CLAIMS

1. A method for selecting a bacterial strain for use in treating ~~serotonin deficiency and/or~~ a disease related to serotonin deficiency, the method comprising:

culturing (S1), under aerobic conditions, bacteria of a ~~lactic acid producing~~ *Lactobacillus* bacterial strain selected from the group consisting of a *L. reuteri* bacterial strain and a *L.* mucosae bacterial strain in a culture medium comprising tryptophan;

detecting (S2) any serotonin produced by the bacteria of the ~~lactic acid producing~~ *Lactobacillus* bacterial strain in the culture medium or a sample thereof; ~~and~~

determining (S15) whether the bacteria of the *Lactobacillus* bacterial strain are capable of attaching to intestinal mucus and/or are capable of adhering to a gastrointestinal mucosa; and

selecting (S3) the ~~lactic acid producing~~ *Lactobacillus* bacterial strain as effective in treating ~~serotonin deficiency and/or~~ a disease related to serotonin deficiency in a subject if serotonin is detected in the culture medium or the sample thereof and if the bacteria of the *Lactobacillus* bacterial strain are capable of attaching to intestinal mucus and/or are capable of adhering to the gastrointestinal mucosa, wherein the disease related to serotonin deficiency is selected from the group consisting of anxiety, depressed mood, aggression, poor memory, eating disorders, obsessive-compulsive disorder, panic disorder, post-traumatic stress disorder, social anxiety disorder, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), a cardiovascular disease, osteoporosis, gastrointestinal motility disorder, autoimmune polyendocrinopathy-candidiasis-ectodermal dystrophy (APECED), osteopenia and a bone loss condition.

2. The method according to claim 1, wherein the culture medium comprises ~~tryptophan and~~ a carbon source.

3. The method according to claim 1 or 2, wherein selecting (S3) the ~~lactic acid producing~~ *Lactobacillus* bacterial strain comprises selecting (S3) the ~~lactic acid producing~~ *Lactobacillus* bacterial strain as effective in treating ~~serotonin deficiency and/or~~ the disease related to serotonin deficiency in a subject if the ~~lactic acid producing~~ *Lactobacillus* bacterial strain is capable of producing serotonin and extracellularly releasing serotonin as detected in the culture medium or the sample thereof and if the bacteria of the *Lactobacillus* bacterial strain are capable of attaching to intestinal mucus and/or are capable of adhering to the gastrointestinal mucosa.

4. The method according to any of the claims 1 to 3, further comprising:

culturing (S10), under anaerobic conditions, bacteria of the ~~lactic acid producing~~ *Lactobacillus* bacterial strain in a culture medium comprising tryptophan;

detecting (S11) any serotonin produced by the bacteria of the ~~lactic acid producing~~ *Lactobacillus* bacterial strain in the culture medium or a sample thereof when cultured under anaerobic conditions; and

calculating (S12) a ratio between a concentration of serotonin detected in the culture medium or the sample thereof when cultured under aerobic conditions and a concentration of serotonin detected in the culture medium or the sample thereof when cultured under anaerobic conditions, wherein

selecting (S3) the ~~lactic acid producing~~ *Lactobacillus* bacterial strain comprises selecting (S3) the ~~lactic acid producing~~ *Lactobacillus* bacterial strain as effective in treating ~~serotonin deficiency and/or~~ the disease related to serotonin deficiency in a subject if the ratio is equal to or larger than 1.0, preferably larger than 1.0, and if the bacteria of the *Lactobacillus* bacteria strain are capable of attaching to intestinal mucus and/or are capable of adhering to the gastrointestinal mucosa.

