Supplement

Table S1 relative abundance (%) of bacterial phyla in the rectal microbiota of donkeys receiving Low-energy diet and High-energy diet.

|  |  |  |  |
| --- | --- | --- | --- |
| Taxa | Groups | | |
| phylum | LE | HE | *p*.value |
| *Firmicutes* | 54.189 | 47.452 | 0.046 |
| *Bacteroidetes* | 37.577 | 41.611 | 0.155 |
| *Proteobacteria* | 1.971 | 6.893 | 0.098 |
| *Fusobacteria* | 0.982 | 0.013 | 0.355 |
| *Cyanobacteria* | 0.006 | 0.655 | 0.209 |
| *Actinobacteria* | 0.834 | 0.501 | 0.288 |
| *Tenericutes* | 0.751 | 0.365 | 0.162 |
| *Verrucomicrobia* | 0.549 | 0.524 | 0.926 |
| *Spirochaetes* | 1.237 | 0.744 | 0.002 |
| *Acidobacteria* | 0.301 | 0.097 | 0.357 |
| *unidentified\_Bacteria* | 0.317 | 0.272 | 0.768 |
| *Elusimicrobia* | 0.366 | 0.141 | 0.016 |
| *Rokubacteria* | 0.156 | 0.047 | 0.330 |
| *Melainabacteria* | 0.134 | 0.174 | 0.630 |
| *Chloroflexi* | 0.139 | 0.064 | 0.313 |
| *Fibrobacteres* | 0.162 | 0.211 | 0.213 |
| *Deferribacteres* | 0.053 | 0.056 | 0.935 |
| *Nitrospirae* | 0.042 | 0.009 | 0.268 |
| *Kiritimatiellaeota* | 0.078 | 0.074 | 0.784 |
| *Synergistetes* | 0.022 | 0.011 | 0.478 |
| *Latescibacteria* | 0.024 | 0.006 | 0.335 |
| *Gemmatimonadetes* | 0.023 | 0.015 | 0.577 |
| *Euryarchaeota* | 0.000 | 0.003 | 0.275 |
| *Lentisphaerae* | 0.007 | 0.005 | 0.441 |
| *Armatimonadetes* | 0.005 | 0.003 | 0.449 |
| *Planctomycetes* | 0.001 | 0.000 | 0.363 |
| *Others* | 0.076 | 0.057 | 0.383 |

The data is the means of 6 replicated smples.

Table S2 relative abundance (%) of bacterial family in the rectal microbiota of donkeys receiving Low-energy diet and High-energy diet.

|  |  |  |  |
| --- | --- | --- | --- |
| Taxa | Groups | | |
| family | LE | HE | p.value |
| *Ruminococcaceae* | 26.441 | 22.563 | 0.210 |
| *Lachnospiraceae* | 15.448 | 11.653 | 0.302 |
| *Lactobacillaceae* | 3.624 | 3.233 | 0.904 |
| *Prevotellaceae* | 3.965 | 9.132 | 0.015 |
| *Rikenellaceae* | 8.708 | 9.189 | 0.726 |
| *Enterococcaceae* | 0.031 | 1.943 | 0.345 |
| *Muribaculaceae* | 5.249 | 6.595 | 0.299 |
| *Pseudomonadaceae* | 0.010 | 3.007 | 0.176 |
| *Bacteroidaceae* | 2.463 | 2.082 | 0.823 |
| *unidentified\_Bacteroidales* | 4.760 | 3.526 | 0.210 |
| *Christensenellaceae* | 4.867 | 4.486 | 0.367 |
| *Fusobacteriaceae* | 0.982 | 0.013 | 0.355 |
| *Veillonellaceae* | 0.826 | 0.090 | 0.250 |
| *Enterobacteriaceae* | 0.074 | 0.981 | 0.107 |
| *unidentified\_Cyanobacteria* | 0.006 | 0.655 | 0.209 |
| *Marinifilaceae* | 0.736 | 1.038 | 0.567 |
| *Erysipelotrichaceae* | 0.371 | 0.961 | 0.166 |
| *Barnesiellaceae* | 0.409 | 0.002 | 0.358 |
| *Desulfovibrionaceae* | 0.662 | 1.003 | 0.374 |
| *Sphingomonadaceae* | 0.065 | 0.542 | 0.174 |
| *Akkermansiaceae* | 0.456 | 0.504 | 0.853 |
| *unidentified\_Clostridiales* | 0.782 | 0.509 | 0.092 |
| *Peptostreptococcaceae* | 0.136 | 0.258 | 0.578 |
| *Staphylococcaceae* | 0.009 | 0.200 | 0.365 |
| *Succinivibrionaceae* | 0.202 | 0.516 | 0.028 |
| *Helicobacteraceae* | 0.240 | 0.166 | 0.634 |
| *Acidaminococcaceae* | 0.424 | 0.314 | 0.179 |
| *Burkholderiaceae* | 0.089 | 0.257 | 0.131 |
| *Spirochaetaceae* | 0.392 | 0.317 | 0.195 |
| *unidentified\_Elusimicrobia* | 0.297 | 0.077 | 0.021 |
| *Anaeroplasmataceae* | 0.156 | 0.037 | 0.153 |
| *Bifidobacteriaceae* | 0.092 | 0.009 | 0.291 |
| *Xanthobacteraceae* | 0.146 | 0.071 | 0.473 |
| *Flavobacteriaceae* | 0.002 | 0.121 | 0.186 |
| *Eggerthellaceae* | 0.157 | 0.173 | 0.790 |
| *unidentified\_Acidobacteria* | 0.100 | 0.032 | 0.362 |
| *Tannerellaceae* | 0.128 | 0.166 | 0.559 |
| *Fibrobacteraceae* | 0.162 | 0.211 | 0.213 |
| *Chthoniobacteraceae* | 0.077 | 0.015 | 0.292 |
| *unidentified\_Bacteria* | 0.056 | 0.088 | 0.465 |
| *Beijerinckiaceae* | 0.010 | 0.077 | 0.158 |
