STEER INTAKE AND DIGESTION OF CPM SUPER-P COTTON BY-PRODUCT BLOCKS

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Introduction

Cow herds in the Southeastern USA, and other regions depend upon hay as a winter feed source. Increased input costs in recent years have vastly increased cow-calf production costs. A key study was proposed to determine the first documented replicated comparison of the new CPM Super-P cotton by-product blocks (CPM; A. G. Daniel Co., 5120 5th Avenue, Eastman, GA 31023) with other supplements (SUP) and hay fed to beef cows during winter. The CPM blocks may supply a total replacement for hay and supplements for beef cows. and They contain considerable portions of cotton gin trash, a by-product of the cotton ginning industry that has environmental consequences if not disposed of properly. Incorporation of low-cost cotton gin trash as a feed ingredient could alleviate part of the environmental problems while providing locally available feed for beef cows across the SE USA. A short-term study was conducted to determine intake and digestion of the original CPM blocks compared with other supplements using 1000 lb steers as models for mature beef cows of similar weights.

Materials and Methods

The original CPM blocks were designed to be fed free-choice, as a replacement for hay and SUP, and they contain large amounts of cotton gin trash, distillers dried grain with solubles (DDG), wheat middlings, molasses, and minerals (Table 1). On November 2, 2009, large beef steers (n=30; approximately 2 yr of age; 1000 lb BW) were selected to simulate effects of feeding experimental diets to mature beef cows.

Steers were individually-fed the following SUP with or without hay (Table 3): 1) Hay only (H); 2) Hay with WCS fed at 0.5% BW daily (HWCS); 3) Hay with dried distillers grain with solubles (HDG); 4) Hay with CPM (HCPM); 5) CPM free-choice with no hay (CPMFC). The A. G. Daniel Company provided the CPM Super-P product in 15 kg (33 lb) blocks for this experiment, which greatly facilitated ease of individually-feeding CPM to steers. Steers on Treatments 1-4 were fed medium quality, coarsely ground, bermudagrass hay, free-choice, with treatment supplements, and CPM was fed without hay (Treatment 5), for 18 d. Feed intake and feed refusals were recorded. Nutrient content of hay, supplements and CPM blocks appears in Table 2**.** Chromic oxide (10 g/steer daily, last 9 days of trial) was fed as an indigestible marker. Fecal samples (11/steer over last 5 days of the experiment) were collected, dried, ground through a 1 mm screen, and SUP, hay, and fecal samples, were chemically analyzed for nutrient content to determine apparent digestion of organic matter, crude protein and fiber components of the diets. Statistical analyses were conducted for the intake and digestion experiment.

Results and Discussion

The concept of providing a product to cattle producers that held potential as a replacement for hay was a popular idea, especially if it could be economically manufactured using locally produced by-products. The original CPM Super-P blocks offer these features. Using cotton gin trash as a principal ingredient reduces cost of the product while providing a disposal mechanism for this abundant environmentally hazardous by-product of the cotton ginning industry. Combining the gin trash with three other by-products, namely wheat middlings, cane molasses, and a new product to South Georgia, dried distillers grain, adds to the strength of the concept of a locally produced cattle feed (Table 1). The A. G. Daniel Company is also producing small 15 kg blocks of the CPM product for deer, goats and cattle, with minor formulation variations for different species.

The original CPM blocks were formulated to meet the nutrient requirements of beef cows through the first 2 months after calving. During this period of time, cows would be at peak lactation, and if they calve in winter, they may be almost totally dependant on the CPM block for nutrients to maintain themselves and produce milk for suckling calves. This is a critical time for cows as they prepare for the upcoming breeding season. In Table 2, chemical analyses are shown for hay, cottonseed, distiller grains, and original CPM blocks that were fed in the steer experiment. The hay was selected to be less than 10% CP, to allow expression of protein supplementation responses with WCS or DDG supplements. The bermudagrass hay was baled in large round bales, stored outside, and then processed with a round bale chopper, yielding 5 cm to 7.5 cm (2-3 inch) hay lengths. The chopped hay resulted in minimal waste, and assured more accurate hay consumption records for the individually-fed steers. The WCS and DDG had typical analyses for these products, except that TDN was lower for both by-products than values found in NRC (1996), which lists TDN for WCS at 96%, DDG at 90% on a DM basis. Over the last 5 yr, Dairy One Labs, Ithaca, NY has consistently reported lower TDN values for WCS than TDN values in NRC (1996). Additionally, sulfur content of DDG and CPM blocks were determined, since sulfur concentrations above 0.4% of the total diet can present metabolic problems for cattle. The CPM blocks contain both molasses and DDG, two sources of sulfur that should be monitored. The CPM blocks used in our experiment contained 0.342% S on a DM basis, which may not be a problem, unless cattle consume large portions of CPM block. The medium quality hay fed in this experiment had lower CP, but somewhat higher TDN, NE_m, and NE_g than the CPM blocks.

