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EVALUATION OF WHOLE CORN SUBSTITUTION IN STEAM-FLAKED CORN-BASED DIETS CONTAINING DIFFERENT CONCENTRATIONS OF WET DISTILLER′S GRAINS

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ABSTRACT: Substituting steam-flaked corn (**SFC**) with whole shelled corn (**WSC**) in finishing diets containing wet distiller′s grains with solubles (**WDGS**) could reduce grain processing costs without affecting feedlot cattle performance, feed conversion, and carcass characteristics. This study used 642 Angus-cross heifers (412 ± 18 kg initial BW) assigned to 36 pens in a randomized complete block design (3 blocks based on initial BW). Treatments (2 × 3 factorial) were 6 finishing diets based on SFC with 0 or 20% WSC replacing SFC, and 0, 15, or 30% WDGS replacing SFC (DM basis). Diets were formulated to contain equal concentrations of RDP and fat, and were fed to heifers for 108 d. No WSC × WDGS interactions ($P \geq 0.08$) occurred for DMI, ADG, G:F, and carcass characteristics. Heifers fed diets containing 20 vs 0% WSC had greater ($P < 0.01$) DMI, but final BW, ADG, and G:F were not affected ($P \geq 0.11$). The percentage of carcasses grading USDA choice or better tended to be lower ($P = 0.07$), and the percentage grading USDA select were higher ($P = 0.03$) for cattle fed diets with 20 vs 0% WSC. Other carcass characteristics, morbidity, and mortality were not affected ($P \geq 0.16$) by WSC. Increasing WDGS in SFC diets decreased final BW (linear, $P < 0.01$), tended to decrease ADG (linear, $P = 0.10$), tended to increase DMI (linear, $P = 0.08$), and decreased G:F (linear, $P = 0.01$). Addition of WDGS to SFC diets tended to decrease HCW (linear, $P = 0.09$), but other carcass characteristics, morbidity, and mortality were not affected ($P \geq 0.18$). In summary, substituting SFC with 20% WSC in finishing diets did not affect animal performance and feed conversion, but decreased carcass quality. In contrast, substituting SFC in finishing diets with increasing amounts of WDGS decreased animal performance and feed conversion, but did not affect carcass characteristics. Limited responses to the substitution of 20% WSC could in part explain the lack of WSC × WDGS interactions. Thus, it is not clear if grain processing could be reduced in finishing diets containing WDGS without affecting feedlot cattle performance and feed conversion.

Key words: corn processing, distiller′s grains, heifers

INTRODUCTION

Steam flaking corn for feedlot finishing diets is a grain processing method that can increase the corn's energy value by 18% (Zinn et al., 2002), and feed conversion is improved by 10% or more when cattle are fed diets based on steam-flaked corn (**SFC**) compared with dry-rolled corn (**DRC**; Owens et al., 1997). However, processing costs are greater for steam flaking corn than for other grain processing methods (Macken et al., 2006).

According to DiLorenzo and Galyean (2010), the use of co-products in feedlot diets has increased over the last 2 decades due to the rapid growth of wet and dry corn milling for ethanol. In review of the literature, DiLorenzo and Galyean (2010) also demonstrated that the inclusion level of distiller's grains in corn-based finishing diets for optimal performance and feed conversion depends on various factors, such as nature of distiller's grains co-product (corn-based vs sorghum-based) and processing method of the grain (SFC vs DRC).

Previous research (Corrigan et al., 2009; Depenbusch et al., 2009; Vander Pol et al., 2008) has demonstrated that there are interactions between grain processing method and inclusion amount of wet distiller's grains plus solubles (**WDGS**) in the diet. For example, Corrigan et al. (2009) reported that G:F was 11.6% greater for cattle fed SFC vs DRC-based diets containing no WDGS, but that G:F was not different between SFC-based and DRC-based diets containing ≥ 27.5% WDGS. Therefore, it is possible that grain processing costs associated with steam flaking can be partly alleviated without compromising cattle performance by substituting a portion of the SFC with WSC in SFC-based diets containing WDGS. The objectives of this study were to evaluate the effects of WSC substitution in SFC-based diets containing different amounts of WDGS on feedlot cattle performance, feed conversion, and carcass characteristics.

