BIFIDOBACTERIUM LONGUM YH295 AND USE THEREOF IN PREPARATION OF PRODUCT REDUCING RISK OF ABDOMINAL OBESITY

TECHNICAL FIELD

The present invention relates to the technical field of probiotic use, and in particular to a strain *Bifidobacterium longum* YH295 and use thereof in the preparation of products reducing the risk of abdominal obesity.

BACKGROUND

Abdominal obesity, also known as central obesity or centripetal obesity, mainly refers that accumulation of body fat in the abdomen results in an increase in abdominal visceral fat, manifesting as 'apple' shapes. In China, abdominal obesity is defined as waist circumference ≥90 cm for males and ≥80 cm for females. Abdominal adipose tissues have been found in patients with abdominal obesity. It reserves energy, and secretes a large number of inflammatory factors, including tumor necrosis factor (TNF) and interleukins (IL-1 and IL-6), which involve in body inflammatory response directly or indirectly, serve as a prerequisite for metabolic syndrome, and closely related to metabolic diseases, such as diabetes, gout, hypertension, arteriosclerosis, and cardio-cerebrovascular diseases. Patients with abdominal obesity have 10.3 times risk of diabetes compared to normal individuals. Abdominal obesity has become an independent risk factor for the onset of diabetes in older people. Whereas, visceral fat significantly increases the risk of non-alcoholic fatty liver disease (NAFLD) and insulin resistance in adolescents with abdominal obesity.

Non-alcoholic fatty liver disease (NAFLD) refers to a clinical-pathological syndrome caused by exclusive of alcohol and other definite liver injury factors, where main lesions are located in hepatic lobules and pathological features manifest as diffuse hepatocyte fatty degeneration and fat accumulation. It consists of three major types: simple fatty liver, fatty hepatitis, and fatty cirrhosis. It is commonly accompanied by susceptible factors, such as obesity, impaired glucose tolerance, and lipid disorder as well as metabolic stress-induced liver injury. In 2014, a study in China found that the morbidity of NAFLD was 20.09%, of which 70%-80% of the obese people had NAFLD.

In recent years, with the change of modern lifestyle, the morbidities of abdominal obesity and NAFLD are increasing worldwide, where both abdominal obesity and NAFLD are the risk factors for metabolic and non-metabolic diseases, leading a serious threat to human health. Therefore, prophylaxis and treatment of abdominal obesity and NAFLD have attracted medical attention worldwide, and the development of food products, supplements, or pharmaceutical products to reduce the risk of abdominal obesity and NAFLD is good for the global population health.

SUMMARY

In view of this, an objective of the present invention is to provide a strain *Bifidobacterium longum* YH295 and use thereof in the preparation of products reducing the risk of abdominal obesity; the strain *Bifidobacterium longum* YH295 can significantly increase the counts of *Lactobacillus* and *Bifidobacterium* in the gut, to regulate expression of the intestinal regenerative gene and intestinal transmembrane binding protein content significantly, and lower the level of serum endotoxin and inflammatory factors, thereby reducing the risk of abdominal obesity and nonalcoholic fatty liver disease (NAFLD).

In order to achieve the above invention object, the present invention provides the following technical solutions:

The present invention provides a strain *Bifidobacterium longum* YH295, where the strain *Bifidobacterium longum* YH295 is deposited at China General Microbiological Culture Collection Center (CGMCC) under the accession number of CGMCC No.14093.

The present invention further provides use of the strain *Bifidobacterium longum* YH295 in increasing counts of *Lactobacillus* and/or *Bifidobacterium* in the gut.

The present invention further provides use of the strain *Bifidobacterium longum* YH295 in upregulating expression of the intestinal regenerative gene and transmembrane binding protein content.

The present invention further provides use of the strain *Bifidobacterium longum* YH295 in lowering the level of plasma endotoxin and intestinal inflammatory factors.

The present invention further provides use of the strain *Bifidobacterium longum* YH295 in the preparation of food products, supplements, or pharmaceutical products for the prophylaxis and treatment of abdominal obesity.

The present invention further provides use of the strain *Bifidobacterium longum* YH295 in the preparation of food products, supplements, or pharmaceutical products for the prophylaxis and treatment of NAFLD.