~~5. The method according to any of the claims 1 to 4, further comprising:~~

~~determining (S15) whether the bacteria of the lactic acid producing bacterial strain are capable of attaching to intestinal mucus and/or are capable of adhering to a gastrointestinal mucosa, wherein~~

~~selecting (S3) the lactic acid producing bacterial strain comprises selecting (S3) the lactic acid producing bacterial strain as effective in treating serotonin deficiency and/or the disease related to serotonin deficiency in a subject if serotonin is detected in the culture medium or the sample thereof and if the bacteria of the lactic acid producing bacterial strain are capable of attaching to intestinal mucus and/or are capable of adhering to the gastrointestinal mucosa.~~

5. The method according to any of the claims 1 to 4, wherein selecting (S3) the *Lactobacillus* bacterial strain comprises selecting (S3) the *Lactobacillus* bacterial strain as effective in treating the disease related to serotonin deficiency in a subject if serotonin is detected in the culture medium or the sample thereof and if the bacteria of the *Lactobacillus* bacterial strain have a mucus adhesion ability that is higher than a mucus adhesion ability of *Lactobacillus reuteri* DSM 27131.

~~6. A method for selecting a bacterial strain for use in treating serotonin deficiency and/or a disease related to serotonin deficiency, the method comprising:~~

~~feeding (S20) a germ free *Tph1-/-* subject with bacteria of a lactic acid producing bacterial strain;~~

~~detecting (S21) any serotonin produced by the bacteria of the lactic acid producing bacterial strain in a body sample taken from the germ free *Tph1-/-* subject; and~~

~~selecting (S22) the lactic acid producing bacterial strain as effective in treating serotonin deficiency and/or a disease related to serotonin deficiency in a subject if serotonin is detected in the body sample.~~

~~7. The method according to any of the claims 1 to 6, wherein the lactic acid producing bacterial strain is a *Lactobacillus* bacterial strain.~~

~~8. The method according to claim 7, wherein the *Lactobacillus* bacterial strain is selected from the group consisting of a *L. reuteri* bacterial strain, a *L. mucosae* bacterial strain, and a *L. plantarum* bacterial strain.~~

6. A *Lactobacillus reuteri* strain selected from the group consisting of *L. reuteri* strain DSM 33509, *L. reuteri* strain DSM 33632, *L. reuteri* strain DSM 33633, *L. reuteri* strain DSM 33634, and *L. reuteri* strain DSM 33635, preferably in lyophilized form.

7. A *Lactobacillus reuteri* strain according to claim 6 for use as a medicament.

8. A *Lactobacillus reuteri* strain according to claim 6 for use in treatment of a disease related to serotonin deficiency, wherein the disease related to serotonin deficiency is selected from the group consisting of anxiety, depressed mood, aggression, poor memory, eating disorders, obsessive-compulsive disorder, panic disorder, post-traumatic stress disorder, social anxiety disorder, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), a cardiovascular disease, osteoporosis, gastrointestinal motility disorder, autoimmune polyendocrinopathy-candidiasis-ectodermal dystrophy (APECED), osteopenia and a bone loss condition.

~~9. *Lactobacillus reuteri* strain DSM 33509, preferably in lyophilized form.~~

~~10. *Lactobacillus reuteri* strain DSM 33509 for use as a medicament.~~

~~11. *Lactobacillus reuteri* strain DSM 33509 for use in treatment of serotonin deficiency a disease related to serotonin deficiency.~~

~~12. *Lactobacillus reuteri* strain DSM 33632, preferably in lyophilized form.~~

~~13. *Lactobacillus reuteri* strain DSM 33632 for use as a medicament.~~

~~14. *Lactobacillus reuteri* strain DSM 33632 for use in treatment of serotonin deficiency a disease related to serotonin deficiency.~~

~~15. *Lactobacillus reuteri* strain DSM 33633, preferably in lyophilized form.~~

~~16. *Lactobacillus reuteri* strain DSM 33633 for use as a medicament.~~

~~17. *Lactobacillus reuteri* strain DSM 33633 for use in treatment of serotonin deficiency a disease related to serotonin deficiency.~~

~~18. *Lactobacillus reuteri* strain DSM 33634, preferably in lyophilized form.~~

~~19. *Lactobacillus reuteri* strain DSM 33634 for use as a medicament.~~

~~20. *Lactobacillus reuteri* strain DSM 33634 for use in treatment of serotonin deficiency a disease related to serotonin deficiency.~~

