Processing cottonseed to moderate fatty acid metabolism and improve milk production by dairy cows

Carine Reveneau*, Claudio V. D. M. Ribeiro2, Maurice L. Eastridge1,2, Normand R. St-Pierre1,2, and Jeffrey L. Finkins1,2

1OSU Nutrition program 2Department of Animal Science The Ohio State University, Columbus

* reneueau.1@osu.edu

Introduction

From cottonseed (CS) — to processed CS feedstocks.

Whole cottonseed (WCS) is a high-energy-by-product with a well-balanced nutrient composition, which makes it a valuable commodity for high-producing dairy cows. Nonetheless, its physical characteristics lead to storage and handling difficulties. Processing CS greatly improves workflow while maintaining nutritional benefits such as similar protein utilization and beneficial effects on rumen fermentation. However, processing CS might modify the nutritional characteristics of the other major nutrient of WCS: fatty acids (FA). In particular, WCS has 53% linoleic acid, which can depress fiber digestibility and milk fat yield if inadequately managed.

Objectives

To determine the effects of feeding LP or SPD vs. SP or WCS on ruminal fermentation, in situ FA disappearance, nutrient digestibility, and milk FA profile.

Field observations and potentially improved fat digestibility support the usage of SPD at about 90% of the feeding rate of WCS.

Material and methods

A control diet was formulated using CS hulls, CS meal, tallow, and Megalac® to supply the same nutrients NDF, 53%; CP, 22%; FA, 20%; ash, 4.0%; and NFC, 1.0% as WCS. Six treatment diets were formulated:

- CS hulls + Megalac® + tallow whole CS
- small CS pellets LP
- large CS pellets SPD
- SPD 90% SPD +10% Concentrate.

The diet composition averaged 31.2% NDF, 18.1% CP, 5.9% FA, 7.0% ash and 37.7% NFC. The FA composition was similar for all diets: C16:0, 22%; C18:0, 2%; C18:1, 54%; and C18:2, 28%, except for SPD: C16:0, 22.9%, C18:0, 2.7%, C18:1, 18.6%, and C18:2, 55.4%. For CS hulls, 18:1, 51.8%; and 18:2, 25.1%. This diet was formulated to provide the same proportion of FA as WCS: 18:0, 22%; 18:1, 24%; 18:2, 28%. The diet was fed as a 5 x 5 Latin square design with 3-wk periods to 5 steers weighing 500 ± 50 kg.

Experiment 1: Sixty cows averaging 105 DIM were fed the WCS diet for 2 wk and then assigned to one of the following diets for 12 wk: WCS, LP, SPD, or SPD90.

Data were analyzed using PROC MIXED, with cow as a random effect. For experiment 2, data were covariance-adjusted and analyzed by repeated measures. When the diet effect was significant, the effect was partitioned using the SLICE option. Differences were deemed significant at \( P < 0.05 \).

Discussion

Processing of WCS did not impair ruminal fermentation (Table 1). There was no depression of NDF digestibility when processed CS were fed (Table 2). FA digestibility was significantly higher for SP and LP than CSH, probably because of the release of fatty acids (FA) in the CSH treatment, which should be slightly less digestible than CS oil.

Because FA digestibility of SPD was lower than both LP and WCS, we propose that delinted cottonseed has lower FA digestibility than WCS or pelleted CS products, possibly from greater passage rate of intact or partially rumenized seeds.

In situ FA digestibility of LP and WCS was significantly faster with CS processing (data not shown). The residual FA in the bag were rapidly enriched with 18:2 biohydrogenation intermediates (trans 18:1 CLA, Fig. 1) with both LP and SPD substrates, supporting no influence of pellet size on release kinetics and that both provided FA in a much more available form than the other products.

There was lower % of small and medium chain FA in milk from cows fed both LP and SPD diets. We hypothesized that increasing the particle size of the CS pellet (large pellet; LP) would lead to a larger residual FA in the bag. However, processing CS might modify the nutritional characteristics of the other major nutrient of WCS: fatty acids (FA). In particular, WCS has 53% linoleic acid, which can depress fiber digestibility and milk fat yield if inadequately managed.

Conclusion

Although having a lower FA digestibility, SPD appeared to maintain FA profile, with similar FA profile compared to WCS and LP. The negative effect of feeding free oil from pelleted CS was further demonstrated in the 12-wk lactation trial by a significant decrease in 3.5% FCM (Table 5) or milk fat production over time (Fig. 2) with the LP diet. Decrease in dry matter intake followed the same pattern as milk production over time (Fig. 3).

Feeding SPD maintained comparable (SPD90) or higher (SPD) milk production over time and provided both handling and nutritional benefits compared with WCS.

Abstract

Whole cottonseed is commonly added to dairy diets to provide energy, protein, and as a partial substrate for forage. For some feeding situations, however, handling problems limit their feasibility for use. Although pelleting and delinting processes overcome these problems, rapid release of free oil or lower total tract digestibility, respectively, can decrease their efficacy. In our study, a mix of pelleted and delinted cottonseed appeared to modify ruminal fatty acid metabolism, decreasing the risk of milk fat depression: dry matter intake and milk production tended to increase with time compared with conventional or pelleted cottonseeds. However, pelleting with a larger die appeared to provide no benefit.

Acknowledgement

Andy Spring and staff from Waterman research farm for care and feeding of the cows. Supported in part by Buckeye Technologies, Memphis, TN and Cotton Inc., Cary, NC.