Selection of two-yr old 450 kg beef steers to be individually-fed the CPM blocks, compared with hay and other supplements occurred because the steers were similar in size to many beef cows. The steers were large enough to have extra rumen capacity, as cows do, allowing processing of large quantities of hay or other fibrous feeds. In Table 3, the intake of hay, supplemental WCS and DDG were compared with consumption of CPM blocks fed with free-choice hay or CPM blocks fed as the sole feedstuff. Hay consumption tended to be similar for steers fed hay only (TRT 1), compared with similar sized steers fed hay only diets in previous experiments (Hill et al., 2007; 2008a,b), but hay intake tended to be lower on HWCS (TRT 2, Table 3) than in the previous studies when steers weighing over 400 kg were utilized in the experiments. The WCS and DDG supplement intake (Table 3) was controlled by feeding pre-designated amounts of each supplement. The WCS was fed at 0.5% of steer initial body weight, adjusted for feed refusals. The DDG was fed at rates to meet CP and TDN requirements of beef cows in the first 2 mo of lactation, when fed with hay. The total DMI was similar for H, HWCS, and HDG.

The steer intake and digestion experiment was the first formal feeding experiment conducted with the original CPM Super-P blocks, therefore intake, acceptance by cattle, and substitution rate for hay by cattle were unknown. Some producers may have hay available, and may wish to feed hay with the CPM blocks. Treatment 4 was designed to determine how much hay would be consumed if it was fed with the CPM blocks, compared with feeding CPM blocks as the sole feedstuff (Table 3). Steers on HCPM began the 18-day experiment by eating mostly hay on d 1, with increasing CPM consumption so that mostly CPM, and very little hay was consumed by d 5. This trend continued for the duration of the experiment. Apparently, given a choice, cattle will consume CPM blocks and leave medium quality hay behind. The CPM blocks have been promoted as a replacement for hay, but no data existed prior to this research regarding intake, palatability, or digestibility of the CPM product. Steers fed CPMFC (Table 3), consumed 15.61 kg (34.41 lb) of block on a DM basis, or 17.48 kg (38.56 lb/steer daily) on an as-fed basis. Steers on HCPM and CPMFC began by breaking the formed blocks up, then consuming the block material. There was no evidence of sorting or picking through the block material, all of each block was consistently consumed. The intake was averaged over the 18 d experimental period, and steers had consistently higher ($P < 0.01$) CPM block intake on both HCPM and CPMFC than hay or hay with supplement treatments. This level of intake exceeded the expectations of the company, which had predicted as-fed intake of 11.4 kg/day (25 lb/cow daily).

Table 4 shows the percentages of various nutrients in the total diet DM for each treatment. Ash content was similar for H, HWCS, and HDG, which were hay-based diets. Ash content in total diet DM increased markedly for HCPM and CPMFC, containing CPM blocks, reflecting higher ash content of CPM blocks (Table 2). Crude protein percentage of DMI was similar for HWCS and HDG, and both had higher CP compared with H. Crude protein was higher in dietary DM for HCPM and CPMFC, resulting from higher CP in DDG contained in CPM blocks. NDF was highest for hay only H, intermediate for HWCS, and HDG, and tended to be lower for diets with CPM (HCPM and CPMFC; Table 4). Higher ash and lower NDF in HCPM and CPMFC could affect digestibility of OM and NDF. While CP content of all supplemented treatments exceeded requirements for beef cows, total diet digestibility may be affected by lower quality cotton gin trash in CPM blocks compared with hay-based supplemented diets.
Determination of digestibility of the original CPM blocks by steers was a primary goal of this experiment. The original CPM blocks contained large amounts (59%, Table 1) of

