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STUDIES ON FEEDING WHEAT MIDDLINGS TO BEEF HEIFERS AND GROWING AND FINISHING BEEF STEERS

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May 2003 AG/Beef-2003-06

INTRODUCTION

The type and amount of concentrate included in beef cattle diets can greatly influence production and profitability. Small grains are typically fed in these rations, but the inclusion of by-product feeds, such as wheat middlings (WM), in growing and finishing diets have recently been studied (Dalke et al., 1997; Blasi et al., 1998).

Wheat middlings are the by-product of the wheat milling industry. Milled wheat contains approximately 72% flour and 28% middlings (D'Appolonia, 1979). They are also referred to as wheat mill run and consist of coarse and fine particles of wheat bran, wheat shorts, wheat germ, wheat flour, and the offal from the tail of the mill. This product contains all of the offal which must be evenly mixed and cannot contain more than 9.5% crude fiber. Typical analysis of WM is 14.5-17.0% protein, 3.5-4.5 % fat and 8.0-9.0% fiber (AAFCO, 1983). These characteristics indicate that WM should have a feeding value similar to cereal grains.

The objective of these studies was to compare the feed value of WM to cereal grains in rations with varying concentrate to roughage levels.

MATERIALS AND METHODS

Trial 1: Replacement Beef Heifers

Forty-eight, predominantly British-based crossbred heifers (720 lbs) were randomly assigned to six pens with eight heifers per pen. All heifers received corn silage and alfalfa hay-based growing rations. The concentrate portion of the diet for three pens each was either dry-rolled barley (B) or wheat middlings (WM) (Tables 1 and 2). Diets contained equal amounts of energy and protein. Rations were fed once daily (08:00 h) to appetite, but such that there was no feed left before the next days feeding. All heifers were weighed individually, days 28, 54 and at trial termination (Day 84). No animals required health treatment throughout the study.

Trial 2: Growing Beef Steer Study

Thirty-two predominantly British-based crossbred steer calves (550 lbs) were used in this trial. All calves had been processed similarly prior to trial initiation and were placed in individual pens and received corn silage-alfalfa hay-based growing diets where the concentrate portion of the ration was either dry rolled corn grain (C) or wheat middlings (WM) (Tables 1, 2 and 3). The diets were equal in energy and protein. Calves were fed at 08:00 h such that there were no refusals as in the growing beef heifer study. Individual calf weights were recorded on days 0, 28, 56 and 84 and feed intake was recorded daily. No animals required health treatment throughout the study.

Trial 3: Finishing Beef Steer Study

Twenty-four steer calves (750 lbs) were used in this 107 d study. There were three treatments that consisted of diets where the concentrate source was either dry rolled corn (C), 35% of the diet was WM (WM35) or 50% of the diet was WM (WM50) (Table 1). To adapt calves to the rations, there was a three week ration warm-up period prior to initiation of the study. Calves were fed at 08:00 h such that there were no refusals. All diets were equal in energy and protein (Tables 2 and 3). Steers were weighed on days 28, 56, 84 and 107. There were no animals that required health treatment throughout the study.

The study was terminated when it was determined that the majority of the calves had reached the Choice quality grade. Steers were slaughtered at the E.A. Miller Ltd. (Hyrum, UT) facility and carcasses were graded after a 24 h chill.

Trial 4: Digestibility Study

The C and WMR50 diets that were used in the steer finishing trial (Tables 1, 2 and 3) were fed to four ruminally cannulated yearling beef heifers in a digestibility trial. Heifers were individually housed in open front 12 m X 30 foot pens with concrete floors. All feedstuffs were fed once daily at 08:00 h for a 21 d adaptation period followed by a 6 d collection period. Rations were fed at amounts that were totally consumed daily.

RESULTS

Growing Heifers and Steers

There were no differences between diets for any of the variables measured, including ADG, DMI and FE (Tables 4 and 5).

There have been few studies evaluating WM for growing cattle, so it was difficult to compare these results with prior work. However, Blasi et al. (1998) found that when wheat middlings was fed to growing calves there was a linear decline in daily gain as the proportion of WM increased. Feed efficiency was unaffected when full-fed silage diets were used as WM increased. However, feed efficiency decreased as WM replaced corn and SBM in the limit-fed diets. Feed value of WM was almost equal to that of corn and SBM in full-fed sorghum silage-based rations, but had a value of 83% in the limit-fed diets.

Drouillard et al. (1999) studied the comparative value of dry-rolled corn, distiller's dried grains, and WM in diets for newly received calves. Diets contained approximately 60% concentrate and 40% roughage (alfalfa hay). In this experiment, they found that gain and efficiency tended to be poorer for steers fed the WM-based diet than for those fed corn.

Finishing Steers

There were no differences between treatments for ADG, DMI or FE (Table 6). Additionally, carcass characteristics were also not affected by treatment (Table 7).

These results suggest that WM can be substituted for rolled corn to constitute up to 50% of finishing diet DM for beef steers without any effect on performance (substituting for 44.6 or 64.0% of the corn respectively).

