**Table S1.** Nutritional components of milk replacer, starter, and alfalfa pellets

|  |  |  |  |
| --- | --- | --- | --- |
| Items | Milk Replacer | Starter Pellets | Alfalfa Pellets |
| Chemical composition, % of DM basis | | | |
| DM (%) | 95.50 | 95.25 | 95.53 |
| Total Energy (MJ/Kg) | 20.74 | 18.03 | 17.39 |
| CP (%) | 25.52 | 19.63 | 14.77 |
| EE (%) | 15.96 | 3.40 | 1.04 |
| NDF (%) | --- | 29.62 | 51.45 |
| ADF (%) | --- | 8.64 | 35.20 |
| Ash (%) | 6.54 | 7.99 | 11.98 |
| Ca (%) | 1.02 | 0.95 | 0.90 |
| P (%) | 0.66 | 0.70 | 0.48 |

DM:Dry matter; CP:Crude protein; EE: Ether extract; NDF: Neutral detergent fibers; ADF: Acid detergent fiber; Ash: Crude ash.

**Table S2** Effect of early supplementary solid diet on growth performance of goat kids

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Treatments | | | SEM |  |
| Items | MRO | MRC | MCA | *P*-value |
| Milk replacer intake/(g•d-1) | 130.62 | 107.91 | 119.90 | 4.95 | 0.1696 |
| Concentrate intake/(g•d-1) | --- | 188.18 | 189.56 | 4.82 | 0.8956 |
| Alfalfa pellets intake/(g•d-1) | --- | --- | 34.34 | --- | --- |
| Dry matter intake/(g•d-1) | 122.47c | 271.50b | 309.97a | 16.12 | <0.0001 |
| Protein intake/(g•d-1) | 31.33c | 58.52b | 66.37a | 4.07 | <0.0001 |
| NDF-Neutral detergent fiber intake/(g•d-1) | --- | 49.25b | 66.08a | 3.13 | 0.0004 |
| NFC-Non-fibrous carbohydrate intake/(g•d-1) | 63.82c | 118.16b | 131.15a | 7.94 | <0.0001 |

MRO=milk replacer, MRC= milk replacer + concentrate, MCA= milk replacer + concentrate + alfalfa; SEM = Standard error of the means.

In the same row, values with different small letter superscripts mean significant difference (*P*＜0.05).

Only data of table S1 (dietary composition) and table S2 (growth performance) were published in Chinese journal paper, thus the authors translated into English since the nutrient intake were used in this draft. (DOI: 10.11843/j.issn.0366-6964.2019.05.011).

**Table S3.** Effects of early supplementary solid diet on growth performance and rumen fermentation parameters in goat kids

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Items | Treatments1 | | | SEM | *P*-value |
|  | MRO | MRC | MCA |  |  |
| Slaughter BW, kg | 7.01b | 10.47a | 10.23a | 0.41 | <0.000 1 |
| Rumen weight, g | 47.42c | 126.70b | 175.67a | 14.94 | <0.001 |
| Average daily gain/g | 70.28b | 123.93a | 126.25a | 5.48 | <0.0001 |
| pH | 7.09a | 5.88b | 6.01b | 0.15 | <0.0001 |
| Isobutyrate, mmol/L | 0.24 | 0.48 | 0.23 | 0.08 | 0.3589 |
| Isovalerate, mmol/L | 0.56 | 0.98 | 0.91 | 0.16 | 0.5470 |
| Valerate, mmol/L | 0.73b | 7.34a | 5.01a | 0.95 | 0.0045 |
| A:P | 2.55 | 2.23 | 2.20 | 0.13 | 0.5502 |

MRO=milk replacer, MRC= milk replacer + concentrate, MCA= milk replacer + concentrate + alfalfa; SEM = Standard error of the means. BW=body weight; A:P= the ratio of acetate and propionate

In the same row, values with different small letter superscripts mean significant difference ( *P*＜0.05) .

**Table S4.**  Pearson correlation between nutrient and rumen fermentation

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Items | CP\_ADI | | NDF\_ADI | | NFC\_ADI | | Slaughter body weight | |
| coefficient | pvalue | coefficient | pvalue | coefficient | pvalue | coefficient | pvalue |
| pH | -0.83 | 0.000 | -0.85 | 0.000 | -0.86 | 0.000 | -0.78 | 0.000 |
| NH3-N | -0.78 | 0.000 | -0.82 | 0.000 | -0.82 | 0.000 | -0.76 | 0.000 |
| MCP | 0.80 | 0.000 | 0.88 | 0.000 | 0.86 | 0.000 | 0.82 | 0.000 |
| acetate | 0.92 | 0.000 | 0.94 | 0.000 | 0.94 | 0.000 | 0.78 | 0.000 |
| propionate | 0.82 | 0.000 | 0.82 | 0.000 | 0.82 | 0.000 | 0.67 | 0.002 |
| butyrate | 0.87 | 0.000 | 0.88 | 0.000 | 0.87 | 0.000 | 0.86 | 0.000 |
| valerate | 0.60 | 0.009 | 0.65 | 0.004 | 0.66 | 0.003 | 0.76 | 0.000 |
| Total VFA | 0.94 | 0.000 | 0.96 | 0.000 | 0.96 | 0.000 | 0.86 | 0.000 |

CP\_ADI: Crude protein average daily intake; NDF\_ADI: Neutral detergent fibers average daily intake; NFC\_ADI: Non-fibrous carbohydrates average daily intake; Total VFA: Total volatile fatty acids; MCP: Microbial crude protein.

The p value equaled 0 meant it smaller than 0.0005.

**Table S5.**  Pearson correlation analysis between phenotypes and Alpha diversity in goat kids.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Items | Shannon Index | | Observed species | | Chao1 | |
| coefficients | pvalue | coefficients | pvalue | coefficients | pvalue |
| CP | -0.04 | 0.880 | -0.65 | 0.003 | -0.66 | 0.003 |
| NFC | -0.12 | 0.642 | -0.73 | 0.001 | -0.70 | 0.001 |
| NDF | -0.13 | 0.594 | -0.74 | 0.001 | -0.69 | 0.001 |
| acetate | -0.09 | 0.717 | -0.64 | 0.004 | -0.59 | 0.011 |
| propionate | -0.10 | 0.687 | -0.58 | 0.011 | -0.57 | 0.014 |
| butyrate | -0.15 | 0.557 | -0.71 | 0.001 | -0.72 | 0.001 |
| Total VFA | -0.18 | 0.484 | -0.75 | 0.000 | -0.71 | 0.001 |
| valerate | -0.58 | 0.012 | -0.88 | 0.000 | -0.78 | 0.000 |
| pH | 0.44 | 0.066 | 0.81 | 0.000 | 0.76 | 0.000 |
| NH3-N | 0.15 | 0.562 | 0.63 | 0.005 | 0.63 | 0.005 |
| MCP | -0.41 | 0.092 | -0.79 | 0.000 | -0.66 | 0.003 |
| Slaughter body weight | -0.16 | 0.534 | -0.76 | 0.000 | -0.74 | 0.000 |

CP\_ADI: Crude protein average daily intake; NDF\_ADI: Neutral detergent fibers average daily intake; NFC\_ADI: Non-fibrous carbohydrates average daily intake; Total VFA: Total volatile fatty acids; MCP: Microbial crude protein.

