Effects of Feeding Citrus Pulp or Corn Supplements With Increasing Levels of Added Undegraded Intake Protein on the Performance of Growing Cattle

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Citrus pulp-based supplements produced average daily gains similar to corn-based supplements. Increasing levels of undegraded intake protein resulted in increased ADG and decreased hay intake in both corn and citrus pulp treatment groups. Animals fed citrus pulp-based supplements consumed less hay compared to those fed corn-based supplements across all levels of undegraded intake protein.

Summary

This trial was designed to compare both corn and citrus pulp with added UIP as potential supplements for growing cattle fed low quality bahiagrass hay. Citrus pulp supplements produced gains similar to corn and performance was enhanced as level of UIP increased. Maximum ADG was achieved at 0.48 lb of added UIP. It is unclear if 0.48 lb of added UIP is the optimal level of supplementation because it was the highest level evaluated in this trial. This research would suggest that citrus pulp with added UIP could be used in place of corn with added UIP as an economical supplement for growing calves depending on availability and price.

Introduction

Extensive research evaluating citrus pulp as a supplement for cattle was conducted in the 1950s and 1960s. These studies have shown that citrus pulp is readily consumed by cattle and can produce similar gains to corn products (Scott, 1926; Chapman et al., 1961; Ammerman et al., 1963). Recent declines in export markets have made citrus pulp an economical byproduct supplement.

Florida forages used for summer grazing and hay do not always provide adequate nutrients to meet the requirements of growing cattle (Moore et al., 1991). This results in the need for supplementation. Citrus pulp is a good (TDN = 82%) energy supplement, but is low in protein (6.7% CP). Therefore, additional protein may increase animal performance or improve utilization of citrus pulp supplements, resulting in a more economical supplement for growing cattle.

Depending on the physiological state of the animal, forage quality, and intake, microbial protein can provide adequate metabolizable protein to meet the requirements of cattle (NRC, 1996). However, some animals, such as growing and lactating cattle, have a higher protein requirement that may not be sufficiently met by microbial protein (Paterson et al., 1996; Nelson, 1997). In these instances, providing additional UIP may result in an increase in cattle performance. The objective of this research was to determine the effects of feeding corn and citrus pulp-based supplements with increasing levels of UIP to growing cattle offered low quality bahiagrass hay.

Procedure

This study was conducted at the University of Florida Beef Research Unit, located in Alachua County, Florida, from February 2002 through May 2002.

Fifty Angus x Brahman crossbred calves (36 steers and 14 heifers, mean body weight 550 ± 190 lb) were utilized in an 84 d intake and performance trial. Calves were predominately Angus with less than 20% Brahman breeding. These cattle were stratified by BW and sex and then randomly assigned to one of ten treatments. Initial BW did not differ across treatments (P>0.20). Animals were housed in seven covered pens with concrete floors. Each pen was equipped with eight Calan gate feeders (American Calan, Inc., Northwood, NH) that allowed for the measurement of total daily hay and supplement intake for each animal.

All hay used for this trial was harvested as small square bales from a pasture of Argentine bahiagrass with minimal infestation of common bermuda grass. Hay quality was initially estimated to be 50% TDN and 7% CP (DM basis) from samples analyzed by DHI Forage Testing Laboratory, Ithaca, NY. Hay, a complete mineral mix, and water were offered free choice throughout the trial. Treatments consisted of five corn-based supplements (CORN 1-5) and five citrus pulp-based supplements (CITR 1-5) with an increasing level of added UIP (Table 1). The five levels of added UIP were: Level 1, 0 lb; Level 2, 0.12 lb; Level 3, 0.24 lb; Level 4, 0.36 lb; and Level 5, 0.48 lb/animal/d. All ten supplements were formulated to have the same level of energy (4.5 lb of TDN/animal/d) and protein (1.34 lb CP/animal/d; Table 2). All supplements were mixed at the University of Florida feed mill, Gainesville, FL.

