COTTON BY-PRODUCTS SUPPLEMENTATION FOR STEERS GRAZING TOBOSAGRASS (*Hilaria mutica* [Buckl.] Benth.) RANGELAND.

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ABSTRACT

The objective of this research was to compare the performance of growing cattle fed COBY-processed (CBP) or a commercial supplement during winter and spring. In addition, forage utilization was also measured. Three treatments were evaluated: (1) control (CON), no supplement, (2) commercial supplement (COMM), and (3) starch coated and extruded cotton gin by-products (CBP). Commercial supplements and CBP were fed three times a week at a rate of 1.0 lbs/head/day. We used a total of 197 British and Continental crossbred steers with an average initial weight of 366 lb/hd (SD ± 17 lbs). Steers that were fed with the COMM supplement gained 35 lbs/head more than the control, whereas steers fed with CBP gained 20 lbs/head more than the controls. In contrast, steers fed with the COMM supplement gained 15 lbs/head more than those fed with CBP. Forage utilization for CBP treatment was 37%, while COMM steers achieved 63%, and CON 52%. The research confirmed that CBP as a supplement was palatable but incomplete on nutritional value to support cost effective performance in growing cattle grazing tobosagrass rangeland.

Key Words: Cotton gin by-products, stockers, cattle, summer weight gain, tobosagrass,

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INTRODUCTION

Supplementation in most areas where domestic ruminants graze is a major factor to consider when making management decisions (Caton and Dhuyvetter, 1997). Providing nutrients to offset deficiencies or to meet production demands is more often practiced during periods of summer dormancy or during the fall and winter months (Caton and Dhuyvetter, 1997).

A significant residual of the cotton lint ginning process is cotton gin by-product (CBP). CBP is composed of leaves, stems, burrs, immature seed, and lint fibers, stripped from the plant along with the cotton lint during harvest (Baker et al,. 1994; Middleton and Elam, 2002). These components of CBP consist mostly of lignified cellulose, hemicellulose, and minerals, which can be improved by chemical processing techniques (Holt et al., 2003; Arndt and Richardson, 1985; Conner, 1985).

Several by-product feeds are also available in Texas and often are lower-cost sources of energy and other nutrients. Many of these feeds do not require processing but may have limitations for handling, storage and feeding. Such is the case of CBP sometimes referred to as "gin trash." CBP is a relatively cheap and abundant by-product available from gins in the Southern High Plains of Texas.

Gin trash is palatable to ruminants and can produce acceptable diets if supplemented with a protein or energy source (Erwin and Roubicek, 1958; Sagebiel and Cisse, 1984; Hill et al., 2000). A feeding performance test by Sherrod et al., (1970) indicated that the intake of cotton burr pellets offered free choice to beef steers was only 49.5% that of alfalfa pellets offered free choice. Thompson et al. (1976) reported that ground cotton burrs, whole burrs, and cotton seed hulls have comparable acceptability. In the case of some feedlot users, molasses is mixed with gin trash to increase acceptability and also furnish additional energy in rations.

Several techniques for upgrading the quality of CBP for ruminant feed have been developed and tested over the past three decades; most of these techniques involve a combination of both chemical and physical effects (Holt et al., 2003). Benefits of these techniques are usually reflected in less sorting of the CBP in diets, increased consumption when compared with unprocessed CBP, and improved animal performance (Holt et al., 2003). Although various techniques have been developed in an attempt to improve the economic feasibility of using CBP as a ruminant feedstuff, no single technique has been accepted for practical use in various animal production situations (Holt et al., 2003). However, the extrusion of CBP in combination with the application of gelatinized starch slurry (COBY process) is different and offers new potential (Holt et al., 2003).

Some studies have been conducted on feeding CBP to steers under feedlot conditions; however, minimal data is available with regard to the feeding value of extruded CBP and the application of gelatinized starch, when fed to steers grazing on a tobosagrass rangeland. Therefore, the objective of this research was to compare the performance of growing cattle fed COBY-processed CBP vs. commercial (common) supplement during winter and spring. In addition forage utilization was measured through each one of the grazing periods. Diets over the treatments were not isonitrogenous; therefore it cannot be concluded that the response to supplementation resulted entirely from protein. The experiment was developed to evaluate CBP as an alternative to more expensive (traditional) protein supplement.

