

Supplementary information

Table S1. Effects of yeast by-product supplementation on proximate composition of the sterile solid-state Lp-fermented *B. papyrifera*.

YB (%)	IT (day)	DM, %	NDF,%DM	CP,%DM	CF,%DM	Ash, %DM	GE, kJ
0	0	44.1±3.0	35.3±2.0 ^c	17.8±1.0	10.5±1.0 ^a	18.8±3.6	16.7±0.9
	4	46.2±0.3	33.4±0.8 ^{bc}	18.4±0.1	12.8±1.4 ^b	21.0±2.2	17.2±0.3
	7	46.1±0.6	33.1±1.2 ^{ab}	18.5±0.1	11.2±0.1 ^a	16.3±2.7	17.2±0.0
5	0	42.9±5.6	31.7±1.4 ^{ab}	18.4±0.5	9.8±1.4 ^a	22.2±0.8	16.4±0.3
	4	47.7±0.9	31.1±0.3 ^a	18.7±0.1	10.5±0.3 ^a	21.5±2.1	16.8±0.1
	7	48.6±0.9	31.7±1.5 ^{ab}	18.7±0.1	10.4±0.6 ^a	22.8±2.8	16.6±0.0

YB: yeast by-product powder; BP: *B. papyrifera*; Lp: *L. plantarum*; IT: incubation time; DM: dry matter; NDF: neutral detergent fiber; CP: crude protein; CF: crude fat; GE: Gross energy;

The data within a column with superscripts mean significant difference ($P < 0.05$).

Table S2. Primers used in the present study.

Gene	Gene Bank ID	Nucleotide sequence of primers (5'-3')	Product size
AhR	XM_015281254.2	F: CGTCAGCTACACTGGGCATT R: ATCGTTTCCCAGTATTGCAGGT	123
Nrf2	NM_205,117.1	F: TGTGTGTGATTCAACCCGACT R: TTAATGGAAGCCGCACCACT	143
IgA	S40610.1	F: GTCACCGTCCACCTGGACTACA R: ACCGATGGTCTCCTTCACATC	114
TNF- α	HQ739087.1	F: GAGCGTTGACTTGGCTGTC R: AAGCAACAACCAGCTATGCAC	129
IL6	NM_204628.1	F:CGTTTATGGAGAAGACCGTGAG R:AGAGGATTGTGCCCCGAATAA	91
Mucin2	XM_421035	F: GCTGATTGTCACTCACGCCTT R: ATCTGCCTGAATCACAGGTGC	442
ZO-1	XM_413773.4	F: TGTAGCCACAGCAAGAGGTG R: CTGGAATGGCTCCTTGTGGT	159
ZO-2	NM_204918.1	F:GGATACAATTCAGCAACAGCAAGG R: ACATGCGATCATCTGCGTCATCT	89
Occludin	NM_205128.1	F: GCAGATGTCCAGCGGTTACTAC R: CGAAGAAGCAGATGAGGCAGAG	176
β -actin	NM_205518.1	F: TTACTCGCCTCTGTGAAGGC R: TCCTAGACTGTGGGGGACTG	228

