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外源纤维酶制剂对青贮玉米体外发酵特性以及甲烷生成的影响

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Exogenous Fibrolytic Enzymes: Effects on *in Vitro* Fermentation and Methane Production of Corn Silage

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摘要 本试验旨在探究添加外源纤维酶制剂对青贮玉米体外(瘤胃)发酵的影响。试验采用单因素试验设计,利用压力读取式体外产气系统,添加11种纤维酶制剂,包括5种纤维素酶(CEL-1、CEL-2、CEL-3、CEL-4、CEL-5)和6种木聚糖酶(XYL-1、XYL-2、XYL-3、XYL-4、XYL-5、XYL-6),对照组不添加酶制剂,纤维素酶组添加水平为30 U/g,木聚糖酶组添加水平为40 U/g。结果表明:与对照组相比,添加纤维素酶显著降低了底物的潜在产气量($P<0.05$),但是显著提高了产气速率($P<0.05$),其中添加CEL-1提升产气速率达82.5%;但除XYL-3显著降低了潜在产气量($P<0.05$)外,添加木聚糖酶对其他产气参数均无显著影响($P>0.05$)。除了XYL-4对酸性洗涤纤维降解率效果不显著($P>0.05$)外,酶制剂组的干物质、中性洗涤纤维和酸性洗涤纤维降解率都显著提高($P<0.05$)。添加XYL-1、XYL-4和CEL-5显著提高了总挥发性脂肪酸的产量($P<0.05$),XYL-3和XYL-4均显著降低了乙酸摩尔比和乙酸:丙酸($P<0.05$),显著提高了丙酸摩尔比($P<0.05$),但仅XYL-4显著提高了丁酸摩尔比($P<0.05$)。体外培养6和12 h时,不同酶制剂对甲烷生成的影响呈现较大的变异性,培养到24 h时,酶制剂对甲烷生成的影响变得不显著($P>0.05$)。由此可知,添加外源纤维酶制剂可提高青贮玉米的干物质、中性洗涤纤维和酸性洗涤纤维的降解率,并可在培养前期改变甲烷的生成量。

关键词: 外源纤维酶制剂 体外发酵 青贮玉米 反刍动物

Abstract: The aim of this study was to investigate the effects of exogenous fibrolytic enzymes on *in vitro* (rumen) fermentation of corn silage. Corn silage as a substrate was added without (control) or with 5 different cellulases (CEL-1, CEL-2, CEL-3, CEL-4 and CEL-5) at 30 units endoglucanase per g of substrate or 6 different xylanases (XYL-1, XYL-2, XYL-3, XYL-4, XYL-5 and XYL-6) at 40 units xylanase per g of substrate using reading pressure technique in a single factor experiment. The results showed as follows: the addition of cellulases resulted in the decreased potential gas production ($P<0.05$) but the increased rate of gas production ($P<0.05$) with the highest improvement of the rate of gas production being 82.5% observed in CEL-1 compared with the control group. The addition of xylanase did not affect the gas production parameters ($P>0.05$) except that the addition of XYL-3 significantly decreased potential gas production ($P<0.05$). Degradation rates of dry matter, neutral detergent fibre and acid detergent fibre were enhanced by the addition of exogenous fibrolytic enzymes ($P<0.05$) except that the addition of XYL-4 did not significantly affect the degradation rate of acid detergent fibre ($P>0.05$). Total volatile fatty acid concentration was increased by the addition of XYL-1, XYL-4 and CEL-5 ($P<0.05$), the molar proportion of acetate and the ratio of acetate to propionate were significantly decreased ($P<0.05$), and the molar proportion of propionate was significantly increased ($P<0.05$), but only the addition of XYL-4 significantly increased the molar proportion of butyrate ($P<0.05$). The enzymes showed various effects on methane production after 6 and 12 h of incubation, but no effects after 24 h of incubation. It is indicated that addition of exogenous fibrolytic enzymes can increase the degradation rates of dry matter, neutral detergent fiber and acid detergent fiber of corn silage, and change methane production at the earlier stage of incubation.

Keywords: exogenous fibrolytic enzymes, *in vitro* fermentation, corn silage, ruminant

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