Materials and Methods

Study Area

This research was conducted at a ranch near Justiceburg in Garza County, Texas. Vegetation consisted mainly of tobosagrass (*Hilaria mutica* [Buckl.] Benth.) and mesquite (Prosopis glandulosa var glandulosa Torr.) range. Other species included alkali sacaton (Sporobolus airoides [Torr.] Torr) in depressions, and buffalograss (Buchloe dactyloides [Nutt.] Engelm.) on upland. The area is dominated by a clay flat range site with gently sloping Stamford Clay soils (fine, montmorillonitic, thermic typic Chromusterts) (Richardson et al., 1965). The climate is warm, temperate and subtropical; with an average daily minimum of 27º F in January and an average daily maximum temperature in July of 95º F. Periods of drought occur frequently. The average annual rainfall of 19 inches occurs mainly from April through July (Richardson et al., 1965). According to previous studies at the same site (Britton and Pitts, 1988, Villalobos et al., 1997), average C.P. diet content during the winter season varied from 4-6%.

Sampling periods and Animal Performance

To determine the effect of supplementation on animal gain; this experiment was divided in 7 grazing periods. Grazing periods were February 24 to March 24 (P1), March 25 to April 20 (P2), April 21 to May 18 (P3), May 19 to June 15 (P4), June 16 to July 13 (P5), July 14 to August 10 (P6) and August 11 to Sept 8 (P7); each one of the periods covered about 28 days. On their arrival, steers were held in a small pasture of dormant old world bluestem. Cattle were watched closely for signs of sickness and were given the supplement. Steers were moved to the tobosagrass study site after 2 weeks and started on the supplement for about one month.

Response of steers grazing tobosagrass to the supplementation was evaluated using 197 crossbred Bos taurus x Bos indicus steers with a mean initial live weight of 366 lb/hd (SD ± 17 lbs). Forage yield was estimated by randomly clipping 20, 0.25 m^2 quadrants in each pasture at the end of the growing season. Stocking rate for each pasture was based on standing crop at the start of grazing trial and estimated yield for the current year, assuming removal of 50% of available forage and average forage intake of 3.0 % of body weight based on 400 pound steers, was used to calculate stocking rates. Pasture areas were 82, 85, 108, 115, 131, and 104 acres, all pastures were not previously used for almost 18 months. In an attempt to maintain similar forage allowances in all pastures, the amount of animals allocated in each pasture-treatment was calculated based on 180 days of use.

Experimental protocol was approved by the Texas Tech University Animal Care and Use Committee. Steers were randomly allocated to each of 3 treatments. (1) Control (CON) no supplement, (2) Commercial Supplement (COMM), and (3) Starch coated and extruded cotton by-products (CBP). Commercial supplements and CBP were fed three times a week at a rate of 1.0 lb/head/day. Two replications per treatment were used. The 6 herds were composed of 15 to 41 steers for an average stocking rate of 1 steer/4.0 acres for the 7 months of study. Cattle were group-fed 3 days per week, between 1100 and 1200 h to avoid grazing interruption. Free choice mineral (7% P, 13% Ca, 50% NaCl) was available at all times. Steers were weighed initially before entering the pastures and then every 28 days. Liveweights were obtained following an overnight period without water and feed.

Cost of additional weight gain by supplemented steers was estimated using CBP and COMM supplement costs ($ 45 and $180/ton) respectively. These costs were derived for the period of December to September from sales reports during the 10 years average and were calculated using the following equation: Cost of additional gain = feed cost ($/hd/day)/gain (lb/hd/day above control).