Each morning cattle were fed their respective supplement in their individual Calan gate. Each afternoon, hay was weighed for each animal, and was provided in excess at all times. All animals consumed the supplements readily. Hay refusals were weighed and recorded weekly and discarded after sampling.

Initial BW was the mean of weights 1 d prior to the start of the trial as well as the first day. Cattle were then weighed every 28 d prior to the a.m. feeding. At the end of the trial, animals were weighed on d 83 and 84 and averaged for the final BW. Body condition score was evaluated at the start of the trial and every 28 d throughout the trial using a 1 thru 9 condition scoring system with increments of 0.25 (Kunkle et al., 1994).

Results

Diets

Supplement formulations and

actual chemical composition of supplements and Bahia grass hay are listed in Tables 1 and 2. The hay used in this experiment was similar in DM, CP, NDF, and IVOMD (P>0.20) concentration throughout the trial. All supplements had similar DM (P=0.73) and OM (P=0.19) contents as expected. There were no differences in CP by level of added UIP (P=0.75), suggesting supplements were formulated correctly.

Animal Response

There was no difference (P=0.38) in ADG of calves fed either corn or citrus pulp at each level of added UIP, but increasing the level of UIP resulted in a linear increase (P<0.001) in ADG (Figure 1). This would suggest that microbial crude protein was inadequate at providing the protein requirements of these growing calves. The greatest 84-d ADG resulted from supplements containing 0.48 lb/hd/d of added UIP. The average BCS for all animals throughout the trial was 5.04. Body condition score was not different (P=0.62) between calves fed citrus pulp or corn.

Hay DMI was lower (P<0.01) for animals supplemented with CITR compared to those supplemented with CORN (Figure 2). Level of added UIP had a significant (P<0.01) effect on hay DMI. As level of UIP increased, hay DMI declined linearly (P<0.01; Figure 2). Total Hay CP and total DOM intakes (Figures 3 and 4, respectively) were greater (P<0.01) for animals supplemented with CORN compared to those supplemented with CITR due to increased hay intake. Also, as level of UIP increased, there was a linear decline in hay CP and DOM intakes (P<0.01). When DMI was combined for all levels of UIP, cattle supplemented with CITR consumed less (651 lb) than those supplemented with CORN (763 lb) throughout the trial. Total DOM intake was not different (P=0.16) between CITR and CORN at each level of UIP. However, increasing levels of added UIP caused a quadratic (P=0.05) depression on total DOM intake (Figure 5). The quadratic decline in total DM, CP, and DOM intakes as level of UIP increased would be expected as a result of the depression of hay DMI as level of UIP increased.

Citrus pulp-based supplements produced ADG similar to corn-based supplements in this trial. As level of UIP increased, ADG increased while hay DM and total DOM intake decreased. Animals fed citrus pulp-based supplements consumed less hay compared to those fed corn-based supplements over all levels of UIP. Citrus pulp-based supplements with added UIP could be used as an economical supplement for growing calves in Florida depending on availability and price.

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Table 1. Composition of supplements fed to growing cattle.

	CITR					CORN				
Ingredient (% DM)	1[a]	2[b]	3[c]	4[d]	5[e]	1[a]	2[b]	3[c]	4[d]	5[e]
Cracked corn	0.00	0.00	0.00	0.00	0.00	91.46	84.59	76.77	69.44	61.22
Citrus pulp	90.65	84.32	78.24	71.74	65.11	0.00	0.00	0.00	0.00	0.00
Soy plus (42.5% CP, 60% UIP)	0.00	7.48	14.49	22.18	29.99	0.00	7.95	16.82	25.12	34.43
Urea	5.25	4.41	3.63	2.77	1.90	5.08	4.19	3.22	2.30	1.27
Dynamate	1.15	1.07	1.02	0.93	0.86	1.17	1.10	1.01	0.92	0.84
Complete mineral	2.01	2.04	2.07	2.11	2.14	2.15	2.17	2.19	2.22	2.25
Dynafos	0.94	0.68	0.55	0.28	0.00	0.14	0.00	0.00	0.00	0.00

[a]CP treatment with 0 lb of added undegraded intake protein.
[b]CP treatment with 0.12 lb of added undegraded intake protein.
[c]CP treatment with 0.24 lb of added undegraded intake protein.
[d]CP treatment with 0.36 lb of added undegraded intake protein.
[e]CP treatment with 0.48 lb of added undegraded intake protein.

