an urgent need for new, effective, and easy-to-use methods for treating or preventing hair loss. The present invention fulfills this and other related needs by identifying beneficial gut microorganisms in an effort to formulate new compositions and devise new methods that are effective for preventing or treating hair loss as well as enhancing hair restoration among individuals, who may be adults or children and suffering or at risk of hair loss, due to varying causes including infectious diseases such as COVID-19.

BRIEF SUMMARY

[0005] The present inventors discovered in their studies the certain gut microbial species can promote and enhance hair growth among individuals who suffer from reduced or thinning hair due to various conditions such as infectious illness (*e.g.*, viral or bacterial infection such as SARS-CoV-2), thus provide an important utility in the treatment of hair loss, a condition of high prevalence in the general population. The microorganisms so identified now serve as the basis of new methods and compositions for prophylactic and therapeutic applications.

[0005a] In a first aspect, the present disclosure provides a use of (1) *Bifidobacterium longum* or *Faecalibacterium prausnitzii* or a combination thereof; and (2) a physiologically acceptable excipient in the manufacture of a medicament for treating hair loss in a subject.

[0005b] In a second aspect, the present disclosure provides a use of a first composition comprising *Bifidobacterium longum* in the manufacture of a first medicament, and use of a second composition comprising *Faecalibacterium prausnitzii* in the manufacture of a second medicament, wherein the first and second medicaments are to be used in combination therapy for treating hair loss in a subject.

[0005c] In a third aspect, the present disclosure provides a kit for treating hair loss in a subject comprising a plurality of compositions each comprising an effective amount of *Bifidobacterium longum* or *Faecalibacterium prausnitzii* or a combination thereof.

[0005d] In a fourth aspect, the present disclosure provides an isolated strain of *Bifidobacterium longum* deposited with the Guangdong Microbial Culture Collection Center (GDMCC) under the Accession Number GBMCC 61784.

[0005e] In a fifth aspect, the present disclosure provides a composition comprising the *Bifidobacterium longum* of the disclosure.

[0005f] In a sixth aspect, the present disclosure provides a use of (1) the *Bifidobacterium longum* of the disclosure or (2) the composition of the disclosure in the manufacture of a medicament for reducing inflammation in a subject.

[0005g] In a seventh aspect, the present disclosure provides a *Bifidobacterium longum* of the disclosure or the composition of the disclosure, for use in therapy.

[0006] In a first example, the present disclosure provides a composition that is useful for treating hair loss in a human subject, an adult or child. The composition comprises an effective amount of (1) *Bifidobacterium longum* or *Faecalibacterium prausnitzii* or a combination thereof; and (2) at least one physiologically acceptable excipient. In some examples, the composition consists essentially of *Bifidobacterium longum* or *Faecalibacterium prausnitzii* or a combination thereof plus one or more physiologically acceptable excipients, optionally with one or more prebiotics. In some examples, the composition contains no detectable quantity of other bacteria of the *Bifidobacterium* species. In some examples, the composition consists essentially of an effective amount of (1) a combination of *Bifidobacterium longum* and *Faecalibacterium prausnitzii*; and (2) one or more physiologically acceptable excipients; and optionally (3) one or more prebiotics. In some examples, the *Bifidobacterium longum* is a strain *Bifidobacterium longum HK003* deposited with the Guangdong Microbial Culture Collection Center (GDMCC) under Accession Number GDMCC 61784. In some examples, the *Bifidobacterium longum* or *Faecalibacterium prausnitzii* is in the form of viable cells. In some examples, the

bacteria are in the form of or non-viable cells, such as heat-inactivated or chemically inactivated cells. In some examples, the amount of each of *Bifidobacterium longum* or *Faecalibacterium prausnitzii* is about $1.7x10^7$-$1x10^{10}$ CFU for adults and about $8.5\ x10^6$-$5x10^9$ CFU for children in daily intake. In some examples, the composition is formulated for oral ingestion, for example, in the form of a food or beverage item.

[0007] In the second example, the present disclosure provides a method for treating hair loss in a subject, who may be an adult or a child. The method includes the step of administering to the subject an effective amount of the composition described above and herein: in other words, comprising an effective amount of *Bifidobacterium longum* or *Faecalibacterium prausnitzii* or a combination thereof along with at least one physiologically acceptable excipient. In some examples, the administering step comprises administering to the subject one single composition comprising both *Bifidobacterium longum* and *Faecalibacterium prausnitzii* in an effective amount. In some examples, the administering step comprises administering to the subject a first composition comprising *Bifidobacterium longum* in an effective amount, and administering to the subject a second composition comprising *Faecalibacterium prausnitzii* in an effective amount. In some examples, the administering step comprises oral ingestion of the composition described above and herein comprising an effective amount of *Bifidobacterium longum* or *Faecalibacterium prausnitzii* or a combination thereof plus at least one physiologically acceptable excipient. In some examples, the administering step comprises oral ingestion of the composition prior to food intake, or shortly after food intake, or at the same time of food intake (*e.g.*, with a meal). In some examples, the subject has recovered from COVID-19, for instance, the subject is a long-COVID patient.