Blasi et al. (1998), however, showed that daily gain and FE decreased linearly as WM level increased in limit-fed diets. Dalke et al. (1997) concluded that WM could replace only 5% of the dry-rolled corn in finishing diets without reducing feedlot performance. In this same study, there was a linear increase in FE as WM were substituted for 5 to 15% of the corn in the diet. They also reported no differences between treatments for hot carcass weight, backfat depth, quality grade, and dressing percentage, although marbling score was increased linearly with increasing WM in the diet. Our study showed similar results, with the exception of marbling score. These results would be expected considering there were no differences in performance variables so all treatments achieved finish weight and condition at the same time.

Digestibility Study

The pH values (Table 8) were lower, total volatile fatty acids were higher, acetate was lower and propionate tended to be higher when WM diets were fed. Other VFA variables and dry matter and neutral detergent fiber (NDF) digestibilities were similar between treatments. The higher propionate levels could have a favorable influence on available energy to the animal. A lower pH could lead to potential acidosis or other rumen-related ailments.

Conclusions

These studies suggest that WM may be included in growing and finishing diets at up to 50% of the diet DM without adverse affects on production, carcass or most ruminal fermentation characteristics, with the exception of pH. Economics of production must also be considered to assess whether a particular concentrate should be included in a diet. Formulating rations on a cost per unit of gain basis is essential when determining whether a particular feedstuff such as WM should be considered. Further studies on WM should be undertaken to determine if these results can be duplicated.

References

AAFCO. 1983. Official Publication. Assoc. Amer. Feed Control Officials, Inc., Dept. of Agr., Charleston, WV 25305.

AOAC. 2000. Official Methods of Analysis. Association of Official Analytical Chemists, Arlington, VA.

Blasi, D.A., J.S. Drouillard, G.L. Kuhl and R.H. Wessels. 1998. Wheat middlings in roughage based or limit-fed, high concentrate diets for growing calves. Kansas Agric. Exp. Sta. Rep. Progr. Rep. 783:36.

Brandt, R.T., R.W. Lee, and J. Carrica. 1986. Replacing corn with pelleted wheat midds in finishing diets. Kansas Agric. Exp. Sta. Rep. Progr. 497:21.

Chen, K.H. 1995. Effect of substituting steam-flaked sorghum for concentrate on lactation and digestion. Journal of Dairy Sci. Vol. 78:362-367.

Coetzer, C.M., J.S. Drouillard, E. Coetzer, and R.H. Wessels. 1999. Effects of supplementing limit-fed, wheat middling-based diets with either soybean meal or non-enzymatically browned soybean meal on growing steer performance. Kansas Agric. Exp. Sta. Rep. Progr. 831:84-85.

Dalke, B.S., R.N. Sonon, Jr., M.A. Young, G L. Huck, K K. Kreikemeier, and K.K. Bolsen. 1997. Wheat middlings in high-concentrate diets: Feedlot performance, carcass characteristics, nutrient digestibilities, passage rates, and ruminal metabolism in finishing steers. J. Anim. Sci. 75:2561-2566.

Dalke, B.S., R.N. Sonon, Jr., D.L. Holthaus, M.A. Young, and K.K. Bolsen. 1995. Wheat middlings in high concentrate finishing rations: Cattle performance. Kansas Agric. Exp. Sta. Rep. Progr. 727:19.

D'Appolonia, B.L. 1979. Uses of nonflour fractions of wheat. Cereal Foods World. Vol. 24:326-331.

Drouillard, J.S., S.E. Ives, D.W. Anderson, and R.H. Wessels. 1999. Comparative value of dry-rolled corn, distiller's dried grains and wheat middlings for receiving diets. Kansas Agric. Exp. Sta. Rep. Progr. 831:81-83.

NRC. 1984. Nutrient Requirements of Beef Cattle. National Academy Press.

Ovenell, K.H. 1990. The value of wheat middlings as a supplement for wintering spring calving beef cows grazing native range. Annual Report - Oklahoma Ag. Exp. St. Vol. 129:51-56.

Perry, T W; Cullison, A E.; Lowrey, R S. (ed.). 1999. Feeds and Feeding, Fifth Ed. Prentice-Hall, New Jersey.

Sunvold, G.D. 1991. Evaluation of wheat middlings as a supplement for beef cattle consuming dormant bluestem-range forage. J. of Anim. Sci. Vol. 69:3044-3054.

Sweeney, Rose A. 1989. Generic combustion method for determination of crude protein in feeds: Collaborative study. J. Assoc. Off. Anal. Chem. 72:770-774.

Van Keulen, J., and B.A. Young. 1977. Evaluation of acid-insoluble ash as a natural marker in ruminant digestibility

studies. J. Anim. Sci. 44:282.
Yeomans, J.C., and J.M. Bremmer. 1991. Carbon and nitrogen analysis of soils by automated combustion techniques. Comm. in Soil Sci. Plant Anal. 22:843-850.

Table 1. Percentage of feedstuffs (DM basis) for replacement heifer, growing and finishing rations.