The p value equaled 0 meant it smaller than 0.0005.

**Table S6** the average abundance of 281 significant OTUs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| OTUID | MRO | MRC | MCA | pvalue-KWtest |
| OTU1\_Sphingobacteriaceae\_unclassified | 0.19182 | 0.01601 | 0.00000 | 0.0013 |
| OTU2\_Prevotella | 0.00041 | 0.09529 | 0.09803 | 0.0401 |
| OTU4\_Prevotellaceae\_unclassified | 0.11709 | 0.00032 | 0.00036 | 0.0418 |
| OTU5\_Sphingobacteriaceae\_unclassified | 0.11134 | 0.00036 | 0.00002 | 0.0020 |
| OTU6\_Prevotella | 0.00005 | 0.01349 | 0.05890 | 0.0022 |
| OTU9\_Succinivibrio | 0.00036 | 0.01498 | 0.04738 | 0.0395 |
| OTU10\_Roseburia | 0.00003 | 0.04486 | 0.00896 | 0.0264 |
| OTU13\_Prevotella | 0.00001 | 0.00414 | 0.04023 | 0.0037 |
| OTU15\_Prevotellaceae\_unclassified | 0.00000 | 0.00291 | 0.03540 | 0.0026 |
| OTU18\_Prevotella | 0.01016 | 0.00016 | 0.01923 | 0.0168 |
| OTU20\_Olsenella | 0.00010 | 0.02279 | 0.00472 | 0.0192 |
| OTU21\_Prevotella | 0.00007 | 0.02081 | 0.00291 | 0.0392 |
| OTU22\_Succiniclasticum | 0.00000 | 0.00491 | 0.01817 | 0.0060 |
| OTU24\_Cloacibacillus | 0.02164 | 0.00001 | 0.00000 | 0.0008 |
| OTU27\_Prevotellaceae\_unclassified | 0.00001 | 0.00756 | 0.01181 | 0.0307 |
| OTU30\_Prevotellaceae\_unclassified | 0.01838 | 0.00035 | 0.00000 | 0.0287 |
| OTU33\_Bacteroidetes\_unclassified | 0.01775 | 0.00000 | 0.00000 | 0.0003 |
| OTU34\_Ruminococcus | 0.00000 | 0.00262 | 0.01489 | 0.0057 |
| OTU36\_Candidatus.Endomicrobium\_unclassified | 0.01322 | 0.00298 | 0.00000 | 0.0034 |
| OTU38\_Prevotellaceae\_unclassified | 0.00001 | 0.00982 | 0.00576 | 0.0281 |
| OTU39\_Ruminococcaceae\_unclassified | 0.01473 | 0.00020 | 0.00024 | 0.0026 |
| OTU40\_Bacteroidetes\_unclassified | 0.00000 | 0.00663 | 0.00808 | 0.0079 |
| OTU43\_Bacteroidetes\_unclassified | 0.01254 | 0.00000 | 0.00000 | 0.0345 |
| OTU44\_Prevotellaceae\_unclassified | 0.00000 | 0.00001 | 0.01248 | 0.0249 |
| OTU47\_Porphyromonadaceae\_unclassified | 0.00007 | 0.00952 | 0.00262 | 0.0395 |
| OTU52\_Bacteria\_unclassified | 0.00002 | 0.01040 | 0.00119 | 0.0189 |
| OTU53\_Lachnospiraceae\_unclassified | 0.00000 | 0.01090 | 0.00021 | 0.0486 |
| OTU54\_Prevotella | 0.00000 | 0.00000 | 0.01110 | 0.0085 |
| OTU55\_Sphaerochaeta | 0.01053 | 0.00006 | 0.00001 | 0.0011 |
| OTU57\_Prevotella | 0.00000 | 0.00774 | 0.00267 | 0.0092 |
| OTU58\_Bacteroidetes\_unclassified | 0.01022 | 0.00000 | 0.00000 | 0.0085 |
| OTU60\_Prevotella | 0.00828 | 0.00119 | 0.00047 | 0.0030 |
| OTU62\_Prevotellaceae\_unclassified | 0.00955 | 0.00000 | 0.00008 | 0.0013 |
| OTU63\_Prevotella | 0.00003 | 0.00682 | 0.00276 | 0.0366 |
| OTU67\_Treponema | 0.00000 | 0.00000 | 0.00906 | 0.0085 |
| OTU71\_Lachnospiraceae\_unclassified | 0.00000 | 0.00020 | 0.00833 | 0.0287 |
| OTU74\_Treponema | 0.00001 | 0.00000 | 0.00818 | 0.0055 |
| OTU75\_Ruminococcaceae\_unclassified | 0.00818 | 0.00000 | 0.00000 | 0.0003 |
| OTU77\_Bacteroidetes\_unclassified | 0.00812 | 0.00000 | 0.00000 | 0.0085 |
| OTU79\_Neisseriaceae\_unclassified | 0.00744 | 0.00013 | 0.00031 | 0.0042 |
| OTU83\_Bacteroidales\_unclassified | 0.00005 | 0.00026 | 0.00727 | 0.0053 |
| OTU86\_Pyramidobacter | 0.00000 | 0.00354 | 0.00330 | 0.0053 |
| OTU87\_Butyrivibrio | 0.00023 | 0.00001 | 0.00657 | 0.0048 |
| OTU89\_Bacteroidetes\_unclassified | 0.00668 | 0.00000 | 0.00000 | 0.0003 |
| OTU90\_Bacteroidetes\_unclassified | 0.00664 | 0.00001 | 0.00000 | 0.0006 |
| OTU93\_Treponema | 0.00013 | 0.00000 | 0.00646 | 0.0028 |
| OTU94\_Clostridiales\_unclassified | 0.00646 | 0.00000 | 0.00000 | 0.0003 |
| OTU97\_Clostridiales\_unclassified | 0.00001 | 0.00515 | 0.00097 | 0.0422 |
| OTU98\_Anaeroplasma | 0.00597 | 0.00000 | 0.00000 | 0.0345 |
| OTU99\_Elusimicrobium | 0.00596 | 0.00001 | 0.00000 | 0.0006 |
| OTU100\_Prevotellaceae\_unclassified | 0.00001 | 0.00025 | 0.00568 | 0.0161 |
| OTU103\_Prevotellaceae\_unclassified | 0.00479 | 0.00006 | 0.00076 | 0.0448 |
| OTU104\_Prevotella | 0.00018 | 0.00010 | 0.00524 | 0.0268 |
| OTU106\_Bacteroidetes\_unclassified | 0.00546 | 0.00000 | 0.00000 | 0.0345 |
| OTU110\_Prevotellaceae\_unclassified | 0.00002 | 0.00075 | 0.00436 | 0.0060 |