Table 2. Feeding rate and nutrient composition of bahia grass hay and supplements fed to growing cattle.

	Hay	CITR					CORN				
		1	2	3	4	5	1	2	3	4	5
Feeding rate lb/hd/d	Ad libitum	7.50	7.40	7.19	7.11	7.00	7.00	6.91	6.80	6.80	6.71
Formulated (lb/hd/d)											
TDN	--	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55	4.55
CP	--	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
DIP	--	1.28	1.14	1.03	0.90	0.79	1.12	1.01	0.88	0.77	0.66
UIP	--	0.09	0.22	0.33	0.46	0.57	0.24	0.35	0.48	0.59	0.73
Actual analysis (%)											
DM	89.39	87.13	87.40	87.46	87.86	88.23	87.91	88.05	88.44	88.55	88.66
OM	96.20	93.28	93.79	93.44	93.36	93.79	95.11	95.10	94.66	94.56	94.17
CP	7.52	25.47	24.68	26.35	25.78	24.78	24.07	24.00	24.44	23.96	24.81
IVOMD	26.80	90.78[c]	90.53[bc]	90.12[b]	88.78[a]	88.62[a]	91.22[c]	89.35[a]	89.57[ab]	89.77[b]	88.75[a]
NDF	71.37	12.35	13.24	14.05	14.85	15.61	10.10	10.40	11.73	12.62	13.22

[a,b,c]LS means within a row with different superscripts are different $P<0.05$.

