Supplementary Materials

1. Supplementary methods

1.1. Polysaccharide purity detection

The purity detection of PEP was carried out using the phenol-sulfuric acid method with some modifications. Briefly, 1 mL PEP solution (2 mg/mL) was added into a 10 mL tube, and then reacted with 1mL 5% (w/v) phenol solution and 5mL concentrated sulfuric acid. After the whole mixture was shaken and incubated for 30 min at room temperature, the absorbance at 490 nm was detected using a microplate reader (Thermo multiskan Mk3, Thermo Fisher Scientific Inc., USA). A standard curve was generated from a series of concentrations of glucose standard solutions (0.02, 0.04, 0.06, 0.08, 0.12, 0.14, 0.16, 0.18 and 0.20 mg/mL).

1.2. Homogeneity and molecular weight determination

The homogeneity and molecular weight of PEP was determined by High Performance Liquid Chromatography (HPLC) on an Agilent 1200 system equipped with a TSK-gel G4000 PWXL column (300 mm × 7.8 mm) and detected by an evaporative light scattering detector (ELSD). The column and ELSD temperature were maintained at 30 °C. A sample solution of 20 μL (1 mg/mL) was injected into the detector and eluted with distilled water at a flow rate of 0.6 mL/min. Homogeneity and molecular weight analysis was evaluated by a standard curve established with T-series dextran standards.

1.3. Analysis of monosaccharide composition

The analysis of monosaccharide composition of PEP using High Performance

Liquid Chromatography (HPLC) was based on the method described previously by (Chen et al., 2016) with slight modifications. Briefly, 5 mg PEP and 2.0 mL TFA was mixed in a 5 mL ampoule bottle, then sealed and incubated in an oven (110 ℃, 5 h) for hydrolysis of PEP. After the hydrolysate was cooled to room temperature and centrifuged at 5000 × g for 5 min, the collected the supernatant was dried in a vacuum evaporator at 70 °C. The centrifugation and drying processes were repeated thrice to completely remove the TFA. The hydrolysate was dissolved in 5 mL distilled water and 0.2 mL of the solution was pipetted into a tube with 0.2 mL PMP (dissolved in methanol, 0.5 mol/L) and 0.2 mL sodium hydroxide (0.3 mol/L) and vortexed. The resulting solution was incubated in a water bath (70 ℃, 60 min). After inicubation, 0.2 mL HCl solution (0.3 mol/L) was added into the solution to make it a neutral. Chloroform (1 mL) was added into the neutral mixture (cooled to room temperature) and vortexed for 60 s. The chloroform layer was removed completely by centrifuging (4000 × g, 5 min) thrice. All the supernatants were diluted to 5 mL using distilled water for the HPLC detection with a UV detector at 245 nm on an Agilent 1200 Infinity Chromatograph after filtration through a 0.22 μm membrane. The mobile phase was acetonitrile (A) and 0.05 mol/mL phosphate buffer solution with pH 6.8 (B) (A: B = 18: 82, v/v). The injection volume was 20 μL and the separating column was Phenomenex Geminin C18 Column (5 μm, 250 mm × 4.6 mm) at 30 ℃, 0.8 mL temperature and flow rate, respectively. All standard sugars (mannose, rhamnose, ribose, glucosamine, galacturonic acid, glucuronic acid, glucose, galactose, galactosamine, fucose, arabinose and xylose) were prepared following the same

protocol. The area normalization method was used for calculating the molar proportions of monosaccharides in the polysaccharides.

1.4. Ultraviolet (UV) and Fourier-transform infrared spectroscopy (FT-IR) assay

UV assay was used for the determination of protein and nucleic acid contents and FT-IR assay was for the revealing of some presented functional groups of PEP.

The UV spectra of the polysaccharides solutions were determined with an ultraviolet spectrophotometer (Shanghai Precision and Scientific Instrument Co. Ltd., Shanghai, China) in the range of 200-400 nm and the FT-IR assay was performed on a Nicolet Fourier Transform Infrared Spectrometer (NICOLET NEXUS470, Thermo Nicolet Co., WI., USA) from 500 to 4000 cm−1 according to the manufacturers' instruction.

1.5. Determination of sulfate and uronic acid contents

The barium chloride-gelatin method was utilized to detect the content of sulfate groups in PEP with some appropriate modifications (Dodgson & Price, 1962). Briefly, PEP was hydrolyzed with 1 mol/L hydrochloric acid and then dried through a rotary evaporator. The dried residue was dissolved in 1 mL of water, reacted with 8% of trichloroacetic acid, 5% of barium chloride-gelatin solution and absorbance were measured at 360 nm after incubation for 20 min at room temperature. A standard curve was generated from the series of concentrations of potassium sulfate solution (0, 20, 40, 60, 80 and 100 μg/mL).