To estimate the effect of supplementation on herbage standing crop (forage use) and forage quality, vegetation was clipped in 20 randomly selected quadrants per paddock per period using a 0.25 m^2 quadrats. Clippings were conducted every 26 days approximately at the middle of each period. Herbage was clipped about 2 cm above the soil surface and old material and litter were removed from the samples. Herbage samples were dried in a lab at 60ºC for 72 hours. Dry weight was measured to the nearest 0.01 g and recorded. Dried forage samples were ground in a Thomas-Wiley Laboratory Mill™ Model 4 using a 1 mm screen. The ground material was stored in Ziploc plastic bags in a dark dry place prior to laboratory analysis.

To estimate forage quality, a composite of all samples per paddock was analyzed. Crude protein content of forage samples was estimated using a LECO CHN-2000 Series Elemental Analyzer (LECO Corp St. Joseph. MI). Four replications from the forage sample composite were analyzed. *In vitro* dry matter digestibility (IVDMD) was determined using the ANKOM Daisy II incubator (ANKOM Techno Corp, Fairport, NY.

All CBP used in this study was of similar quality and was obtained from cotton grown and ginned on the Texas South Plains. Composition of the supplements is shown in Table 1.

Table 1. Composition (% dry matter) of Ingredient and Nutrient.

Content of Supplements fed to steers grazing Tobosagrass Rangeland

Item	Commercial Supplement	Composition of Cotton Byproducts
Protein	20	7.7
Fat	2.3	1.4
Acid Detergent Fiber	-	52.0
Neutral Detergent Fiber	-	56.6
Calcium	1.5	.81
Phosphorus	1.1	.14
Starch	-	11.2
Magnesium	0.3	.22
Ash	-	10.23
Potassium	1.3	2.71
Total Digestible Nutrients	73.1	40.0

Statistical Analysis

Average Daily Gain and forage use (availability) was analyzed as a completely randomized (CRD) design, with periods (PER) as repeated measurements, to evaluate changes in steer weights every (28 days) throughout the supplementation period. Pastures (REP) were the experimental units. Mean separation was accomplished using Least Significant Difference (LSD) at 0.05 significant level.

Results and Discussion

Rainfall and Herbage Mass

Rainfall in 2000 was below (53%) of the 50-year average in April, June, July, and August (Fig. 1). Thus, standing crop and quality forage was far below the normal values reported in previous studies conducted using this same area during the same months of evaluation. During the length of the experiment, February and March were the only months were precipitation was above the long term average. However, adequate temperatures for plant growth were present just at the end of March. June precipitation was similar to the long-term average, while May, July and August received only 63, 45, and 7.0% from the long-term average respectively.

All the pastures in this research were at rest for more than 18 months; therefore herbage standing crop availability at the beginning was high but mainly composed from old material of low quality. Although these forage masses provided sufficient forage for diet selection so that forage quality was likely the major limitation on steer performance, composition was primarily of stem with minimal leaf material (Fig. 2). Average forage standing crop was similar ($P>.05$) for all treatments, with 1974 lb/acre for the CON pastures, 2095 lb/acre for the COMM treatment and 2129 for the CBP. Herbage standing crop availability at the beginning of the supplementation average 3000 lb/ac and average residual standing crop was 1157 lb/ac 1446 lb/ac and 1876 lb/ ac, for COMM, CON and CBP respectively.

Standing forage biomass showed a similar pattern to our supplement treatment and the periods of evaluation. Standing crop decreased on all treatments from February to May, increasing again in June and July and decreasing to the lowest values in August. Standing crop drop was more noticeable for the CON treatment with 54% from February to May, while COMM and CBP standing crop decreased 42 and 38% during the same period of time respectively. During April standing crop was 778 lb/ac higher for steers grazing on the COMM treatment and 1092 lb/ac higher for the CBP treatment than the CON. Forage utilization was 63, 54 and 37% for COMM, CON and CBP respectively. Our results agree with Kartchner (1980), who mentioned that the effect of supplemental feeding on forage intake can be positive, negative or null depending on forage quality and the composition of the supplement. Reductions in forage intake in response to supplementation have been termed substitution. This resulted in our CBP treatment, where forage utilization was less than in the CON and COMM treatments. Generally, substitution is considered to be a negative phenomenon; however, depending on the availability, quality, and cost of the supplement, substitution may represent the most economical means of meeting the nutritional demands of the cowherd, especially during a drought situation.