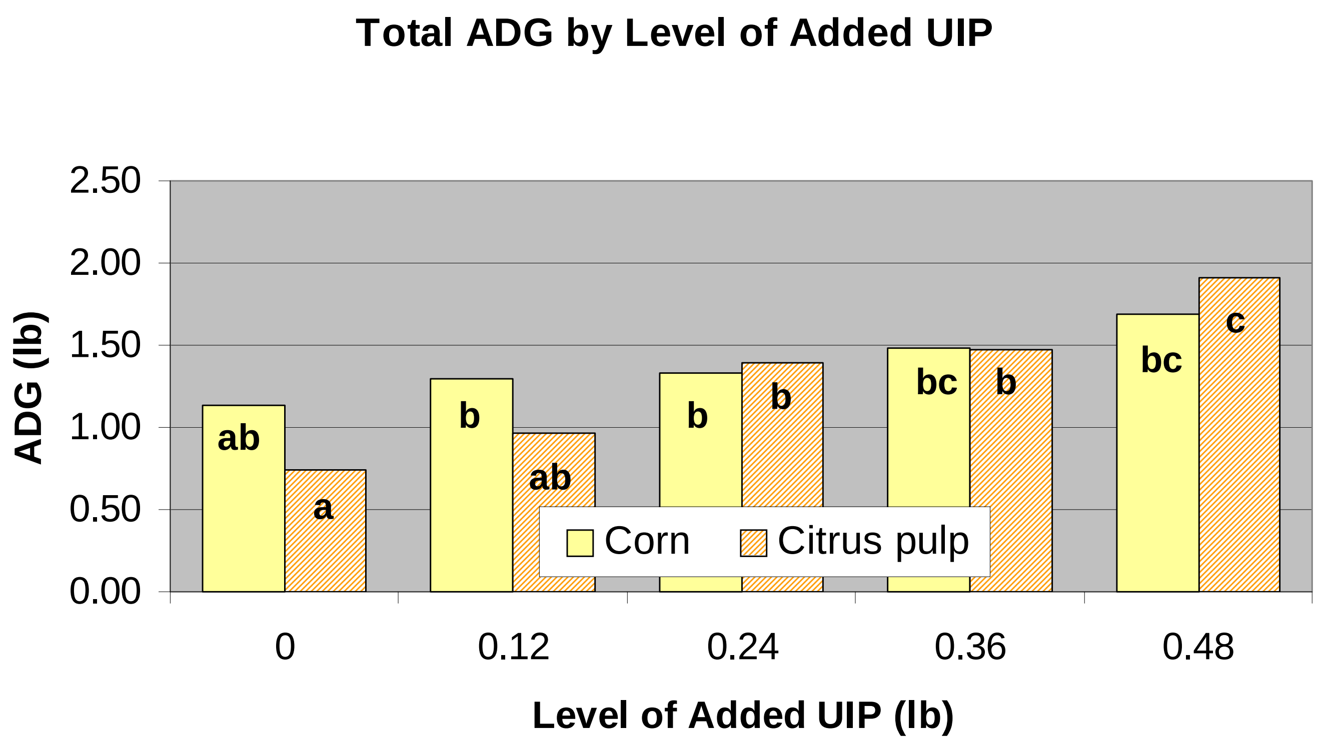

Figure 1. Total ADG of calves supplemented with corn or CP with increasing levels of UIP. UIP effect *P*<0.01. Contrasts by level: Linear *P*<0.01. Quadratic *P*=0.78.
[a,b,c]Means with different superscripts differ *P*<0.05. SE=$\pm$0.16.