| *Gaiellaceae* | 0.056 | 0.016 | 0.349 |
| *Nitrosomonadaceae* | 0.050 | 0.026 | 0.555 |
| *Coriobacteriaceae* | 0.034 | 0.001 | 0.315 |
| *Bacillaceae* | 0.036 | 0.019 | 0.637 |
| *Pyrinomonadaceae* | 0.041 | 0.009 | 0.339 |
| *Deferribacteraceae* | 0.053 | 0.056 | 0.935 |
| *Peptococcaceae* | 0.104 | 0.099 | 0.853 |
| *Rhizobiaceae* | 0.021 | 0.051 | 0.380 |
| *unidentified\_Alphaproteobacteria* | 0.052 | 0.014 | 0.222 |
| *Nitrospiraceae* | 0.042 | 0.009 | 0.268 |
| *Elusimicrobiaceae* | 0.069 | 0.064 | 0.820 |
| *Defluviitaleaceae* | 0.059 | 0.033 | 0.194 |
| *Aeromonadaceae* | 0.021 | 0.000 | 0.363 |
| *Microbacteriaceae* | 0.003 | 0.039 | 0.178 |
| *Streptococcaceae* | 0.082 | 0.063 | 0.122 |
| *unidentified\_Rhizobiales* | 0.029 | 0.027 | 0.920 |
| *Moraxellaceae* | 0.020 | 0.015 | 0.807 |
| *Desulfarculaceae* | 0.029 | 0.005 | 0.273 |
| *Atopobiaceae* | 0.016 | 0.056 | 0.084 |
| *Caulobacteraceae* | 0.003 | 0.029 | 0.180 |
| *Sphingobacteriaceae* | 0.002 | 0.030 | 0.198 |
| *Mycoplasmataceae* | 0.018 | 0.004 | 0.414 |
| *Rhodanobacteraceae* | 0.020 | 0.008 | 0.492 |
| *Synergistaceae* | 0.022 | 0.011 | 0.478 |
| *Acidothermaceae* | 0.019 | 0.003 | 0.340 |
| *Streptomycetaceae* | 0.020 | 0.006 | 0.353 |
| *Spirosomaceae* | 0.001 | 0.024 | 0.187 |
| *Anaerolineaceae* | 0.022 | 0.033 | 0.329 |
| *unidentified\_Gammaproteobacteria* | 0.009 | 0.013 | 0.761 |
| *Micrococcaceae* | 0.027 | 0.018 | 0.497 |
| *Acetobacteraceae* | 0.012 | 0.010 | 0.880 |
| *Mycobacteriaceae* | 0.021 | 0.003 | 0.239 |
| *unidentified\_Solibacterales* | 0.021 | 0.007 | 0.348 |
| *Frankiaceae* | 0.016 | 0.011 | 0.715 |
| *Paludibacteraceae* | 0.018 | 0.032 | 0.164 |
| *Gemmatimonadaceae* | 0.023 | 0.015 | 0.577 |
| *Hyphomicrobiaceae* | 0.023 | 0.010 | 0.352 |
| *Leuconostocaceae* | 0.011 | 0.001 | 0.408 |
| *unidentified\_Melainabacteria* | 0.008 | 0.019 | 0.247 |
| *Xanthomonadaceae* | 0.024 | 0.005 | 0.138 |
| *Planococcaceae* | 0.006 | 0.012 | 0.552 |
| *unidentified\_Rokubacteria* | 0.014 | 0.002 | 0.212 |
| *Eubacteriaceae* | 0.021 | 0.024 | 0.643 |
| *Nocardiaceae* | 0.012 | 0.003 | 0.282 |
| *Paenibacillaceae* | 0.009 | 0.002 | 0.424 |
| *Propionibacteriaceae* | 0.011 | 0.010 | 0.881 |
| *Thermomonosporaceae* | 0.007 | 0.002 | 0.474 |
| *Micromonosporaceae* | 0.014 | 0.006 | 0.281 |
| *unidentified\_Cardiobacteriales* | 0.007 | 0.000 | 0.363 |
| *Methylococcaceae* | 0.007 | 0.000 | 0.363 |
| *Hymenobacteraceae* | 0.000 | 0.009 | 0.212 |
| *unidentified\_Chthoniobacterales* | 0.013 | 0.004 | 0.368 |
| *unidentified\_Bacillales* | 0.001 | 0.009 | 0.279 |
| *Streptosporangiaceae* | 0.007 | 0.001 | 0.399 |
| *Coxiellaceae* | 0.005 | 0.017 | 0.042 |
| *unidentified\_Rickettsiales* | 0.001 | 0.011 | 0.192 |
| *Nocardiopsaceae* | 0.006 | 0.000 | 0.363 |
| *Limnochordaceae* | 0.006 | 0.000 | 0.363 |
| *Syntrophomonadaceae* | 0.017 | 0.007 | 0.115 |
| *Rhodobacteraceae* | 0.006 | 0.005 | 0.938 |
| *Campylobacteraceae* | 0.021 | 0.019 | 0.609 |
| *Chitinophagaceae* | 0.005 | 0.006 | 0.927 |
| *Corynebacteriaceae* | 0.004 | 0.012 | 0.066 |
| *unidentified\_Chloroflexi* | 0.007 | 0.002 | 0.344 |
| *Microscillaceae* | 0.007 | 0.001 | 0.244 |
| *unidentified\_Coriobacteriales* | 0.011 | 0.008 | 0.442 |
| *Myxococcaceae* | 0.004 | 0.000 | 0.363 |
| *Pseudonocardiaceae* | 0.005 | 0.004 | 0.908 |
| *Archangiaceae* | 0.006 | 0.001 | 0.278 |
| *unidentified\_Acidobacteriales* | 0.000 | 0.009 | 0.055 |
| *Thermoactinomycetaceae* | 0.003 | 0.000 | 0.363 |
| *Methylophilaceae* | 0.003 | 0.000 | 0.363 |
| *Geminicoccaceae* | 0.005 | 0.000 | 0.105 |
| *Haliangiaceae* | 0.006 | 0.002 | 0.220 |
| *Methanobacteriaceae* | 0.000 | 0.003 | 0.275 |
| *Marinilabiliaceae* | 0.006 | 0.009 | 0.416 |
| *Oligosphaeraceae* | 0.007 | 0.005 | 0.441 |