MATERIALS AND METHODS

Animals and Experimental Design

All procedures were approved by the Institutional Animal Care and Use Committee at New Mexico State University. The experiment was conducted at New Mexico State University's Clayton Livestock Research Center and used Angus-crossed heifers (n = 642, average BW = 412 ± 18 kg) in a randomized complete block design (3 blocks based on initial BW). Heifers were assigned to 36 soil-surfaced pens (12 × 35 m) equipped with fenceline bunks and a water source.

Treatments

Treatments (Table 1) were arranged in a 2 × 3 factorial, and consisted of 6 finishing diets based on SFC with 0 or 20% WSC replacing SFC, and 0, 15, or 30% WDGS replacing SFC (DM basis). Within each weight block,

dietary treatments were randomly assigned to 12 pens per block. Diets were formulated to contain approximately 8% RDP, and were not isonitrogenous. Due to the high concentration of fat in WDGS, tallow was used to decrease the variability in ether extract among dietary treatments. The WSC was conditioned, but not flaked. The WDGS contained a blend of corn grain with no more than 10% sorghum grain. The WDGS were procured from an ethanol plant in Hereford, TX, transported as needed to the research center, and stored in a commodity barn.

Dietary treatments were mixed in an overhead mixer, and delivered to pens of cattle once a day. A slick-bunk management protocol was implemented throughout the experiment, in which bunks were managed to allow only trace amounts of feed in the bunks before feeding each morning.

Collections and Sample Analysis

Pens of heifers were weighed using a pen scale on d 0, 56, and 108. Before weighing, residual feed was removed to be analyzed for DM content. Cattle were shipped approximately 216 km to a local commercial abattoir in Amarillo, TX. All heifers were slaughtered after 108 days on feed.

Weekly samples of feedstuffs and complete diets were obtained to calculate dietary DM. Samples were composited and were analyzed by a commercial laboratory (Servi-Tech Laboratories, Amarillo, TX). Orts were collected, weighed, and sampled for DM to calculate DMI. The DM delivered to each pen was calculated by subtracting dried orts from total DM delivered to the pen.

Carcass data were collected by trained personnel from Cattlemen's Carcass Data Service (West Texas A & M University, Canyon, TX). The data collected included HCW, LM area, 12th rib backfat, KPH, and the calculated USDA yield grade. Livers were evaluated for presence and severity of abscesses and were either not condemned or scored (A-, A, A+) using a scale similar to Brown et al. (1975). Cattle which were railed out with excessive trim were not used in analyzing HCW and dressing percent data. Carcasses were evaluated for USDA quality grade, marbling score, and LM area following a 24-h chill.

Statistical Analysis

Performance and carcass data were analyzed as a randomized complete block design using the Mixed procedure of SAS (SAS Inst. Inc., Cary, NC). Treatments included a 2 × 3 factorial arrangement with pen as the experimental unit. The effects of WSC, WDGS, and the WSC × WDGS interaction were included in the model, and the random effect was block. Contrasts included the linear and quadratic effects of increasing concentrations of WDGS.

Due to an abattoir error, 15% of the heifers were slaughtered before an antemortem inspection, which caused these carcasses to be condemned. Therefore, only 542 carcasses were available for statistical analyses, and carcass adjusted performance measures were not calculated. Carcass quality grades and liver abscesses were analyzed as binomial proportions using the GLIMMIX procedure of SAS. Treatment proportions and standard errors were calculated using the ILINK option. Health data were analyzed using the Freq and Chi-Square procedure of SAS using Fisher's exact test. All analyses had an α of ≤ 0.05, and *P*-values ranging from 0.05 and ≤ 0.10 were considered tendencies.

RESULTS

No WSC × WDGS interactions ($P \geq 0.08$) occurred for DMI, ADG, G:F, and carcass characteristics. Therefore, means for the main effects of WSC and WDGS are presented separately.