| OTU111\_Methanomassiliicoccus | 0.00499 | 0.00003 | 0.00001 | 0.0017 |
| OTU114\_Megasphaera | 0.00000 | 0.00287 | 0.00204 | 0.0046 |
| OTU115\_Fibrobacter | 0.00000 | 0.00231 | 0.00257 | 0.0107 |
| OTU119\_Prevotella | 0.00437 | 0.00000 | 0.00003 | 0.0006 |
| OTU121\_Bacteroidales\_unclassified | 0.00325 | 0.00031 | 0.00079 | 0.0321 |
| OTU124\_Bacteroidetes\_unclassified | 0.00426 | 0.00000 | 0.00003 | 0.0041 |
| OTU126\_Anaeroplasma | 0.00420 | 0.00003 | 0.00001 | 0.0159 |
| OTU127\_Acidaminococcus | 0.00002 | 0.00175 | 0.00244 | 0.0500 |
| OTU128\_Bacteroidetes\_unclassified | 0.00421 | 0.00000 | 0.00001 | 0.0041 |
| OTU130\_Clostridiales\_unclassified | 0.00420 | 0.00000 | 0.00000 | 0.0018 |
| OTU131\_Bacteroidetes\_unclassified | 0.00412 | 0.00000 | 0.00008 | 0.0057 |
| OTU132\_Pyramidobacter | 0.00261 | 0.00059 | 0.00097 | 0.0043 |
| OTU134\_Prevotella | 0.00404 | 0.00000 | 0.00000 | 0.0018 |
| OTU137\_Escherichia.Shigella | 0.00195 | 0.00104 | 0.00089 | 0.0362 |
| OTU138\_Prevotella | 0.00382 | 0.00000 | 0.00003 | 0.0009 |
| OTU139\_Bacteroidetes\_unclassified | 0.00385 | 0.00000 | 0.00000 | 0.0003 |
| OTU140\_Anaerovibrio | 0.00003 | 0.00214 | 0.00157 | 0.0429 |
| OTU141\_Prevotella | 0.00369 | 0.00000 | 0.00002 | 0.0057 |
| OTU142\_Bacteroidales\_unclassified | 0.00321 | 0.00049 | 0.00000 | 0.0373 |
| OTU144\_Saccharofermentans | 0.00331 | 0.00022 | 0.00001 | 0.0408 |
| OTU145\_Ruminococcaceae\_unclassified | 0.00000 | 0.00000 | 0.00352 | 0.0085 |
| OTU147\_Bacteroidales\_unclassified | 0.00333 | 0.00000 | 0.00000 | 0.0003 |
| OTU148\_Lachnospiraceae\_unclassified | 0.00001 | 0.00251 | 0.00073 | 0.0045 |
| OTU151\_Ruminococcaceae\_unclassified | 0.00309 | 0.00001 | 0.00000 | 0.0007 |
| OTU152\_Mitsuokella | 0.00002 | 0.00093 | 0.00211 | 0.0117 |
| OTU153\_Firmicutes\_unclassified | 0.00302 | 0.00000 | 0.00000 | 0.0085 |
| OTU154\_Methanomassiliicoccus | 0.00301 | 0.00001 | 0.00001 | 0.0010 |
| OTU158\_Clostridiales\_unclassified | 0.00285 | 0.00006 | 0.00000 | 0.0009 |
| OTU159\_Lachnospiraceae\_unclassified | 0.00290 | 0.00000 | 0.00000 | 0.0085 |
| OTU165\_Prevotellaceae\_unclassified | 0.00000 | 0.00006 | 0.00264 | 0.0057 |
| OTU167\_Veillonellaceae\_unclassified | 0.00160 | 0.00093 | 0.00014 | 0.0347 |
| OTU168\_Methanomicrobium | 0.00250 | 0.00013 | 0.00000 | 0.0009 |
| OTU169\_Bacteroidetes\_unclassified | 0.00261 | 0.00000 | 0.00000 | 0.0003 |
| OTU173\_Megasphaera | 0.00000 | 0.00171 | 0.00083 | 0.0447 |
| OTU174\_Bacteroidetes\_unclassified | 0.00243 | 0.00007 | 0.00002 | 0.0227 |
| OTU175\_Prevotella | 0.00195 | 0.00000 | 0.00057 | 0.0206 |
| OTU176\_Prevotellaceae\_unclassified | 0.00209 | 0.00035 | 0.00001 | 0.0050 |
| OTU177\_Campylobacter | 0.00134 | 0.00054 | 0.00054 | 0.0391 |
| OTU178\_Bacteroides | 0.00240 | 0.00000 | 0.00000 | 0.0003 |
| OTU182\_Bacteroidetes\_unclassified | 0.00211 | 0.00006 | 0.00015 | 0.0161 |
| OTU183\_Bacteroidetes\_unclassified | 0.00222 | 0.00008 | 0.00001 | 0.0096 |
| OTU186\_Prevotella | 0.00001 | 0.00163 | 0.00064 | 0.0075 |
| OTU190\_Sphaerochaeta | 0.00198 | 0.00022 | 0.00005 | 0.0038 |
| OTU191\_Lachnospiraceae\_unclassified | 0.00001 | 0.00077 | 0.00146 | 0.0162 |
| OTU192\_Methanimicrococcus | 0.00220 | 0.00000 | 0.00000 | 0.0003 |
| OTU193\_Bacteroidetes\_unclassified | 0.00215 | 0.00000 | 0.00000 | 0.0018 |
| OTU205\_Firmicutes\_unclassified | 0.00000 | 0.00007 | 0.00176 | 0.0090 |
| OTU206\_Lachnospiraceae\_unclassified | 0.00131 | 0.00012 | 0.00041 | 0.0110 |
| OTU208\_Bacteria\_unclassified | 0.00180 | 0.00000 | 0.00000 | 0.0003 |
| OTU209\_Parabacteroides | 0.00175 | 0.00000 | 0.00000 | 0.0085 |
| OTU210\_Desulfovibrio | 0.00155 | 0.00012 | 0.00004 | 0.0112 |
| OTU213\_Clostridiales\_unclassified | 0.00166 | 0.00000 | 0.00000 | 0.0345 |
| OTU216\_Ruminococcaceae\_unclassified | 0.00136 | 0.00025 | 0.00000 | 0.0025 |
| OTU217\_Bacteroidetes\_unclassified | 0.00160 | 0.00000 | 0.00000 | 0.0003 |
| OTU218\_Treponema | 0.00159 | 0.00000 | 0.00000 | 0.0018 |
| OTU219\_Bacteroidetes\_unclassified | 0.00155 | 0.00003 | 0.00000 | 0.0009 |
| OTU220\_Prevotella | 0.00000 | 0.00058 | 0.00099 | 0.0227 |