| *unidentified\_Dehalococcoidia* | 0.004 | 0.000 | 0.121 |
| *Roseiflexaceae* | 0.003 | 0.002 | 0.664 |
| *unidentified\_Acidimicrobiia* | 0.001 | 0.003 | 0.252 |
| *Ktedonobacteraceae* | 0.003 | 0.001 | 0.284 |
| *Micropepsaceae* | 0.003 | 0.002 | 0.799 |
| *unidentified\_Gaiellales* | 0.002 | 0.001 | 0.374 |
| *Solimonadaceae* | 0.002 | 0.000 | 0.363 |
| *Geodermatophilaceae* | 0.003 | 0.004 | 0.512 |
| *Lentimicrobiaceae* | 0.002 | 0.000 | 0.363 |
| *Woeseiaceae* | 0.002 | 0.002 | 0.817 |
| *Dietziaceae* | 0.003 | 0.004 | 0.608 |
| *unidentified\_Deltaproteobacteria* | 0.003 | 0.002 | 0.825 |
| *Halomonadaceae* | 0.002 | 0.002 | 1.000 |
| *Hyphomonadaceae* | 0.002 | 0.001 | 0.309 |
| *Aerococcaceae* | 0.001 | 0.001 | 1.000 |
| *Solirubrobacteraceae* | 0.000 | 0.001 | 0.363 |
| *Iamiaceae* | 0.002 | 0.001 | 0.220 |
| *unidentified\_Acidobacteriia* | 0.000 | 0.001 | 0.363 |
| *Brachyspiraceae* | 0.001 | 0.000 | 0.363 |
| *Alcanivoracaceae* | 0.001 | 0.000 | 0.363 |
| *Rhodocyclaceae* | 0.001 | 0.001 | 0.668 |
| *unidentified\_Spirochaetes* | 0.001 | 0.000 | 0.363 |
| *Gemmataceae* | 0.001 | 0.000 | 0.363 |
| *Sporichthyaceae* | 0.001 | 0.000 | 0.363 |
| *Vibrionaceae* | 0.001 | 0.000 | 0.363 |
| *unidentified\_Verrucomicrobiae* | 0.004 | 0.002 | 0.304 |
| *Sanguibacteraceae* | 0.000 | 0.001 | 0.363 |
| *Entomoplasmataceae* | 0.001 | 0.000 | 0.363 |
| *Acidimicrobiaceae* | 0.001 | 0.000 | 0.363 |
| *Others* | 14.727 | 12.071 | 0.312 |

Table S3 relative abundance (%) of bacterial genera in the rectal microbiota of donkeys receiving Low-energy diet and High-energy diet.

|  |  |  |  |
| --- | --- | --- | --- |
| Taxa | Groups | | |
| genera | LE | HE | p.value |
| *Lactobacillus* | 3.624 | 3.233 | 0.904 |
| *Enterococcus* | 0.031 | 1.943 | 0.345 |
| *Pseudomonas* | 0.010 | 3.007 | 0.176 |
| *Lachnoclostridium* | 1.785 | 0.544 | 0.427 |
| *Bacteroides* | 2.463 | 2.082 | 0.823 |
| *unidentified\_Bacteroidales* | 4.760 | 3.526 | 0.210 |
| *unidentified\_Prevotellaceae* | 0.765 | 3.162 | 0.077 |
| *unidentified\_Ruminococcaceae* | 5.687 | 4.665 | 0.064 |
| *unidentified\_Lachnospiraceae* | 3.227 | 2.481 | 0.572 |
| *Cetobacterium* | 0.936 | 0.008 | 0.365 |
| *Alistipes* | 0.743 | 1.268 | 0.355 |
| *Dialister* | 0.734 | 0.004 | 0.255 |
| *unidentified\_Cyanobacteria* | 0.006 | 0.655 | 0.209 |
| *unidentified\_Enterobacteriaceae* | 0.043 | 0.800 | 0.181 |
| *Odoribacter* | 0.658 | 0.988 | 0.531 |
| *Blautia* | 0.202 | 0.416 | 0.478 |
| *Oscillibacter* | 0.918 | 0.863 | 0.841 |
| *Sphingomonas* | 0.049 | 0.441 | 0.170 |
| *Akkermansia* | 0.456 | 0.504 | 0.853 |
| *Alloprevotella* | 0.642 | 0.823 | 0.473 |
| *Intestinimonas* | 0.442 | 0.530 | 0.712 |
| *Ruminiclostridium* | 0.485 | 0.413 | 0.768 |
| *Clostridioides* | 0.017 | 0.226 | 0.327 |
| *Staphylococcus* | 0.009 | 0.200 | 0.365 |
| *Faecalibacterium* | 0.212 | 0.099 | 0.517 |
| *unidentified\_Clostridiales* | 0.420 | 0.271 | 0.286 |
| *Coprobacillus* | 0.000 | 0.163 | 0.363 |
| *unidentified\_Erysipelotrichaceae* | 0.012 | 0.176 | 0.318 |
| *Helicobacter* | 0.240 | 0.166 | 0.634 |
| *Desulfovibrio* | 0.128 | 0.373 | 0.077 |
| *Phascolarctobacterium* | 0.424 | 0.314 | 0.179 |
| *Succinivibrio* | 0.143 | 0.350 | 0.070 |
| *Candidatus\_Stoquefichus* | 0.000 | 0.106 | 0.361 |
| *Klebsiella* | 0.028 | 0.161 | 0.215 |
| *Roseburia* | 0.259 | 0.140 | 0.274 |
| *Rikenella* | 0.096 | 0.153 | 0.517 |
| *unidentified\_Elusimicrobia* | 0.297 | 0.077 | 0.021 |
| *Anaeroplasma* | 0.156 | 0.037 | 0.153 |
| *Bifidobacterium* | 0.092 | 0.009 | 0.291 |
| *Ileibacterium* | 0.001 | 0.074 | 0.355 |
| *Parasutterella* | 0.004 | 0.075 | 0.352 |
| *Flavobacterium* | 0.002 | 0.121 | 0.186 |
| *Agathobacter* | 0.127 | 0.042 | 0.197 |