The determination of uronic acid content in the polysaccharides was achieved by sulfuric acid-carbazole method with some modifications (Ma et al., 2014). Briefly, 0.2

mL polysaccharides solution (1 mg/mL) was mixed with 5 mL of sodium tetraborate sulfuric acid solution (9.54 mg/mL) and incubated in a boiling water bath for 10 min. Then, 0.2 mL of carbazole ethanol solution (1.25 mg/mL) was added into the solution for another reaction for 10 min. The absorbance of the solution was determined at 530 nm at room temperature while D-glucuronic acid served as the reference.

References

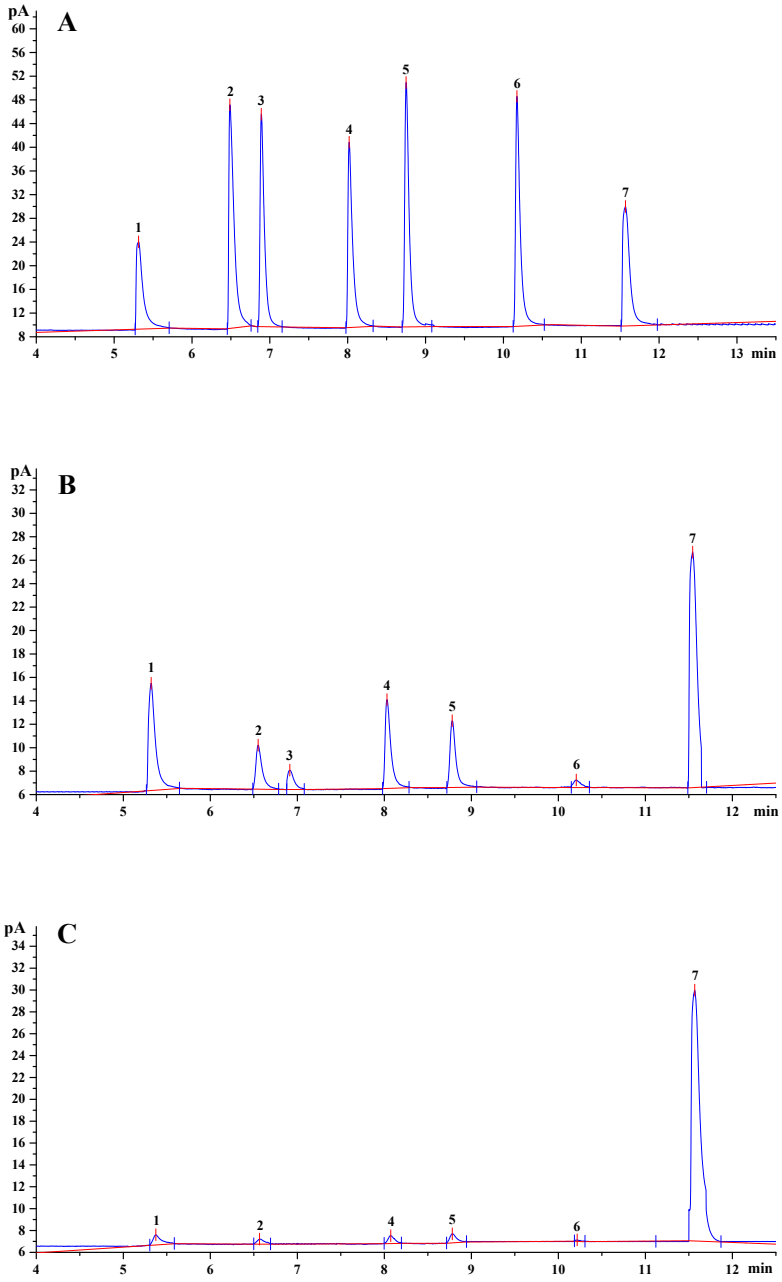
Chen, Z., Zhang, W., Tang, X., Fan, H., Xie, X., Wan, Q., et al. (2016). Extraction and characterization of polysaccharides from Semen Cassiae by microwave-assisted aqueous two-phase extraction coupled with spectroscopy and HPLC. *Carbohydrate Polymers,* 144, 263-270.

Dodgson, K. S., & Price, R. G. (1962). A note on the determination of the ester sulphate content of sulphated polysaccharides. *Biochemitry Journal,* 84(1), 106-110.

Ma, G., Yang, W., Mariga, A. M., Fang, Y., Ma, N., Pei, F., et al. (2014). Purification, characterization and antitumor activity of polysaccharides from *Pleurotus eryngii residue*. *Carbohydrate Polymers,* 114, 297-305.