Preferably, the concentration of the viable *Bifidobacterium longum* YH295 is independently 10^6-10^9 CFU/mL or 10^6-10^9 CFU/g.

The present invention provides a strain *Bifidobacterium longum* YH295, being a species *Bifidobacterium longum* of genus *Bifidobacterium*, and belonging to not only an autochthonous human bacterium colonizing in the gut across all age groups, but also a family member of probiotics. The strain *Bifidobacterium longum* YH295 in the present invention can reduce the risk of abdominal obesity and NAFLD in such a way that it significantly increases counts of *Lactobacillus* and *Bifidobacterium* in the gut, upregulates expression of the intestinal regenerative gene and intestinal transmembrane binding protein content significantly, and lowers the level of plasma endotoxin and intestinal inflammatory factors. Therefore, this can be used to prepare food

products, supplements, or pharmaceutical products for the prophylaxis and/or treatment of abdominal obesity and/or NAFLD.

DEPOSIT

Bifidobacterium longum, with a strain number of YH295, is deposited at China General Microbiological Culture Collection Center (CGMCC), Institute of Microbiology, Chinese Academy of Sciences, #3, No. 1, Beichen West Road, Chaoyang District, Beijing on May 4, 2017 under the accession number of CGMCC No.14093.

DETAILED DESCRIPTION

The present invention provides a strain *Bifidobacterium longum* YH295. The strain *Bifidobacterium longum* YH295 is deposited at China General Microbiological Culture Collection Center (CGMCC) under the accession number of CGMCC No.14093.

In the present invention, the source of the strain *Bifidobacterium longum* YH295 is not particularly limited; the strain is preferably isolated and obtained from healthy baby feces, has polymorphic rod shapes, is Gram-positive, does not generate spores, has negative catalase and oxidase, and presents an obligate anaerobe. In the present invention, the strain *Bifidobacterium longum* YH295 can engage in metabolic activities by means of L-arabinose, D-glucose, D-mannitol, D-lactose, D-sucrose, D-maltose, salicin, D-xylose, D-melezitose, and D-raffinose, but not D-sorbitol, L-rhamnose, D-trehalose, gelatin, aescigenin, glycerol, D-cellobiose, and D-mannose.

In the present invention, the strain *Bifidobacterium longum* YH295 is isolated on an MRS plate, specifically including the steps of: using an inoculating loop to pick up the strain *Bifidobacterium longum* YH295 under aseptic condition, streaking on the MRS plate, and anaerobically culturing the plate in an incubator at 37°C for 72 h. A single colony appears gibbous, smooth-faced, completely edged, milk white in color, lustrous, and soft in texture.

In the present invention, the strain *Bifidobacterium longum* YH295 is preferably stored on an agar slant. The agar slant is preferably an MRS agar slant.

The present invention further provides use of the strain *Bifidobacterium longum* YH295 in increasing counts of *Lactobacillus* and *Bifidobacterium* in the gut.

In the use of the present invention, the concentration of the viable *Bifidobacterium longum* YH295 is preferably 10^6-10^9 CFU/mL or 10^6-10^9 CFU/g. During the use of the present invention, the state of the strain *Bifidobacterium longum* YH295 is preferably lyophilized viable bacteria powder. In the present invention, preparation methods of the lyophilized viable bacteria powder preferably include strain fermentation and bacteria powder preparation. Preferably, the strain fermentation is to use an inoculating loop to pick up two loops of the strain *Bifidobacterium*

longum YH295 from an agar-slant into a liquid medium with 50 mL of MRS, anaerobically culture at 37°C for 24 h, then inoculate 5% of inoculation amount into the 50 mL MRS liquid medium, and anaerobically culture at 37°C for 72 h to obtain a *Bifidobacterium longum* YH295 broth, where cells are diffusing and there are usually tiny granular deposits at the bottom of a test tube. Viable cell count is 1.0×10^9 - 5.0×10^9 cfu/mL in the broth. In the present invention, the bacteria powder preparation preferably includes steps of centrifuging the broth to obtain bacterial sludge, mixing the bacterial sludge with water and a lyophilizate carrier, and lyophilizing to obtain the lyophilized viable bacteria powder. In the present invention, the mass of the water is preferably 6-15, more preferably 8-12, and most preferably 10-11 times that of the bacterial sludge. The lyophilizate carrier of the present invention preferably includes maltodextrin, sucrose, milk powder, glycerol, and cysteine hydrochloride. In the present invention, the consumption of the lyophilizate carrier is 0.5-3 times of the mass of the bacterial sludge. The viable cell count in the lyophilized viable cell count of the present invention is preferably at least 1.0×10^{10} - 5.0×10^{10} cfu/g.

