SEQ ID NO:2 operably linked to a heterologous regulatory element further encodes a protein tag or label. The protein tag is optionally an affinity tag. The protein tag is optionally a histidine tag. The protein tag is optionally $(His)_6$.

[0015] In specific examples, the polynucleotide encoding the polypeptide having sweet-taste modulation activity is SEQ ID NO:76, SEQ ID NO:77, SEQ ID NO:79, SEQ ID NO:80, SEQ ID NO:82, SEQ ID NO:83, SEQ ID NO:85, SEQ ID NO:86, SEQ ID NO:88, SEQ ID NO:89, SEQ ID NO:90, SEQ ID NO:91, SEQ ID NO:93, SEQ ID NO:94, SEQ ID NO:96, SEQ ID NO:97, SEQ ID NO:99, SEQ ID NO:100, SEQ ID NO:102, SEQ ID NO:103, SEQ ID NO:104, SEQ ID NO:105, SEQ ID NO:107, SEQ ID NO:108, SEQ ID NO:110, SEQ ID NO:111, SEQ ID NO:112, SEQ ID NO:113, SEQ ID NO:115, SEQ ID NO:116, SEQ ID NO:117, SEQ ID NO:118, SEQ ID NO:120, SEQ ID NO:121, SEQ ID NO:122, SEQ ID NO:123, SEQ ID NO:125, SEQ ID NO:126, SEQ ID NO:128, SEQ ID NO:129, SEQ ID NO:130, SEQ ID NO:131, SEQ ID NO:133, SEQ ID NO:134,

[0016] Another example of the invention provides a polynucleotide comprising the nucleotide of SEQ ID NO:20, which corresponds to the coding sequence for His tagged mycodulcein in *E. coli* (wherein residues 364-381 correspond to an optional His tag sequence). SEQ ID NO:20 is codon-optimized for expression in *E. coli*. In a related example, the invention provides a polynucleotide having at least 80% sequence identity to the nucleotide of SEQ ID NO:20. In yet another example, the polynucleotide comprises SEQ ID NO:22, which corresponds to the coding sequence for His tagged mycodulcein in *S. cerevisiae* (wherein residues 364-381 correspond to an optional His tag sequence). SEQ ID NO:22 is codon-optimized for expression in *S. cerevisiae*. The corresponding polypeptide of SEQ ID NO:21 corresponds to the His-tagged mycodulcein protein (wherein residues 122-127 correspond to the optional His tag sequence), which polypeptide sequence is the same for expression in *E. coli* and *S. cerevisiae*. In a related example, the invention provides a polynucleotide having at least 80% sequence identity to the nucleotide of SEQ ID NO:22.

[0017] In additional examples, the invention provides an expression cassette comprising the polynucleotide and a vector comprising the polynucleotide, as well as a host cell transformed with the vector is provided. Additionally, a method of producing a protein having sweet-taste modulation activity, comprising culturing the transformed host cell in a medium under conditions that result in producing the protein having sweet-taste modulation activity also is provided.

[0018] Another example of the invention provides a polypeptide (e.g., isolated polypeptide) having sweet-taste modulation activity and comprising (i) a polypeptide sequence selected from that of SEQ ID NO:3, 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:15, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:71, SEQ ID NO:72, SEQ ID NO:73, SEQ ID NO:74, SEQ ID NO:75, SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137, SEQ ID NO:140 and SEQ ID NO:141; wherein the polypeptide sequence is optionally different from SEQ ID NO:3 or (ii) a polypeptide having at least 80% sequence identity to a polypeptide sequence selected from the group consisting of SEQ ID NO:3, 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:15, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137, and SEQ ID NO:140, wherein the polypeptide sequence is optionally different from SEQ ID NO:3. In additional examples, the polypeptide (a) contains at least one modification relative to a polypeptide sequence selected from

the group consisting of SEQ ID NO:3, 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:15, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137, and SEQ ID NO:140, wherein the polypeptide is optionally different from polypeptide SEQ ID NO:3, or (b) further comprises a protein tag, particularly a histidine tag, and wherein the polypeptide has sweet-taste modulation activity.

[0019] Another example of the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising an amino acid sequence selected from the group consisting of SEQ ID NO:71, SEQ ID NO:72, SEQ ID NO:73, SEQ ID NO:74, SEQ ID NO:75, and SEQ ID NO:141, wherein the polypeptide optionally differs from SEQ ID NO:3. Another example of the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising an amino acid sequence selected from the group consisting of SEQ ID NO:71, SEQ ID NO:72, SEQ ID NO:73, SEQ ID NO:74, SEQ ID NO:75, and SEQ ID NO:141, wherein the polypeptide differs from SEQ ID NO:3.

[0020] In another example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by at least one mutation selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by two mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by three mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by four mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by five mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by six mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide)

comprising the amino acid sequence of SEQ ID NO:3 which is modified by seven mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by eight mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by nine mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by ten mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by eleven mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by twelve mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by thirteen mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by fourteen mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by fifteen mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by sixteen mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by seventeen mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by eighteen mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by

nineteen mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by twenty mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by twenty one mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by twenty two mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by twenty three mutations at different positions selected from those listed in Table 7. In a related example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by twenty four mutations at different positions selected from those listed in Table 7. The invention also provides polynucleotides encoding the foregoing mutant polypeptides of SEQ ID NO:3. The invention further provides the foregoing mutant polypeptides which further comprise a protein tag and more specifically a histidine tag. The invention also provides polynucleotides encoding the foregoing mutant polypeptides of SEQ ID NO:3 which further comprise a protein tag and more specifically a histidine tag.

