Substituting dried distillers' grains from wheat for rolled barley in finisher diets improves the *trans*-18:1 composition in beef fat

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Abstract

Ethanol production has increased in Canada and USA creating opportunities for feeding lower cost by-products. Substitution of barley for dried distillers' grains with solubles (DDGS) from wheat also creates opportunities for producing beef with enhanced fatty acid profiles. To investigate this, heifers were finished on diets containing either 0, 20, 40 or 60% DDGS substituted for rolled barley (n = 24; 133 d finishing period). Adding DDGS to the diet increased oil (from 1.9 up to 3.7%) but dietary fatty acid compositions remained consistent. Feeding DDGS caused a linear increase in 18:2n-6 in brisket fatty acids (1.67 to 2.12%). This was accompanied by a linear decrease in 10*t*-18:1 (1.17 to 0.71%), a linear increase in 11*t*-18:1 (0.85 to 1.11%;) but no change in total *trans*-18:1. Feeding DDGS also caused a linear increase in 9*c*11*t*-conjugated linoleic acid (CLA) (0.31 to 0.36%) and a linear trend for increased total CLA. Overall, feeding DDGS enhanced the fatty acid composition of brisket fat by decreasing the atherogenic 10*t*-18:1 while increasing 9*c*11*t*-CLA and its precursor 11*t*-18:1 that have potential roles in prevention and treatment of several diseases including cancer.

Introduction

In 2007, ethanol production in Canada was 1 billion litres with planed expansion to increase production to 1.6 billion litres per year. With diversion of traditional feed grains into ethanol production, grain prices have gone up while creating opportunities for feeding lower cost dried distillers grains plus solubles (DDGS).

Cattle in Western Canada are typically finished on diets containing high levels of barley, and substitution of barley for DDGS from wheat also creates opportunities to enhance beef fatty acid profiles. Ethanol production removes starch from grain and increases crude protein, fat and fibre levels. Rumen bacteria isomerize and hydrogenate polyunsaturated fatty acids (PUFA) and metabolic intermediates can accumulate among which rumenic acid (ex. 9*c*11*t*-18:2) and its precursor vaccenic acid (11*t*-18:1) have known health benefits (Belury 2002).

However, the profile of *trans*-18:1 produced has been demonstrated to depend on the diet fed with diets high in ground barley producing higher levels of 10*t*-18:1 (Dugan *et al.*, 2007). Feeding DDGS would reduce dietary starch and increase crude fibre levels which would help maintain higher rumen pH and favour 11*t*-18:1 instead of 10*t*-18:1 production (Bauman & Griinari 2003). Higher levels of 11*t*-18:1 would increase potential for rumenic acid synthesis while lowering 10*t*-18:1 would also be beneficial due to its atherogenic properties (Bauchart *et al.,* 2007).

The objective of the present study was, therefore, to establish to what extent substitution of DDGS from wheat for ground barley can be used to enhance beef fatty acid profiles.

Materials and methods

Samples collected for the present study were part of a live animal performance trial examining growth and feed efficiency when feeding heifers increasing levels of DDGS from wheat (animal production data will be reported separately). Twenty four heifers were fed per diet during a 133 d finishing period and diets contained either 0, 20, 40 or 60% DDGS from wheat substituted for rolled barley.

The balance of the diets included 10% barley silage and a 5% vitamin and mineral supplement. Animals were penned individually. Animals were slaughtered commercially and samples of brisket fat were frozen on dry ice and transported to the lab. Fat samples were freeze dried, solublized in toluene, direct methylated with sodium methoxide and the fatty acid methyl esters (FAME) were analyzed using the GC and Ag^{+}-HPLC (Dugan *et al.,* 2007; *Kramer et al.,* 2008).

Individual animal was the experimental unit with diet as the only class variable. The MIXED procedure of SAS (SAS Institute Inc.) was used to compare fatty acids using the residual error as the error term. Orthogonal contrasts were also used to look for linear and quadratic effects of including 0, 20, 40, or 60% dietary DDGS.

Results and discussion

Substituting DDGS for rolled barley increased the level of crude fat in the diet from 1.9 to 3.7% (Table 1). The overall fatty acid percentages of the diets were fairly consistent with DDGS diets containing slightly more linoleic acid (18:2n-6) and less palmitic (16:0) and oleic acids (9*c*-18:1).

Table 1. Crude fat and fatty acid compositions of experimental diets containing different levels of DDGS from wheat

	%dietary DDGS			
Diet composition	0	20	40	60
Crude fat (dry matter basis)	1.9	2.5	3.1	3.7
Dry matter	74.7	75.7	76.7	77.8
Fatty acid (% of total FAME)				
16:0	22.59	20.95	20.69	20.21
18:0	1.78	1.58	1.45	1.44
9*c*-18:1	16.53	15.66	15.05	14.82
11*c*-18:1	1.01	1.12	1.14	1.21
18:2n-6	51.29	54.31	55.41	56.03
20:0	0.43	0.32	0.26	0.24
18:3n-3	4.56	4.50	4.63	4.69
11*c*-20:1	0.86	0.78	0.74	0.72
22:0	0.46	0.35	0.29	0.28
13*c*-22:1	0.14	0.13	0.12	0.10
24:0	0.35	0.30	0.23	0.27

DDGS - Dried distillers grains with solubles.
FAME - Fatty acid methyl esters.