The present invention further provides use of the strain *Bifidobacterium longum* YH295 in upregulating expression of the intestinal regenerative gene and transmembrane binding protein content.

In the use of the present invention, the concentration of the viable *Bifidobacterium longum* YH295 is preferably 10^6-10^9 CFU/mL or 10^6-10^9 CFU/g. During the use of the present invention, the state of the strain *Bifidobacterium longum* YH295 is preferably lyophilized viable bacteria powder. In the present invention, preparation methods of the lyophilized viable bacteria powder preferably include strain fermentation and bacteria powder preparation. Preferably, the strain fermentation is to use an inoculating loop to pick up two loops of the strain *Bifidobacterium longum* YH295 from an agar-slant into a liquid medium with 50 mL of MRS, anaerobically culture at 37°C for 24 h, then inoculate 5% of inoculation amount into the 50 mL MRS liquid medium, and anaerobically culture at 37°C for 72 h to obtain a *Bifidobacterium longum* YH295 broth, where cells are diffusing and there are usually tiny granular deposits at the bottom of a test tube. The viable cell count is 1.0×10^9 - 5.0×10^9 cfu/mL in the broth. In the present invention, the bacteria powder preparation preferably includes steps of centrifuging the broth to obtain bacterial sludge, mixing the bacterial sludge with water and a lyophilizate carrier, and lyophilizing to obtain the lyophilized viable bacteria powder. In the present invention, the mass of the water is preferably 6-15, more preferably 8-12, and most preferably 10-11 times that of the bacterial sludge. The lyophilizate carrier of the present invention preferably includes maltodextrin, sucrose, milk powder, glycerol, and cysteine hydrochloride. In the present invention, the consumption of the lyophilizate carrier is 0.5-3 times of the mass of the bacterial sludge. The

viable cell count in the lyophilized viable cell count of the present invention is preferably at least 1.0×10^{10} - 5.0×10^{10} cfu/g.

The present invention further provides use of the strain *Bifidobacterium longum* YH295 in lowering the level of plasma endotoxin and intestinal inflammatory factors.

In the use of the present invention, the concentration of the viable *Bifidobacterium longum* YH295 is preferably 10^6-10^9 CFU/mL or 10^6-10^9 CFU/g. During the use of the present invention, the state of the strain *Bifidobacterium longum* YH295 is preferably lyophilized viable bacteria powder. In the present invention, preparation methods of the lyophilized viable bacteria powder preferably include strain fermentation and bacteria powder preparation. Preferably, the strain fermentation is to use an inoculating loop to pick up two loops of the strain *Bifidobacterium longum* YH295 from an agar-slant into a liquid medium with 50 mL of MRS, anaerobically culture at 37°C for 24 h, then inoculate 5% of inoculation amount into the 50 mL MRS liquid medium, and anaerobically culture at 37°C for 72 h to obtain a *Bifidobacterium longum* YH295 broth, where cells are diffusing and there are usually tiny granular deposits at the bottom of a test tube. The viable cell count is 1.0×10^9 - 5.0×10^9 cfu/mL in the broth. In the present invention, the bacteria powder preparation preferably includes steps of centrifuging the broth to obtain bacterial sludge, mixing the bacterial sludge with water and a lyophilizate carrier, and lyophilizing to obtain the lyophilized viable bacteria powder. In the present invention, the mass of the water is preferably 6-15, more preferably 8-12, and most preferably 10-11 times that of the bacterial sludge. The lyophilizate carrier of the present invention preferably includes maltodextrin, sucrose, milk powder, glycerol, and cysteine hydrochloride. In the present invention, the consumption of the lyophilizate carrier is 0.5-3 times of the mass of the bacterial sludge. The viable cell count in the lyophilized viable cell count of the present invention is preferably at least 1.0×10^{10} - 5.0×10^{10} cfu/g.

