Effects of Barley Diets with Distillers Grains Plus Solubles on Feedlot Performance and N and P Balance

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Summary

Effects of barley starch:NDF ratio and DDGS inclusion on feedlot performance, carcass characteristics, and N and P mass balance were evaluated in a commercial feedyard in Alberta, Canada. Yearling heifers were assigned randomly at reimplant to four treatments (0 or 20% DDGS and LOW or HIGH starch:NDF barley). Feeding LOW starch:NDF barley improved feedlot performance and increased N retention. Feeding 20% DDGS increased DMI, had a slight negative impact on F:G, and increased N and P losses.

Introduction

In a previous study, barley was segregated into high and low digestible energy based on Near Infrared Spectroscopy (NIR). Feed conversion on an adjusted carcass weight basis was improved for the low-energy barley compared to the high-energy barley. Using starch:NDF ratio by NIR instead of digestible energy may more accurately identify barley that will affect cattle performance.

Inclusion of DDGS in the diet has been shown to improve feedlot performance, but it also increases dietary nitrogen (N) and phosphorus (P), subsequently increasing the amount of N and P excreted and N lost. The objective of this study was to evaluate the impact of starch:NDF by NIR of barley and 0% or 20% DDGS on feedlot performance, carcass characteristics, and N and P mass balance in commercial sized pens.

Procedure

Crossbred yearling heifers (n = 9,538 in 32 pens, 1,085 ± 108 lb initial BW) were assigned randomly at the time of reimplant to a 2 x 2 factorial arrangement of treatments and fed for an additional 81 days from February to July 2010 at a commercial feedyard near High River, Alberta, Canada. Main effects included LOW or HIGH starch:NDF barley and 0 or 20% inclusion of DDGS. At reimplant, heifers were stratified by BW and implanted with Synovex® Choice.

Barley was characterized as HIGH (starch:NDF > 3.25) or LOW (starch:NDF < 3.25) at feedlot arrival based on values determined by NIR. One-third of the barley that arrived at the feedlot had a starch:NDF ratio greater than 3.25. Once a shipment of barley was determined to be HIGH or LOW, it was tempered, rolled, and stored in bins by barley treatment.

Treatment diets and nutrient analysis are presented in Table 1. The supplement included Rumensin® at 24.3 g/ton DM and Tylan® at 10.7 g/ton DM. Pens of cattle were fed *ad libitum* once daily in the morning at approximately 0700 hours.

At the end of the feeding period, heifers were shipped for slaughter by weight strata identified at reimplant. All cattle were slaughtered at the same commercial abattoir with the same number of heifers shipped within a replicate on a given day. Hot carcass weight, fat thickness, longissimus muscle area (LM), marbling score, USDA Quality Grade (QG), and USDA Yield Grade (YG) were recorded electronically at the packing plant.

Nutrient Balance

Nutrient mass balance was conducted using 32 open-air feedlot pens. Since the feedlot was a large commercial yard, runoff from the 32 trial pens could not be separated from runoff from the rest of the feedlot. Pens were cleaned initially at the time of reimplant while pens of cattle were at the rehandling facility. When all heifers in a pen had been shipped for harvest,

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Table 1. Composition of complete mixed finishing diets.

	Experimental Group[1]			
	HIGH/0	HIGH/20	LOW/0	Low/20
Ingredient, DM				
HIGH barley	98.08	78.08	—	—
LOW barley	—	—	98.08	78.08
DDGS	—	20.00	—	20.00
Supplement	1.92	1.92	1.92	1.92
Nutrient Composition, DM				
Starch	53.1	39.5	50.2	34.1
NDF	15.1	21.0	15.9	20.2
CP	11.5	18.2	12.1	18.1
Calcium	1.6	1.9	1.6	1.9
Phosphorus	0.3	0.5	0.3	0.5

[1]High barley (HIGH) is barley that was segregated based on a high starch:NDF ratio (> 3.25). Low barley (LOW) is barley that was segregated based on a low starch:NDF ratio (< 3.25). DDGS is corn based dried distillers grains with solubles. 0 is 0% DDGS included in the diet, 20 is 20% DDGS included in the diet.
[2]Supplement contained 24.3 g/ton DM Rumensin, 10.7 g/ton DM Tylan.

Table 2. Main effects of barley starch:NDF ratio and DDGS level on feedlot performance and carcass characteristics.