| *Romboutsia* | 0.077 | 0.013 | 0.341 |
| *Candidatus\_Soleaferrea* | 0.236 | 0.144 | 0.021 |
| *Tyzzerella* | 0.110 | 0.141 | 0.611 |
| *unidentified\_Christensenellaceae* | 0.243 | 0.185 | 0.077 |
| *Parabacteroides* | 0.128 | 0.166 | 0.559 |
| *unidentified\_Acidobacteria* | 0.088 | 0.027 | 0.347 |
| *Erysipelatoclostridium* | 0.015 | 0.107 | 0.203 |
| *Fibrobacter* | 0.162 | 0.211 | 0.213 |
| *Anaerovorax* | 0.237 | 0.164 | 0.017 |
| *Flavonifractor* | 0.052 | 0.029 | 0.664 |
| *Candidatus\_Udaeobacter* | 0.077 | 0.015 | 0.292 |
| *Subdoligranulum* | 0.060 | 0.056 | 0.935 |
| *Muribaculum* | 0.105 | 0.058 | 0.445 |
| *Acetitomaculum* | 0.096 | 0.025 | 0.110 |
| *Polymorphobacter* | 0.000 | 0.082 | 0.175 |
| *Candidatus\_Saccharimonas* | 0.054 | 0.086 | 0.450 |
| *Enterorhabdus* | 0.076 | 0.086 | 0.842 |
| *Gaiella* | 0.056 | 0.016 | 0.349 |
| *Butyricicoccus* | 0.116 | 0.084 | 0.346 |
| *Papillibacter* | 0.096 | 0.080 | 0.666 |
| *unidentified\_Spirochaetaceae* | 0.076 | 0.040 | 0.235 |
| *Angelakisella* | 0.084 | 0.097 | 0.767 |
| *Dubosiella* | 0.038 | 0.002 | 0.281 |
| *Collinsella* | 0.034 | 0.001 | 0.315 |
| *Dorea* | 0.031 | 0.009 | 0.469 |
| *Faecalibaculum* | 0.001 | 0.030 | 0.370 |
| *Mucispirillum* | 0.053 | 0.056 | 0.935 |
| *Bradyrhizobium* | 0.047 | 0.027 | 0.565 |
| *Intestinibacter* | 0.033 | 0.019 | 0.635 |
| *Candidatus\_Arthromitus* | 0.024 | 0.000 | 0.363 |
| *Fusobacterium* | 0.046 | 0.005 | 0.111 |
| *Elusimicrobium* | 0.069 | 0.064 | 0.820 |
| *Paraprevotella* | 0.037 | 0.027 | 0.727 |
| *Negativibacillus* | 0.046 | 0.053 | 0.775 |
| *Allobaculum* | 0.000 | 0.021 | 0.363 |
| *Methylobacterium* | 0.007 | 0.037 | 0.200 |
| *Aeromonas* | 0.021 | 0.000 | 0.363 |
| *unidentified\_Rhizobiaceae* | 0.004 | 0.035 | 0.197 |
| *Frigoribacterium* | 0.003 | 0.034 | 0.196 |
| *Marvinbryantia* | 0.079 | 0.047 | 0.061 |
| *Streptococcus* | 0.081 | 0.063 | 0.145 |
| *Saccharofermentans* | 0.063 | 0.048 | 0.351 |
| *Massilia* | 0.007 | 0.035 | 0.275 |
| *Delftia* | 0.000 | 0.018 | 0.349 |
| *Oribacterium* | 0.060 | 0.044 | 0.258 |
| *Mycoplasma* | 0.018 | 0.004 | 0.414 |
| *Luteibacter* | 0.016 | 0.007 | 0.587 |
| *Rhodoferax* | 0.001 | 0.028 | 0.184 |
| *Acidothermus* | 0.019 | 0.003 | 0.340 |
| *Bacillus* | 0.013 | 0.018 | 0.797 |
| *Oceanobacillus* | 0.016 | 0.002 | 0.374 |
| *Streptomyces* | 0.020 | 0.006 | 0.353 |
| *Anaerotruncus* | 0.017 | 0.022 | 0.805 |
| *Dyadobacter* | 0.001 | 0.023 | 0.191 |
| *unidentified\_Rhizobiales* | 0.023 | 0.015 | 0.691 |
| *Ralstonia* | 0.017 | 0.000 | 0.253 |
| *Pedobacter* | 0.002 | 0.021 | 0.217 |
| *Cloacibacillus* | 0.013 | 0.003 | 0.466 |
| *Flexilinea* | 0.022 | 0.033 | 0.329 |
| *Acetobacter* | 0.012 | 0.000 | 0.363 |
| *Arthrobacter* | 0.021 | 0.016 | 0.720 |
| *Mycobacterium* | 0.021 | 0.003 | 0.239 |
| *Jatrophihabitans* | 0.016 | 0.011 | 0.715 |
| *Lachnospira* | 0.032 | 0.026 | 0.570 |
| *Weissella* | 0.011 | 0.001 | 0.408 |
| *Sutterella* | 0.001 | 0.012 | 0.337 |
| *Mogibacterium* | 0.043 | 0.028 | 0.106 |
| *Variovorax* | 0.002 | 0.017 | 0.234 |
| *Pedomicrobium* | 0.018 | 0.009 | 0.433 |
| *Acinetobacter* | 0.011 | 0.012 | 0.967 |
| *Brevundimonas* | 0.001 | 0.015 | 0.170 |
| *unidentified\_Melainabacteria* | 0.008 | 0.019 | 0.247 |
| *Candidatus\_Solibacter* | 0.014 | 0.004 | 0.339 |
| *Sphingopyxis* | 0.010 | 0.004 | 0.594 |
| *Planomicrobium* | 0.000 | 0.009 | 0.363 |
| *Harryflintia* | 0.019 | 0.025 | 0.468 |
| *Proteocatella* | 0.009 | 0.000 | 0.363 |
| *Pseudoxanthomonas* | 0.010 | 0.001 | 0.359 |
| *Mucilaginibacter* | 0.000 | 0.009 | 0.334 |
| *Bilophila* | 0.021 | 0.022 | 0.921 |
| *unidentified\_Beijerinckiaceae* | 0.000 | 0.018 | 0.123 |
| *unidentified\_Rokubacteria* | 0.014 | 0.002 | 0.212 |