The present invention further provides use of the strain *Bifidobacterium longum* YH295 in the preparation of food products, supplements, or pharmaceutical products for the prophylaxis and treatment of abdominal obesity.

In the use of the present invention, the concentration of the viable *Bifidobacterium longum* YH295 is preferably 10^6-10^9 CFU/mL or 10^6-10^9 CFU/g. During the use of the present invention, the state of the strain *Bifidobacterium longum* YH295 is preferably lyophilized viable bacteria powder. In the present invention, preparation methods of the lyophilized viable bacteria powder preferably include strain fermentation and bacteria powder preparation. Preferably, the strain fermentation is to use an inoculating loop to pick up two loops of the strain *Bifidobacterium longum* YH295 from an agar-slant into a liquid medium with 50 mL of MRS, anaerobically culture at 37°C for 24 h, then inoculate 5% of inoculation amount into the 50 mL MRS liquid

medium, and anaerobically culture at 37°C for 72 h to obtain a *Bifidobacterium longum* YH295 broth, where cells are diffusing and there are usually tiny granular deposits at the bottom of a test tube. The viable cell count is 1.0×10^9 - 5.0×10^9 cfu/mL in the broth. In the present invention, the bacteria powder preparation preferably includes steps of centrifuging the broth to obtain bacterial sludge, mixing the bacterial sludge with water and a lyophilizate carrier, and lyophilizing to obtain the lyophilized viable bacteria powder. In the present invention, the mass of the water is preferably 6-15, more preferably 8-12, and most preferably 10-11 times that of the bacterial sludge. The lyophilizate carrier of the present invention preferably includes maltodextrin, sucrose, milk powder, glycerol, and cysteine hydrochloride. In the present invention, the consumption of the lyophilizate carrier is 0.5-3 times of the mass of the bacterial sludge. The viable cell count in the lyophilized viable cell count of the present invention is preferably at least 1.0×10^{10} - 5.0×10^{10} cfu/g.

The present invention further provides use of the strain *Bifidobacterium longum* YH295 in the preparation of food products, supplements, and pharmaceutical products for the prophylaxis and treatment of nonalcoholic fatty liver disease (NAFLD).

In the use of the present invention, the concentration of the viable *Bifidobacterium longum* YH295 is preferably 10^6-10^9 CFU/mL or 10^6-10^9 CFU/g. During the use of the present invention, the state of the strain *Bifidobacterium longum* YH295 is preferably lyophilized viable bacteria powder. In the present invention, preparation methods of the lyophilized viable bacteria powder preferably include strain fermentation and bacteria powder preparation. Preferably, the strain fermentation is to use an inoculating loop to pick up two loops of the strain *Bifidobacterium longum* YH295 from an agar-slant into a liquid medium with 50 mL of MRS, anaerobically culture at 37°C for 24 h, then inoculate 5% of inoculation amount into the 50 mL MRS liquid medium, and anaerobically culture at 37°C for 72 h to obtain a *Bifidobacterium longum* YH295 broth, where cells are diffusing and there are usually tiny granular deposits at the bottom of a test tube. The viable cell count is 1.0×10^9 - 5.0×10^9 cfu/mL in the broth. In the present invention, the bacteria powder preparation preferably includes steps of centrifuging the broth to obtain bacterial sludge, mixing the bacterial sludge with water and a lyophilizate carrier, and lyophilizing to obtain the lyophilized viable bacteria powder. In the present invention, the mass of the water is preferably 6-15, more preferably 8-12, and most preferably 10-11 times that of the bacterial sludge. The lyophilizate carrier of the present invention preferably includes maltodextrin, sucrose, milk powder, glycerol, and cysteine hydrochloride. In the present invention, the consumption of the lyophilizate carrier is 0.5-3 times of the mass of the bacterial sludge. The viable cell count in the lyophilized viable cell count of the present invention is preferably at least 1.0×10^{10} - 5.0×10^{10} cfu/g.

The strain *Bifidobacterium longum* YH295 and use thereof in lowering the risk of metabolic syndrome or improving abdominal obesity will be described in detail below in conjunction with embodiments, but they should not be construed as limiting the scope of the invention.

