Summary of Invention

Technical Problem

[0006] It is an object of the present invention to provide an agent for enhancing lipid metabolism which is capable of efficiently reducing body fats by enhancing lipid metabolism more effectively.

Solution to Problem

[0007] As a result of intensive studies for materials that enhance fat metabolism and efficiently reduce body fats, the present inventors have found that an amino acid mixture containing arginine, phenylalanine, and alanine, which are major amino acids that have been eaten, at high concentrations has a high lipid metabolism-enhancing effect and a high anti-obesity effect, thereby accomplishing the present invention.

[0008] Specifically, it has been found that, as a result of monitoring the amount of change in blood glycerol in animals to which adrenaline is administered, a composition containing a combination of two or more of arginine, phenylalanine, and alanine at high concentrations significantly enhances lipolysis as compared to conventional amino acid compositions. Further, the lipid metabolism-enhancing effect could be observed in animals subjected to high-fat diet feeding and exercise and also in humans subjected to exercise.

[0009] That is, the present invention includes the following aspect:

[0010]

An agent for enhancing lipid metabolism comprising an amino acid mixture comprising arginine, alanine, and phenylalanine, wherein the agent comprises the amino acids in a molar ratio of 60 mol or more, in total, per 100 mol of an amount of all amino acids.

Also described herein are the following examples:

[1] An agent for enhancing lipid metabolism comprising an amino acid mixture comprising at least two amino acids selected from the group consisting of arginine, alanine, and phenylalanine, wherein the agent comprises the at least two amino acids in a molar ratio of 60 mol or more, in total, per 100 mol of an amount of all amino acids;

[0011]

[2] The agent for enhancing lipid metabolism according to the aforementioned example [1], wherein the amino acid mixture comprises arginine, alanine, and phenylalanine;

[0012]

[3] The agent for enhancing lipid metabolism according to the aforementioned example [1] or [2], wherein the agent comprises arginine, alanine, and phenylalanine in a molar ratio of arginine:alanine:phenylalanine of 8-30 mol:18-30 mol:10-20 mol, per 100 mol of the amount of all amino acids;

[0013]

[4] The agent for enhancing lipid metabolism according to any one of the aforementioned examples [1] to [3], wherein the amounts of arginine, alanine, and phenylalanine contained satisfy at least one weight ratio of (i) arginine:alanine of 1.5:1 to 1:1.5, (ii) alanine:phenylalanine of 4:1 to 1:4, and (iii) arginine:phenylalanine of 1:1 to 1:4;

[0014]

[5] The agent for enhancing lipid metabolism according to any one of the aforementioned examples [1] to [4], wherein the agent comprises arginine, alanine, and phenylalanine in a molar ratio of 100 mol, in total, per 100 mol of the amount of all amino acids;

[0015]

[6] The agent for enhancing lipid metabolism according to any one of the aforementioned examples [1] to [4], wherein the amino acid mixture further comprises glycine, and the agent comprises arginine, alanine, phenylalanine, and glycine in a molar ratio of 85 mol or more, in total, per 100 mol of the amount of all amino acids;

[0016]

[7] The agent for enhancing lipid metabolism according to any one of the aforementioned examples [1] to [4] and [6], wherein the amino acid mixture further comprises exclusively proline, lysine, tyrosine, threonine, leucine, valine, isoleucine, glutamic acid, tryptophan, histidine, serine, methionine, and aspartic acid as other amino acids;

[0017]

[8] The agent for enhancing lipid metabolism according to the aforementioned example [7], wherein the amino acid mixture comprises the other amino acids in the following molar ratios per 100 mol of the amount of all amino acids:

0.01 to 4 mol of proline,

0.01 to 2 mol of lysine,

0.01 to 2 mol of tyrosine,

0.01 to 2 mol of threonine,

0.01 to 2 mol of leucine,

0.01 to 2 mol of valine,

0.01 to 2 mol of isoleucine,

0.01 to 1 mol of glutamic acid,

0.01 to 1 mol of tryptophan,

0.01 to 1 mol of histidine,

0.01 to 1 mol of serine,

0.01 to 0.2 mol of methionine, and

0.01 to 0.1 mol of aspartic acid;

[0018]

[9] The agent for enhancing lipid metabolism according to any one of the aforementioned examples [1] to [8], wherein the agent is for use in acting on a condition where adrenaline secretion is increased;

[0019]

[10] The agent for enhancing lipid metabolism according to the aforementioned example [9], wherein the condition where adrenaline secretion is increased is a condition of being stimulated by exercise, stress, cold exposure, bathing, or overeating; and

[0020]

[11] The agent for enhancing lipid metabolism according to any one of the aforementioned examples [1] to [10], wherein the agent is for the enhancement of lipid metabolism that is accompanied by at least one selected from the group consisting of increased blood glycerol concentration, suppressed weight gain, increased blood free fatty acid concentration, increased

blood glucagon concentration, reduced blood cortisol concentration, increased blood total ketone body concentration, increased blood 3-hydroxybutyric acid concentration, and increased UCP-1 expression level in brown adipose tissue.