| OTU221\_Pseudobutyrivibrio | 0.00012 | 0.00001 | 0.00142 | 0.0108 |
| OTU222\_Firmicutes\_unclassified | 0.00153 | 0.00000 | 0.00002 | 0.0061 |
| OTU223\_Ruminococcaceae\_unclassified | 0.00155 | 0.00000 | 0.00000 | 0.0018 |
| OTU224\_Prevotella | 0.00000 | 0.00090 | 0.00064 | 0.0473 |
| OTU226\_Prevotella | 0.00138 | 0.00000 | 0.00015 | 0.0488 |
| OTU228\_Subdivision3\_bacteria\_incertae\_sedis | 0.00151 | 0.00000 | 0.00000 | 0.0018 |
| OTU230\_Bacteroidetes\_unclassified | 0.00001 | 0.00030 | 0.00118 | 0.0448 |
| OTU232\_Lachnospiraceae\_unclassified | 0.00147 | 0.00000 | 0.00000 | 0.0085 |
| OTU239\_Bacteroidales\_unclassified | 0.00001 | 0.00044 | 0.00091 | 0.0295 |
| OTU245\_Clostridiales\_unclassified | 0.00122 | 0.00000 | 0.00000 | 0.0003 |
| OTU246\_Bacteroidetes\_unclassified | 0.00102 | 0.00019 | 0.00001 | 0.0339 |
| OTU248\_Desulfovibrionaceae\_unclassified | 0.00104 | 0.00016 | 0.00000 | 0.0078 |
| OTU249\_Bacteroides | 0.00119 | 0.00000 | 0.00000 | 0.0085 |
| OTU252\_Treponema | 0.00000 | 0.00117 | 0.00001 | 0.0396 |
| OTU255\_Comamonas | 0.00114 | 0.00000 | 0.00001 | 0.0061 |
| OTU258\_Olsenella | 0.00000 | 0.00073 | 0.00036 | 0.0101 |
| OTU262\_Firmicutes\_unclassified | 0.00021 | 0.00082 | 0.00000 | 0.0180 |
| OTU263\_Lachnospiraceae\_unclassified | 0.00104 | 0.00000 | 0.00000 | 0.0345 |
| OTU265\_Clostridiales\_unclassified | 0.00102 | 0.00000 | 0.00000 | 0.0085 |
| OTU266\_Porphyromonadaceae\_unclassified | 0.00102 | 0.00000 | 0.00000 | 0.0003 |
| OTU268\_Mitsuokella | 0.00001 | 0.00033 | 0.00066 | 0.0377 |
| OTU269\_Ruminococcus | 0.00000 | 0.00044 | 0.00057 | 0.0106 |
| OTU270\_Bibersteinia | 0.00088 | 0.00004 | 0.00003 | 0.0326 |
| OTU273\_Prevotella | 0.00052 | 0.00000 | 0.00041 | 0.0463 |
| OTU275\_Saccharofermentans | 0.00093 | 0.00000 | 0.00000 | 0.0018 |
| OTU277\_Lachnospiracea\_incertae\_sedis | 0.00000 | 0.00000 | 0.00092 | 0.0345 |
| OTU278\_Paraprevotella | 0.00075 | 0.00006 | 0.00009 | 0.0276 |
| OTU279\_Clostridiales\_unclassified | 0.00090 | 0.00000 | 0.00000 | 0.0003 |
| OTU281\_Bacteroidetes\_unclassified | 0.00089 | 0.00000 | 0.00000 | 0.0003 |
| OTU282\_Lachnospiraceae\_unclassified | 0.00000 | 0.00024 | 0.00064 | 0.0250 |
| OTU287\_Pasteurellaceae\_unclassified | 0.00078 | 0.00004 | 0.00003 | 0.0071 |
| OTU290\_Bacteroidetes\_unclassified | 0.00082 | 0.00000 | 0.00000 | 0.0003 |
| OTU296\_Clostridiales\_unclassified | 0.00075 | 0.00000 | 0.00001 | 0.0006 |
| OTU298\_Pyramidobacter | 0.00071 | 0.00004 | 0.00000 | 0.0016 |
| OTU306\_Megasphaera | 0.00000 | 0.00023 | 0.00048 | 0.0246 |
| OTU310\_Treponema | 0.00068 | 0.00000 | 0.00000 | 0.0018 |
| OTU311\_Clostridiales\_unclassified | 0.00002 | 0.00050 | 0.00015 | 0.0182 |
| OTU313\_Methanomassiliicoccus | 0.00062 | 0.00003 | 0.00000 | 0.0009 |
| OTU314\_Blautia | 0.00000 | 0.00019 | 0.00046 | 0.0179 |
| OTU320\_Alloprevotella | 0.00061 | 0.00000 | 0.00000 | 0.0018 |
| OTU322\_Allisonella | 0.00000 | 0.00030 | 0.00029 | 0.0248 |
| OTU325\_Bacteroides | 0.00037 | 0.00010 | 0.00011 | 0.0177 |
| OTU326\_Ruminococcaceae\_unclassified | 0.00054 | 0.00003 | 0.00000 | 0.0078 |
| OTU327\_Clostridium.XlVa | 0.00046 | 0.00003 | 0.00007 | 0.0055 |
| OTU328\_Ethanoligenens | 0.00056 | 0.00000 | 0.00000 | 0.0085 |
| OTU329\_Methanomassiliicoccus | 0.00056 | 0.00000 | 0.00000 | 0.0018 |
| OTU330\_Firmicutes\_unclassified | 0.00056 | 0.00000 | 0.00000 | 0.0003 |
| OTU333\_Ruminococcaceae\_unclassified | 0.00036 | 0.00019 | 0.00000 | 0.0138 |
| OTU337\_Bacteroidetes\_unclassified | 0.00050 | 0.00000 | 0.00001 | 0.0249 |
| OTU338\_Prevotella | 0.00040 | 0.00012 | 0.00000 | 0.0476 |
| OTU340\_Intestinimonas | 0.00024 | 0.00025 | 0.00003 | 0.0221 |
| OTU342\_Lachnospiracea\_incertae\_sedis | 0.00037 | 0.00013 | 0.00000 | 0.0137 |
| OTU343\_Prevotellaceae\_unclassified | 0.00050 | 0.00000 | 0.00000 | 0.0018 |
| OTU344\_Firmicutes\_unclassified | 0.00048 | 0.00000 | 0.00000 | 0.0345 |
| OTU346\_Bacteroidetes\_unclassified | 0.00048 | 0.00000 | 0.00000 | 0.0085 |
| OTU348\_Mannheimia | 0.00045 | 0.00001 | 0.00000 | 0.0079 |
| OTU349\_Bacteroidetes\_unclassified | 0.00038 | 0.00008 | 0.00000 | 0.0021 |