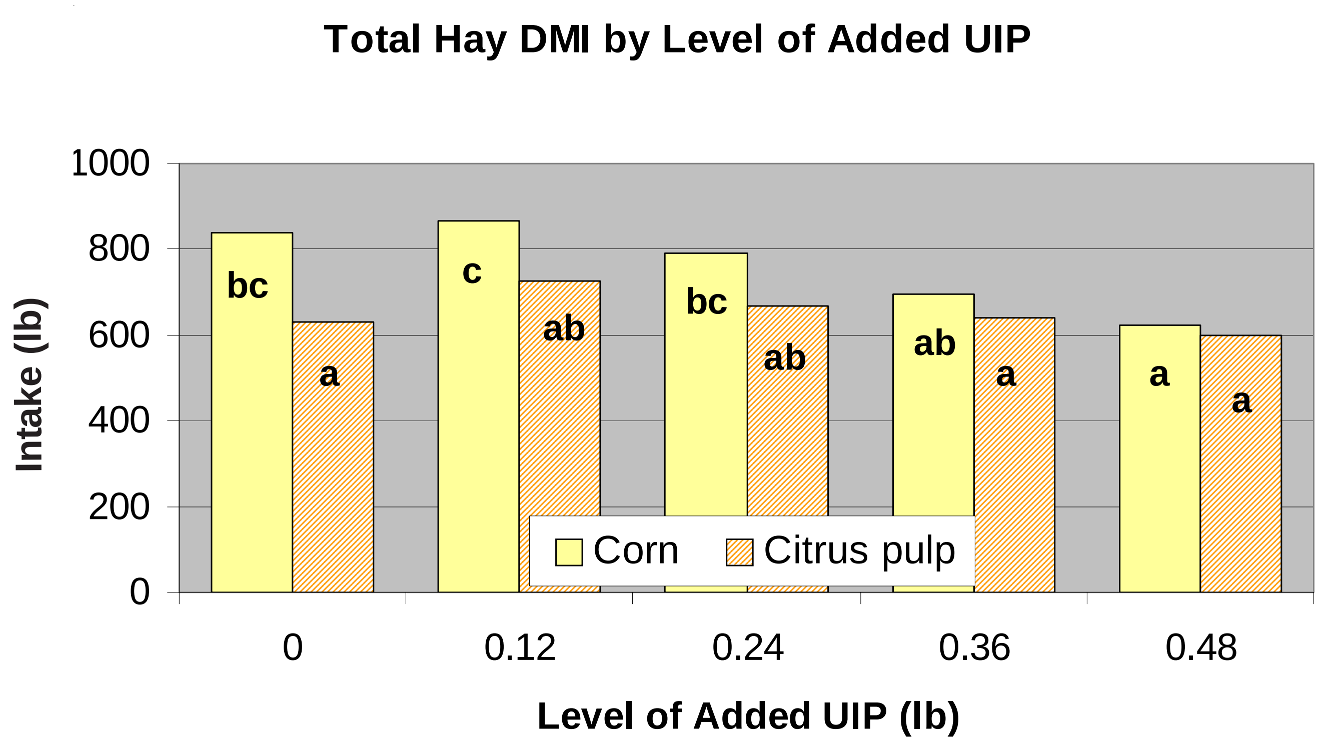

Figure 2. Total hay DM intake of calves supplemented with corn or CP with increasing levels of UIP by level of added UIP. CHO x UIP interaction *P*=0.35, UIP effect *P*<0.01. Linear *P*<0.01. Quadratic *P*=0.09.
[a,b,c]Means with different superscripts differ *P*<0.05. SE=$\pm$47.