[0021]

The present disclosure further includes the following examples:

[0022]

[a] A agent for enhancing lipid metabolism comprising arginine, alanine, and phenylalanine as active ingredients, wherein the total number of moles of arginine, alanine, and phenylalanine is 60 mol or more, per 100 mol of the total number of moles of all amino acids;

[b] The agent for enhancing lipid metabolism according to the aforementioned example [a], comprising arginine in a molar ratio of 8 to 30 mol, alanine in a molar ratio of 18 to 30 mol, and phenylalanine in a molar ratio of 10 to 20 mol;

[c] The agent for enhancing lipid metabolism according to the aforementioned example [a] or [b], wherein the total number of moles of arginine, alanine, and phenylalanine is 100 mol, per 100 mol of the total number of moles of all amino acids;

[d] An agent for enhancing lipid metabolism comprising arginine, alanine, phenylalanine, and glycine as active ingredients, wherein the total number of moles of arginine, alanine, phenylalanine, and glycine is 85 mol or more, per 100 mol of the total number of moles of all amino acids;

[e] The agent for enhancing lipid metabolism according to the aforementioned example [d], comprising arginine in a molar ratio of 8 to 30 mol, alanine in a molar ratio of 18 to 30 mol, phenylalanine in a molar ratio of 10 to 20 mol, and the glycine in a molar ratio of 20 to 27 mol;

[f] The agent for enhancing lipid metabolism according to the aforementioned example [d] or [e], wherein the total number of moles of arginine, alanine, phenylalanine, and glycine is 100 mol, per 100 mol of the total number of moles of all amino acids;

[g] The agent for enhancing lipid metabolism according to the aforementioned example [a] or [d], further comprising exclusively proline, lysine, tyrosine, threonine, leucine, valine,

isoleucine, glutamic acid, tryptophan, histidine, serine, methionine, and aspartic acid as other amino acids;

[h] The agent for enhancing lipid metabolism according to the aforementioned example [b] or [e], further comprising exclusively the following amino acids as the other amino acids in the following molar ratios:

0.01 to 4 mol of proline,

0.01 to 2 mol of lysine,

0.01 to 2 mol of tyrosine,

0.01 to 2 mol of threonine,

0.01 to 2 mol of leucine,

0.01 to 2 mol of valine,

0.01 to 2 mol of isoleucine,

0.01 to 1 mol of glutamic acid,

0.01 to 1 mol of tryptophan,

0.01 to 1 mol of histidine,

0.01 to 1 mol of serine,

0.01 to 0.2 mol of methionine, and

0.01 to 0.1 mol of aspartic acid;

[i] The agent for enhancing lipid metabolism according to any one of the aforementioned examples [a] to [h], wherein the agent for enhancing lipid metabolism is ingested in a condition where adrenaline secretion is increased;

[j] The agent for enhancing lipid metabolism according to the aforementioned example [i], wherein the condition where adrenaline secretion is increased is a condition of being stimulated by exercise, stress, cold exposure, bathing, or overeating;

[k] The agent for enhancing lipid metabolism according to any one of the aforementioned examples [a] to [j], wherein the agent for enhancing lipid metabolism increases UCP-1 expression level in brown adipose tissue;

[l] The agent for enhancing lipid metabolism according to any one of the aforementioned examples [a] to [j], wherein the agent for enhancing lipid metabolism enhances breakdown of fats into fatty acids;

[m] The agent for enhancing lipid metabolism according to any one of the aforementioned examples [a] to [j], wherein the agent for enhancing lipid metabolism enhances conversion of fatty acids into heat; and [n] The agent for enhancing lipid metabolism according to any one of the aforementioned examples [a] to [j], wherein the agent for enhancing lipid metabolism enhances conversion of fatty acids into energy.

Effect of Invention

[0023] The agent for enhancing lipid metabolism of the present invention has an effect of enhancing lipid metabolism and can efficiently exhibit the lipid metabolism-enhancing effect particularly in a condition where adrenaline secretion is increased.

[0024] This description includes the disclosure in JP Patent Application No. 2013-168690 to which the present application claims priority.

Brief Description of Drawings

[0025] [Figure 1] Figure 1 shows the rate of change in blood glycerol concentration determined in Example 1 (the rate of change in glycerol AUC; Glycerol AUC change (%) of Vehicle group).