Dietary Nutritive Values

Forage CP and IVOMD was used as an index of plane of nutrition. Forage samples used to analyzed quality were obtained by clippings rather than by the grazing animals which show high selectivity for particular plant parts. It is recognized that selective grazing improves nutrient value of diets compared to available forage. However, forage CP is relatively easy to measure and is frequently used in the field to monitor plane of nutrition (Pitts et al. 1992).

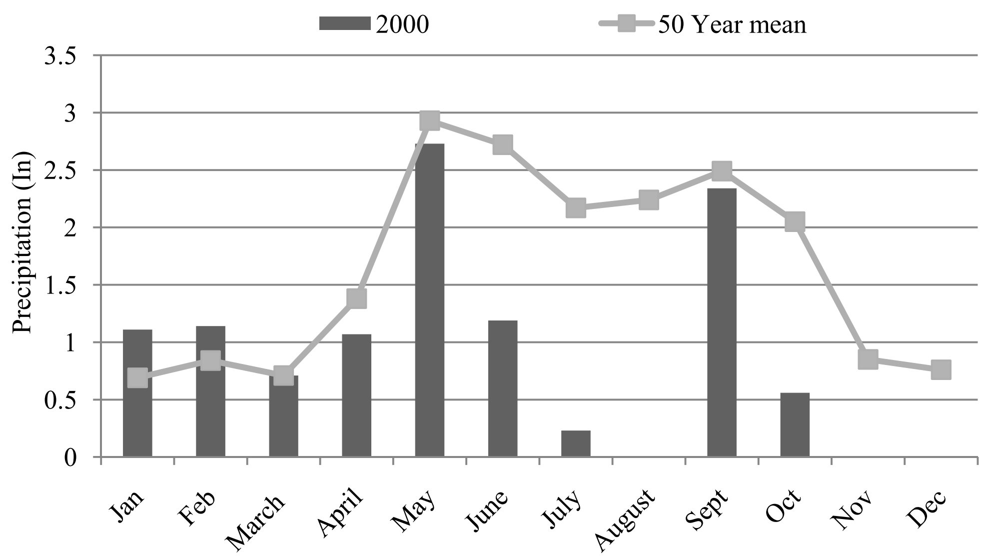

Fig. 1. Precipitation at the Texas Tech Experimental Ranch during 2000 and long term average. Average precipitation is taken from the Garza County Soil Survey.

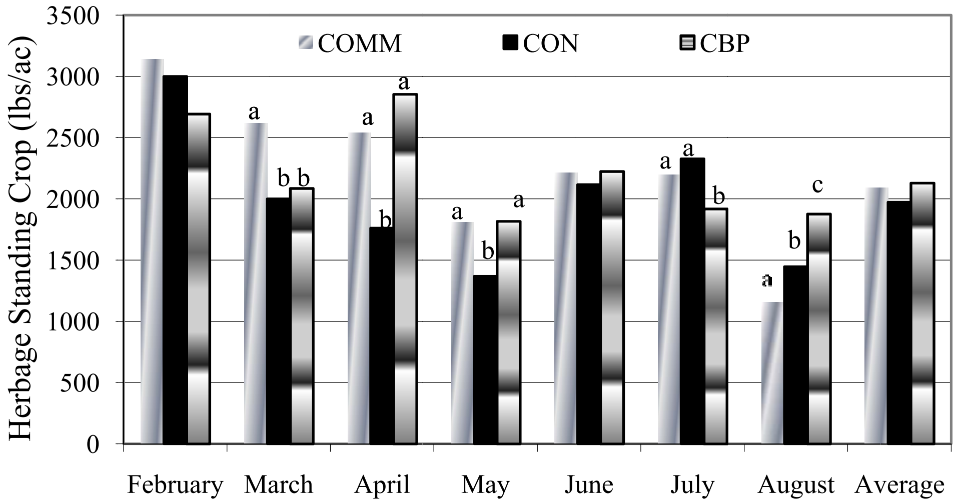

Figure 2. Herbage standing crop for steers grazing Tobosagrass fed 2 sources of protein supplementation in Garza County Texas. CON=Control (no supplement), COMM = Commercial Supplement, CBP = Starch coated and extruded cotton by-products. Means followed by the same letters are not significantly different (P≤0.05).