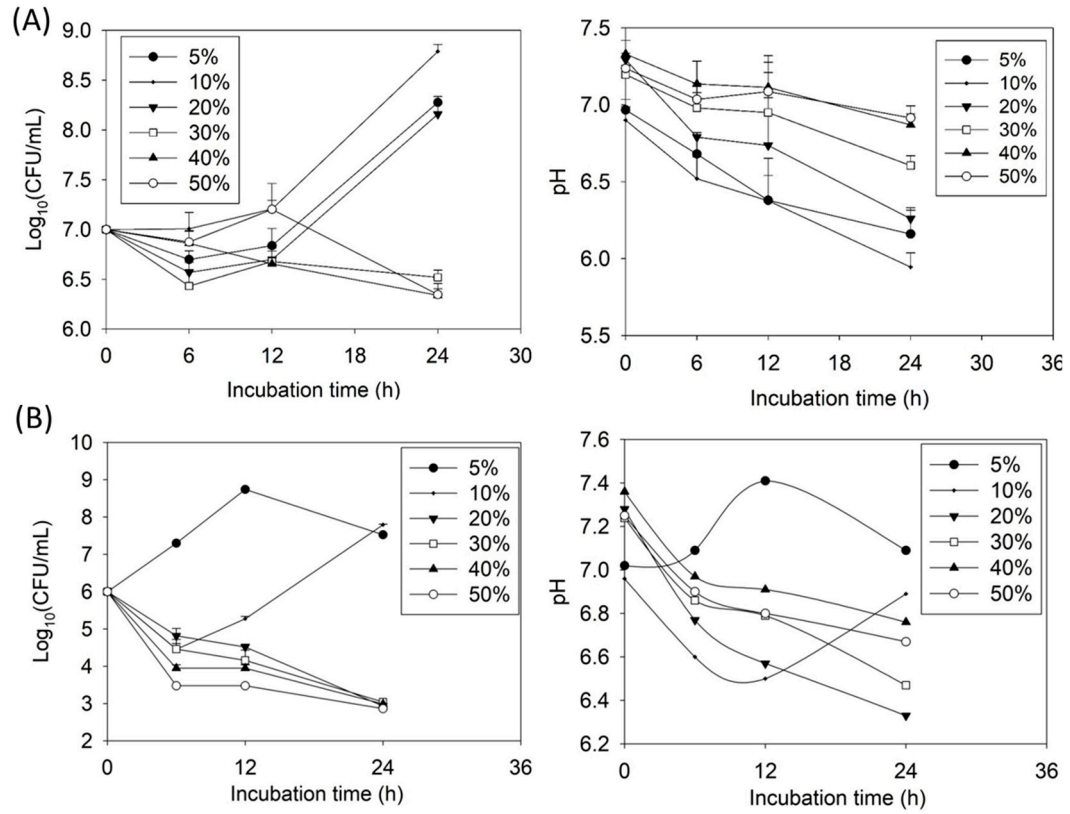


Fig. S1. Effects of incremental levels of yeast by-product supplementation on the growth and pH of the sterile solid-state Lp- (A) and Bv- (B) fermented *B. papyrifera*.

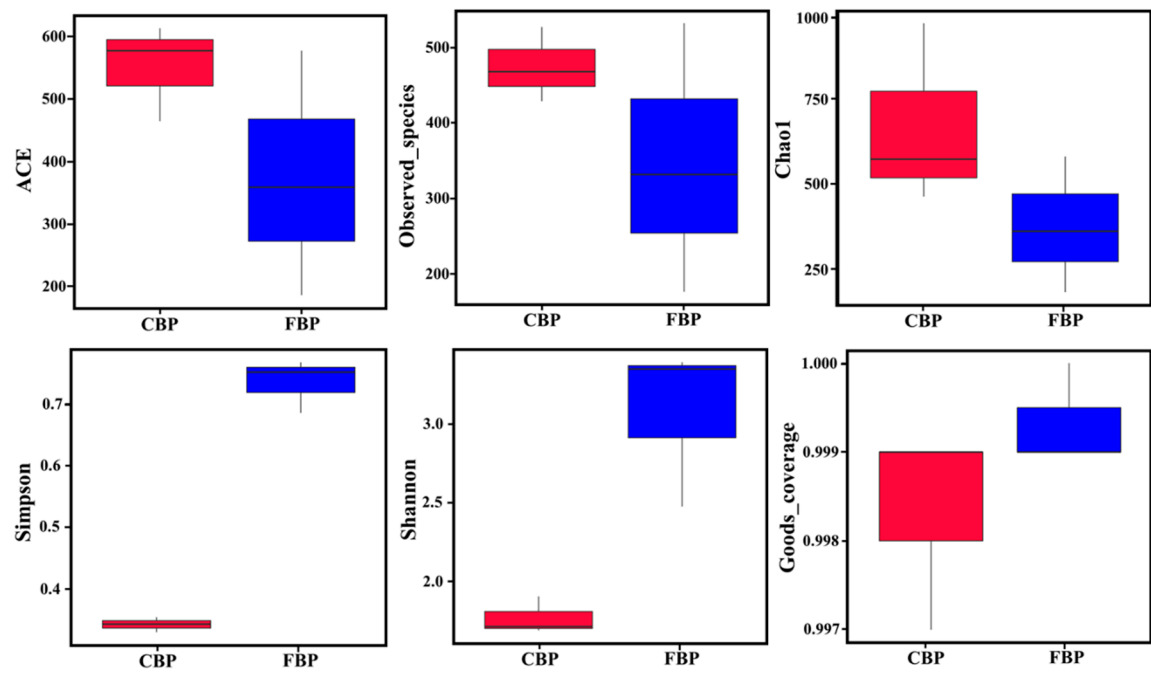


Fig. S2. Alpha diversity in raw (CBP) and Lp-fermented *B. papyrifera* product (FBP) under practical condition.