[Figure 2] Figure 2 shows transitions of the amount of change (Δ glycerol) in blood glycerol concentration determined in Example 2. #: $p < 0.05$ (vs. Vehicle group, Fisher's PLSD test).

[Figure 3] Figure 3 shows transitions of the amount of change (Δ glycerol) in blood glycerol concentration determined in Example 3. Means ± standard error are indicated. *: $p < 0.05$ (vs. Vehicle group, Fisher's PLSD test).

[Figure 4] Figure 4 shows transitions of body weight measured in Example 4 (Figure 4A), and shows values of feed intake/body weight during the test period (Figure 4B). Means ± standard error are indicated. Normal group: There is a significant difference in body weight from the 3rd day (Day 3) to the 42nd day (Day 42). Preparation Example 3 group: There is a significant difference in body weight from the 3rd day (Day 3) to the 39th day (Day 39). (vs. High-fat group, $p < 0.05$, Fisher's PLSD test).

Claims

1. An agent for enhancing lipid metabolism comprising:

an amino acid mixture comprising arginine, alanine, and phenylalanine,

wherein the agent comprises the amino acids in a molar ratio of 60 mol or more, in total, per 100 mol of an amount of all amino acids.

2. The agent for enhancing lipid metabolism according to claim 1, wherein the agent comprises arginine, alanine, and phenylalanine in a molar ratio of arginine:alanine:phenylalanine of 8-50 mol:18-50 mol:10-70 mol, per 100 mol of the amount of all amino acids.

3. The agent for enhancing lipid metabolism according to claim 1 or 2, wherein the amounts of arginine, alanine, and phenylalanine contained satisfy at least one weight ratio of (i) arginine:alanine of 1.5:1 to 1:1.5, (ii) alanine:phenylalanine of 4:1 to 1:4, and (iii) arginine:phenylalanine of 1:1 to 1:4.

4. The agent for enhancing lipid metabolism according to any one of claims 1 to 3, wherein the amounts of arginine, alanine, and phenylalanine contained satisfy a weight ratio of 2 to 3 :1 to 1.5 :1.

5. The agent for enhancing lipid metabolism according to any one of claims 1 to 3, wherein the amounts of arginine, alanine, and phenylalanine contained satisfy a weight ratio of 1:1:1 to 1:1:3.

6. The agent for enhancing lipid metabolism according to any one of claims 1 to 5, wherein the agent comprises arginine, alanine, and phenylalanine in a molar ratio of 100 mol, in total, per 100 mol of the amount of all amino acids.

7. The agent for enhancing lipid metabolism according to any one of claims 1 to 5, wherein the amino acid mixture further comprises glycine, and the agent comprises arginine, alanine, phenylalanine, and glycine in a molar ratio of 85 mol or more, in total, per 100 mol of the amount of all amino acids.

8. The agent for enhancing lipid metabolism according to any one of claims 1 to 5 and 7, wherein the amino acid mixture further comprises exclusively proline, lysine, tyrosine, threonine, leucine, valine, isoleucine, glutamic acid, tryptophan, histidine, serine, methionine, and aspartic acid as other amino acids.

9. The agent for enhancing lipid metabolism according to claim 8, wherein the amino acid mixture comprises the other amino acids in the following molar ratios per 100 mol of the amount of all amino acids:

0.01 to 4 mol of proline,
0.01 to 2 mol of lysine,
0.01 to 2 mol of tyrosine,
0.01 to 2 mol of threonine,
0.01 to 2 mol of leucine,
0.01 to 2 mol of valine,
0.01 to 2 mol of isoleucine,
0.01 to 1 mol of glutamic acid,
0.01 to 1 mol of tryptophan,
0.01 to 1 mol of histidine,
0.01 to 1 mol of serine,
0.01 to 0.2 mol of methionine, and
0.01 to 0.1 mol of aspartic acid.

10. The agent for enhancing lipid metabolism according to any one of claims 1 to 9, wherein the agent is for use in enhancing lipid metabolism in a subject having a condition where adrenaline secretion is increased.

11. The agent for enhancing lipid metabolism according to claim 10, wherein the condition where adrenaline secretion is increased is a condition of being stimulated by exercise, stress, cold exposure, bathing, or overeating.

12. The agent for enhancing lipid metabolism according to any one of claims 1 to 11, wherein the agent is for the enhancement of lipid metabolism that is accompanied by at least one selected from the group consisting of increased blood glycerol concentration, suppressed weight gain, increased blood free fatty acid concentration, increased blood glucagon concentration, reduced blood cortisol concentration, increased blood total ketone body concentration, increased blood 3-hydroxybutyric acid concentration, and increased UCP-1 expression level in brown adipose tissue.