lower quality cotton gin trash (27.1% IVDMD digestibility, Newton et al., 2000), which was countered with distillers grains, wheat middlings and molasses, resulting in a medium quality product. The original CPM blocks contained 16.4% CP in DM, and lower NDF than the hay fed in the same experiment on other treatments. In Table 5, organic matter (OM) digestibility was highest ($P < 0.05$) for HCPM, followed by CPM, and both were higher than H, HWCS and HDDG. The OM was determined by removing ash from the DM of each diet and fecal DM for each treatment. Interestingly, CPM had the highest level of ash of any feed ingredient (Table 2), but OM digestibility was higher for CPM treatments. All treatments had relatively high OM digestibility (> 69%), and although significant, treatment differences were not that great. The CP digestibility was highest (Table 5; $P < 0.01$) for HCPM, intermediate for HWCS, HDG, and CPMFC, and lowest for the non-supplemented hay treatment. Again, supplemented treatments had higher CP digestion, compared with Hay Only (Table 4). As with OM digestibility, HCPM had the highest CP digestibility. Although consumption of hay was low for the HCPM treatment, increased OM and CP digestibility for this treatment suggests that the Tifton 85 hay was apparently digested at higher rates than CPM blocks, containing 59% cotton gin trash. Cotton gin trash is lower in digestibility than average quality hay (Newton et al., 2000; NRC, 1996), and may not support cow gains without higher level energy supplementation (Hill et al., 2000a,b). Therefore, higher digestibility hay complemented higher CP of CPM blocks. Rate of passage of the short fiber in cotton gin trash might have been decreased in CPM blocks by feeding longer fiber hay, allowing higher nutrient absorption of the total diet. Tifton 85 hay harvested at various maturity stages has had relatively high OM, CP, and fiber digestibility in small plot and steer digestion experiments (Corriher et al., 2007; Hill et al., 2001; Mandebvu et al., 1999; West et al., 1998). Fiber digestibility of the steer diets was variable, with ADF digestibility being highest ($P < 0.01$; Table 5) for the Hay Only treatment, again indicating the higher digestibility of the Tifton 85 hay. This is further supported by increased ADF digestibility for HCPM compared with CPM. The ADF digestibility was similar for HWCS, HDG, and CPMFC. Increased ADF and fat in WCS, and increased fat in DDG (Tables 2 and 4) probably contributed to lower ADF digestibility for these treatments. The NDF digestibility was highest ($P < 0.01$; Table 5) Hay Only, intermediate for HWCS, HDG, HCPM, and all were substantially higher than CPMFC digestibility. Once again, lower NDF digestibility of CPM probably resulted from the combination of lower quality cotton gin trash in blocks, and possible negative associative effects of including DDG with increased fat, which contributed to depressed fiber digestibility. This could be contrasted to the HWCS and HDDG NDF digestion rates being higher because of increased digestion of the hay. Fiber (ADF and NDF) digestibility is important, because they affect dietary intake, and fiber is converted to energy. Even though CPM treatments had twice the DMI as other treatments (Table 3), digestibility coefficients were adjusted for individual steer intake on each treatment, and the fecal Cr marker concentrations were different for these treatments compared with other treatments, resulting in consistent digestibility coefficients for the nutrients. The relatively low standard errors of means (Table 5; SE) indicate consistent digestibility for each steer on each treatment.

Consumption of original CPM blocks, first documented in this research project, invokes questions of economics. If the original CPM product costs $160 / ton, and if a beef cow consumed 17.5 kg/day (38.56 lb/day), as steers did in the present experiment, the cost would be $3.08 / cow / day for the product. If intake was conservatively increased by 15%, which is conceivable assuming beef cows may weigh 1300 lb or more, and if she was suckling a calf during winter, the cost would rise to $ 3.55 / cow /day (38.56 lb/d X 1.15=44.34 lb/d; 44.34 lb CPM X $0.08= $3.55 / cow /day). This may be compared with feeding WCS at 0.5% cow weight with hay priced at $100/ton when WCS is priced at $160 / ton or $200 / ton. Using intake data for cows fed WCS with hay (Hill et al., 2008b), total cost of hay and WCS with were $1.94 and $2.07/cow daily. The steer intake data suggested that cows may consume higher rates of CPM than predicted, consequently, costs of the original product may prove to be prohibitive, even when feeding convenience, ease of storage, and possibly higher nutrient content of the feed are considered. Higher consumption may require CPM block formulation changes, or employment of alternative feeding methods to limit product consumption.

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Table 1. Description of original CPM Super-P Cotton Gin Trash Blocks Fed to Steers in the Intake and Digestion Experiment.

Item	Lb/ton	% as mixed
CGBP(Cotton Gin Trash)	1182	59.1
Dried Distiller Grain w/Solubles	300	15.0
Wheat Middlings	300	15.0
Purina Liquid Supplement (12% CP)	200	10.0
AG Pro Mineral	10	0.5
Binder	5	0.25
Mold Inhibitor	2	0.1
Oil	1	0.05
Total	2000	100.00

Table 2. Nutrient analyses of hay, supplements, and original CPM Super P Blocks fed to steers in the intake and digestion experiment.