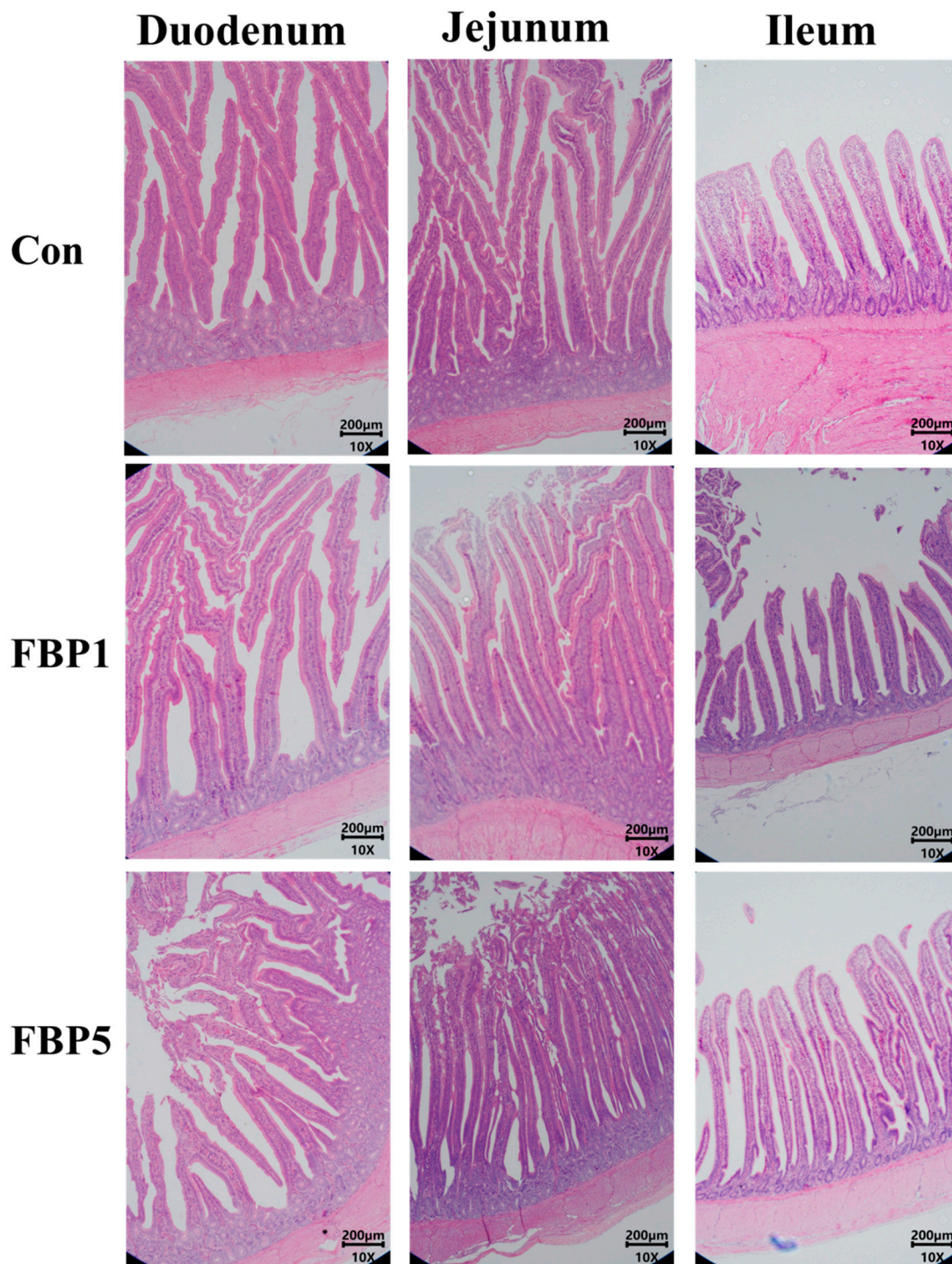


Fig. S3. Dietary effects of Lp-fermented *B. papyrifera* (FBP) on intestinal morphology of laying hens. Con: the hens fed with basal diet; FBP1, the hens fed with 1% (wt/wt) FBP product in basal diet; FBP5, the hens fed with 5% (wt/wt) FBP product in basal diet.