~~21. *Lactobacillus reuteri* strain DSM 33635, preferably in lyophilized form.~~

~~22. *Lactobacillus reuteri* strain DSM 33635 for use as a medicament.~~

~~23. *Lactobacillus reuteri* strain DSM 33635 for use in treatment of serotonin deficiency a disease related to serotonin deficiency.~~

9. A *Lactobacillus mucosae* strain selected from the group consisting of *L. mucosae* strain DSM 33291, *L. mucosae* strain DSM 33292, *L. mucosae strain* DSM 33293, and *L. mucosae* strain DSM 33661, preferably in lyophilized form.

10. A *Lactobacillus mucosae* strain according to claim 9 for use as a medicament.

11. A *Lactobacillus mucosae* strain according to claim 9 for use in treatment of a disease related to serotonin deficiency, wherein the disease related to serotonin deficiency is selected from the group consisting of anxiety, depressed mood, aggression, poor memory, eating disorders, obsessive-compulsive disorder, panic disorder, post-traumatic stress disorder, social anxiety disorder, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), a cardiovascular disease, osteoporosis, gastrointestinal motility disorder, autoimmune polyendocrinopathy-candidiasis-ectodermal dystrophy (APECED), osteopenia and a bone loss condition.

~~24. *Lactobacillus mucosae* strain DSM 33291, preferably in lyophilized form.~~

~~25. *Lactobacillus mucosae* strain DSM 33291 for use as a medicament.~~

~~26. *Lactobacillus mucosae* strain DSM 33291 for use in treatment of serotonin deficiency and/or a disease related to serotonin deficiency.~~

~~27. *Lactobacillus mucosae* strain DSM 33292, preferably in lyophilized form.~~

~~28. *Lactobacillus mucosae* strain DSM 33292 for use as a medicament.~~

~~29. *Lactobacillus mucosae* strain DSM 33292 for use in treatment of serotonin deficiency a disease related to serotonin deficiency.~~

~~30. *Lactobacillus mucosae* strain DSM 33293, preferably in lyophilized form.~~

~~31. *Lactobacillus mucosae* strain DSM 33293 for use as a medicament.~~

~~32. *Lactobacillus mucosae* strain DSM 33293 for use in treatment of serotonin deficiency a disease related to serotonin deficiency.~~

~~33. *Lactobacillus mucosae* strain DSM 33661, preferably in lyophilized form.~~

~~34. *Lactobacillus mucosae* strain DSM 33661 for use as a medicament.~~

~~35. *Lactobacillus mucosae* strain DSM 33661 for use in treatment of serotonin deficiency a disease related to serotonin deficiency.~~

~~36. *Lactobacillus plantarum* strain DSM 33295, preferably in lyophilized form.~~

~~37. *Lactobacillus plantarum* strain DSM 33295 for use as a medicament.~~

~~38. *Lactobacillus plantarum* strain DSM 33295 for use in treatment of serotonin deficiency a disease related to serotonin deficiency.~~

~~39. *Lactobacillus plantarum* strain DSM 33662, preferably in lyophilized form.~~

~~40. *Lactobacillus plantarum* strain DSM 33662 for use as a medicament.~~

~~41. *Lactobacillus plantarum* strain DSM 33662 for use in treatment of serotonin deficiency a disease related to serotonin deficiency.~~

~~42~~12. The *Lactobacillus reuteri* strain for use according to claim ~~8 11, 14, 17, 20 or 23~~, or the *Lactobacillus mucosae* strain for use according claim ~~11 23, 26, 29, 32 or 35, or the *Lactobacillus plantarum* strain for use according to claim 38 or 41~~, wherein the disease related to serotonin deficiency is ~~selected from the group consisting of anxiety, depressed mood, aggression, poor memory, eating disorders, obsessive-compulsive disorder, panic disorder, post-traumatic stress disorder, social anxiety disorder, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), a cardiovascular disease, osteoporosis, gastrointestinal motility disorder, autoimmune polyendocrinopathy-candidiasis-ectodermal dystrophy (APECED), osteopenia and a bone loss condition, preferably~~ selected from the group consisting of IBS, IBD, a cardiovascular disease, osteoporosis, gastrointestinal motility disorder, APECED, osteopenia and a bone loss condition.

