**Supplementary Table 1.** Composition of rumen microbiota at the phylum level.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Phylum | Groups1 | | | SEM | *P*-value |
| HAL | MAL | LAL |
| Bacteroidetes | 54.528a | 43.531b | 54.031a | 2.3708 | <0.001 |
| Firmicutes | 37.061b | 49.563a | 36.710b | 1.9620 | <0.001 |
| Proteobacteria | 1.448b | 0.871c | 2.037a | 0.1565 | <0.001 |
| Tenericutes | 1.273b | 1.126b | 1.805a | 0.2817 | 0.011 |
| Actinobacteria | 0.882b | 1.382a | 0.889b | 0.2941 | 0.058 |
| Verrucomicrobia | 1.161a | 0.652b | 1.018a | 0.2238 | 0.020 |
| Saccharibacteria | 0.692ab | 0.894a | 0.487b | 0.1760 | 0.021 |
| SR1\_Absconditabacteria | 0.676 | 0.532 | 0.603 | 0.0919 | 0.784 |
| Spirochaetae | 0.529ab | 0.421b | 0.610a | 0.0820 | 0.021 |
| Synergistetes | 0.757a | 0.354b | 0.350b | 0.1800 | 0.009 |

1 HAL represents the high-altitude region (Zhongba County, Xigatse City, 4 800 m altitude), MAL represents the medium-altitude region (Nagqu City, 4 500 m altitude), LAL represents the low-altitude region (Dangxiong County, Lhasa City, 3 800 m altitude).

Different superscript letters in the same row denote significant differences (*P* < 0.05).

**Supplementary Table 2.** Composition of rumen microbiota at the family level.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Family | Groups1 | | | SEM | *P*-value |
| HAL | MAL | LAL |
| Prevotellaceae | 0.234 | 0.235 | 0.271 | 0.011 | 0.228 |
| Ruminococcaceae | 0.152 | 0.144 | 0.146 | 0.003 | 0.496 |
| Rikenellaceae | 0.157a | 0.082c | 0.111b | 0.007 | <0.001 |
| Lachnospiraceae | 0.084b | 0.109a | 0.081b | 0.004 | 0.011 |
| Christensenellaceae | 0.070b | 0.102a | 0.081b | 0.004 | 0.004 |
| Bacteroidales\_BS11\_gut\_group | 0.081a | 0.068b | 0.068b | 0.002 | 0.010 |
| Veillonellaceae | 0.012b | 0.099a | 0.011b | 0.011 | 0.004 |
| unidentified | 0.042a | 0.032b | 0.045a | 0.002 | 0.015 |
| Bacteroidales\_S24-7\_group | 0.032b | 0.025b | 0.046a | 0.003 | 0.009 |
| Acidaminococcaceae | 0.022 | 0.017 | 0.020 | 0.001 | 0.367 |
| Bacteroidales\_RF16\_group | 0.013b | 0.013b | 0.020a | 0.001 | 0.017 |

1 HAL represents the high-altitude region (Zhongba County, Xigatse City, 4 800 m altitude), MAL represents the medium-altitude region (Nagqu City, 4 500 m altitude), LAL represents the low-altitude region (Dangxiong County, Lhasa City, 3 800 m altitude).

Different superscript letters in the same row denote significant differences (*P* < 0.05).

**Supplementary Table 3.** Composition of rumen microbiota at the genus level.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Genus | Groups1 | | | SEM | *P* |
| HAL | MAL | LAL |
| *Christensenellaceae\_R-7\_group* | 6.786b | 9.573a | 7.830b | 0.890 | 0.002 |
| *Prevotellaceae\_UCG-003* | 3.300a | 1.903b | 3.671a | 0.615 | 0.002 |
| *unidentified* | 25.399a | 19.802b | 26.116a | 1.563 | <0.001 |
| *Ruminococcaceae\_NK4A214\_group* | 2.695b | 3.653a | 2.906b | 0.410 | 0.014 |
| *Rikenellaceae\_RC9\_gut\_group* | 15.190a | 7.884c | 10.711b | 1.214 | <0.001 |
| *Eubacterium\_coprostanoligenes\_group* | 1.888a | 1.030c | 1.413b | 0.163 | <0.001 |
| *Saccharofermentans* | 1.457a | 0.951b | 1.380a | 0.163 | 0.001 |
| *Ruminococcaceae\_UCG-010* | 1.296a | 0.946b | 0.923b | 0.132 | 0.002 |
| *Prevotellaceae\_NK3B31\_group* | 1.220a | 0.379b | 1.480a | 0.265 | <0.001 |
| *Ruminococcaceae\_UCG-005* | 0.982b | 1.285a | 0.619c | 0.178 | <0.001 |
| *Papillibacter* | 0.907b | 0.632b | 1.697a | 0.175 | <0.001 |
| *Quinella* | 0.745b | 8.865a | 0.594b | 2.451 | <0.001 |
| *Butyrivibrio\_2* | 0.574c | 1.056a | 0.814b | 0.147 | <0.001 |
| *Olsenella* | 0.364b | 0.972a | 0.531b | 0.240 | 0.009 |
| *Lachnospiraceae\_NK3A20\_group* | 0.310b | 2.747a | 0.295b | 0.227 | <0.001 |
| *Acetitomaculum* | 0.189b | 1.321a | 0.209b | 0.160 | <0.001 |

1 HAL represents the high-altitude region (Zhongba County, Xigatse City, 4 800 m altitude), MAL represents the medium-altitude region (Nagqu City, 4 500 m altitude), LAL represents the low-altitude region (Dangxiong County, Lhasa City, 3 800 m altitude).

Different superscript letters in the same row denote significant differences (*P* < 0.05).



**Supplementary Fig.1**Rank abundance curves based on the OUT level.