Heifers fed SFC-based diets containing 20 vs 0% WSC had greater ($P < 0.01$) DMI, but final BW, ADG, and G:F were not affected ($P \geq 0.11$; Table 2). Replacing 20% of the SFC with WSC did not affect ($P \geq 0.16$) HCW, LM area, 12th rib fat thickness, KPH, calculated USDA yield grade, marbling score, or liver abscesses. The percentage of carcasses grading USDA choice or better tended to be lower ($P = 0.07$), and the percentage of carcasses grading USDA select were higher ($P = 0.03$) for cattle fed SFC-based diets with 20 vs 0% WSC. Morbidity and mortality of heifers were not affected ($P \geq 0.60$) by replacing 20% of SFC with WSC (data not presented).

Increasing concentrations of WDGS in SFC-based diets decreased ($P < 0.01$) final BW linearly, tended to decrease ($P = 0.10$) ADG linearly, tended to increase ($P = 0.08$) DMI linearly, and decreased ($P = 0.01$) G:F linearly (Table 3). Addition of increasing amounts of WDGS to SFC-based diets tended to decrease ($P = 0.09$) HCW linearly, but did not affect ($P \geq 0.18$) other carcass characteristics. Morbidity and mortality of heifers were not affected ($P \geq 0.16$) by the addition of WDGS in SFC-based diets (data not presented).

DISCUSSION

Adding WSC to SFC-based Diets

Greater DMI of heifers fed SFC-based diets containing 20 vs 0% WSC was likely due to altered ruminal fermentation. High concentrate diets reduce DMI, fiber digestion, and change the concentrations of VFA within the rumen (Calsamiglia et al., 2008). Replacing 20% of the SFC with WSC may have decreased the concentration of highly fermentable starch, which could have resulted in differences in ruminal pH and fermentation end products. In confirmation of our theory, Tracey et al. (2011) reported a 3.9% lower pH, a 4.4% lower acetate concentration, a 7.4% greater propionate concentration, and a lower acetate:propionate within the rumens of heifers consuming the 0% WSC diets compared to the 20% WSC diets. The reduction in the percentage of carcasses grading USDA choice or better, and the higher percentage of carcasses grading USDA select caused by replacing 20% of the SFC with WSC is not congruent with the thoughts of Owens and Gardner (2007). The authors determined that feeding cattle SFC-based diets has negative implications on quality grades compared to less extensively processed corn.

Adding WDGS to SFC-based Diets

The fact that DMI tended to increase linearly with the addition of a higher amount of WDGS does not align with current research where DMI was either not affected (Depenbusch et al., 2008; Leibovich et al., 2009; Vander Pol et al., 2009) or it decreased (Drouillard et al., 2005) with inclusion of WDGS in finishing diets The tendency for ADG to decrease as the amount of WDGS increased is supported by a similar response observed by Corrigan et al. (2009) with increasing concentrations of WDGS in SFC-based diets. The combined effects of DMI and ADG with increasing amounts of WDGS in SFC-based diets resulted in a linear decrease in feed conversion as the concentration of WDGS rose.

Conclusion

The results of this study demonstrate that substituting SFC with 20% WSC in finishing diets did not affect animal performance and feed conversion, but decreased carcass quality. In contrast, substituting SFC in finishing diets with increasing amounts of WDGS decreased animal performance and feed conversion, but did not affect carcass characteristics. Limited responses to the substitution of 20% WSC could in part explain the lack of WSC × WDGS interactions. Thus, it is not clear if grain processing could be reduced in finishing diets containing WDGS without affecting feedlot cattle performance and feed conversion.

LITERATURE CITED

Brown, H., R. F. Bing, H. P. Grueter, J. W. McAskill, C. O. Cooley, and R. P. Rathmacher. 1975. Tylosin and chlortetracycline for the prevention of liver abscesses, improved weight gains and feed efficiency in feedlot cattle. J. Anim. Sci. 40: 207-213.

Calsamiglia, S., P. W. Cardoza, A. Ferret, and A. Bach. 2008. Changes in rumen microbial fermentation are due to a combined effect of diet type and pH[1]. J. Anim. Sci. 86:702-711.

Corrigan, M. E., G. E. Erickson, T. J. Klopfenstein, M. K. Luebbe, K. J. Vander Pol, N. F. Meyer, C. D. Buckner, S. J. Vanness, and K. J. Hanford. 2009. Effect of corn processing method and corn wet distillers grains plus solubles inclusion levels in finishing steers. J. Anim. Sci. 87:3351-3362.