Embodiment 1

Bifidobacterium longum YH295 was inoculated into a liquid medium with 50 mL of MRS, and anaerobically cultured at 37°C for 24 h; then 5% of inoculation amount was inoculated into the 50 mL MRS liquid medium, and anaerobically cultured at 37°C for 72 h to obtain a *Bifidobacterium longum* YH295 broth.

Bacteria powder preparation

1) Centrifugation: The foregoing broth was centrifuged to obtain bacterial sludge;

2) Lyophilization: Water quantity was 10 times the weight of the bacterial sludge. The bacterial sludge was mixed with water and a lyophilizate carrier, and followed by lyophilization to obtain a lyophilized viable bacteria powder. The viable cell count in the lyophilized viable cell count was at least 1.0×10^{10} - 5.0×10^{10} cfu/g.

Embodiment 2

Effect of *Bifidobacterium longum* YH295 on counts of *Lactobacillus* and *Bifidobacterium* in the gut

Thirty male Wistar rats were divided into three groups: a control group (n = 10), fed with normal diet; a model group (n = 10), fed with high-fat diet; and a YH295 group (n = 10), fed with high-fat diet and given lyophilized *Bifidobacterium longum* YH295 powder (10^8 CFU per day) diluted in PBS by gavage. *Lactobacillus* and *Bifidobacterium* were counted after 12 weeks. Data are represented as x±s, as shown in Table 1:

Table 1 Effect of *Bifidobacterium longum* YH295 on counts of *Lactobacillus* and *Bifidobacterium* in the high fat diet rat gut

(x±s, $lg10^n$/mL)

Group	*Lactobacillus*	*Bifidobacterium*
Control	10.59±0.42	9.60±0.32
Model	9.52±0.38	8.43±0.26
YH295	11.9±0.51*	10.5±0.43*

* YH295 group, $p<0.05$ compared with the model group

As shown in Table 1, compared with the model group, the administration of viable *Bifidobacterium longum* YH295 powder by gavage results in a significant increase in

Lactobacillus and *Bifidobacterium* in the high fat diet rat gut, and the difference is significant (p<0.05). This indicates that *Bifidobacterium longum* YH295 can increase the number of beneficial bacteria in the gut.

Embodiment 3

Effects of *Bifidobacterium longum* YH295 on expression of the intestinal regenerative gene and transmembrane binding protein content

The same experiment as Embodiment 2 was conducted. After the experiment was completed, small intestinal mucosa was removed for RNA extraction. Intestinal Reg I mRNA content and total housekeeping gene content were determined by real-time quantitative PCR, while concentrations of Reg I expressed protein and housekeeping gene expressed protein were determined by Western blotting; effect of *Bifidobacterium longum* YH295 on Reg I was evaluated using the ratio of Reg I content to housekeeping gene content (RVmRNA) and the ratio of both expressed proteins (RV protein) as indexes, respectively; meanwhile, frozen sections of terminal ileal and colonic tissues were made, and indirect immunofluorescence assay was used to determine the content of transmembrane binding protein occluding in small intestinal and colonic mucosae. Results are shown in Tables 2 and 3:

Table 2 Effect of *Bifidobacterium longum* YH295 on expression of regenerative gene in the high fat diet rat gut

Group	RVmRNA	RV protein
Control	0.19±0.02	0.23±0.07
Model	0.23±0.07	0.32±0.06
YH295	0.82±0.28*	1.21±0.06*

* YH295 group, p<0.001 compared with the model group and the control group

Table 3 Effect of *Bifidobacterium longum* YH295 on expression of transmembrane binding protein in the high fat diet rat gut

Group	Small intestinal transmembrane binding protein content%	Colonic transmembrane binding protein content %
Control	1.4±0.7	1.5±0.4
Model	1.2±0.5	1.3±0.2
YH295	2.2±0.6*	2.4±0.5*

* YH295 group, $p<0.05$ compared with the model group and the control group

As shown in Table 2, Reg I mRNA level and protein expression are maximal in the YH295 group, which are more than 4 times those of the control group and more than 3 times those of the model group (Table 2); meanwhile, the YH295 group shows significantly higher small intestinal and colonic transmembrane binding protein contents than both the model group and the control group (both $p<0.05$) (Table 3).