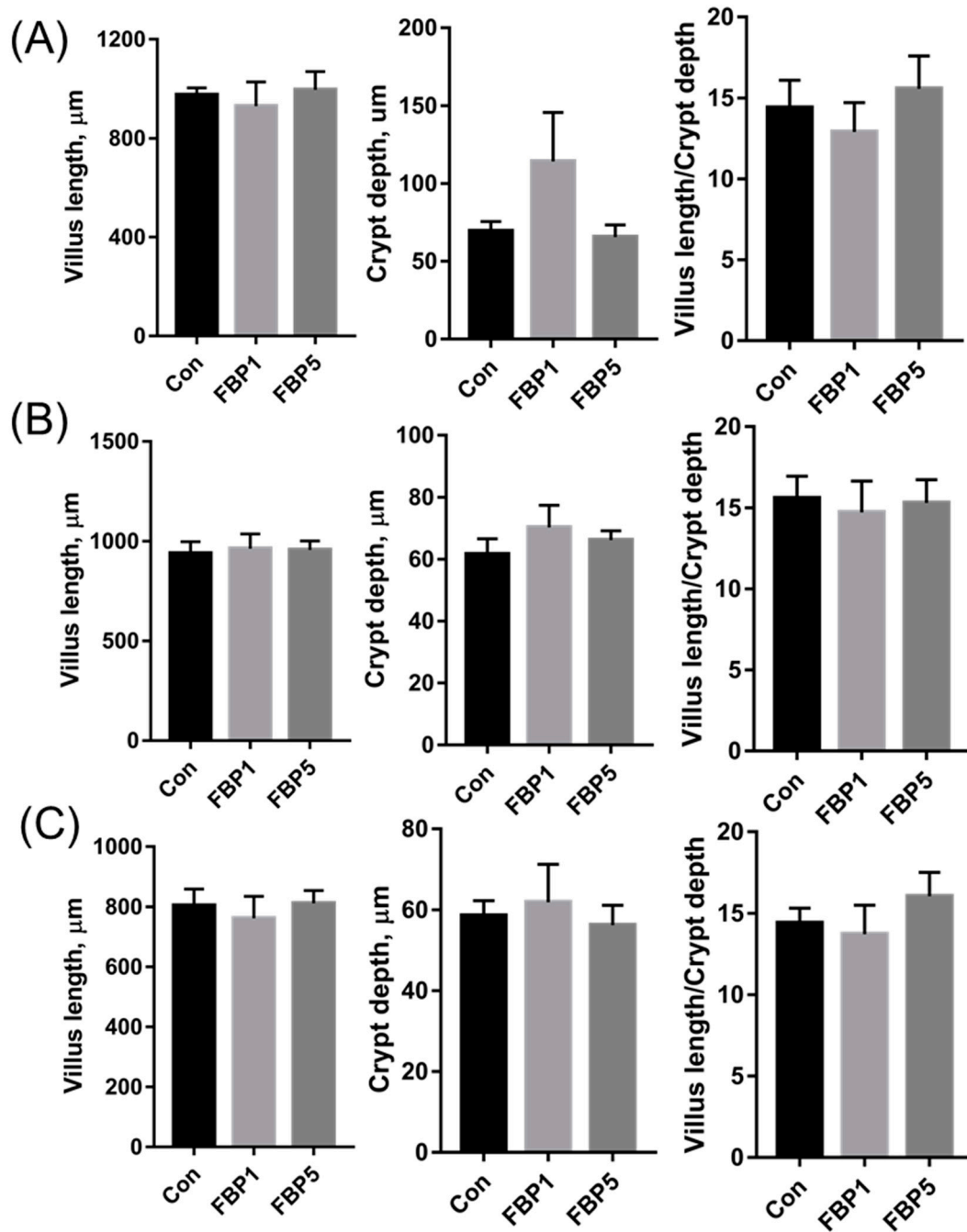


Fig. S4. Dietary effects of Lp-fermented *B. papyrifera* (FBP) product on villus length, crypt depth and villus length-to-crypt depth ratio of laying hens. Con: the hens fed with basal diet; FBP1, the hens fed with 1% (wt/wt) FBP product in basal diet; FBP5, the hens fed with 5% (wt/wt) FBP product in basal diet. (A) Duodenum; (B) Jejunum; (C) Ileum.