

Table S3. The partial Mantel test revealed the correlation between node connectivity of some taxa and the OTU significance of physiological traits in microbial co-occurrence networks.

Treatment group	Physiological parameter	Taxon (Level)	<i>r</i> (Correlation coefficient)	Significance (Probability)
M	Lee's index	Butyricimonas (Genus)	0.8169	0.0500
M	adipose tissue weight	Butyricimonas (Genus)	0.9485	0.0500
M	adipocytes diameter	Clostridiaceae (Family)	0.7574	0.0250
MA	TBARS	Lactobacillaceae (Family)	0.9162	0.0333
MA	TBARS	Lactobacillus (Genus)	0.9162	0.0333
MA	ALT	Porphyromonadaceae (Family)	0.7790	0.0100
MA	ALT	Parabacteroides (Genus)	0.7790	0.0040
MA	ALT	distasonis (Species)	0.9016	0.0111
MAL	TBARS	[Odoribacteraceae] (Family)	0.5789	0.0450
MAL	TBARS	Butyricimonas (Genus)	0.5042	0.0444

ALT: alanine aminotransferase; TBARS: thiobarbituric acid reactive substances; M: high-fat and high-sucrose diet + saline; MA: high-fat and high-sucrose diet + astaxanthin in oil phase; MAL: high-fat and high-sucrose diet + astaxanthin-loaded emulsion. The mice were supplemented with astaxanthin for 4 weeks at a daily dose of 30 mg/kg body weight after the mice were fed with a normal or high-fat and high-sucrose diet for 8 weeks.