Crude protein and IVOMD values from clipped samples are shown in Figures 3 and 4, exhibited similar trend. Crude protein and IVOMD values were really close among all treatments. The highest CP levels and IVOMD values from clipping samples were measured around May whereas the lowest values were detected in the rest of the sampling periods (Fig.3 and 4). Protein content increased 28% from the first three months of evaluations to May, where the highest value was detected (Fig 3). Protein content declined about 30% from May to June and July (Fig 3). The CP values measured 6 out of 7 months in this type of vegetation ranged from 4.0% to 5.0%. These very low nutritional values from tobosagrass don't meet the maintenance requirements for steers and without supplementation it is impossible to obtain weight gain. Any ruminant requires at least a 6 to 7 % crude protein diet to maintain rumen function and 45-50% IVOMD.

Substantial declines in CP and dry matter digestibility have been reported with tobosagrass maturation (Britton and Steuter 1983). CP in mature tobosagrass can drop below 5.0% which is an unacceptable nutritional level (Nelson et al. 1970). During the dormant period, tobosagrass CP was found below 4.5%, and dry matter digestibility below 35% (Britton and Pitts, 1988). Forage protein content of this study was close to those reported by (Britton and Steuter 1983; Pitts el al. 1992) and Villalobos et al., 1997). They reported an average of 5.0% CP in tobosagrass during February and March, which covers the months in our sampling periods. In contrast, from April to July tobosagrass ranged from 16.0% to 5.0% protein concentration (Britton and Steuter 1983). Pitts (1989) reported a range from 10.0% to 13.0% in CP and 36.0% to 60.0% for IVDMD during the same season. Our values are similar to July but different for April where our CP content was 5.0%.

Values for IVOMD followed a pattern similar to protein content in the forages with values ranging from 23.0% to 30.0 % (Fig. 4). Other research has noted similar relationship between in vitro digestibility and diet crude protein content (Campbell, 1989; Brandyberry et al., 1992; Park et al., 1989; Gunter 1993). Lower IVOMD and CP values were found at the beginning of this study, increased to the highest values during May and dropped again during June, July and August.

The amount of soil moisture available for plant growth affects both the yield and chemical composition of plants (Laycok and Price, 1970). Early in the growing season, if soil moisture is abundant, most plants are green and rapidly growing; the moisture, protein, phosphorous, and carotene content of such plants generally is high; whereas, the fiber and lignin contents are low. During the middle and latter part of the growing season in temperate regions with continental climate, precipitation and soil moisture decreases, temperature increases, and plants grow to maturity and became dry. Therefore, forage quality will decrease (Laycok and Price, 1970).

