

青贮玉米-牛粪尿体系的¹⁵N标记及氮素转化研究*

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摘要 ¹⁵N示踪技术已开始应用于畜禽粪便氮素循环与利用研究领域,而¹⁵N在畜禽粪便不同组分和不同形态氮素中的丰度与数量将直接影响到畜禽粪便¹⁵N示踪去向与氮素实际去向的一致性。为了解¹⁵N在畜禽粪便标记过程的转化特点和在标记粪尿的分布特征,本文首先采用改进的、含有¹⁵N标记硫酸铵(60 atom% ¹⁵N)的Hoagland营养液砂培种植¹⁵N玉米,然后将¹⁵N玉米和普通玉米以55:45的氮配比作为混合青贮饲料饲喂1头已空腹2d的2龄黄牛,饲喂4d后停喂2d,收集全部牛粪尿并对其不同组分和形态氮素的¹⁵N丰度和数量进行分析。结果表明:标记玉米、混合青贮饲料、牛粪尿的¹⁵N丰度分别为48.024%、26.579%和8.044%;标记玉米对硫酸铵¹⁵N的回收率为26.3%,牛粪尿对标记玉米¹⁵N回收率为36.0%。在收集的牛粪尿氮中,牛粪全氮、牛尿全氮、牛粪铵态氮和牛尿铵态氮量分别占70.25%、29.75%、5.44%和0.03%,其¹⁵N丰度分别为9.223%、5.261%、6.505%和5.419%。在短期内通过饲喂黄牛¹⁵N青贮饲料制备的标记牛粪尿中,¹⁵N丰度在不同组分和形态氮素中的分布并不相同,牛尿氮的¹⁵N丰度低于牛粪氮,矿质态和易于矿化态氮的¹⁵N丰度低于不易矿化态氮。

关键词 ¹⁵N标记 硫酸铵 牛粪尿 青贮玉米 氮素回收 氮素转化

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Nitrogen-15 labeling and nitrogen transformation in silage maize-cattle manure system

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Abstract ¹⁵N tracer technique has been used in N cycling and utilization for livestock manure. The abundance and amount of ¹⁵N in different manure components and N forms affect whether ¹⁵N fate is consistent with all manure N. The purpose of this article is to better understand the characteristics of ¹⁵N transformation in silage maize-cattle manure system and distribution in cattle feces and urine by using ¹⁵N tracer technique. First, a sand culturing experiment was conducted by watering improved Hoagland nutrient solution with ¹⁵N labeled ammonium sulfate (AS, 60 atom% ¹⁵N) to cultivate ¹⁵N labeled maize ("Nongda-108"). Then, ¹⁵N labeled maize was mixed with unlabeled maize at a ratio of 55 : 45, according to their amount of nitrogen, to get mixed ¹⁵N forage. Finally, a 2-years-old cattle starved for 2 days was fed on the mixed ¹⁵N forage for 4 days and starved 2 days again. During the 6 days, cattle feces and urine were collected and measured separately. The results showed that ¹⁵N abundance was 48.024% in labeled maize, 26.579% in mixed silages, and 8.044% in cattle manure. In addition, 26.3% of AS ¹⁵N was discovered in maize, 36.0% of silage ¹⁵N was discovered in cattle manure. In all the manure N collected, fecal N, urine N, fecal ammonium N and urine ammonium N accounted for 70.25%, 29.75%, 5.44% and 0.03%, their ¹⁵N abundance were 9.223%, 5.261%, 6.505% and 5.419%, respectively. In ¹⁵N labeled manure of cattle fed on ¹⁵N labeled silage in a short period, the abundance of ¹⁵N in cattle urine and feces, and in different N forms were different. The ¹⁵N abundance of urine was lower than that of feces, and ¹⁵N abundance of mineral and easy-mineralized nitrogen was lower than that of hardly mineralized nitrogen.

Key words ¹⁵N labeling, Ammonium sulfate, Cattle manure, Silage maize, Nitrogen recovery, Nitrogen transformation

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