Depenbusch, B. E., J. S. Drouillard, E. R. Loe, J. J. Higgins, M. E. Corrigan, and M. J. Quinn. 2008. Efficacy of monensin and tylosin in finishing diets based on steam-flaked corn with and without corn wet distillers grains with solubles. J. Anim. Sci. 86:2270–2276

Drouillard, J., R. Daubert, E. Loe, B. Depenbusch, J. Sindt, M. Greenquist, and M. Corrigan. 2005. Wet sorghum distiller's with solubles in flaked corn finishing diets for heifers. J. Anim. Sci. 83(Suppl. 2):95. (Abstr.)

DiLorenzo, N., and M. L. Galyean. 2010. Applying technology with newer feed ingredients: Do the old paradigms apply? J. Anim. Sci. 88:123-132.

Leibovich, J., J. T. Vasconcelos, and M. L. Galyean. 2009. Effects of corn processing method in diets containing sorghum wet distillers grain plus solubles on performance and carcass characteristics of finishing beef cattle and on in vitro fermentation of diets. J. Anim. Sci. 87:2124–2132

Macken, C. M. , G. E. Erickson, and T. J. Klopfenstein. 2006. The cost of corn processing for finishing cattle. Prof. Anim. Sci. 22:23-32.

Owens, F. N., D. S. Secrist, W. J. Hill, and D. R. Gill. 1997. The effect of grain source and grain processing on performance of feedlot cattle: A Review. J. Anim. Sci. 75:868-879.

Owens, F. N., and B. A. Gardner. 2000. A review of the impact of feedlot management and nutrition on carcass measurements of feedlot cattle. J. Anim. Sci. 77:1-18.

Tracey. L. N., M. R. McDaniel, J. Browne-Silva, N. A. Cole, C. A. Löest, and S. L. Lodge-Ivey. 2011. Whole corn and wet distiller's grains substitution in steam-flaked corn diet alters rumen fermentation and bacterial dynamics. Proc. Western Section Am. Soc. Anim. Sci. (submitted).

Vander Pol, K. J., M. A. Greenquist, G. E. Erickson, T. J. Klopfenstein, and T. Robb. 2008. Effect of corn processing in finishing diets containing wet distillers grains on feedlot performance and carcass characteristics of fininshing steers. Prof. Anim. Sci. 24:439-444.

Vander Pol, K. J., M. K. Luebbe, G. I. Crawford, G. E. Erickson, and T. J. Klopfenstein. 2009. Performance and digestibility characteristics of finishing diets containing distillers grains, composites of corn processing coproducts, or supplemental corn oil. J. Anim. Sci. 87:639–652.

Zinn, R. A., F. N. Owens, and R. A. Ware. 2002. Flaking corn: processing mechanics, quality standards, and impacts on energy availability and performance of feedlot cattle. J. Anim. Sci. 80:1145-1156.

Table 1. Composition of dietary treatments (2 × 3 factorial arrangement) with whole shelled corn (WSC) and wet distiller's grains plus solubles (WDGS) replacing steam-flaked corn

	0% WSC			20% WSC		
Item	0% WDGS	15% WDGS	30% WDGS	0% WDGS	15% WDGS	30% WDGS
Ingredient, % of DM						
Steam-flaked corn	78.5	67.7	56.8	58.5	47.7	36.8
Whole shelled corn	-	-	-	20.0	20.0	20.0
WDGS	-	15.0	30.0	-	15.0	30.0
Wheat silage	9.0	9.0	9.0	9.0	9.0	9.0
Soybean meal	7.0	4.0	1.0	7.0	4.0	1.0
Supplement[1]	2.5	2.5	2.5	2.5	2.5	2.5
Tallow	2.0	1.0	-	2.0	1.0	-
Urea	1.00	0.85	0.75	1.00	0.85	0.75
Nutrient[2], % of DM						
CP	14.5	16.3	18.3	14.2	16.3	18.1
NDF	13.3	16.5	18.9	13.9	16.5	19.6
ADF	7.2	9.7	10.7	7.5	8.8	10.5
Ether extract	4.4	5.1	5.8	4.8	5.2	5.7
K	0.74	0.78	0.80	0.73	0.78	0.78
Ca	0.70	0.70	0.69	0.67	0.72	0.68
P	0.25	0.32	0.39	0.24	0.32	0.37
S	0.13	0.21	0.29	0.13	0.21	0.27