| OTU352\_Bacteroidetes\_unclassified | 0.00040 | 0.00005 | 0.00000 | 0.0090 |
| OTU353\_Bacteroidetes\_unclassified | 0.00044 | 0.00000 | 0.00000 | 0.0345 |
| OTU360\_Bacteroidetes\_unclassified | 0.00000 | 0.00007 | 0.00036 | 0.0377 |
| OTU363\_Firmicutes\_unclassified | 0.00035 | 0.00000 | 0.00006 | 0.0034 |
| OTU364\_Ruminococcaceae\_unclassified | 0.00017 | 0.00000 | 0.00023 | 0.0181 |
| OTU365\_Neisseriaceae\_unclassified | 0.00038 | 0.00001 | 0.00001 | 0.0010 |
| OTU366\_Bacteroidetes\_unclassified | 0.00039 | 0.00000 | 0.00000 | 0.0082 |
| OTU370\_Clostridiales\_unclassified | 0.00039 | 0.00000 | 0.00000 | 0.0345 |
| OTU371\_Sphaerochaeta | 0.00035 | 0.00003 | 0.00001 | 0.0063 |
| OTU372\_Bacteria\_unclassified | 0.00037 | 0.00001 | 0.00000 | 0.0217 |
| OTU373\_Clostridiales\_unclassified | 0.00023 | 0.00015 | 0.00000 | 0.0181 |
| OTU382\_Prevotellaceae\_unclassified | 0.00000 | 0.00000 | 0.00035 | 0.0345 |
| OTU383\_Bacteria\_unclassified | 0.00035 | 0.00000 | 0.00000 | 0.0345 |
| OTU385\_Moraxella | 0.00033 | 0.00001 | 0.00000 | 0.0040 |
| OTU387\_Bacteroidetes\_unclassified | 0.00035 | 0.00000 | 0.00000 | 0.0003 |
| OTU389\_Bacteroidetes\_unclassified | 0.00034 | 0.00000 | 0.00000 | 0.0345 |
| OTU391\_Lachnospiraceae\_unclassified | 0.00000 | 0.00022 | 0.00012 | 0.0233 |
| OTU392\_Bilophila | 0.00033 | 0.00000 | 0.00000 | 0.0003 |
| OTU393\_Sphaerochaeta | 0.00027 | 0.00006 | 0.00000 | 0.0089 |
| OTU396\_Proteobacteria\_unclassified | 0.00000 | 0.00001 | 0.00030 | 0.0061 |
| OTU402\_Firmicutes\_unclassified | 0.00030 | 0.00000 | 0.00000 | 0.0085 |
| OTU403\_Treponema | 0.00028 | 0.00002 | 0.00000 | 0.0023 |
| OTU406\_Proteobacteria\_unclassified | 0.00030 | 0.00000 | 0.00000 | 0.0085 |
| OTU411\_Clostridia\_unclassified | 0.00028 | 0.00000 | 0.00000 | 0.0003 |
| OTU412\_Treponema | 0.00028 | 0.00000 | 0.00000 | 0.0345 |
| OTU413\_Clostridium.XlVb | 0.00023 | 0.00003 | 0.00001 | 0.0031 |
| OTU415\_Dorea | 0.00000 | 0.00024 | 0.00003 | 0.0078 |
| OTU416\_Bacteroidetes\_unclassified | 0.00027 | 0.00000 | 0.00000 | 0.0085 |
| OTU418\_Bacteroidetes\_unclassified | 0.00027 | 0.00000 | 0.00000 | 0.0018 |
| OTU421\_Sphaerochaeta | 0.00019 | 0.00008 | 0.00000 | 0.0045 |
| OTU422\_Porphyromonadaceae\_unclassified | 0.00027 | 0.00000 | 0.00000 | 0.0003 |
| OTU430\_Clostridiales\_unclassified | 0.00026 | 0.00000 | 0.00000 | 0.0018 |
| OTU443\_Subdivision5\_bacteria\_incertae\_sedis | 0.00023 | 0.00000 | 0.00000 | 0.0018 |
| OTU447\_Firmicutes\_unclassified | 0.00019 | 0.00000 | 0.00004 | 0.0037 |
| OTU449\_Alysiella | 0.00022 | 0.00000 | 0.00000 | 0.0018 |
| OTU454\_Bacteroidetes\_unclassified | 0.00021 | 0.00000 | 0.00000 | 0.0018 |
| OTU459\_Ruminococcaceae\_unclassified | 0.00021 | 0.00000 | 0.00000 | 0.0018 |
| OTU462\_Ruminococcaceae\_unclassified | 0.00001 | 0.00011 | 0.00009 | 0.0236 |
| OTU464\_Burkholderiales\_unclassified | 0.00000 | 0.00006 | 0.00015 | 0.0030 |
| OTU472\_Ruminococcaceae\_unclassified | 0.00020 | 0.00000 | 0.00000 | 0.0018 |
| OTU477\_Ruminococcaceae\_unclassified | 0.00017 | 0.00000 | 0.00002 | 0.0008 |
| OTU479\_Subdivision5\_bacteria\_incertae\_sedis | 0.00019 | 0.00000 | 0.00000 | 0.0017 |
| OTU480\_Alloprevotella | 0.00019 | 0.00000 | 0.00000 | 0.0085 |
| OTU481\_Bacteroidetes\_unclassified | 0.00019 | 0.00000 | 0.00000 | 0.0016 |
| OTU484\_Kingella | 0.00018 | 0.00000 | 0.00000 | 0.0085 |
| OTU487\_Firmicutes\_unclassified | 0.00018 | 0.00000 | 0.00000 | 0.0003 |
| OTU489\_Bacteria\_unclassified | 0.00017 | 0.00000 | 0.00000 | 0.0345 |
| OTU499\_Ruminococcaceae\_unclassified | 0.00017 | 0.00000 | 0.00000 | 0.0345 |
| OTU500\_Butyricimonas | 0.00015 | 0.00001 | 0.00001 | 0.0266 |
| OTU501\_Bacteria\_unclassified | 0.00016 | 0.00000 | 0.00000 | 0.0016 |
| OTU502\_Moraxella | 0.00016 | 0.00000 | 0.00000 | 0.0018 |
| OTU505\_Butyrivibrio | 0.00014 | 0.00000 | 0.00001 | 0.0039 |
| OTU506\_Bacteria\_unclassified | 0.00015 | 0.00000 | 0.00000 | 0.0003 |
| OTU509\_Bacteroidales\_unclassified | 0.00015 | 0.00000 | 0.00000 | 0.0084 |
| OTU517\_Treponema | 0.00015 | 0.00000 | 0.00000 | 0.0085 |
| OTU518\_Bacteroidales\_unclassified | 0.00013 | 0.00001 | 0.00000 | 0.0039 |