| *Sphaerochaeta* | 0.026 | 0.011 | 0.044 |
| *Rhodococcus* | 0.012 | 0.003 | 0.282 |
| *Psychrobacter* | 0.009 | 0.001 | 0.359 |
| *Microlunatus* | 0.009 | 0.008 | 0.923 |
| *Pseudobutyrivibrio* | 0.030 | 0.015 | 0.032 |
| *Actinomadura* | 0.007 | 0.002 | 0.474 |
| *Ignatzschineria* | 0.007 | 0.000 | 0.363 |
| *Anaerovibrio* | 0.026 | 0.023 | 0.658 |
| *Exiguobacterium* | 0.001 | 0.007 | 0.358 |
| *Duganella* | 0.000 | 0.013 | 0.175 |
| *Acetatifactor* | 0.015 | 0.001 | 0.071 |
| *Sphaerisporangium* | 0.007 | 0.001 | 0.399 |
| *Candidatus\_Xiphinematobacter* | 0.013 | 0.004 | 0.368 |
| *Hymenobacter* | 0.000 | 0.009 | 0.212 |
| *Holdemanella* | 0.006 | 0.001 | 0.402 |
| *unidentified\_Rickettsiales* | 0.001 | 0.011 | 0.192 |
| *Coxiella* | 0.005 | 0.017 | 0.042 |
| *Thermobifida* | 0.006 | 0.000 | 0.363 |
| *Pseudaminobacter* | 0.014 | 0.002 | 0.163 |
| *Lysobacter* | 0.011 | 0.002 | 0.268 |
| *Anaerosporobacter* | 0.010 | 0.000 | 0.093 |
| *Rhodopseudomonas* | 0.003 | 0.010 | 0.303 |
| *Frondihabitans* | 0.000 | 0.005 | 0.363 |
| *Sphingoaurantiacus* | 0.000 | 0.008 | 0.185 |
| *Caproiciproducens* | 0.005 | 0.012 | 0.181 |
| *Bryobacter* | 0.007 | 0.003 | 0.530 |
| *Dongia* | 0.009 | 0.003 | 0.349 |
| *Acidiphilium* | 0.000 | 0.009 | 0.176 |
| *Devosia* | 0.003 | 0.009 | 0.323 |
| *Mailhella* | 0.017 | 0.005 | 0.012 |
| *Sinibacillus* | 0.005 | 0.000 | 0.363 |
| *Campylobacter* | 0.021 | 0.019 | 0.609 |
| *Shuttleworthia* | 0.003 | 0.013 | 0.067 |
| *Turicibacter* | 0.006 | 0.001 | 0.361 |
| *unidentified\_Chloroflexi* | 0.007 | 0.002 | 0.344 |
| *Catenisphaera* | 0.014 | 0.014 | 1.000 |
| *Butyricimonas* | 0.012 | 0.007 | 0.315 |
| *unidentified\_Corynebacteriaceae* | 0.002 | 0.005 | 0.490 |
| *Stenotrophobacter* | 0.005 | 0.001 | 0.364 |
| *Acidibacter* | 0.003 | 0.005 | 0.662 |
| *Prevotella* | 0.000 | 0.004 | 0.363 |
| *Reyranella* | 0.008 | 0.003 | 0.427 |
| *Novosphingobium* | 0.002 | 0.006 | 0.354 |
| *Faecalitalea* | 0.002 | 0.005 | 0.518 |
| *unidentified\_Burkholderiaceae* | 0.006 | 0.008 | 0.691 |
| *Chryseolinea* | 0.004 | 0.000 | 0.363 |
| *Anaeromyxobacter* | 0.006 | 0.001 | 0.278 |
| *unidentified\_Gammaproteobacteria* | 0.005 | 0.004 | 0.830 |
| *Anaerofustis* | 0.013 | 0.011 | 0.597 |
| *Phoenicibacter* | 0.011 | 0.008 | 0.442 |
| *Oxalobacter* | 0.006 | 0.004 | 0.771 |
| *Kocuria* | 0.006 | 0.002 | 0.305 |
| *unidentified\_Alphaproteobacteria* | 0.009 | 0.002 | 0.174 |
| *Bosea* | 0.001 | 0.004 | 0.294 |
| *Gallicola* | 0.003 | 0.000 | 0.363 |
| *Caulobacter* | 0.002 | 0.005 | 0.487 |
| *Oscillospira* | 0.002 | 0.010 | 0.017 |
| *Peptococcus* | 0.006 | 0.005 | 0.907 |
| *Methylorosula* | 0.001 | 0.008 | 0.098 |
| *Sporosarcina* | 0.003 | 0.000 | 0.363 |
| *Terriglobus* | 0.000 | 0.006 | 0.120 |
| *Ammoniibacillus* | 0.003 | 0.000 | 0.363 |
| *Novibacillus* | 0.003 | 0.000 | 0.363 |
| *Rhizobacter* | 0.004 | 0.006 | 0.731 |
| *Pseudochrobactrum* | 0.000 | 0.006 | 0.177 |
| *Hyphomicrobium* | 0.005 | 0.002 | 0.383 |
| *Candidatus\_Alysiosphaera* | 0.005 | 0.000 | 0.105 |
| *Pseudonocardia* | 0.005 | 0.003 | 0.536 |
| *Aureimonas* | 0.001 | 0.005 | 0.292 |
| *Fournierella* | 0.003 | 0.007 | 0.228 |
| *Haliangium* | 0.006 | 0.002 | 0.220 |
| *Paracoccus* | 0.003 | 0.003 | 1.000 |
| *Rhodoplanes* | 0.005 | 0.003 | 0.674 |
| *Gemmatimonas* | 0.003 | 0.002 | 0.863 |
| *Acidovorax* | 0.006 | 0.005 | 0.796 |
| *Sphingobium* | 0.003 | 0.001 | 0.596 |
| *Pyramidobacter* | 0.005 | 0.004 | 0.740 |
| *Parvibaculum* | 0.003 | 0.000 | 0.363 |
| *Methanobrevibacter* | 0.000 | 0.003 | 0.275 |
| *Methylophilus* | 0.003 | 0.000 | 0.363 |
| *Phenylobacterium* | 0.000 | 0.004 | 0.191 |
| *unidentified\_Dehalococcoidia* | 0.004 | 0.000 | 0.121 |