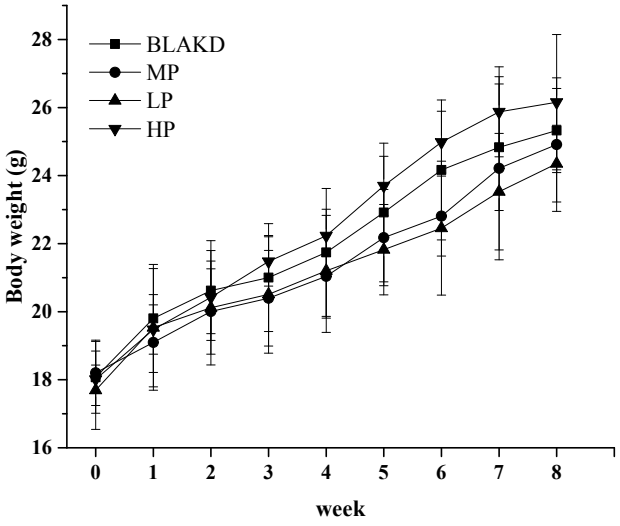
2. Supplementary Figures

Supplementary figure. 1



Supplementary figure. 1 Gas chromatograms (GC) of short-chain fatty acids (SCFAs) detection of luminal contents in cecum and colon of C57BL/6 mice. (A) Standard solution of SCFAs. (B) Luminal contents in mice cecum sample. (C) Luminal contents in mice colon sample. Peaks: 1 = acetic acid, 2 = propionic acid, 3 = *i*-butyric acid; 4 = *n*-butyric acid; 5 = *i*-valeric acid; 6 = *n*-valeric acid, 7 = 4-methylvaleric (internal standard).

Supplementary figure. 2



Supplementary figure. 2 Effects of different treatments on body weight.

3. Supplementary Tables

Supplementary table. 1. Taxonomic analysis based on 16S rRNA gene sequences in different groups.

Sample ID	Reads	0.03				
		OTU	Chao	Coverage	Shannon	Simpson
0-1	40075	281	352	0.998802	3.28	0.0745
0-2	40075	321	369	0.999002	3.36	0.0601
0-3	40075	291	322	0.998902	3.02	0.1424
0-4	40075	311	333	0.999177	3.76	0.0929
0-5	40075	315	351	0.998927	3.53	0.062
0-6	40075	306	344	0.998852	3.69	0.0677
0-7	40075	360	377	0.999177	4.26	0.0493
0-8	40075	359	403	0.998603	4	0.0513
0-9	40075	304	415	0.998328	3.11	0.0655
0-10	40075	299	344	0.998827	3.24	0.1345
1-1	40075	322	337	0.999201	4.14	0.0357
1-2	40075	350	282	0.999077	3.78	0.1019
1-3	40075	344	364	0.999177	3.97	0.0587
1-4	40075	319	376	0.998503	3.57	0.053
1-5	40075	339	387	0.998927	4.02	0.043
1-6	40075	320	362	0.998528	3.69	0.0557
1-7	40075	312	349	0.998827	3.84	0.0554
1-8	40075	305	336	0.998877	3.62	0.0674
1-9	40075	282	328	0.998727	3.29	0.1001
1-10	40075	360	343	0.998553	3.86	0.0603
2-1	40075	310	360	0.998628	3.86	0.0422
2-2	40075	320	353	0.998952	3.99	0.1074
2-3	40075	314	350	0.998628	3.88	0.0593
2-4	40075	355	402	0.998702	4.05	0.0361
2-5	40075	365	395	0.998852	4.01	0.0446
2-6	40075	298	344	0.998677	3.65	0.0576
2-7	40075	319	360	0.998702	3.85	0.0487
2-8	40075	316	365	0.998653	3.78	0.0447
2-9	40075	319	349	0.998952	3.78	0.0575
2-10	40075	300	332	0.998877	3.67	0.0611
3-1	40075	366	361	0.998827	4.13	0.0338
3-2	40075	338	318	0.999177	3.97	0.0377
3-3	40075	331	338	0.999077	3.92	0.0355
3-4	40075	357	330	0.998702	3.91	0.0449
3-5	40075	328	369	0.998752	3.9	0.0412
3-6	40075	325	358	0.998877	4.16	0.039
3-7	40075	345	318	0.999152	3.94	0.0477

3-8	40075	297	345	0.998603	3.21	0.1261
3-9	40075	300	384	0.998578	3.95	0.0353
3-10	40075	373	378	0.998752	4.1	0.0312

NOTE: Sample ID marked with 0-1 to 0-10, 1-1 to 1-10, 2-1 to 2-10 and 3-1 to 3-10 showed the Blank group, LP group, MP group and HP group individual variations, respectively.