Steam-flaked corn improves Holstein heifers performance by modulating ruminal bacterial community and rumen metabolites

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Cereal grains are the prevailing feed energy source for ruminants in the livestock industry and have significant economic importance for human consumption (Marshall *et al*. 2013). The improvement of starch utilization may improve animal health conditions and performance and alleviate the competition between livestock and humans for food availability (Ertl *et al*. 2016). Studies have shown that feeding ruminants SFC increases milk performance in cows (Miyaji and Nonaka 2018) and the growth performance in feedlot cattle (May *et al.* 2010). However, the detailed mechanisms underlying the effect of corn processing methods on animal performance are not fully understood. Considering the increased performance and physical changes in heifers fed SFC, we hypothesized that differently processed corn modulated the ruminal bacterial community and the rumen metabolites, thereby improving animal performance.

Twenty-six Holstein heifers were blocked by weight and randomly assigned into two groups with thirteen heifers each. The heifers were fed with SFC or FGC diet respectively for 4 weeks. Rumen fluid was collected by oral stomach tubes at 2 h and 4 h post feeding on the sampling day for ruminal VFA profile and ruminal bacterial community. The microbiota OTU data, phylum and genus relative abundances, rumen VFA profile, NH3-N concentration, rumen pH and average daily gain (ADG) were analyzed using the one-way ANOVA of SPSS.

The SFC diet resulted in an increased ADG in heifers, an increased rumen propionate concentration and a decreased rumen NH3-N concentration. The relative abundance of the phylum *Firmicutes* tended to increase and *Proteobacteriat* was significantly increased in the heifers fed SFC diet compared with FGC diet. In addition, the relative abundance of amylolytic bacteria of the genera *Succinivibrio*, *Roseburia* and *Blautia* were elevated, and the cellulolytic bacteria (*Ruminococcaceae_UCG-014* and *Ruminococcaceae_UCG-013*) were decreased by the steam flaking method. Spearman correlation analysis between the ruminal bacteria and the microbial metabolites showed that the rumen propionate concentration was positively correlated with genera *Succinivibrio* and *Blautia* abundance, but negatively correlated with genera *Ruminococcaceae_UCG-014* abundance.

Items[1]	Treatments		SEM	*P* value
	SFC	FGC		
Bacteroidales_S24-7_group	7.24	5.15	0.616	0.091
Roseburia	2.85	1.55	0.314	0.035
Blautia	3.34	0.75	0.374	<0.001
Ruminococcaceae_UCG-014	0.95	1.66	0.169	0.033
Alistipes	0.62	1.54	0.207	0.022
Marvinbryantia	1.11	0.69	0.087	0.013
Ruminococcaceae_UCG-013	0.31	0.96	0.110	0.002
[Ruminococcus]_gauvreauii_group	0.77	0.36	0.094	0.027
Succinivibrio	0.75	0.04	0.125	0.002

Table. 1 Percent relative abundance of genera with a significant effect of diet with steam flaked corn (SFC) or finely ground corn (FGC).

In summary, our results suggested that SFC promoted the increased abundance of amylolytic bacteria, especially the genus *Succinivibrio*, thereby increasing propionate production. Propionate is the highest energetic efficiency metabolite for ruminant hosts, and thus, dairy heifers with increased propionate concentration exhibited relatively higher average daily gain. This study provides comparative evidence for the mechanism underlying the enhanced performance of ruminants fed steam flaked corn.

References

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