	BARLEY		DDGS			*P*-Value		
Variable	HIGH	LOW	0	20	sem	BARLEY	DDGS	INT
Carcass Adjusted Performance								
Initial BW, lb	1074	1074	1074	1074	51.8	0.79	0.86	0.90
Final BW, lb	1288	1300	1293	1295	5.6	0.03	0.70	0.46
DMI, lb/day	20.7	21.3	20.7	21.3	0.16	<0.01	<0.01	0.23
ADG, lb	2.47	2.61	2.54	2.54	0.21	0.02	0.92	0.94
F:G	9.20	8.96	8.91	9.25	0.60	0.25	0.12	0.72
Carcass characteristics								
HCW, lb	754	761	757	758	3.3	0.03	0.74	0.45
12th Rib Fat, in	0.46	0.45	0.45	0.47	0.01	0.28	0.02	0.22
LM Area, in	13.35	13.40	13.43	13.32	0.07	0.61	0.21	0.39

[1]High barley is barley that was segregated based on a high starch:NDF ratio (> 3.25). Low barley is barley that was segregated based on a low starch:NDF ratio (< 3.25). DDGS is corn based dried distillers grains with solubles. 0 is 0% DDGS included in the diet, 20 is 20% DDGS included in the diet.
[2]Carcass Weight Basis values were calculated using carcass weights obtained at slaughter, converted to live weights using a fixed dressing percentage of 60.0%.
[3]Live Weight Basis values were calculated using shrunk live weights obtained prior to slaughter.
[4]Marbling Score 600 = Modest, 500 = Small, 400 = Slight.
[5]Dressing % of cattle marketed in Canada will differ from that of similar animals marketed in the United States. The U.S. carcass weight includes the weight of the kidney, pelvic, and heart fat.

Table 3. Simple effects of barley starch:NDF ratio and DDGS inclusion on nitrogen and phosphorus mass balance.

	Experimental Group					*P*-Value		
Variable	HIGH/0	HIGH/20	LOW/0	LOW/20	SEM	BARLEY	DDGS	INT
Average days	84	84	86	86	12	0.13	0.81	0.71
Manure DM, lb/head	570.0	656.8	700.2	711.4	104.4	0.18	0.47	0.58
N Intake, lb/head	37.7^{a}	60.50^{b}	42.0^{a}	57.8^{b}	3.3	0.62	<0.01	0.04
N Retention, lb/head	4.6	4.6	4.7	4.9	1.1	0.03	0.28	0.35
N Excretion, lb/head	33.2^{a}	55.9^{b}	37.3^{a}	52.9^{b}	2.3	0.70	<0.01	0.03
N Removed manure, lb/head	5.1	5.7	6.0	6.6	0.9	0.17	0.34	0.98
N Loss, lb/head	28.1^{a}	50.2^{b,d}	31.3^{a,b}	46.4^{b,c}	1.7	0.83	<0.01	0.02
N Loss, %	84.18	89.44	81.98	87.67	1.90	0.19	<0.01	0.88
P Intake, lb/head	6.5^{c}	9.6^{a}	7.3^{b}	9.4^{a}	0.5	0.18	<0.01	0.03
P Retention, lb/head	1.1	1.1	1.2	1.2	0.3	0.03	0.28	0.37
P Excreted, lb/head	4.8^{c}	7.4^{a}	5.6^{b}	7.7^{a}	0.8	0.20	<0.01	0.05
P Removed manure lb/head	2.5	2.9	2.9	3.3	0.4	0.21	0.15	0.98
P Loss, lb/head	2.4	4.5	2.7	4.3	0.5	0.69	<0.01	0.43
P Loss, %	45.79	58.52	45.15	56.62	5.61	0.63	<0.01	0.89

[1]High barley is barley that was segregated based on a high starch:NDF ratio (> 3.25). Low barley is barley that was segregated based on a low starch:NDF ratio (< 3.25). DDGS is corn based dried distillers grains with solubles. 0 is 0% DDGS included in the diet, 20 is 20% DDGS included in the diet.
[2]Retention is retention in the animal calculated from NRC equations (NRC, 1996).
[3]Excreted is calculated as the difference between intake and retention.
[4]Removed is the waste material removed from feedlot surface when pens were cleaned after all animals had been shipped for slaughter.
[5]Runoff is included in the loss and is less than 5% of the total N loss, or an average of 1.46 lbs N/head and 0.13 lbs P/head.
[abc]Means with in a row with different superscripts differ (P < 0.05).

pens were cleaned by scraping manure into a pile in the middle of the pen and loading into a tractor-trailer using a loader tractor. Two composite manure samples were taken as the pile was hauled out of the pen by collecting 20 sub-samples. Composites were submitted to Agri-Food Laboratories for nutrient analysis. Trucks hauling manure were weighed and the weight was recorded by pen before the manure was hauled away.