[1]Supplement composition: 75.5% limestone; 8.0% potassium chloride; 7.7% salt; 2.9% magnesium oxide; 0.86% zinc sulfate; 0.49% selenium premix (0.06% Se); 0.42% manganese sulfate; 0.31% copper sulfate; 0.036% ethylenediamine dihydroiodide (4.4%); 0.034% vitamin E (500 IU/g); 0.028% vitamin A (30,000 IU/g); 0.004% cobalt sulfate; 0.72% Rumensin (176 g/kg monensin; Elanco Animal Health, Indianapolis, IN); 0.48% Tylan (88 g/kg tylosin; Elanco Animal Health); 0.39% MGA-200 (0.44 g/kg melengestrol acetate; Pfizer Animal Health, New York, NY); 2.1% mineral oil.
[2]Nutrient composition analyzed by Servi-Tech Laboratories, Amarillo, TX.

Table 2. Effects of whole shelled corn (WSC) substitution in steam-flaked corn-based finishing diets on performance and carcass characteristics of feedlot heifers[1]

	WSC, % of DM			
Item	0	20	SEM	*P*-value
No of pens	18	18		
Days on feed	108	108		
Initial BW, kg	413.0	410.4	17.96	0.25
Final BW, kg	541.4	545.5	16.76	0.11
DMI, kg/d	7.83	8.18	0.27	<0.01
ADG, kg/d	1.17	1.21	0.018	0.17
G:F	0.150	0.148	0.005	0.56
HCW, kg	332.8	334.9	11.71	0.30
LM area, cm	83.20	85.07	1.81	0.20
12th rib fat, cm	1.48	1.50	0.06	0.67
KPH, %	3.16	3.22	0.04	0.16
Yield grade	3.02	2.94	0.09	0.41
Marbling score[2]	482	474	12.67	0.40
Choice or better, %	88.91	83.09	0.02	0.07
Select, %	9.75	16.49	0.02	0.03
Abscessed livers, %	3.40	3.58	0.017	0.90

[1]Treatments were a 2 × 3 factorial arrangement of whole shelled corn (WSC) and wet distiller's grains plus solubles (WDGS) replacing steam-flaked corn.
[2]400 = Small^0.

Table 3. Effects of wet distiller's grain plus solubles (WDGS) substitution in steam-flaked corn-based finishing diets on performance and carcass characteristics of feedlot heifers[1]

	WDGS, % of DM				*P*-value	
Item	0	15	30	SEM	Linear	Quadratic
No of pens	12	12	12			
Days on feed	108	108	108			
Initial BW, kg	414.9	410.6	409.6	17.99	0.06	0.50
Final BW, kg	550.4	542.6	537.3	16.81	<0.01	0.66
DMI, kg/d	7.90	8.05	8.07	0.27	0.08	0.40
ADG, kg/d	1.21	1.20	1.16	0.02	0.10	0.55
G:F	0.153	0.149	0.144	0.005	0.01	0.81
HCW, kg	335.4	335.0	331.1	11.76	0.09	0.42
LM area, cm	83.76	84.83	83.82	1.95	0.97	0.49
12th rib fat, cm	1.53	1.50	1.44	0.06	0.18	0.70
KPH, %	3.17	3.16	3.23	0.04	0.24	0.43
Yield grade	3.04	2.97	2.94	0.10	0.35	0.81
Marbling score[2]	477	483	474	13.46	0.78	0.46
Choice or better, %	87.49	88.14	82.64	0.02	0.23	0.37
Select, %	12.51	10.06	16.31	0.02	0.33	0.18
Abscessed livers, %	4.06	3.66	2.85	0.02	0.51	0.87

[1]Treatments were a 2 × 3 factorial arrangement of whole shelled corn (WSC) and wet distiller's grains plus solubles (WDGS) replacing steam-flaked corn.
[2]400 = Small^0.