~~43~~13. A *Lactobacillus* ~~lactic acid producing~~ bacterial strain selected from the group consisting of a *L. reuteri* bacterial strain and a *L. mucosae* bacterial strain capable of attaching to intestinal mucus and/or capable of adhering to the gastrointestinal mucosa and capable of producing and extracellularly releasing serotonin under aerobic conditions on the intestinal mucosae of a subject for use in treatment of ~~serotonin deficiency and/or~~ a disease related to serotonin deficiency in a subject, wherein the disease related to serotonin deficiency is selected from the group consisting of anxiety, depressed mood, aggression, poor memory, eating disorders, obsessive-compulsive disorder, panic disorder, post-traumatic stress disorder, social anxiety disorder, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), a cardiovascular disease, osteoporosis, gastrointestinal motility disorder, autoimmune polyendocrinopathy-candidiasis-ectodermal dystrophy (APECED), osteopenia and a bone loss condition.

~~44~~14. The *Lactobacillus* ~~lactic acid producing~~ bacterial strain for use according to claim ~~43~~13, wherein the disease related to serotonin deficiency is ~~selected from the group consisting of anxiety, depressed mood, aggression, poor memory, eating disorders, obsessive-compulsive disorder, panic disorder, post-traumatic stress disorder, social anxiety disorder, irritable bowel syndrome (IBS), inflammatory bowel disease (IBD), a cardiovascular disease, osteoporosis, gastrointestinal motility disorder, autoimmune polyendocrinopathy-candidiasis-ectodermal dystrophy (APECED) osteopenia and a bone~~

~~loss condition, preferably~~ selected from the group consisting of IBS, IBD, a cardiovascular disease, osteoporosis, gastrointestinal motility disorder, APECED, osteopenia and a bone loss condition.

~~45. The lactic acid producing bacterial strain for use according to claim 43 or 44, wherein the lactic acid producing bacterial strain is capable of attaching to intestinal mucus and/or capable of adhering to the gastrointestinal mucosa.~~

~~46. The lactic acid producing bacterial strain for use according to any of the claims 43 to 45, wherein the lactic acid producing bacterial strain is capable of producing serotonin on the intestinal mucosa of a subject.~~

~~47. The lactic acid producing bacterial strain for use according to any of the claims 43 to 46, wherein the lactic acid producing bacterial strain is a *Lactobacillus* bacterial strain.~~

~~48. The lactic acid producing bacterial strain for use according to claim 47, wherein the *Lactobacillus* bacterial strain is selected from a group consisting of a *L. reuteri* strain, a *L. mucosae* strain and a *L. plantarum* strain.~~

~~49~~15. The lactic acid producing bacterial strain for use according to claim ~~48~~13 or 14, wherein

the *L. reuteri* strain is selected from the group consisting of *L. reuteri* DSM 32846, *L. reuteri* DSM 32848, *L. reuteri* DSM 32849, *L. reuteri* DSM 27131, *L. reuteri* DSM 33509, *L. reuteri* DSM 33632, *L. reuteri* DSM 33633, *L. reuteri* DSM 33634, *L. reuteri* DSM 33635 and *L. reuteri* DSM 32465; and

the *L. mucosae* strain is selected from the group consisting of *L. mucosae* DSM 33291, *L. mucosae* DSM 33292, *L. mucosae* DSM 33293 and *L. mucosae* DSM 33661.~~; and~~

~~the *L. plantarum* strain is selected from the group consisting of *L. plantarum* DSM 33295 and *L. plantarum* DSM 33662,~~

~~50. A method of preventing, inhibiting or treating serotonin deficiency and/or a disease related to serotonin deficiency in a subject, the method comprises administering bacteria of a lactic acid producing bacterial strain capable of producing and extracellularly releasing serotonin under aerobic conditions to the subject.~~