| OTU522\_Ruminococcaceae\_unclassified | 0.00014 | 0.00000 | 0.00000 | 0.0345 |
| OTU529\_Bacteria\_unclassified | 0.00012 | 0.00001 | 0.00000 | 0.0118 |
| OTU531\_Ruminococcaceae\_unclassified | 0.00011 | 0.00001 | 0.00001 | 0.0489 |
| OTU532\_Bacteroidetes\_unclassified | 0.00000 | 0.00000 | 0.00013 | 0.0342 |
| OTU533\_Ruminococcaceae\_unclassified | 0.00013 | 0.00000 | 0.00000 | 0.0345 |
| OTU537\_Sphaerochaeta | 0.00013 | 0.00000 | 0.00000 | 0.0018 |
| OTU539\_Clostridiales\_unclassified | 0.00000 | 0.00004 | 0.00008 | 0.0044 |
| OTU540\_Bacteroidetes\_unclassified | 0.00012 | 0.00000 | 0.00001 | 0.0217 |
| OTU541\_Parabacteroides | 0.00012 | 0.00000 | 0.00000 | 0.0345 |
| OTU545\_Clostridiales\_unclassified | 0.00012 | 0.00000 | 0.00000 | 0.0085 |
| OTU546\_Oligosphaera | 0.00010 | 0.00002 | 0.00001 | 0.0343 |
| OTU549\_Alistipes | 0.00012 | 0.00000 | 0.00000 | 0.0017 |
| OTU553\_Bacteria\_unclassified | 0.00012 | 0.00000 | 0.00000 | 0.0085 |
| OTU554\_Bacteroidales\_unclassified | 0.00010 | 0.00001 | 0.00000 | 0.0371 |
| OTU556\_Clostridiales\_unclassified | 0.00011 | 0.00001 | 0.00000 | 0.0249 |
| OTU559\_Ruminococcaceae\_unclassified | 0.00011 | 0.00000 | 0.00000 | 0.0085 |
| OTU563\_Oxalobacteraceae\_unclassified | 0.00011 | 0.00000 | 0.00000 | 0.0082 |
| OTU566\_Porphyromonadaceae\_unclassified | 0.00010 | 0.00000 | 0.00001 | 0.0046 |
| OTU569\_Clostridiales\_unclassified | 0.00010 | 0.00000 | 0.00001 | 0.0010 |
| OTU576\_Chryseobacterium | 0.00008 | 0.00001 | 0.00001 | 0.0241 |
| OTU577\_Bacteroidetes\_unclassified | 0.00010 | 0.00000 | 0.00000 | 0.0345 |
| OTU579\_Ruminococcaceae\_unclassified | 0.00009 | 0.00000 | 0.00000 | 0.0345 |
| OTU597\_Clostridiales\_unclassified | 0.00008 | 0.00000 | 0.00000 | 0.0345 |
| OTU598\_Streptococcus | 0.00008 | 0.00000 | 0.00000 | 0.0345 |
| OTU601\_Ruminococcaceae\_unclassified | 0.00008 | 0.00000 | 0.00000 | 0.0082 |
| OTU603\_Lachnospiraceae\_unclassified | 0.00006 | 0.00001 | 0.00000 | 0.0101 |
| OTU617\_Bacteroidetes\_unclassified | 0.00008 | 0.00000 | 0.00000 | 0.0017 |
| OTU619\_Pasteurellaceae\_unclassified | 0.00007 | 0.00000 | 0.00001 | 0.0279 |
| OTU624\_Ruminococcaceae\_unclassified | 0.00000 | 0.00000 | 0.00007 | 0.0342 |
| OTU625\_Bacteria\_unclassified | 0.00007 | 0.00000 | 0.00000 | 0.0342 |
| OTU626\_Spirochaetales\_unclassified | 0.00000 | 0.00000 | 0.00007 | 0.0345 |
| OTU629\_Neisseriaceae\_unclassified | 0.00007 | 0.00000 | 0.00000 | 0.0085 |
| OTU630\_Subdivision5\_bacteria\_incertae\_sedis | 0.00007 | 0.00000 | 0.00000 | 0.0345 |
| OTU637\_Porphyromonas | 0.00006 | 0.00000 | 0.00001 | 0.0055 |
| OTU639\_Lachnospiraceae\_unclassified | 0.00000 | 0.00000 | 0.00007 | 0.0345 |
| OTU658\_Bacteria\_unclassified | 0.00006 | 0.00000 | 0.00000 | 0.0082 |
| OTU659\_Meganema | 0.00004 | 0.00001 | 0.00001 | 0.0491 |
| OTU663\_Neisseriaceae\_unclassified | 0.00006 | 0.00000 | 0.00000 | 0.0345 |
| OTU678\_Lachnospiraceae\_unclassified | 0.00000 | 0.00001 | 0.00005 | 0.0281 |
| OTU688\_Moraxella | 0.00005 | 0.00000 | 0.00000 | 0.0345 |
| OTU691\_Bacteria\_unclassified | 0.00005 | 0.00000 | 0.00000 | 0.0345 |
| OTU705\_Pasteurellaceae\_unclassified | 0.00004 | 0.00000 | 0.00000 | 0.0334 |
| OTU709\_Cardiobacteriaceae\_unclassified | 0.00004 | 0.00000 | 0.00000 | 0.0084 |
| OTU720\_Bacteroidetes\_unclassified | 0.00004 | 0.00000 | 0.00000 | 0.0342 |
| OTU729\_Fibrobacter | 0.00003 | 0.00000 | 0.00000 | 0.0342 |
| OTU732\_Synergistes | 0.00003 | 0.00000 | 0.00000 | 0.0342 |
| OTU767\_Victivallis | 0.00003 | 0.00000 | 0.00000 | 0.0342 |
| OTU768\_Clostridiales\_unclassified | 0.00000 | 0.00000 | 0.00003 | 0.0342 |
| OTU770\_Streptococcus | 0.00003 | 0.00000 | 0.00000 | 0.0342 |
| OTU771\_Peptostreptococcus | 0.00003 | 0.00000 | 0.00000 | 0.0342 |
| OTU779\_Coriobacteriaceae\_unclassified | 0.00003 | 0.00000 | 0.00000 | 0.0078 |
| OTU782\_Brevundimonas | 0.00003 | 0.00000 | 0.00000 | 0.0078 |
| OTU783\_Porphyromonas | 0.00003 | 0.00000 | 0.00000 | 0.0078 |
| OTU807\_Corynebacterium | 0.00002 | 0.00000 | 0.00000 | 0.0334 |
| OTU813\_Lachnospiraceae\_unclassified | 0.00002 | 0.00000 | 0.00000 | 0.0334 |