| *Serratia* | 0.001 | 0.003 | 0.284 |
| *Hydrogenoanaerobacterium* | 0.002 | 0.002 | 0.830 |
| *Mesorhizobium* | 0.003 | 0.004 | 0.576 |
| *unidentified\_Acidimicrobiia* | 0.001 | 0.003 | 0.252 |
| *Enhydrobacter* | 0.001 | 0.003 | 0.252 |
| *Amaricoccus* | 0.002 | 0.000 | 0.363 |
| *Catabacter* | 0.000 | 0.003 | 0.259 |
| *Lawsonia* | 0.002 | 0.000 | 0.363 |
| *Cutibacterium* | 0.002 | 0.002 | 0.820 |
| *Cuneatibacter* | 0.002 | 0.000 | 0.363 |
| *Arenimonas* | 0.004 | 0.002 | 0.577 |
| *Rickettsiella* | 0.000 | 0.003 | 0.185 |
| *Lentimicrobium* | 0.002 | 0.000 | 0.363 |
| *Halomonas* | 0.002 | 0.002 | 1.000 |
| *Megamonas* | 0.003 | 0.001 | 0.252 |
| *Garciella* | 0.002 | 0.000 | 0.363 |
| *unidentified\_Deltaproteobacteria* | 0.003 | 0.002 | 0.825 |
| *Amycolatopsis* | 0.000 | 0.002 | 0.363 |
| *Oligella* | 0.003 | 0.002 | 0.781 |
| *Thermobacillus* | 0.002 | 0.000 | 0.363 |
| *Ammoniphilus* | 0.001 | 0.002 | 0.590 |
| *Synergistes* | 0.000 | 0.002 | 0.235 |
| *Panacagrimonas* | 0.002 | 0.000 | 0.363 |
| *Ezakiella* | 0.002 | 0.000 | 0.363 |
| *Kurthia* | 0.002 | 0.000 | 0.363 |
| *Woeseia* | 0.002 | 0.000 | 0.363 |
| *Gemmatirosa* | 0.000 | 0.002 | 0.235 |
| *Microvirga* | 0.002 | 0.001 | 0.550 |
| *Mucinivorans* | 0.006 | 0.001 | 0.002 |
| *Barnesiella* | 0.002 | 0.000 | 0.363 |
| *unidentified\_Gaiellales* | 0.002 | 0.001 | 0.374 |
| *Altererythrobacter* | 0.003 | 0.000 | 0.111 |
| *Gordonibacter* | 0.000 | 0.002 | 0.363 |
| *Dietzia* | 0.003 | 0.004 | 0.608 |
| *Anaerostipes* | 0.001 | 0.002 | 0.788 |
| *Eubacterium* | 0.006 | 0.003 | 0.196 |
| *Lactococcus* | 0.002 | 0.001 | 0.550 |
| *Paenibacillus* | 0.002 | 0.000 | 0.363 |
| *Sediminispirochaeta* | 0.002 | 0.003 | 0.341 |
| *Herbaspirillum* | 0.001 | 0.000 | 0.363 |
| *Dokdonella* | 0.000 | 0.001 | 0.363 |
| *Leisingera* | 0.001 | 0.000 | 0.363 |
| *Rummeliibacillus* | 0.001 | 0.003 | 0.361 |
| *unidentified\_Acidobacteriia* | 0.000 | 0.001 | 0.363 |
| *Sanguibacter* | 0.000 | 0.001 | 0.363 |
| *unidentified\_Verrucomicrobiae* | 0.004 | 0.002 | 0.304 |
| *Labrys* | 0.003 | 0.002 | 0.756 |
| *Aerosphaera* | 0.001 | 0.000 | 0.363 |
| *Terrimonas* | 0.001 | 0.001 | 0.668 |
| *Iamia* | 0.002 | 0.001 | 0.220 |
| *Spirosoma* | 0.000 | 0.001 | 0.363 |
| *Georgfuchsia* | 0.001 | 0.001 | 0.668 |
| *Veillonella* | 0.001 | 0.002 | 0.688 |
| *Aerococcus* | 0.000 | 0.001 | 0.363 |
| *Kaistia* | 0.000 | 0.002 | 0.203 |
| *Erysipelothrix* | 0.001 | 0.000 | 0.363 |
| *Conexibacter* | 0.000 | 0.001 | 0.363 |
| *unidentified\_Spirochaetes* | 0.001 | 0.000 | 0.363 |
| *Alcanivorax* | 0.001 | 0.000 | 0.363 |
| *Blastocatella* | 0.000 | 0.002 | 0.203 |
| *Ruminobacter* | 0.001 | 0.002 | 0.220 |
| *Vibrio* | 0.001 | 0.000 | 0.363 |
| *Gemella* | 0.001 | 0.002 | 0.409 |
| *Brachyspira* | 0.001 | 0.000 | 0.363 |
| *Corynebacterium* | 0.000 | 0.001 | 0.363 |
| *Bauldia* | 0.002 | 0.000 | 0.203 |
| *Candidatus\_Tammella* | 0.001 | 0.001 | 1.000 |
| *unidentified\_Bacteria* | 0.002 | 0.002 | 0.688 |
| *Rothia* | 0.001 | 0.001 | 0.668 |
| *Entomoplasma* | 0.001 | 0.000 | 0.363 |
| *Breznakia* | 0.000 | 0.001 | 0.363 |
| *Holdemania* | 0.000 | 0.001 | 0.175 |
| *Cellulosilyticum* | 0.001 | 0.001 | 1.000 |
| *Planosporangium* | 0.001 | 0.000 | 0.363 |
| *Longispora* | 0.001 | 0.000 | 0.363 |
| *Others* | 64.573 | 60.800 | 0.384 |

Table S4 Different metabolites with LC-MS/MS(ESI+)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | log2FC | Pvalue | VIP | Up.Down |
| 2,4-dihydroxyheptadec-16-en-1-yl acetate | 1.603 | <0.01 | 1.965 | up |
| Fumonisin B1 | -2.528 | <0.01 | 3.118 | down |
| Fumonisin B2 | -2.670 | <0.01 | 3.313 | down |
| D-(+)-Camphor | 1.199 | <0.01 | 1.464 | up |
| Fenvalerate | -2.352 | <0.01 | 2.901 | down |
