CORN GLUTEN FEED SUPPLEMENTATION AND ITS EFFECTS ON MATURATION RATES IN RAMBOUILLET EWE LAMBS

A Thesis

Presented to the

Faculty of the College of Graduate Studies and Research

Angelo State University

In Partial Fulfillment of the

Requirements for the Degree

MASTER OF SCIENCE

by

SHERRI JAYE CHASTEEN

May 2017

Major: Animal Science

CORN GLUTEN FEED SUPPLEMENTATION AND ITS EFFECTS ON

MATURATION RATES IN RAMBOUILLET EWE LAMBS

by

SHERRI JAYE CHASTEEN

APPROVED:

Dr. J. Will Dickison

Sr. Cody B. Scott

Dr. Chase Runyan

Dr. John Carl Smith III

April 13, 2017

APPROVED:

Dr. Susan E. Keith
Dean, College of Graduate Studies and Research

ACKNOWLEDGEMENTS

I would like to express my gratitude to all of those who were involved in this project. First, I must thank my committee members, Dr. J. Will Dickison, Dr. Cody B. Scott, Dr. Chase A. Runyan, and Dr. John Carl Smith III for their time and insight. Also, I would like to express gratitude to all the members of the Agriculture Department faculty for their continuous assistance and support of my education at Angelo State University.

I would like to thank the variety of student workers at the ASU Ranch who helped me maintain my project and collect data. They made the project possible. I would also like to thank Kurt Skelton of Ballinger, TX for providing the ewe lambs for this study.

Last, I know without my family, friends, and peers this project would not have been possible.

ABSTRACT

The objective of this study was to determine the effects of corn gluten feed on reproductive efficiency in Rambouillet ewe lambs. This study utilized 60 Rambouillet ewe lambs that were assigned to three different supplemental ration treatments (0%, 10%, & 30% Dry CGFP), with five animals per pen and four pens per treatment. Ewe lambs were exposed to three different supplementation diets and observed for average daily gain, the rate of conception, and lambing rate. Average daily gain was similar ($P > 0.05$) among treatments. Conception and lambing rates were higher ($P > 0.05$) for ewes supplemented with 30% CGF compared to ewes supplemented with 0% CGF.

Results indicate overall supplementation of 30% Dry CGF as a winter supplement, along with a high roughage diet, allows for greater reproductive production.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

Page

INTRODUCTION

Sixty percent of corn produced in the U.S. goes toward livestock consumption with other portions supported by a secondary market of food and industrial products from milling and refined corn. Corn utilized for human consumption produces viable byproducts, such as corn gluten feed, that can be used in supplemental feeding programs in order to reduce final cost in sheep production (Blasi et al., 2001).

Nutrition plays a vital role in sheep production and in order to reach optimum production supplementation is sometimes required to sustain productivity throughout the entire year, especially at critical times of stress due to climate (Lupton, 2008). Corn gluten feed (CGF) is a byproduct of the production of corn-derived sweeteners (high-fructose corn syrup) and used as a supplemental feed to improve animal production. It contains energy, crude protein, digestible fiber, and minerals (Blasi et al., 2001). Two forms of CGF produced through the corn milling process are wet CGF and dry CGF (Ham et al., 1995). Wet CGF is more digestible, but dry CGF aids in increasing fiber digestibility when fed with high amounts of roughage. Dry CGF has a longer shelf life and will not spoil quickly like wet CGF, and is also the least cost ratio formulation due to transportation costs (Blasi et al., 2001). When CGF is supplemented with forage, an increase in forage intake and feed efficiency has been observed (Hannah et al., 1990). Increased intake and feed efficiency can accelerate the onset of puberty in ewe lambs. Age of first breeding is ultimately determined by the onset of puberty. If a ewe lamb can produce a lamb by one year of age then a better reproductive efficiency is obtained (Nieto et al., 2013).

Journal of Animal Science

OBJECTIVES

1. Evaluated the effects of corn gluten feed on reproductive efficiency in Rambouillet ewe lambs.

LITERATURE REVIEW

Sheep fed a high-quality protein source and poor quality roughage low in digestible energy can be supplemented with corn gluten feed (CGF) as a source of highly digestible fiber and high-energy (Oliveros et.al, 1988). This literature review addresses past and present research of processing, methods and utilization, relevance to reproduction, and impacts on the industry by utilization of CGF as a feed supplement.

Processing

Corn gluten feed is produced as a byproduct of milling corn for high fructose corn sweeteners (Ham et al., 1995). When a bushel of corn goes through the milling process about 11% CGF is yielded from the original weight. The wet corn milling process uses steeping, germ separation, grinding and washing. Corn gluten feed remained after starch, gluten and germ are extracted for corn-based sweeteners. Corn bran is combined with steep liquor in the manufacturing process of CGF. Wet CGF is the result of a pressed mixture, whereas dry CGF is the mixture dried in a rotary drum dryer (Blasi et al., 2001).