[0008] In a related example, the present disclosure provides a novel use of a composition for treating hair loss in a subject. The composition comprises an effective amount of (1) *Bifidobacterium longum* or *Faecalibacterium prausnitzii* or a combination thereof; and (2) at least one physiologically acceptable excipient. In some examples, the composition consists essentially of *Bifidobacterium longum* or *Faecalibacterium prausnitzii* or a combination thereof plus one or more physiologically acceptable excipients, optionally with

one or more prebiotics. In some examples, the composition contains no detectable quantity of other bacteria of the *Bifidobacterium* species. In some examples, the composition consists essentially of an effective amount of (1) a combination of *Bifidobacterium longum* and *Faecalibacterium prausnitzii*; and (2) one or more physiologically acceptable excipients; and optionally (3) one or more prebiotics. In some examples, the *Bifidobacterium longum* is a strain deposited with the Guangdong Microbial Culture Collection Center (GDMCC) under Accession Number GDMCC 61784. In some examples, the *Bifidobacterium longum* or *Faecalibacterium prausnitzii* is in the form of viable cells. In some examples, the bacteria are in the form of or non-viable cells, such as heat-inactivated or chemically inactivated cells. In some examples, the amount of each of *Bifidobacterium longum* or *Faecalibacterium prausnitzii* is about $1.7x10^7$-$1x10^{10}$ CFU for adults and about $8.5\ x10^6$- $5x10^9$ CFU for children in daily intake. In some examples, the composition is formulated for oral ingestion, for example, in the form of a food or beverage item.

[0009] In a third example, the present disclosure provides a kit for treating hair loss in a subject comprising a plurality of containers, each containing a composition comprising an effective amount of *Bifidobacterium longum* or *Faecalibacterium prausnitzii* or a combination thereof. In some examples, the kit includes two compositions, each comprising an effective amount of *Bifidobacterium longum* or *Faecalibacterium prausnitzii* along with one or more physiologically acceptable excipients. In some examples, the compositions are in the form of a powder, liquid, paste, cream, tablet, or capsule. In some examples, the compositions are formulated for oral administration or for local deposit as means for delivery.

[0010] In a fourth example, the present disclosure provides a newly isolated strain of *Bifidobacterium, Bifidobacterium longum HK003*, deposited with the Guangdong Microbial Culture Collection Center (GDMCC) under Accession Number GDMCC 61784, as well as compositions comprising *B. longum HK003*, and methods of their use. In one example, a composition is provided, which comprises the *Bifidobacterium longum* of this disclosure. For example, such a composition is in the form of a freeze-dried powder comprising the *B.*

longum. In some examples, the freeze-dried powder is produced by freeze-drying the *B. longum* preserved in a lyoprotectant comprising gelatin, skimmed milk powder, trehalose, and sucrose. In one example, the lyoprotectant comprises about 1.5% (weight/volume or w/v, expressed in 1.5 grams of solid dissolved in 100 ml of solvent, *e.g.*, water) of gelatin, about 15% (w/v) of skimmed milk powder, about 15% (w/v) of trehalose, and about 5% (w/v) sucrose. In some examples, such a composition is in the form of a capsule or microcapsule in which the *B. longum* is encapsulated with a carrier material comprising soybean protein isolate and konjac gum.

[0011] In one example, a method of reducing inflammation is provided by way of administration to a subject in need thereof an effective amount of (1) the *B. longum* of this disclosure or (2) the composition comprising the *B. longum* of this disclosure. In some examples, the effective amount of the *B. longum* of this disclosure or (2) the composition comprising the *B. longum* of this disclosure reduces inflammatory cytokine levels in the subject. In some examples, the effective amount of the *B. longum* of this disclosure or (2) the composition comprising the *B. longum* of this disclosure reduces pathogenic bacteria levels in the gastrointestinal tract of the subject. Such pathogenic bacteria may include *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aereus*, *enterococcus faecalis*, or any combination thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] **Figure 1. Alopecic condition in mice after each treatment. Figure 1A**, Schematic diagram of treatment interventions in mice. In Group 1 - Water, mice were treated with normal drinking water throughout the experiment. In Group 2 - P80, mice were treated with 1% P80 throughout the experiment. In Group 3 – P80+Abx, mice were treated with 1% P80 throughout the experiment, and additionally treated with Abx at week 13 and left for 2 weeks without treatment for observation. In Group 4 – P80+Abx+FMT, mice were treated with 1% P80 throughout the experiment, and additionally treated with Abx+FMT at week 13 (n = 10; except n = 8 for Group 1). **Figure 1B**, Mice after P80 adminstration before treatment challenges. In water group, no mouse showed sign of hair thinning or development

WHAT IS CLAIMED IS:

1. Use of (1) *Bifidobacterium longum* or *Faecalibacterium prausnitzii* or a combination thereof; and (2) a physiologically acceptable excipient in the manufacture of a medicament for treating hair loss in a subject.