Increasing crude fat levels in the diet with the addition of DDGS provided increasing levels of 18:2n-6 and 18:3n-3 available for ruminal biohydrogenation. Increasing dietary DDGS led to a linear increase in 18:2n-6 in brisket fat ($P < 0.01$), however, there were no changes in 18:3n-3 (Table 2). This led to a linear increase in both total n-6 fatty acids ($P < 0.01$) and the n-6/n-3 ratio ($P = 0.01$). Levels of total saturated, branched chain and monounsaturated fatty acids in brisket fat were also unaffected by addition of DDGS to the diet and within monounsaturates there were no changes in total *trans*-18:1 but differences were found for individual *trans* isomers. Feeding increasing levels of DDGS led to a linear reduction in 10*t*-18:1 ($P = 0.03$) and linear increases ($P < 0.05$) in other *trans*-18:1 isomers among which 11*t*-18:1 predominated. Feeding increasing levels of DDGS also led to a linear increase in 9*c*11*t*-18:2 but this was limited to an increase of only ~0.05%.

Table 2. Fatty acid composition of brisket fat from heifers fed increasing levels of DDGS

Fatty acid (% of total FAME)*	%dietary DDGS					Linear
	0	**20**	**40**	**60**	**SEM**	**P**
Total saturated	38.87	39.67	38.92	39.57	0.83	0.72
Total branched chain	1.55	1.42	1.54	1.51	0.05	0.99
Total monounsaturated	57.60	56.84	56.74	56.37	0.87	0.34
Total *trans*-18:1	3.14	2.73	3.16	3.01	0.19	0.98
6-8*t*	0.16	0.14	0.18	0.16	0.01	0.27
9*t*	0.21b	0.20b	0.24a	0.22ab	0.01	0.09
10*t*	1.17	0.78	0.90	0.72	0.13	**0.03**
11*t*	0.85b	0.87b	1.00ab	1.11a	0.07	**<0.01**
12*t*	0.10b	0.10b	0.12ab	0.13a	0.01	**0.01**
13-14*t*	0.14	0.14	0.17	0.17	0.01	0.10
15*t*	0.42	0.42	0.44	0.39	0.03	0.57
16*t*	0.09b	0.09b	0.11ab	0.12a	0.01	**0.01**
Total CLA	0.46	0.43	0.49	0.50	0.02	0.09
7*t*9*c*	0.029b	0.027b	0.033a	0.030ab	0.00	0.13
8*t*10*c*	0.01	0.01	0.01	0.01	0.00	0.30
9*c*11*t*	0.31	0.30	0.35	0.36	0.02	**0.04**
9*t*11*c*	0.04	0.03	0.03	0.03	0.00	0.09
11*t*13*c*	0.01	0.01	0.01	0.01	0.00	0.62
11*c*13*t*	0.01	0.01	0.01	0.01	0.00	0.54
10*c*12*t*	0.003	0.003	0.005	0.004	0.000	0.198
18:2n-6	1.67c	1.79bc	2.40a	2.12ab	0.13	**<0.01**
18:3n-3	0.32	0.31	0.35	0.34	0.02	0.26
20:3n-6	0.06bc	0.05c	0.07a	0.06ab	0.00	**0.03**
20:4n-6	0.06	0.05	0.06	0.05	0.00	0.49
n-3	0.38	0.37	0.43	0.42	0.02	0.11
n-6	1.86b	1.96b	2.62a	2.32a	0.13	**<0.01**
n-6/n-3	4.89c	5.35bc	6.20a	5.67ab	0.26	**0.01**

DDGS – Dried distilles grains with solubles

*All values are means as weight percentages of total FAME (fatty acid methyl esters).

SEM - Standard error of the mean.

FAME – fatty acid methyl ester.

a-c Means within columns without common are different P < 0.05; n = 24.

Conclusions

Levels of total saturated, branched chain and monounsaturated fatty acids in brisket fat were unaffected by adding DDGS to the diet. Feeding DDGS increased 18:2n-6 without increasing 18:3n-3 in brisket fat leading to an increased n-6/n-3 ratio. Overall, however, feeding DDGS enhanced the fatty acid composition of brisket fat by decreasing 10*t*-18:1 which has atherogenic properties while increasing 9*c*11*t*-CLA and its precursor 11*t*-18:1 which have potential roles in prevention and treatment of several diseases including cancer.

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