**Table S7** the top 50 features selected ofRandomForest classification model based on MDA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| order based on MDA | MRO-MRC-MCA | MRO-MRC | MRO-MCA | MRC-MCA |
| 1 | OTU93\_Treponema | OTU365\_Neisseriaceae\_unclassified | OTU216\_Ruminococcaceae\_unclassified | OTU74\_Treponema |
| 2 | OTU87\_Butyrivibrio | OTU296\_Clostridiales\_unclassified | OTU464\_Burkholderiales\_unclassified | OTU104\_Prevotella |
| 3 | OTU539\_Clostridiales\_unclassified | OTU5\_Sphingobacteriaceae\_unclassified | OTU60\_Prevotella | OTU396\_Proteobacteria\_unclassified |
| 4 | OTU330\_Firmicutes\_unclassified | OTU148\_Lachnospiraceae\_unclassified | OTU22\_Succiniclasticum | OTU539\_Clostridiales\_unclassified |
| 5 | OTU313\_Methanomassiliicoccus | OTU290\_Bacteroidetes\_unclassified | OTU422\_Porphyromonadaceae\_unclassified | OTU87\_Butyrivibrio |
| 6 | OTU83\_Bacteroidales\_unclassified | OTU18\_Prevotella | OTU39\_Ruminococcaceae\_unclassified | OTU83\_Bacteroidales\_unclassified |
| 7 | OTU89\_Bacteroidetes\_unclassified | OTU111\_Methanomassiliicoccus | OTU94\_Clostridiales\_unclassified | OTU42\_Prevotella |
| 8 | OTU396\_Proteobacteria\_unclassified | OTU411\_Clostridia\_unclassified | OTU178\_Bacteroides | OTU93\_Treponema |
| 9 | OTU75\_Ruminococcaceae\_unclassified | OTU569\_Clostridiales\_unclassified | OTU147\_Bacteroidales\_unclassified | OTU221\_Pseudobutyrivibrio |
| 10 | OTU24\_Cloacibacillus | OTU119\_Prevotella | OTU290\_Bacteroidetes\_unclassified | OTU110\_Prevotellaceae\_unclassified |
| 11 | OTU154\_Methanomassiliicoccus | OTU487\_Firmicutes\_unclassified | OTU349\_Bacteroidetes\_unclassified | OTU599\_Spartobacteria\_unclassified |
| 12 | OTU387\_Bacteroidetes\_unclassified | OTU447\_Firmicutes\_unclassified | OTU539\_Clostridiales\_unclassified | OTU100\_Prevotellaceae\_unclassified |
| 13 | OTU217\_Bacteroidetes\_unclassified | OTU281\_Bacteroidetes\_unclassified | OTU55\_Sphaerochaeta | OTU163\_Prevotellaceae\_unclassified |
| 14 | OTU104\_Prevotella | OTU422\_Porphyromonadaceae\_unclassified | OTU154\_Methanomassiliicoccus | OTU54\_Prevotella |
| 15 | OTU422\_Porphyromonadaceae\_unclassified | OTU154\_Methanomassiliicoccus | OTU330\_Firmicutes\_unclassified | OTU432\_Lachnospiraceae\_unclassified |
| 16 | OTU74\_Treponema | OTU217\_Bacteroidetes\_unclassified | OTU208\_Bacteria\_unclassified | OTU88\_Treponema |
| 17 | OTU178\_Bacteroides | OTU79\_Neisseriaceae\_unclassified | OTU313\_Methanomassiliicoccus | OTU67\_Treponema |
| 18 | OTU5\_Sphingobacteriaceae\_unclassified | OTU24\_Cloacibacillus | OTU89\_Bacteroidetes\_unclassified | OTU643\_Neisseria |
| 19 | OTU290\_Bacteroidetes\_unclassified | OTU208\_Bacteria\_unclassified | OTU411\_Clostridia\_unclassified | OTU177\_Campylobacter |
| 20 | OTU55\_Sphaerochaeta | OTU114\_Megasphaera | OTU24\_Cloacibacillus | OTU145\_Ruminococcaceae\_unclassified |
| 21 | OTU39\_Ruminococcaceae\_unclassified | OTU506\_Bacteria\_unclassified | OTU413\_Clostridium.XlVb | OTU205\_Firmicutes\_unclassified |
| 22 | OTU90\_Bacteroidetes\_unclassified | OTU330\_Firmicutes\_unclassified | OTU296\_Clostridiales\_unclassified | OTU273\_Prevotella |
| 23 | OTU94\_Clostridiales\_unclassified | OTU75\_Ruminococcaceae\_unclassified | OTU403\_Treponema | OTU15\_Prevotellaceae\_unclassified |
| 24 | OTU365\_Neisseriaceae\_unclassified | OTU94\_Clostridiales\_unclassified | OTU266\_Porphyromonadaceae\_unclassified | OTU314\_Blautia |
| 25 | OTU411\_Clostridia\_unclassified | OTU313\_Methanomassiliicoccus | OTU298\_Pyramidobacter | OTU48\_Treponema |
| 26 | OTU296\_Clostridiales\_unclassified | OTU387\_Bacteroidetes\_unclassified | OTU5\_Sphingobacteriaceae\_unclassified | OTU591\_Atopobium |
| 27 | OTU487\_Firmicutes\_unclassified | OTU147\_Bacteroidales\_unclassified | OTU281\_Bacteroidetes\_unclassified | OTU415\_Dorea |
| 28 | OTU147\_Bacteroidales\_unclassified | OTU178\_Bacteroides | OTU1\_Sphingobacteriaceae\_unclassified | OTU123\_Prevotella |
| 29 | OTU99\_Elusimicrobium | OTU139\_Bacteroidetes\_unclassified | OTU151\_Ruminococcaceae\_unclassified | OTU52\_Bacteria\_unclassified |
| 30 | OTU392\_Bilophila | OTU477\_Ruminococcaceae\_unclassified | OTU111\_Methanomassiliicoccus | OTU171\_Olsenella |
| 31 | OTU506\_Bacteria\_unclassified | OTU93\_Treponema | OTU119\_Prevotella | OTU143\_Fibrobacter |
| 32 | OTU169\_Bacteroidetes\_unclassified | OTU363\_Firmicutes\_unclassified | OTU217\_Bacteroidetes\_unclassified | OTU6\_Prevotella |
| 33 | OTU119\_Prevotella | OTU39\_Ruminococcaceae\_unclassified | OTU34\_Ruminococcus | OTU611\_Bacteria\_unclassified |
| 34 | OTU279\_Clostridiales\_unclassified | OTU169\_Bacteroidetes\_unclassified | OTU365\_Neisseriaceae\_unclassified | OTU115\_Fibrobacter |
| 35 | OTU139\_Bacteroidetes\_unclassified | OTU62\_Prevotellaceae\_unclassified | OTU387\_Bacteroidetes\_unclassified | OTU165\_Prevotellaceae\_unclassified |
| 36 | OTU221\_Pseudobutyrivibrio | OTU279\_Clostridiales\_unclassified | OTU83\_Bacteroidales\_unclassified | OTU29\_Prevotella |
| 37 | OTU208\_Bacteria\_unclassified | OTU266\_Porphyromonadaceae\_unclassified | OTU392\_Bilophila | OTU96\_Alloprevotella |
| 38 | OTU266\_Porphyromonadaceae\_unclassified | OTU33\_Bacteroidetes\_unclassified | OTU6\_Prevotella | OTU86\_Pyramidobacter |
| 39 | OTU33\_Bacteroidetes\_unclassified | OTU392\_Bilophila | OTU219\_Bacteroidetes\_unclassified | OTU91\_Prevotellaceae\_unclassified |
| 40 | OTU245\_Clostridiales\_unclassified | OTU89\_Bacteroidetes\_unclassified | OTU33\_Bacteroidetes\_unclassified | OTU140\_Anaerovibrio |
| 41 | OTU110\_Prevotellaceae\_unclassified | OTU86\_Pyramidobacter | OTU75\_Ruminococcaceae\_unclassified | OTU768\_Clostridiales\_unclassified |
| 42 | OTU111\_Methanomassiliicoccus | OTU99\_Elusimicrobium | OTU192\_Methanimicrococcus | OTU698\_Parasutterella |
| 43 | OTU281\_Bacteroidetes\_unclassified | OTU245\_Clostridiales\_unclassified | OTU190\_Sphaerochaeta | OTU313\_Methanomassiliicoccus |
| 44 | OTU192\_Methanimicrococcus | OTU55\_Sphaerochaeta | OTU421\_Sphaerochaeta | OTU626\_Spirochaetales\_unclassified |
| 45 | OTU42\_Prevotella | OTU90\_Bacteroidetes\_unclassified | OTU13\_Prevotella | OTU78\_Bacteroidales\_unclassified |
| 46 | OTU79\_Neisseriaceae\_unclassified | OTU192\_Methanimicrococcus | OTU115\_Fibrobacter | OTU524\_Lachnospiraceae\_unclassified |
| 47 | OTU477\_Ruminococcaceae\_unclassified | OTU138\_Prevotella | OTU168\_Methanomicrobium | OTU464\_Burkholderiales\_unclassified |
| 48 | OTU6\_Prevotella | OTU168\_Methanomicrobium | OTU487\_Firmicutes\_unclassified | OTU66\_Treponema |
| 49 | OTU60\_Prevotella | OTU60\_Prevotella | OTU506\_Bacteria\_unclassified | OTU596\_Ruminococcaceae\_unclassified |
| 50 | OTU158\_Clostridiales\_unclassified | OTU186\_Prevotella | OTU40\_Bacteroidetes\_unclassified | OTU382\_Prevotellaceae\_unclassified |

