Italian Journal of Animal Science

ISSN: (Print) 1828-051X (Online) Journal homepage: http://www.tandfonline.com/loi/tjas20

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To cite this article: Adolfo Corato, Severino Segato & Igino Andrighetto (2005) Effects of extruded corn on milk yield and composition and blood parameters in lactating dairy cows, Italian Journal of Animal Science, 4:sup3, 166-168, DOI: 10.4081/ijas.2005.3s.166

To link to this article: https://doi.org/10.4081/ijas.2005.3s.166

Published online: 02 Mar 2016.

COMMUNICATION

Effects of extruded corn on milk yield and composition and blood parameters in lactating dairy cows

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ABSTRACT

According to a 2x2 cross over design, fourteen Holstein dairy cows at 99±55 DIM were fed two diets containing 21.5% DM of either ground corn (GC) or extruded corn (EC). Performance and metabolic profile were detected during the third week of each experimental period. DMI and milk yield were not affected by dietary treatments. Milk fat and protein percentage of EC diet were significantly ($P<0.10$) lower than those of GC diet. Probably the higher rumen degradability of starch from EC thesis modified the synthesis of specific fatty acids leading to a milk fat depression event. Diets did not influence blood parameters, except for lower values of total protein and glucose content in EC diet-fed cows. Results suggested that the dietary inclusion of extruded corn should not be used at the tested level of substitution.

Key words: Corn extrusion, Dairy cows, Milk quality, Plasma parameters

Introduction

High producing dairy cows need high energy concentration in diets. This objective can be achieved by dietary inclusion of large amount of grains, and/or improving their starch availability. Corn is the most important grain for dairy cow feeding since it is cheap and spread, even if its starch degradability is lower than that of other cereals (barley, sorghum). Starch ruminal degradation of grain can be increased by physical treatments (grinding, crushing, rolling) or involving the addition of heat, water and pressure (flaking, extrusion). In general, extrusion processing improves corn starch availability more than other physical treatments (Gaebe *vs*, 1998). It seems that intestinal digestive capacity by amylase is the primary limitation to total absorption of monosaccharides from starch digestion. Thus, dairy cows benefit more from a supply of quickly fermented starch than from an increased supply of ruminal by-pass starch (Huntington, 1997). An increase of readily degradable starch allows the improvement of nutrient production by rumen fermentation. However, the use of high degradable starch on lactating dairy cow diets causes uncertain effects on performance (Theurer *vs*, 1998). The objective of the present study was to assess the effects of a complete substitution of ground corn with extruded one on milk production and composition and metabolic profiles in Holstein dairy cows.

Material and methods

Fourteen lactating Italian Holstein dairy cows at 99±55 DIM were used in a 2x2 cross over design with three weeks periods. Two experimental diets based on corn silage (33.5% DM), hay (12.2% DM) and alfalfa silage (7.6% DM) were formulated: GC using 21,5% of ground corn and EC by using the same percentage of

Table 1. Chemical composition of the experimental diets.

		Experimental diets	
		Extruded Corn	Ground Corn
Dry Matter	%	51.8	52.4
Crude Protein	% DM	15.6	15.5
Ether Extracts	"	4.3	4.0
Ash	"	7.2	7.1
NDF	"	35.2	35.8
ADF	"	21.6	18.1
NSC[1]	"	37.7	37.6

[1] *Non structural carbohydrates*

extruded corn. Diet samples were dried, ground and analyzed for proximate composition (AOAC, 2000); NDF and ADF were evaluated by ANKOM method (Table 1). Cows were fed *ad libitum* and DM intake (DMI) was individually and continuously recorded by *BIOcontrol sistem* A/S (Grimstad Gard, Norway). Cows were milked twice daily and milk yield was recorded at each milking over the last five days of each period. Milk samples from two daily milking were collected on the 16th and 18th day and analyzed for fat, protein, lactose (midinfrared spectroscopy) and milk urea nitrogen (MUN, enzymatic method). At the 17th day, blood samples were collected from jugular vein by venipunctur into heparinized tubes at 9:00 and 14:00 h. Plasma was analyzed for the following parameters: total protein, albumin, plasma urea nitrogen (PUN), glucose and NEFA. Data were analyzed by ANOVA (GLM of SAS) according to the following model: Yijkl = μ + Di + Cj + Pk + eijkl, where Yijkl is the variable, μ is the overall mean, Di is the diet effect, Cj is the cow effect, Pk is the period effect and eijkl is the residual error.