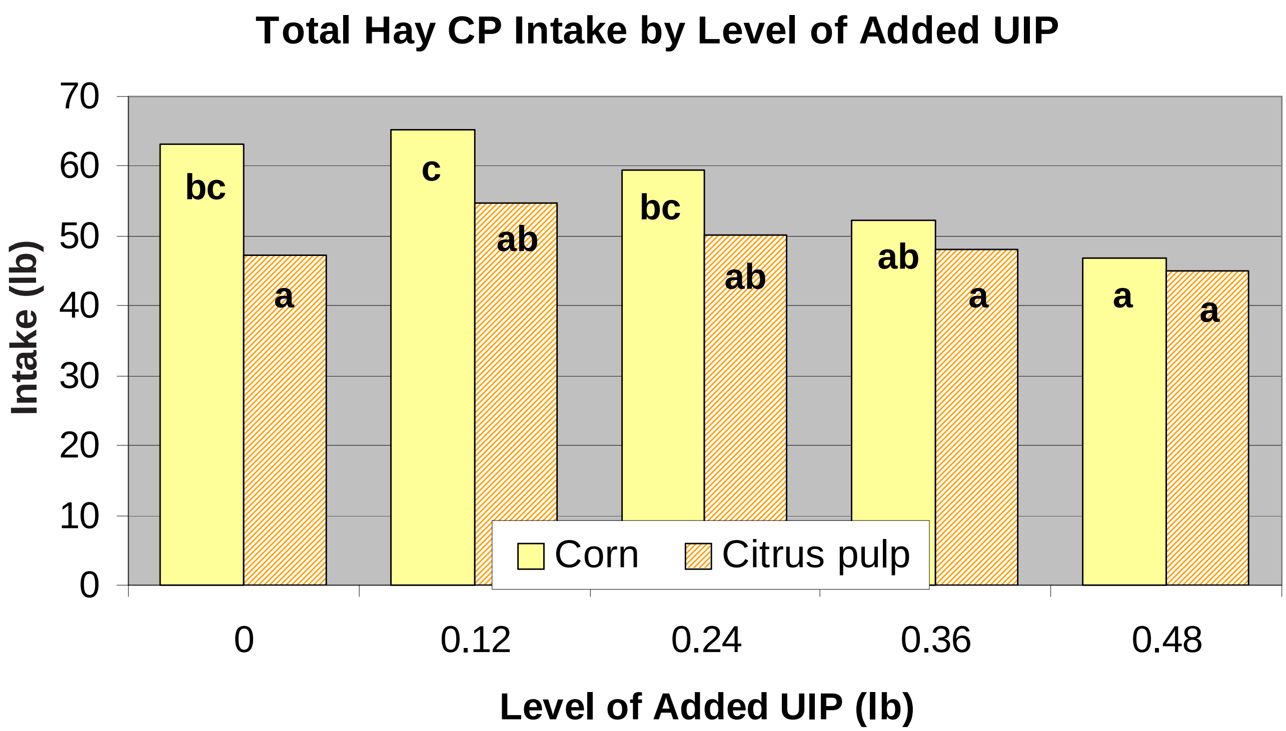

Figure 3. Total hay CP intake of calves supplemented with corn or CP with increasing levels of UIP by level of added UIP. CHO x UIP interaction *P*=0.35, pooled CHO effect *P*<0.01, UIP effect *P*<0.01. Linear *P*<0.01. Quadratic *P*=0.09.

[a,b,c]Means with different superscripts differ *P*<0.05. SE=±3.70.

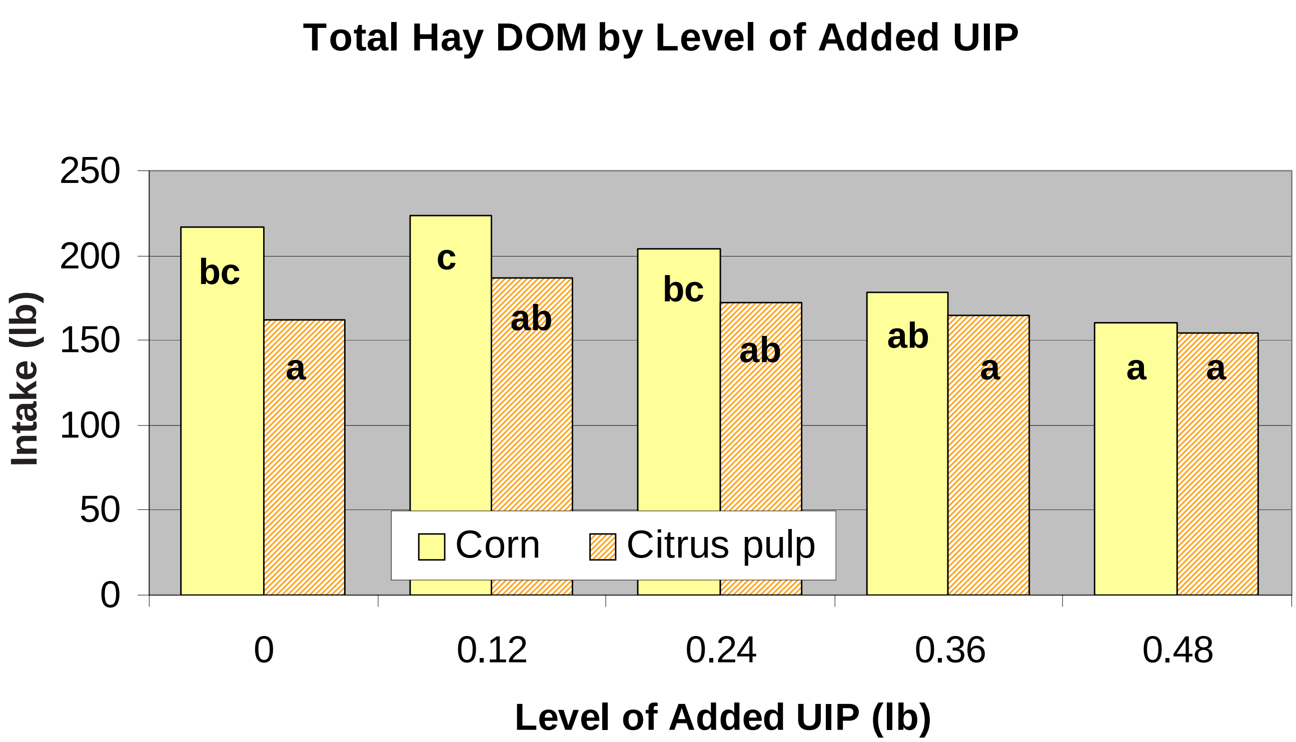

Figure 4. Total hay DOM intake of calves supplemented with corn or CP with increasing levels of UIP by level of added UIP. CHO x UIP interaction *P*=0.35, pooled CHO effect *P*<0.01, UIP effect *P*<0.01. Linear *P*<0.01. Quadratic *P*=0.09.