**Table S8.** The prediction accuracy of RandomForest regression model

|  |  |
| --- | --- |
| Items | Prediction accuracy (%) |
| CP | 73.01 |
| NDF | 73.79 |
| NFC | 75.81 |
| acetate | 61.40 |
| propionate | 40.95 |
| butyrate | 57.03 |
| valerate | 73.05 |
| Total VFA | 70.06 |
| Slaughter weight | 69.50 |

Random forest regression model were used to select the rumen bacteria that were important for intake of major nutrient (CP, NDF and NFC). The model was run in R software using randomForest pachkage (v 4.6-14) with 10000 ntrees. The percent variance explained was reported for the estimation of accuracy of regression model.

CP: Crude protein average daily intake; NDF: Neutral detergent fibers average daily intake; NFC: Non-fibrous carbohydrates average daily intake, Total VFA: Total volatile fatty acids.

**Supplemental figure legends**

**Figure S1** The rumen microbiome across three groups at genus level

Each bar shows the relative abundance of individual (A) or average (B) samples collected at MRO, MRC and MCA.

**Figure S2** AUC curve of RandomForest classification model for differentiating MRO, MRC and MCA based on mean decrease accuracy: A: 3 groups; B: MRO vs MRC; C: MRO vs MCA; D: MRC vs MCA.

The ‘Kopt’ shows the number of optimal variables fitted the AUCRF model. The values in parentheses are (specificity, sensitivity).

**Figure S3**  top 50 features boxplots identified by AUCRF that differentiate MRO, MRC and MCA.

The p values were calculated by using Kruskal–Wallis test. MRO=milk replacer, MRC= milk replacer + concentrate, MCA= milk replacer + concentrate + alfalfa.

**Figure S4** top 25 predictors of pairwise AUCRF for differentiating MRO-MRC

**Figure S5** top 25 predictors of pairwise AUCRF for differentiating MRO and MCA

**Figure S6** top 25 predictors of pairwise AUCRF for differentiating MRC-MCA

**Figure S7** Predictive function analysis (levels 3 PICRUSt)

**Figure S8** Comparing taxon-level contribution profiles of functional shifts in MRC rumen samples by FishTaco

Taxon-level shift contribution profiles for some case-associated (MRC case, MRO control) functional modules by FishTaco. The horizontal axis represents rank and statistic scores, and the vertical axis represents related pathways. For each functional pathway, the bar on the top-right of Y axis represents case-associated bacteria driving the enrichment in the functional module; the bar on the top-left of Y axis indicates case-associated bacteria attenuating functional shift; the bar on the bottom-right of Y axis represents bacteria depleted in control driving functional shift; the bar on the bottom-left of Y axis shows bacteria depleted in control attenuating functional shift. White diamonds represent bacterial-based functional shift scores

FishTaco:Functional Shifts’ Taxonomic Contributors; MRO=milk replacer; MRC= milk replacer + concentrate

**Figure S9** Comparing taxon-level contribution profiles of functional shifts in MCA rumen samples by fishtaco

Taxon-level shift contribution profiles for some case-associated (MCA case, MRO control) functional modules by FishTaco. The horizontal axis represents rank and statistic scores, and the vertical axis represents related pathways. For each functional pathway, the bar on the top-right of Y axis represents case-associated bacteria driving the enrichment in the functional module; the bar on the top-left of Y axis indicates case-associated bacteria attenuating functional shift; the bar on the bottom-right of Y axis represents bacteria depleted in control driving functional shift; the bar on the bottom-left of Y axis shows bacteria depleted in control attenuating functional shift. White diamonds represent bacterial-based functional shift scores.

MRO=milk replacer; MCA= milk replacer + concentrate + alfalfa;

FishTaco:Functional Shifts’ Taxonomic Contributors;

**Supplemental files legends**

File S1: Pearson correlation between top 50 species selected by RandomForest regression and major nutrient intake of goat kids (sheet ‘ADFI’) and fermentation parameters and pre-slaughter live weight of goat kids (sheet ‘VFA’)

File S2: FishTaco ouput for MRO as control vs MRC as case

File S3: FishTaco ouput for MRO as control vs MCA as case

File S4: OTUs taxonomy, their NCBI blast results and sequences