2. The use of claim 1, wherein the medicament comprises no detectable amount of other *Bifidobacterium* bacteria.

3. The use of claim 1, wherein the medicament consists essentially of an effective amount of (1) *Bifidobacterium longum*; (2) one or more physiologically acceptable excipients; and optionally (3) a prebiotic.

4. The use of claim 1, wherein the medicament consists essentially of an effective amount of (1) *Faecalibacterium prausnitzii*; and (2) one or more physiologically acceptable excipients; and optionally (3) a prebiotic material.

5. The use of claim 1, wherein the medicament consists essentially of an effective amount of (1) a combination of *Bifidobacterium longum* and *Faecalibacterium prausnitzii*; and (2) one or more physiologically acceptable excipients; and optionally (3) a prebiotic material.

6. The use of claim 1, wherein the *Bifidobacterium longum* is a strain deposited with Guangdong Microbial Culture Collection Center (GDMCC) under Accession Number GDMCC 61784.

7. The use of any one of claims 1-6, wherein the *Bifidobacterium longum* or *Faecalibacterium prausnitzii* is in the form of viable cells or non-viable cells.

8. The use of any one of claims 1-6, wherein the amount of *Bifidobacterium longum* or *Faecalibacterium prausnitzii* is $1.7x10^7$-$1x10^{10}$ CFU for adults and $8.5\ x10^6$- $5x10^9$ CFU for children in daily intake.

9. The use of claim 8, wherein the medicament is formulated for oral ingestion.

10. The use of claim 9, wherein the medicament is in the form of a food or beverage item.

11. The use of any one of claims 1-10, wherein the subject is an adult.

12. The use of any one of claims 1-10, wherein the subject is a child.

13. The use of any one of claims 1-12, wherein the medicament comprising *Bifidobacterium longum* and *Faecalibacterium prausnitzii* is to be administered to the subject.

14. Use of a first composition comprising *Bifidobacterium longum* in the manufacture of a first medicament, and use of a second composition comprising *Faecalibacterium prausnitzii* in the manufacture of a second medicament, wherein the first and second medicaments are to be used in combination therapy for treating hair loss in a subject.

15. The use of any one of claims 1-14, wherein the medicament is to be orally ingested.

16. The use of claim 15, wherein the medicament is to be orally ingested prior to or with food intake.

17. The use of any one of claims 1-16, wherein the subject has recovered from COVID-19.

18. A kit for treating hair loss in a subject comprising a plurality of compositions each comprising an effective amount of *Bifidobacterium longum* or *Faecalibacterium prausnitzii* or a combination thereof.

19. The kit of claim 18, comprising two compositions each comprising an effective amount of *Bifidobacterium longum* or *Faecalibacterium prausnitzii*.

20. The kit of claim 18 or 19, wherein the compositions are in the form of a powder, liquid, paste, cream, tablet, or capsule.

21. An isolated strain of *Bifidobacterium longum* deposited with the Guangdong Microbial Culture Collection Center (GDMCC) under the Accession Number GBMCC 61784.

22. A composition comprising the *Bifidobacterium longum* of claim **21**.

23. The composition of claim **22**, which is a freeze-dried powder.

24. The composition of claim **23**, wherein the freeze-dried powder is freeze-dried in a lyoprotectant comprising gelatin, skimmed milk powder, trehalose, and sucrose.

25. The composition of claim **24**, wherein the lyoprotectant comprises about 1.5% (w/v) of gelatin, about 15% (w/v) of skimmed milk powder, about 15% (w/v) of trehalose, and about 5% (w/v) sucrose.

26. The composition of any one of claims **22-25**, which is microencapsulated with a carrier material comprising soybean protein isolate and konjac gum.

27. Use of (1) the *Bifidobacterium longum* of claim **21** or (2) the composition of any one of claims **22**-**26** in the manufacture of a medicament for reducing inflammation in a subject.

28. The use of claim **27**, wherein the effective amount of (1) the *Bifidobacterium longum* of claim **21** or (2) the composition of any one of claims **22**-**26** reduces inflammatory cytokine levels.

29. The use of claim **27**, wherein the effective amount of (1) the *Bifidobacterium longum* of claim **21** or (2) the composition of any one of claims **22**-**26** reduces pathogenic bacteria levels in the subject's gastrointestinal tract.

30. The use of claim **29**, wherein the pathogenic bacteria comprise *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aereus*, or *enterococcus faecalis*.

31. The *Bifidobacterium longum* of claim **21** or the composition of any one of claims **22**-**26**, for use in therapy.