Feedbunks and feed ingredients were sampled every two weeks to determine nutrient intake by pen. Retained heifer N and P were calculated using the energy, protein, and P equations (NRC, 1996). Nutrient excretion was determined by subtracting nutrient retention from intake. Total N lost (lb/head) was calculated by subtracting manure N from excreted N. Percentage of N lost was calculated as N lost divided by N excretion. Total P lost (lb/head) was calculated by subtracting manure P from excreted P. Percentage of P lost was calculated as P lost divided by P excretion.

Statistical Analysis

All data were analyzed using the Mixed procedure of SAS (SAS Inst., Inc., Cary, N.C.). Treatments were included in the model as fixed effects and replicate was included as a random effect.

Results

Feedlot Performance

No barley by DDGS interactions were observed when feedlot performance data were analyzed, therefore only main effects of barley starch:NDF ratio and DDGS are presented (Table 2).

With respect to the main effects of barley starch:NDF ratio, carcass adjusted final BW was 12.3 lb greater ($P = 0.03$) for heifers fed LOW starch:NDF barley compared to heifers fed HIGH starch:NDF barley. Carcass adjusted ADG was also greater ($P = 0.02$) for heifers fed LOW than HIGH, but carcass adjusted F:G was not different ($P > 0.10$). On a live weight basis, ADG and F:G were not different ($P \geq 0.24$) between the two barley treatments. Intake was 0.6 lb/day greater ($P < 0.01$) for heifers fed LOW starch:NDF barley than heifers fed HIGH starch:NDF barley. Barley treatment did not affect 12th rib fat, LM, marbling score, dressing percentage, YG or QG (P>0.10).

Carcass adjusted final BW, ADG, and F:G were not affected ($P > 0.10$) by DDGS treatment. On a live weight basis, ADG and F:G were greater ($P < 0.01$) for 20% compared to 0% DDGS. Fat depth and the percentage of YG 3 and YG 4 carcasses were greater ($P < 0.04$) for 20% DDGS compared to 0%, but no differences in USDA QG were observed ($P > 0.10$). Longissimus muscle area, marbling score, and dressing percentage were not affected ($P > 0.10$) by DDGS treatment.

Nutrient Balance

Barley by DDGS interactions were observed for several variables when nutrient balance data were analyzed; therefore, the simple effects are presented (Table 3). Barley by DDGS interactions ($P = 0.02$) were observed for N excretion and N loss lb/head. Nitrogen excretion, removal, loss (lb/head), loss expressed as a %, and total manure DM removed from the pen were not different ($P > 0.10$) between the HIGH and LOW barley treatments. Nitrogen retention was greater ($P = 0.03$) for the LOW starch:NDF barley compared to the HIGH starch:NDF barley. Nitrogen excretion, N loss (lb/head), and N loss expressed as a % were greater ($P = 0.01$) for 20DDGS compared to 0DDGS. Nitrogen retention and total manure DM removed from the pen were not affected by DDGS treatment.

Phosphorus balance data are presented in Table 3. Barley by DDGS interactions ($P < 0.10$) were observed for P intake and P excreted. Phosphorus excreted, P removed from the pen, P loss on a lb/head basis, and P loss expressed as a % were not affected ($P \geq 0.18$) by barley treatment. Phosphorus retained was greater ($P = 0.03$) for LOW starch:NDF barley compared to HIGH starch:NDF barley. Phosphorus excreted, P loss (lb/head), and P loss expressed as a % were greater ($P < 0.10$) for 20% compared to 0% DDGS. Phosphorus retention was not different ($P > 0.10$) between the two DDGS treatments.

Feeding LOW starch:NDF barley increased DMI, final BW on a carcass weight basis and HCW, improved ADG on a carcass weight basis, and had no effect on YG or QG. Feeding LOW starch:NDF barley increased N and P retention but did not affect N and P losses. Feeding 20% DDGS had a slight negative impact on F:G, and increased N and P losses to the environment.

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