| N-Acetyl-5-aminosalicylic acid | -4.332 | <0.01 | 5.133 | down |
| LPE 16:2 | -3.059 | <0.01 | 3.660 | down |
| Cynaropicrin | 1.398 | <0.01 | 1.686 | up |
| Desthiobiotin | 1.921 | <0.01 | 2.424 | up |
| N-(9-oxodecyl)acetamide | 1.124 | <0.01 | 1.392 | up |
| N6,N6,N6-Trimethyl-L-lysine | -1.652 | <0.01 | 2.091 | down |
| Histamine | -3.529 | <0.01 | 4.237 | down |
| Phosphocreatine | -1.056 | <0.01 | 1.278 | down |
| N-Cyclohexyl-N-methylcyclohexanamine | -3.723 | <0.01 | 4.276 | down |
| Vindoline | -1.983 | <0.01 | 2.515 | down |
| 2-phenyl-4H-furo[2,3-h]chromen-4-one | -1.118 | <0.01 | 1.358 | down |
| N-Methyl-L-arginine hydrochloride | -1.114 | <0.01 | 1.378 | down |
| Ethyl oleate | 1.085 | <0.01 | 1.353 | up |
| Phenylpyruvic Acid | 1.194 | <0.01 | 1.504 | up |
| Isohomovanillic acid | 1.114 | <0.01 | 1.406 | up |
| 2-Arachidonoyl glycerol | 1.028 | <0.01 | 1.240 | up |
| cis-gondoic acid | -1.250 | <0.01 | 1.491 | down |
| 15-Deoxy-Δ12,14-prostaglandin A1 | 1.272 | <0.01 | 1.508 | up |
| 1,5-Diaminopentane | -2.195 | <0.01 | 2.764 | down |
| Methionine | -1.684 | <0.01 | 1.983 | down |
| 4-(allyloxy)-1,2-dihydroquinolin-2-one | 1.234 | <0.01 | 1.542 | up |
| 6-Pentyl-2H-pyran-2-one | 1.004 | 0.001 | 1.193 | up |
| L-(+)-Citrulline | -1.198 | 0.001 | 1.414 | down |
| DL-Lysine | -1.065 | 0.001 | 1.261 | down |
| SDMA/ADMA | -1.271 | 0.001 | 1.498 | down |
| (R)-Lipoic Acid | -1.287 | 0.001 | 1.526 | down |
| Asp-Phe methyl ester | -1.100 | 0.001 | 1.331 | down |
| 17α-Ethinylestradiol | 1.316 | 0.001 | 1.578 | up |
| Serotonin | -1.119 | 0.002 | 1.410 | down |
| Isomaltose | 1.135 | 0.002 | 1.313 | up |
| L-Aspartic acid β-benzyl ester | 1.262 | 0.002 | 1.478 | up |
| Lysope 14:0 | 1.147 | 0.002 | 1.392 | up |
| Dl-Indole-3-lactic acid | -1.567 | 0.002 | 1.778 | down |
| Menaquinone | 1.144 | 0.003 | 1.349 | up |
| Lysopc 15:0 | -1.298 | 0.003 | 1.580 | down |
| Nervonic ceramide | -1.567 | 0.003 | 1.761 | down |
| Methyl N-cyano-N'-[2-(2,2-dichlorocyclopropyl)ethyl]carbamimidothioate | -1.244 | 0.003 | 1.590 | down |
| Kahweol | 1.647 | 0.004 | 1.899 | up |
| Lagochilin | 1.265 | 0.004 | 1.448 | up |
| L-Isoleucine | -1.038 | 0.005 | 1.190 | down |
| Acetylcholine | -1.366 | 0.006 | 1.526 | down |
| XLR11 N-(4-hydroxypentyl) metabolite | 1.112 | 0.007 | 1.539 | up |
| D-Phenylalanine | -1.116 | 0.009 | 1.260 | down |
| 5α-Androstan-3,6,17-trione | 1.124 | 0.009 | 1.557 | up |
| Butein | 1.163 | 0.011 | 1.304 | up |
| Indole | -1.003 | 0.011 | 1.356 | down |
| gamma-Glutamylmethionine | -1.318 | 0.011 | 1.609 | down |
| Glutamine | -1.183 | 0.012 | 1.391 | down |
| Argininosuccinic acid | 1.309 | 0.014 | 1.426 | up |
| N-[1-(4-methoxy-2-oxo-2H-pyran-6-yl)-2-methylbutyl]acetamide | 1.482 | 0.014 | 2.387 | up |
| N-[2-(1,5-dimethyl-4-nitro-1H-pyrazol-3-yl)vinyl]-N,N-dimethylamine | -4.067 | 0.018 | 3.789 | down |
| Cholest-4-en-3-one | 5.575 | 0.019 | 4.503 | up |
| α-Aspartylphenylalanine | -1.245 | 0.020 | 1.654 | down |
| 3-hydroxy-2-octylpentanedioic acid | -2.304 | 0.025 | 2.271 | down |
| Hypoxanthine | -1.330 | 0.027 | 1.431 | down |
| Adenine | -1.114 | 0.029 | 1.248 | down |
| Tyramine | -1.962 | 0.029 | 2.019 | down |
| L-Phenylalanine | -1.042 | 0.029 | 1.172 | down |
| 5-Hydroxyindole-3-acetic acid | -5.098 | 0.031 | 4.162 | down |
| LPE 14:0 | 1.172 | 0.031 | 1.206 | up |
| 8-Hydroxyquinoline | -2.965 | 0.032 | 2.651 | down |
| DL-Arginine | -1.673 | 0.032 | 1.844 | down |
| L(-)-Carnitine | -1.032 | 0.035 | 1.441 | down |
| 5-methyl-3-(2-morpholino-2-oxoethyl)-1,3-benzoxazol-2(3H)-one | 1.785 | 0.039 | 1.697 | up |
| Etiocholanolone | -2.035 | 0.040 | 1.874 | down |

Table S5 Different metabolites with LC-MS/MS(ESI-)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | log2FC | Pvalue | VIP | Up.Down |