Evidently, *Bifidobacterium longum* YH295 significantly upregulates both expression of Reg I and transmembrane binding protein content to induce small intestinal cell proliferation, thereby playing an important role in the structural repair and regeneration of intestinal villi, increasing intestinal transmembrane binding protein content, and boosting the intestinal mucosal barrier function.

Embodiment 4

Effects of *Bifidobacterium longum* YH295 on the level of plasma endotoxin and intestinal inflammatory factors

The same experiment as Embodiment 2 was conducted. After the experiment was completed, blood was sampled for plasma lipopolysaccharide determination; interleukin IL-1β and myeloperoxidase (MPO) in the small intestinal tissue were determined by ELISA. Results are shown in Table 4:

Table 4 Effects of *Bifidobacterium longum* YH295 on the level of plasma endotoxin and intestinal inflammatory factors in the high fat diet rat

Group	Plasma lipopolysaccharide EU/ml	IL-1β pg/mg, small intestinal tissue	MPO pg/mg, small intestinal tissue
Control	5.12±0.55	4.83±0.12	47.1±2.1
Model	8.23±1.12*	18.53±1.16*	148.2±4.3*
YH295	6.01±1.15**	6.80±0.26***	51.2±3.1***

*Model group, $p<0.001$ compared with the control group

** YH295 group, $p<0.05$ compared with the model group

*** YH295 group, $p<0.001$ compared with the model group

As shown in Table 4, plasma lipopolysaccharide is also known as metabolic endotoxin. Plasma lipopolysaccharide is significantly higher in the high-fat diet group than in the control group, and the difference is very significant ($p<0.001$), indicating that high-fat diet induces an

increase in plasma endotoxin; however, plasma lipopolysaccharide is significantly lower in the YH295 group than in the model group ($p<0.05$), indicating that YH295 significantly lowers the endotoxin induced and produced by the high-fat diet. Similarly, in the high-fat diet group, intestinal inflammatory factors interleukin IL-1β and myeloperoxidase (MPO) also increase significantly compared with the control group, and the difference is very significant ($p<0.001$); however, in the YH295 group, both of them decrease very significantly ($p<0.001$). Evidently, *Bifidobacterium longum* YH295 significantly lowers the level of plasma endotoxin and intestinal inflammatory factors produced by high-fat diet.

Embodiment 5

Effects of *Bifidobacterium longum* YH295 on body weight and abdominal fat induced by high-fat diet

The same experiment as Embodiment 2 was conducted. Rats were weighed daily till the end of the experiment. After 12-week experiment, infra-abdominal fat was excised and weighed. Results are shown in Table 5:

Table 5 Effects of *Bifidobacterium longum* YH295 on body weight and abdominal fat of the high-fat diet rat

Group	Body weight, g	Abdominal fat, g/100 g of body weight
Control	418.08±20.36	4.16±0.32
Model	481.43±38.42*	7.13±0.26*
YH295	439.16±29.15**	4.58±0.22**

* Model group, $p<0.05$ compared with the control group

** YH295 group, $p<0.05$ compared with the model group

As shown in Table 5, with respect to body weight and abdominal fat, the model group increases significantly compared with the control group ($p<0.05$), and the YH295 group decreases significantly compared with the model group ($p<0.05$), indicating that high-fat diet results in increased body weight and abdominal fat, model of abdominal obesity is established, and administration of YH295 by gavage can reduce increments in body weight and abdominal fat induced by high-fat diet. Evidently, *Bifidobacterium longum* YH295 can reduce the risk of increased body weight and abdominal fat induced by high-fat diet.