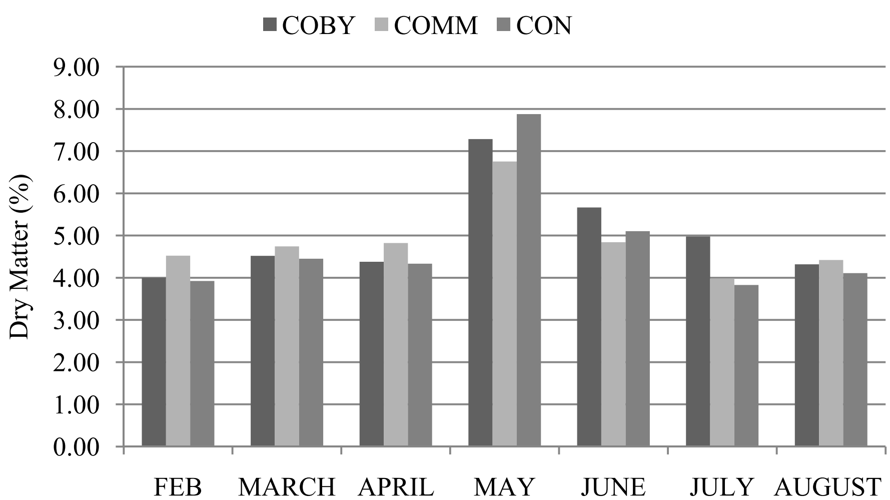

Figure 3. Dietary crude protein (% of dry matter) for steers grazing Tobosagrass fed 2 sources of protein supplementation in Garza County Texas. CON=Control (no supplement), COMM = Commercial Supplement, CBP = Starch coated and extruded cotton by-products. Means followed by the same letters are not significantly different (P≤0.05).

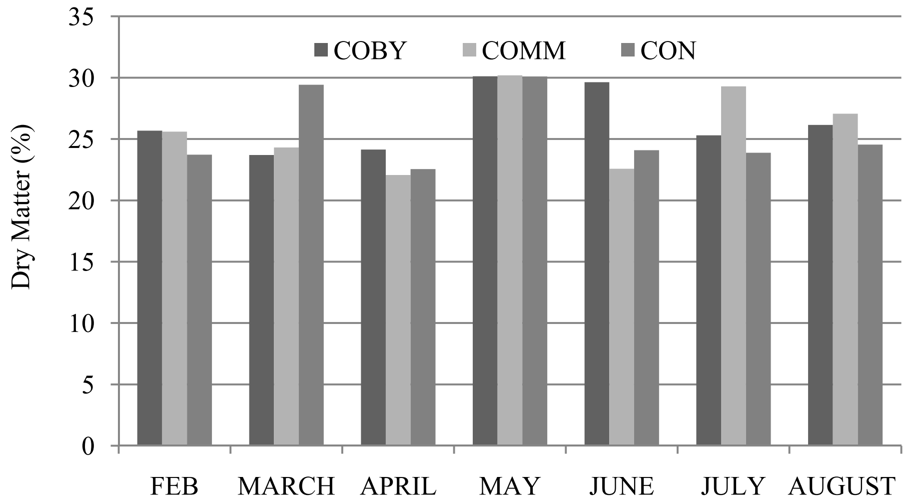

Figure 4. *In Vitro* Organic Matter Digestibility (% of dry matter) for steers grazing Tobosagrass fed 2 sources of protein supplementation in Garza County Texas. CON=Control (no supplement), COMM = Commercial Supplement, CBP = Starch coated and extruded cotton by-products. Means followed by the same letters are not significantly different (P≤0.05).

Steer Performance

Average daily gain (ADG) was different (P≤0.05) between sources of supplementation (Fig. 5). Steers on the CBP and CON treatments had a similar (P≥0.05) gain. Steers that were fed with the COMM supplement gained 35 lbs/head more than the CON, whereas steers fed with CBP gained 20 lbs/head more than the CON. In contrast, steers fed with the COMM supplement gained 15 lbs/head more than those fed with CBP. In contrast, steers receiving no supplemental protein averaged only 0.75 lb/hd/day, essentially maintaining body weight. This low gain was a result of weight lost during the June period.