[0021] In another example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by at least one mutation selected from mutations Q37K, Q37E, Q37N, V74A, V76A, V87A, V100A or Q102K. In another example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by two mutations at different positions selected from mutations Q37K, Q37E, Q37N, V74A, V76A, V87A, V100A or Q102K. In another example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by three mutations at different positions selected from mutations Q37K, Q37E, Q37N, V74A, V76A, V87A, V100A or Q102K. In another example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by four mutations at different positions selected from mutations Q37K, Q37E, Q37N, V74A, V76A, V87A, V100A or Q102K. In another example, the invention provides a polypeptide having sweet-taste

modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by five mutations at different positions selected from mutations Q37K, Q37E, Q37N, V74A, V76A, V87A, V100A or Q102K. In another example, the invention provides a polypeptide having sweet-taste modulation activity (e.g., isolated polypeptide) comprising the amino acid sequence of SEQ ID NO:3 which is modified by six mutations at different positions selected from mutations Q37K, Q37E, Q37N, V74A, V76A, V87A, V100A or Q102K. The invention also provides polynucleotides encoding the foregoing mutant polypeptides of SEQ ID NO:3. The invention further provides the foregoing mutant polypeptides which further comprise a protein tag and more specifically a histidine tag. The invention also provides polynucleotides encoding the foregoing mutant polypeptides of SEQ ID NO:3 which further comprise a protein tag and more specifically a histidine tag.

[0022] In another example, the polypeptides of the invention are optionally isolated and/or optionally purified. In another example, the polynucleotides of the invention are optionally isolated and/or purified. In another example, the polypeptides of the invention optionally comprise a protein tag. In another example, the polypeptides of the invention optionally comprise a histidine tag.

[0023] Another example of the invention provides a composition. The composition includes a combination of (a) a product for oral administration other than *Mattirolomyces terfezioides* truffle, and (b) a sweetening composition comprising the polypeptide, wherein the combination has enhanced sweet taste compared to the product for oral administration. The polypeptide includes one or more amino acid sequences, either individually or in a combination of two or more thereof having sweet-taste modulation activity and comprising (i) a polypeptide sequence selected from SEQ ID NO:3, 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:15, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:71, SEQ ID NO:72, SEQ ID NO:73, SEQ ID NO:74, SEQ ID NO:75, SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137, SEQ ID NO:140 and SEQ ID NO:141, wherein the polypeptide sequence is optionally different from SEQ ID NO:3; or (ii) a polypeptide having at least 80% sequence identity to a polypeptide sequence selected from the group consisting of SEQ ID NO:3, 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:15, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137, and SEQ ID NO:140, wherein the

polypeptide sequence is optionally different from SEQ ID NO:3; or (iii) wherein the polypeptide of SEQ ID NO listed above further comprises a protein tag, wherein the protein tag is optionally a histidine tag.

[0024] Another more specific example of the invention provides a composition including a combination of (a) a product for oral administration other than *Mattirolomyces terfezioides* truffle, and (b) a sweetening composition comprising the polypeptide, wherein the combination has enhanced sweet taste compared to the product for oral administration. The polypeptide includes (a) one or more amino acid sequences selected from the group consisting of the amino acid sequences of SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID NO:101, SEQ ID NO:106, SEQ ID NO:109, SEQ ID NO:114, SEQ ID NO:119, SEQ ID NO:124, SEQ ID NO:127, SEQ ID NO:132, SEQ ID NO:137, and SEQ ID NO:140, (b) one or more amino acid sequences selected from the group consisting of the amino acid sequences of 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:15, SEQ ID NO:16, SEQ ID NO:17, or (c) one or more amino acid sequences selected from the group consisting of the amino acid sequences of SEQ ID NO:71, SEQ ID NO:72, SEQ ID NO:73, SEQ ID NO:74, SEQ ID NO:75 and SEQ ID NO: 141. In embodiments, the polypeptide is not the polypeptide of SEQ ID NO:3.

[0025] Another example of the invention provides a method for modulating the taste of a product for oral administration. The method comprises combining the product for oral administration with an effective amount of a sweetening composition comprising the polypeptide, wherein the product for oral administration differs from *Mattirolomyces terfezioides* truffle, and wherein the combination has enhanced sweet taste compared to the product for oral administration. The polypeptide includes one or more sequences as listed herein, either individually or in a combination of two or more thereof.

[0026] Another example of the invention provides a method of purifying a polypeptide having sweet-taste modulation activity. The method includes: (a) conducting a hydrophobic interaction chromatography (HIC) on a composition comprising a polypeptide, and (b) then conducting size exclusion chromatography (SEC) on the composition comprising the polypeptide. The polypeptide includes one or more sequences, either individually or in a combination of two or more thereof having sweet-taste modulation activity and comprising (i) a polypeptide sequence selected from SEQ ID NO:3, 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:15, SEQ ID NO:16, SEQ ID NO:17, SEQ ID NO:71, SEQ ID NO:72, SEQ ID NO:73, SEQ ID NO:74, SEQ ID NO:75, SEQ ID NO:78, SEQ ID NO:81, SEQ ID NO:84, SEQ ID NO:87, SEQ ID NO:92, SEQ ID NO:95, SEQ ID NO:98, SEQ ID