Results and conclusions

Dry matter intake (DMI) was not influenced by diets (Table 2). Many works on dairy cows (Lykos *vs*, 1997; Knowlton *vs*, 1998) reported no difference on DMI in relation to different corn starch digestibility. Reduction in DMI was often observed using diets characterized by a more rapid starch degradability both in dairy cows (Yu *vs*, 1998) and steers (Gaebe *vs*, 1998). Any significant difference was found between treatments in milk yield according to literature (Crocker *vs*, 1998). However, Shabi *vs* (1999) found a decrease of DMI and milk yield using an experimental diet with 20% of extruded corn. Fat corrected milk (FCM) was lower on EC diet (28.5 *vs*. 30.4 kg/d; P<0.05) because of fat percentage reduction (3.91 *vs*. 4.15%; P<0.10). Theurer *vs* (1998), in a wide review, reported a reduction of milk fat content if cows were fed with a higher amount of degradable NSC, even if the phenomenon was always associated with a dietary NDF value lower than that used in this experiment. Since extrusion increases starch rumen degradability, probably EC diet-fed cows reached a lower ruminal fluid pH. As a consequence, a higher production of trans fatty acids (particularly C18:2 trans-10-cis-12) could have inhibited one o more steps of fat synthesis by mammary gland (Baumgard *vs*, 2000). Thus, the observed reduction of milk fat percentage probably is explained by biohydrogenation theory of milk fat depression (MFD). Milk protein percentage of EC diet tended to be lower than that of GC (3.58 *vs*. 3.70%; P<0.10). As confirmed by similar milk urea nitrogen (MUN) values between diets, probably the total substitution of ground corn by extruded one did not alter nitrogen metabolism. This result was unexpected: as provision of high degradable starch increases milk protein percentage, MUN concentration should decrease (Lycos *vs*, 1997). Plasma total protein was significantly lower in EC-fed cows (76.2 *vs*. 79.5 g/l; P<0.05) because of a tendentious reduction of both albumin and globulin concentration. Plasma glucose concentration was higher in GC thesis (3.38 *vs*. 3.61 mmol/l; P<0.01), whereas concentration of NEFA was not affected by dietary treatment. These results are not in agreement with Lykos *vs* (1997) and Khorasani *vs* (1994) who found a NEFA linear decreasing and a stable glucose concentration as a more degradable starch level has been fed. More over, a change on NEFA plasma concentration could occur if dietary starch availability influenced milk fat percent-

Table 2. Dry matter intake, milk production and plasma parameters.

		Experimental diets		*P*	SEM
		Extruded Corn	Ground Corn		
Dry matter intake	kg/d	23.3	24.0	ns	0.4
Milk yield	"	29.4	30.0	ns	1.5
FCM[1]	"	28.7	30.6	*	0.5
Milk fat	%	3.91	4.15	†	0.09
Milk protein	"	3.58	3.70	†	0.04
Milk urea	mg/100 ml	29.6	27.6	ns	4.5
Plasma parameters					
Total protein	g/l	76.2	79.5	*	1.0
Albumin	"	33.8	34.6	ns	0.4
Urea	mmol/l	5.85	5.66	ns	0.19
Glucose	"	3.38	3.61	**	0.03
NEFA	"	0.09	0.07	ns	0.02

[1] *4.0% Fat Corrected Milk; †: P<0.1; *: P<0.05; **: P<0.01*

age. An increase in the proportion of dietary concentrate often results in a higher plasma glucose concentration (Dhiman *vs*, 1991). Since cows were fed diets having the same concentrate level, the significant different plasma glucose concentration observed was probably due specifically to the kind of corn treatment. As expected, plasma urea nitrogen (PUN) and MUN were similar between the two theses since PUN is the main source of MUN.

Summarizing, experimental data suggested that a complete (as 21.1% of DM) substitution of ground corn seed with extruded one did not affect dry matter intake and milk production. As a consequence of extrusion, the increase of degradability rate of starch induced a reduction of milk fat percentage and afterwards a FCM decrease. Probably a change in ruminal fermentation occurred, modifying the synthesis of chemical constituent of milk. In feeding lactating dairy cows, the dietary inclusion of extruded corn should not be used at the experimental level tested in the present trial.

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