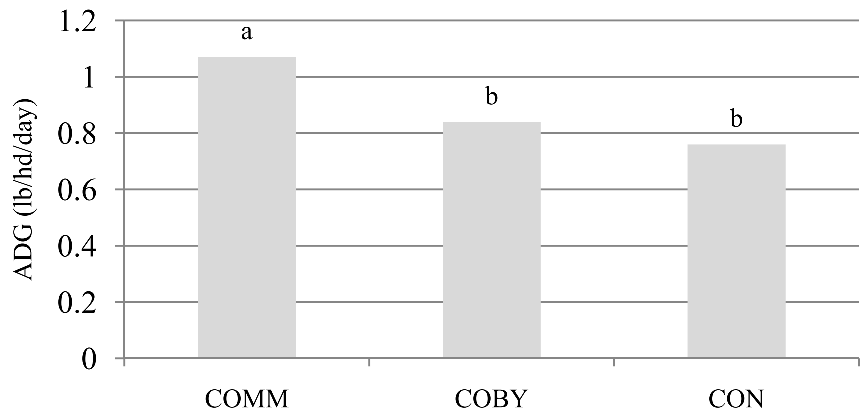

Figure 5. Average daily gain (ADG) of steers fed 2 sources of protein supplementation while grazing dormant tobosagrass. CON=Control (no supplement), COMM = Commercial Supplement, CBP = Starch coated and extruded cotton by-products. Means followed by the same letters are not significantly different (P≤0.05).

ADG showed a larger variation between grazing periods (Fig 6). The ADG of CON steers ranged from 1.13 to -0.23 lb/hd. Steers on the COMM treatment gained from 1.50 to 0.49 lb/hd while CBP steers ADG range from 1.42 to 0.23 lb/hd. (Fig 6). ADG showed a similar pattern seen in the CP and IVOMD data. The highest average daily gain for CBP and CON treatments was detected during May and the lowest for CON group was during June, during this month animals in the CON group lost weight. In the similar way the highest CP and IVOMD values from clipping samples were measured around May, whereas the lowest values were detected in the rest of the sampling periods. Judkins et al. (1987) and McCollum (1983) reported weight loss by unsupplemented cattle grazing dormant blue grama rangeland during time periods similar to those in the present study. Lantow (1930) reported gains of 0.06, 0.17, 0.24, 0.29 and 0.34 kg/hd/day for heifers grazing dormant tobosagrass supplemented at the rates of 0.0, 0.28, 0.45, 0.68, and 0.90 kg/hd/day of cottonseed meal during the winter in New Mexico.

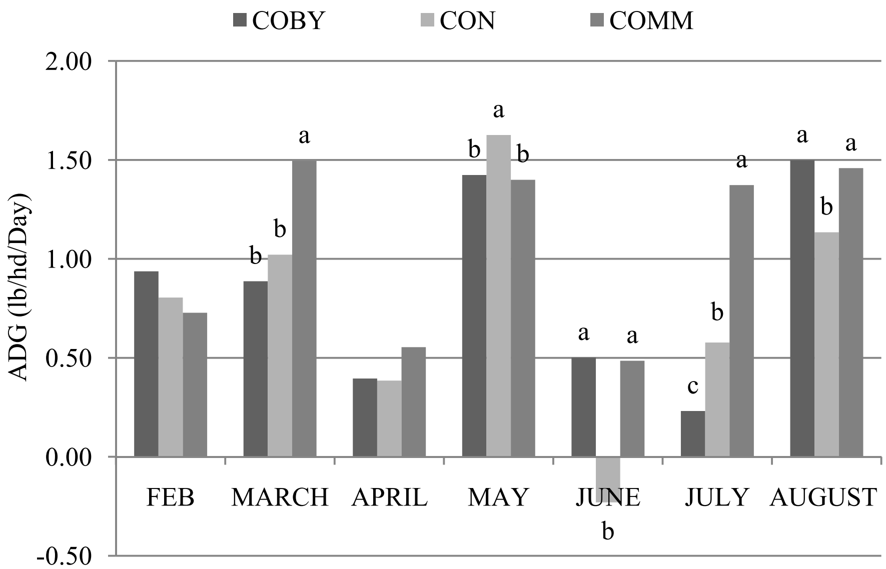

Figure 6. Average daily gain (ADG) of steers fed 2 sources of protein supplementation while grazing dormant tobosagrass. CON=Control (no supplement), COMM = Commercial Supplement, CBP = Starch coated and extruded cotton by-products. Means followed by the same letters are not significantly different (P≤0.05).