| Saccharin | -2.187 | <0.01 | 2.447 | down |
| Cyclamic acid | -1.951 | <0.01 | 2.200 | down |
| Trehalose | 2.391 | <0.01 | 2.675 | up |
| Asp-glu | -1.797 | <0.01 | 1.998 | down |
| γ-Glutamylglutamic acid | -1.380 | <0.01 | 1.527 | down |
| Glycerol-3-phosphate | -1.469 | <0.01 | 1.612 | down |
| Acetildenafil | -2.214 | <0.01 | 2.547 | down |
| D-Methionine | -1.556 | <0.01 | 1.726 | down |
| L-Aspartic acid | -1.746 | <0.01 | 1.928 | down |
| Mycophenolic acid | -1.527 | <0.01 | 1.725 | down |
| D-Galactosamine | -1.316 | <0.01 | 1.444 | down |
| Calcitriol | -2.587 | <0.01 | 2.879 | down |
| N-Acetylaspartic acid | -1.857 | <0.01 | 2.014 | down |
| N-Methylthreonine | -1.331 | <0.01 | 1.468 | down |
| 7-Ketodeoxycholic acid | -1.783 | <0.01 | 2.045 | down |
| Pyrophosphate | -1.935 | <0.01 | 2.269 | down |
| N-Methyl-a-aminoisobutyric acid | -1.434 | 0.001 | 1.550 | down |
| 11β-Prostaglandin F2α | -1.239 | 0.001 | 1.423 | down |
| Protocatechuic Aldehyde | 1.099 | 0.001 | 1.327 | up |
| Isoleucine | -1.456 | 0.001 | 1.552 | down |
| 20-Hydroxy-(5Z,8Z,11Z,14Z)-eicosatetraenoic acid | -1.570 | 0.001 | 1.848 | down |
| Ornithine | -1.805 | 0.001 | 1.872 | down |
| Ofloxacin impurity E | -1.456 | 0.001 | 1.705 | down |
| Citrulline | -1.300 | 0.001 | 1.361 | down |
| 17-α-Methyltestosterone | -2.151 | 0.001 | 2.254 | down |
| FAHFA (2:0/21:0) | -1.418 | 0.002 | 1.618 | down |
| FAHFA (4:0/18:0) | -1.309 | 0.002 | 1.444 | down |
| 4-Hexylresorcinol | 1.526 | 0.002 | 1.624 | up |
| Lysine | -1.094 | 0.003 | 1.226 | down |
| Anacardic acid | -3.357 | 0.003 | 3.277 | down |
| Lysopc 18:3 | 1.367 | 0.003 | 1.543 | up |
| Urethane | -1.098 | 0.003 | 1.268 | down |
| methyl 5-{[2-(ethoxycarbonyl)-3-oxohex-1-enyl]amino}-2-furoate | -1.553 | 0.004 | 1.731 | down |
| N1-(3-amino-4-chlorophenyl)-2-[2,4-di(tert-pentyl)phenoxy]acetamide | -1.307 | 0.004 | 1.497 | down |
| Cholic acid | -1.863 | 0.005 | 2.046 | down |
| L-Serine | -1.265 | 0.005 | 1.277 | down |
| L-Glutamine | -1.521 | 0.005 | 1.628 | down |
| Flavin adenine dinucleotide | -1.073 | 0.005 | 1.186 | down |
| Flavin mononucleotide (FMN) | -1.242 | 0.006 | 1.396 | down |
| Hesperetin | 1.658 | 0.006 | 1.980 | up |
| Corchorifatty acid F | 1.131 | 0.006 | 1.367 | up |
| 2-Hydroxycaproic acid | -1.699 | 0.006 | 1.660 | down |
| FAHFA (18:0/22:3) | -1.276 | 0.006 | 1.313 | down |
| Nicotinic Acid | -1.171 | 0.007 | 1.251 | down |
| DL-α-Methoxyphenylacetic acid | -1.390 | 0.008 | 1.797 | down |
| Orotidine | -1.575 | 0.008 | 1.672 | down |
| 3-Hydroxy-3-Methyl Butyric Acid | -1.551 | 0.009 | 1.524 | down |
| LPS 20:1 | -1.657 | 0.009 | 1.937 | down |
| Deoxyadenosine | -2.350 | 0.010 | 2.105 | down |
| Trolox | -1.086 | 0.012 | 1.175 | down |
| UDP-N-acetylglucosamine | -1.071 | 0.013 | 1.145 | down |
| Uridine5-diphosphate | -1.085 | 0.013 | 1.116 | down |
| LPG 19:1 | -1.614 | 0.014 | 1.903 | down |
| Butylparaben | 1.056 | 0.016 | 1.556 | up |
| Dl-Tropic acid | -1.142 | 0.017 | 1.544 | down |
| Thymidine | -1.270 | 0.021 | 1.378 | down |
| 2-(Formylamino)Benzoic Acid | -1.350 | 0.022 | 1.400 | down |
| cAMP | -1.422 | 0.025 | 1.328 | down |
| D-glyceraldehdye-3-phosphate | -1.080 | 0.026 | 1.225 | down |
| Adenosine 3'5'-cyclic monophosphate | -1.007 | 0.027 | 1.164 | down |
| 2'-Deoxyinosine | -1.527 | 0.033 | 1.436 | down |
| Methyl indole-3-acetate | -1.265 | 0.034 | 1.284 | down |
| Deoxyribose 5-Phosphate | -1.746 | 0.034 | 1.648 | down |
| Tetradecanedioic acid | -1.184 | 0.044 | 1.479 | down |
| LPE 16:1 | -1.127 | 0.045 | 1.062 | down |
| D-Mannose 6-phosphate | -1.071 | 0.046 | 1.114 | down |
| 2-(acetylamino)-4-(methylthio)butanoic acid | -1.269 | 0.047 | 1.250 | down |