[a,b,c]Means with different superscripts differ *P*<0.05. SE=±12.70.

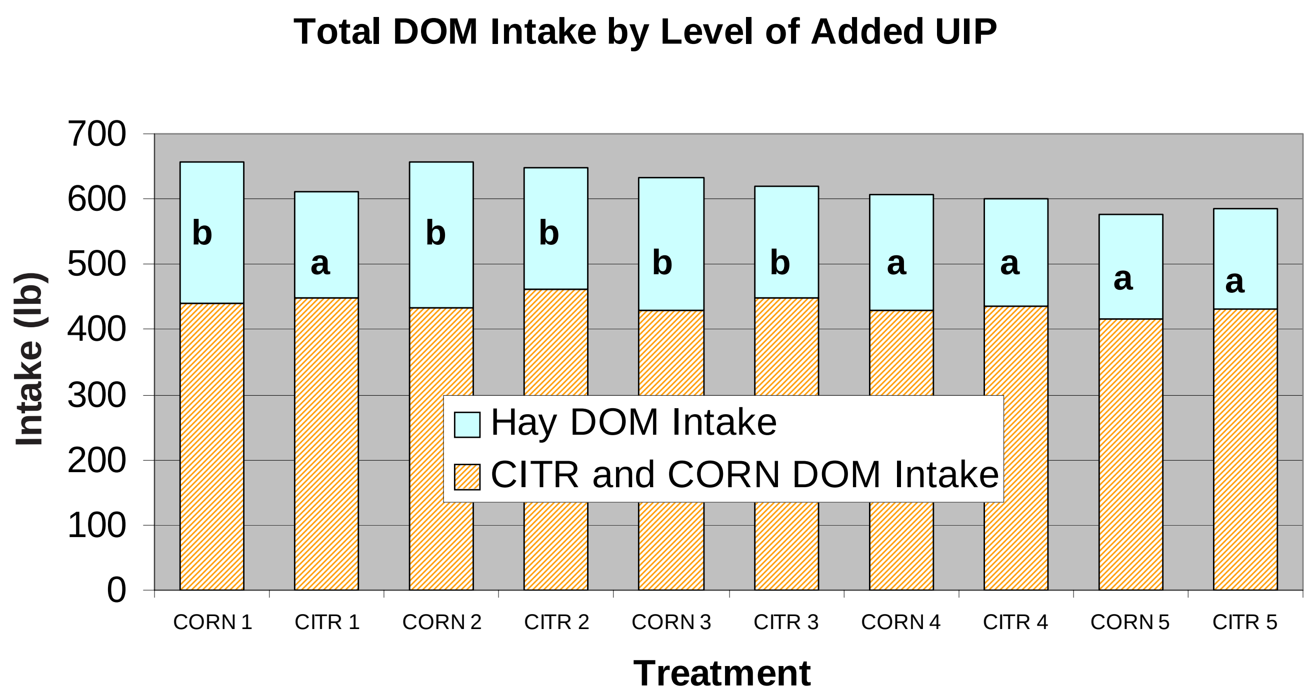

Figure 5. Total DOM intake of calves supplemented with corn or CP with increasing levels of UIP by treatment. CHO x UIP interaction P=0.44, pooled CHO effect P<0.01, UIP effect P<0.01.
Contrasts CHO source: Linear P<0.01. Quadratic P=0.05.
[a,b]Means with different superscripts differ P<0.05. SE=$\pm$15.