Item[a]	No. Samples	DM, %	Ash	CP	ADF	NDF	Crude Fat	TDN, %	NE_m Mcal/lb	NE_g Mcal/lb	Sulfur %DM[b]
			------------DM Basis, %--------------								
Hay	7	87.06	6.79	9.33	44.06	76.91	-----	52.4	0.416	0.169	0.21

WCS[c]	11	91.44	3.85	23.38	39.21	53.53	18.12	71.2	0.828	0.548	-----
DDG[c]	11	86.70	5.68	31.63	15.07	31.69	11.17	82.4	0.971	0.664	0.657
CPM	10	89.26	9.90	16.43	44.66	56.63	5.22	47.7	0.393	0.147	0.342

[a]Abbreviations: DM=Dry Matter; CP=Crude Protein; ADF=Acid Detergent Fiber; NDF=Neutral Detergent Fiber; TDN=Total Digestible Nutrients; NE_m =Net Energy, Maintenance; NE_g= Net Energy, Gain; WCS=Whole Cottonseed; DDG= Dried distillers grain with solubles; CPM= A.G. Daniel Co. CPM Super-P Blocks.
[b]Sulfur analyses conducted on following number of samples: Hay= 1; DDG= 6; CPM= 5.
[c]TDN values for WCS and DDG were consistently lower in the computations from samples submitted to Dairy One Labs, Ithaca, NY, compared with NRC values. NRC (2000) lists TDN for WCS at 96%, DDG at 90% on DM basis.

Table. 3. Hay and supplement or original CPM block intake by steers individually-fed diets for 18 days.

Item[a]	Hay Only H	Hay + WCS HWCS	Hay + DDG HDG	Hay + CPM HCPM	CPM Only CPMFC	SE	*P*<
No. steers	6	6	6	6	6		
Initial BW, kg	455.1	454.5	453.3	453.0	451.8		
Hay, as fed, kg	7.67	6.05	5.88	2.2	0.0		
Hay, DMI, kg	**6.68**	**5.30**	**5.12**	**1.90**	**0.0**		
Hay, LSM, kg	**6.68**	**5.30**	**5.15**	**1.98**	**0.0**	**0.23**	**0.01**
SUP or CPM, as-fed, kg	0.0	2.06	1.72	15.09	17.49		
SUP or CPM, DMI, kg	**0.0**	**1.88**	**1.49**	**13.09**	**15.61**		
Total, as-fed, kg	7.67	8.11	7.60	17.29	17.49		
Total,DMI,kg[b]	**6.68**	**7.15**	**6.61**	**14.99**	**15.61**		
Tot.LSM, kg	**6.77**	**7.20**	**6.67**	**15.51**	**15.64**	**0.37**	**0.01**

[a]Abbreviations: WCS=Whole cottonseed; DDG=Dried Distillers grain; CPM= CPM Super P block; SUP=Supplement, DMI=Dry Matter Intake. Tot = total; LSM= Least squares adjusted means, adj. for TRT, Steer breed, Steer initial body weight.
[b]Total DMI includes corn fed as carrier for Chromic oxide marker fed last 9 d on all treatments: (0.55lb = 0.25kg/steer daily, as-fed, last 9 d).

Table 4. Nutrient content of diets in total dry matter consumed by steers.

Item[ab]	Hay Only H	Hay + WCS HWCS	Hay + DDG HDG	Hay + CPM HCPM	CPM Only CPMFC
DM, %	87.31	88.13	87.01	88.98	89.26
Ash, %	6.70	5.97	6.46	9.45	9.84
CP, %	9.32	12.80	14.00	15.50	16.38
ADF,%	43.39	42.22	37.30	44.29	44.37
NDF, %	75.83	70.09	66.32	58.81	56.30

[a]Abbreviations: WCS=Whole cottonseed; DDG=Dried Distillers grain; CPM= CPM Super P block; DMI=Dry Matter Intake; DM=Dry matter; CP=Crude Protein; ADF=Acid Detergent Fiber; NDF=Neutral Detergent Fiber.
[b]Total DMI includes corn fed as carrier for chromic oxide marker fed last 9d on all treatments: (0.55lb = 0.25kg/steer daily, as-fed, last 9 d)

Table 5. Apparent digestion of hay with supplements and original CPM Super P cotton by-product blocks individually-fed to beef steers

Item[a]	Hay Only H	Hay + WCS HWCS	Hay + DDG HDG	Hay + CPM HCPM	CPM Only CPMFC	SE	*P*<
TRT		2	3	4	5		
No.	1	6	6	6	6		
Steers	6						
		454.5	453.3	453.0	451.8		
Avg.wt,kg	455.1						
Digestion	-------------------Apparent Digestibility, % ------------------------						
Organic matter	70.58	69.13	70.29	74.03	72.25	1.00	0.02
Crude protein	63.66	69.78	70.84	73.33	71.15	1.06	0.01
Acid det. fiber	69.91	57.91	57.55	61.68	57.81	1.41	0.01
Neutral det. fiber	70.66	66.57	66.89	65.70	62.66	1.32	0.01

[a]Abbreviations: WCS=Whole cottonseed; DDG=Dried Distillers grain; CPM= CPM Super P block.

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