Embodiment 6

Effects of *Bifidobacterium longum* YH295 on hyperglycemia and hyperlipidemia induced by high-fat diet

The same experiment as Embodiment 2 was conducted. After 12-week experiment, fasting blood samples were collected to determine fasting blood glucose (FBG) and blood lipid. Results

are shown in Table 6:

Table 6 Effects of *Bifidobacterium longum* YH295 on blood glucose and blood lipid in the high-fat diet rat

Group	FBG mmol/L	Triglyceride mmol/L	Cholesterol mmol/L
Control	4.87±0.16	0.96±0.05	5.77±0.25
Model	7.33±0..46*	1.53±0.27*	8.65±0.34*
YH295	5.16±0.15**	0.96±0.12**	5.87±0.21**

* Model group, $p<0.05$ compared with the control group

** YH295 group, $p<0.05$ compared with the model group

As shown in Table 6, with respect to FBG, triglyceride (TG), and cholesterol (CHOL), the model group increases significantly compared with the control group ($p<0.05$), and the YH295 group decreases significantly compared with the model group ($p<0.05$), indicating that high-fat diet results in increased body weight and abdominal fat, while increasing FBG and blood lipid, whereas administration of YH295 by gavage can reduce hyperglycemia and hyperlipidemia induced by high-fat diet. Evidently, *Bifidobacterium longum* YH295 can reduce the risk of hyperglycemia and hyperlipidemia induced by high-fat diet.

Embodiment 7

Effect of *Bifidobacterium longum* YH295 on nonalcoholic fatty liver disease (NAFLD)

Thirty male SD rats were divided into three groups: a control group (n = 10), fed with normal diet; a model group (n = 10), fed with high-fat diet; and a YH295 group (n = 10), fed with high-fat diet and given lyophilized *Bifidobacterium longum* YH295 powder (10^8 CFU per day) diluted in PBS by gavage. Livers were taken and livers and liver fat were weighed after 12 weeks. Results are shown in Table 7:

Table 7 Effect of *Bifidobacterium longum* YH295 on liver fat in the high-fat diet rat

Group	Liver fat, g/g of liver
Control	0..05±0.01
Model	0.18±0.06*
YH295	0.10±0.02**

* Model group, $p<0.001$ compared with the control group

** YH295 group, $p<0.05$ compared with the model group

As shown in Table 7, liver fat increases significantly in the model group compared with the control group ($p<0.001$) and decreases significantly in the YH295 group compared with the

model group (p<0.05), indicating that high-fat diet induces NAFLD, whereas administration of YH295 by gavage can reduce high liver fat induced by high-fat diet. Evidently, *Bifidobacterium longum* YH295 can reduce the risk of NAFLD.

The present invention provides a strain *Bifidobacterium longum* YH295, which can reduce the risk of abdominal obesity and nonalcoholic fatty liver disease (NAFLD) in such a way that it significantly increases counts of *Lactobacillus* and *Bifidobacterium* in the gut, upregulates expression of the intestinal regenerative gene and intestinal transmembrane binding protein content significantly, and lowers the level of plasma endotoxin and intestinal inflammatory factors; this can be used to prepare food products, supplements, or pharmaceutical products for the prophylaxis and/or treatment of metabolic syndrome.

The foregoing descriptions are only preferred implementation manners of the present invention. It should be noted that for a person of ordinary skill in the art, several improvements and modifications may further be made without departing from the principle of the present invention. These improvements and modifications should also be deemed as falling within the protection scope of the present invention.

What is claimed is:

1. A strain *Bifidobacterium longum* YH295, wherein the strain *Bifidobacterium longum* YH295 is deposited at China General Microbiological Culture Collection Center (CGMCC) under the accession number of CGMCC No.14093.

2. Use of the strain *Bifidobacterium longum* YH295 according to claim 1 in increasing counts of *Lactobacillus* and/or *Bifidobacterium* in the gut.

3. Use of the strain *Bifidobacterium longum* YH295 according to claim 1 in upregulating expression of the intestinal regenerative gene and transmembrane binding protein content.

4. Use of the strain *Bifidobacterium longum* YH295 according to claim 1 in lowering the level of plasma endotoxin and/or intestinal inflammatory factors.

5. Use of the strain *Bifidobacterium longum* YH295 according to claim 1 in the preparation of food products, supplements, or pharmaceutical products for the prophylaxis and treatment of abdominal obesity.

6. Use of the strain *Bifidobacterium longum* YH295 according to claim 1 in the preparation of food products, supplements, or pharmaceutical products for the prophylaxis and treatment of nonalcoholic fatty liver disease (NAFLD).

7. The use according to any one of claims 2 to 6, wherein the concentration of the viable *Bifidobacterium longum* YH295 is independently 10^6-10^9 CFU/mL or 10^6-10^9 CFU/g.