Steers receiving the COMM supplement protein on average gained more during the entire experiment. Gain obtained from this treatment was really consistent, steers gained close to a 1.5 lb/hd/day during four months out of seven of evaluation. Our research agrees with Parker et al. (1966), who described increased weight gains of supplemented weaning calves. Bellido et al. (1981) and Smith (1981) also reported improved weight gains of range livestock as a result of protein supplementation. Soybean meal cubes fed at 1.10 lb/hd/day increased gains by 0.50 lb/hd/day for supplemented versus non-supplemented steers according to Cantrell et al. (1985). Judkins et al. (1987) observed increased weight gains by supplemented heifers compared to non-supplemented heifers.

Usually spring gains are more closely related to rainfall quantity and distribution (Villalobos. et al, 1997). In this year, rainfall was 53% below the long term average, thus, low ADG, as well as poor forage quality and lower yield were the result of the low soil moisture available for plants. One particular interest of this research was the incorporation of CBP as a potential supplement with the possibilities to decrease the cost of gain in grazing situations. The research confirmed that CBP as a supplement was palatable but incomplete on nutritional value to support cost effective performance in growing cattle grazing tobosagrass rangeland (Table 2). There appears to be a marginal advantage to CBP, although this slight advantage did not significantly affect average daily weight of steers. When economically feasible situations arise, CBP can be used as an effective supplement for mature cows. Lack of improved steer performance during supplementation indicated that a CBP supplement, regardless of processing, was not effective in improving nutritional status during the treatment period. CBP fed alone was relatively low quality and was inadequate to meet the nutritive needs of growing cattle, for CBP to be effective supplement; it should be fortified with an N source. In addition, one of the limitations of using CBP as a supplement is its bulky presentation, increasing transportation and storage costs.

Table 2. Supplement cost ($/lb), average daily gain (ADG), extra gain and profit by steers grazing tobosagrass supplemented with 2 sources of supplementation.

Amount Supplement (lbs/day)	Cost/Day	ADG	Extra Gain With Supplement	Profit/Day ($1.00/lb.calf)
0.00 (Control)	0	0.75		
1.0 CBP[a]	0.02	0.84	0.09	0.09
1.0 COMM[b]	0.09	1.07	0.32	0.32

a Feed cost ($/lb) $0.02/lb CBP
b Feed cost ($/lb) $0.09/lb COMM

Despite inconsistent responses, producers commonly supplement grazing cattle to achieve maximum animal performance while effectively utilizing the forage resource base. Common reasons for feeding supplements to cattle include improving forage utilization and correcting nutrient deficiencies to increase economic return (Lusby, 1990). Supplementation may be used to enhance the quality of forage-based diets, and may also serve as a forage substitute when forage availability is limiting (Bowman and Sanson, 2000), also to relieve grazing pressure when range conditions are poor, or during periods of reduced forage growth (typically drought).

The effect of supplemental feeding on forage intake can be positive, negative or null depending on forage quality and the composition of the supplement. (Kartchner 1980). Energy supplementation is often practiced during summer dormancy and in winter to maintain desired production levels or minimize weight losses. Providing additional energy in the form of supplement has often produced reductions in intake of grazed forage. Chase and Hibberd (1987) fed incremental levels of corn to cows consuming low-quality forage and reported linear decreases in forage OM intake. These results support observations from earlier work on energy supplementation (Lusby and Wagner, 1986). More recently, Pordomingo et al. (1991) reported that cattle supplemented with corn while grazing summer pasture in New Mexico had reduced forage intakes. One important finding of this study was that averaged forage utilization during the study period from steers on CBP treatment was 37%, In contrast, COMM steers achieved 63%, and CON 52%. The effect from CBP on forage use was null, this is an example where a supplement can be use to stretch forage particularly during a drought and maintain the condition of the animals at a minimum cost. During periods of reduced forage growth (typically drought), livestock must have an alternative source of feed. However, producers spend an extraordinary amount of money on providing these alternative feeds. The use of CBP may be beneficial to livestock, especially for dry cows during periods of reduced forage growth (i.e., drought, winter). The source of supplementation should be determined by expected response coupled with economic and management considerations.

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