	Feedstuff[1]						
Study and Treatment	AH	CS	WM	BG	CG	SBM	SUPP
Heifer Study							
Control	35.8	26.4		32.1		2.9	2.8
WMH	35.5	26.1	35.6				2.8
Growing Steers							
Control	39.7	29.2			22.3	5.7	3.10
WMG	35.5	26.1	35.5				2.90
Finishing Steers							
Control	8.55	12.1			65.0	9.0	5.35
WM35	7.11	10.02	35.0		43.4		4.47
WM50	7.11	10.02	50.0		28.4		4.47

[1]AH=Alfalfa Hay; CS=Corn Silage; WM=Wheat Middlings; BG=Barley Grain; CG=Corn Grain; SBM=Soybean Meal; SUPP=Supplement.

Table 2. Chemical composition of feedstuffs (DM basis).

	Nutrient					
Feedstuff[1]	DM (%)	NE_m (Mcal/lb)	NE_g (Mcal/lb)	CP (%)	Ca (%)	P (%)
AH	94.7	.54	.28	16.6	1.34	.28
CS	35.3	.74	.46	6.2	.28	.24
WM	93.0	.91	.61	16.3	.12	.84
BG	95.7	.92	.62	11.0	.07	.38
CG	93.7	.97	.66	8.1	.03	.29
SBM	90	.96	.66	47.0	.51	.75
SUPP[2]	95	.73	.46	11.0	8.4	.88

[1]AH=Alfalfa Hay; CS=Corn Silage; WM=Wheat Middlings; BG=Barley Grain; CG=Corn Grain; SBM=Soybean Meal; SUPP=Supplement.
[2]Consisted of 5.0% NaCl, .24% Mg, .76% K, 200 ppm Cu, 400 ppm Mn, 650 ppm Zn, 2 ppm Se, 22 ppm I, 9 ppm Co, 121000 $IU.kg^{-1}$ Vit. A, 37400 $IU.kg^{-1}$ Vit. D, 55 $IU.kg^{-1}$ Vit. E and 360 ppm Rumensin.

Table 3. Chemical composition (DM basis) of diets fed to replacement heifers, growing and finishing steers.

Study and Treatment	DM (%)	NE_m (Mcal/lb)	NE_g (Mcal/lb)	CP (%)	Ca (%)	P (%)
			Nutrient			
Heifers						
Control	64.2	.83	.46	13.4	.97	.29
WMH	65.2	.82	.46	13.6	.96	.50
Growing Steers						
Control	63.0	.82	.46	13.5	1.07	.27
WMG	65.2	.82	.46	13.6	.97	.50
Finishing Steers						
Control	77.8	.89	.60	12.7	.71	.33
WM35	80.0	.89	.60	12.8	.60	.50
WM50	80.0	.89	.60	12.7	.61	.55

Table 4. The effect of including WM in growing rations on heifer productivity.

Period	Variable	Control	WM
		Treatment	
0-28d			
	ADG (lb)	2.33	2.20
	DMI (lb)	18.7	17.6
	FE	8.06	8.03
28-56d			
	ADG (lb)	2.13	2.44
	DMI (lb)	20.5	20.7
	FE	9.59	8.59
56-84d			
	ADG (lb)	2.51	2.09
	DMI (lb)	22.2	22.7
	FE	9.14	11.1

Table 5. The effect of including WM in growing steer rations on performance.

Period	Variable	Treatment: Corn	WM
0-84d			
	ADG (lb)	2.86	2.57
	DMI (lb)	20.0	18.8
	FE	7.00	7.31

Table 6. The effect of varying levels of WM on finishing steer productivity.

Period	Variable	Treatment: Corn	WM35	WM50
0-107d				
	ADG (lb)	2.93	2.82	2.68
	DMI (lb)	25.3	25.3	23.8
	FE	9.20	9.78	9.50

Table 7. The effect of varying levels of WM on carcass characteristics of finishing steers.

Variable	Treatment: Control	WM35	WM50
SW (lb)	1146	1115	1118
HW (lb)	707	713	694
MS	5.14	5.00	4.80
KPH (%)	2.29	2.33	2.40
REA (sq in)	12.4	12.3	12.6
BF (in)	.35	.36	.30
CUT (%)	50.8	50.7	51.4
YG	2.57	2.64	2.33
QG (% Choice)	86.0	67.0	60.0

SW=Slaughter Weight; HW=Hot Weight; MS=Marbling Score; KPH=Kidney, Pelvic and Heart Fat; REA=Ribeye Area; BF=Backfat; CUT=Cutability; YG=Yield Grade; QG=Quality Grade.

Table 8. The effect of WM on variables of rumen fermentation and whole tract digestibility.

	Treatment	
	Control	Treated
Rumen parameters		
pH	5.81	5.55
Acetate (mol/100 mol)	51.2	48.2
Propionate (mol/100 mol)	31.03	32.09
Butyrate (mol/100 mol)	15.3	15.17
Total VFA (mmol/l)	91.52	103.51
Whole tract digestibility (%)		
DM Digestibility	64.86	66.26
NDF Digestibility	53.84	50.77

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