Methods and Utilization

Wet CGF is shown to have higher digestibility along with the ability to replace up to 50% of dry rolled corn in the diet (Blasi et al., 2001). Corn processing methods were analyzed for finishing diets containing wet CGF in two trials using cattle (Scott et.al, 2003). The first trial of steers consuming wet CGF diets gained similarly and at a rate 6% faster than steers not fed wet CGF diets. Trial two steers were fed finishing diets with wet CGF, and consumed more dry matter (DM) than steers fed a dry-rolled corn or steam-flaked corn only diet. Similar to other studies, average daily gain did not differ among groups (Firkins et al., 1985; Ham et al., 1995; Scott et al., 2003). Through two trials the study concluded that the extensive processing of corn allowed for better gain to feed ratio in finishing diets containing wet CGF (Scott et al., 2003).

Firkins et al., (1985) conducted a study analyzing the wet and dry corn gluten feeds as a feed source for cattle and sheep. Concentrations of 0%, 35%, and 70% dry CGF and wet CGF were fed in one trial of the study to measure ruminal pH, volatile fatty acid concentrations, and ruminal dilution rates in sheep. A higher pH and acetate to propionate ratio was observed, within the first 3h of post feeding, in sheep fed wet CGF. This induces more efficient digestion and ease of fermentation for the wet CGF (Firkins et al., 1985). However, after comparison, digestibility of DM, neutral detergent fiber (NDF), and Nitrogen with those fed both wet and dry CGF were comparable (Firkins et al., 1985).

Dry corn gluten feed can replace up to 25% of dry rolled corn in the diet while contributing a better least cost ratio formulation due to cheaper transportation costs from the milling factory (Blasi et al., 2001). Dry CGF fed at 25% and 50% replacement in corn silage diets shows an increase in intake by 11.3% and even an increase of gain by 13.8% (Green et.al, 1987). Dry corn gluten feed is proven to balance Nitrogen and protein-N flow to the abomasum of mature cows, and create a faster rate of gain in yearling heifers (Cordes et.al, 1988).

Firkins et al. (1985) also analyzed Steers fed the wet CGF and dry CGF to show a faster utilization of DM than those fed wet or dry distiller grains (WDG or DDG). Steers in a separate trial were fed wet CGF and showed similar daily gain, but showed less consumption and lower feed to gain ratios compared to steers fed dry CGF. Steers also fed wet CGF at concentrations of 50%, 70%, and 90% had faster growth compared to steers on a 90% concentrated diet. Firkins et al (1985) concluded CGF at levels greater than or equal to 50%

of diet DM can sustain comparable performance to steers fed corn-based finishing diets (Firkins et al., 1985).

Bowman and Paterson (1988) mimicked the Firkins et al. (1985) study by analyzing CGF in high-energy diets for cattle and sheep. The study evaluated in vitro NH_3-N concentrations, DM, fiber and N intakes and digestibility, N-balance, N flow to the abomasum and amino acid flow to and disappearance from the small intestine as their variables. Key results found NH_3-N released after microbial degradation were lowest for dry CGF and intermediate for wet CGF. Also, sheep results indicated a greater flow of DM, ADF, and protein-N to the abomasum on a daily basis when fed dry, wet or ensiled CGF diets. Bowman and Paterson (1988) found similar results supporting CGF as a substitute for up to 50% of DM in high-concentrate diets for cattle and sheep.

Ham et al. (1995) went on to analyze the net energy value (NE_g) of wet and dry CGF in beef growing and finishing diets. His growing trial found a 65% wet CGF diet with alfalfa to have a more efficient and faster rate of gain compared to control diets. This increase from 49% to 65% wet CGF created a higher energy density within the diet (Ham et al., 1995). The NE_g of the control diets were estimated at .99 and 1.03 Mcal/kg. Wet corn gluten feed diets had an estimated NE_g of 1.21 Mcal/kg for the 61% diet, and 1.20 Mcal/kg for the 65% diet. An average NE_g of 1.75 Mcal/kg was taken for all the wet CGF diets. This resulted in an average energy value of 13% more than the dry-rolled corn diet. The remaining trials did conclude wet CGF to contain more NE_g than dry CGF when fed in dry-rolled corn diets, but none of the differences were of significant value. Ham et al. (1995) were consistent with Firkins et al. (1985) with results of similar daily gains in wet CGF. Cattle fed high percentages of dry CGF had no significant differences from the higher percentage of wet CGF diets fed (Ham et al., 1995).

Hannah et al. (1990) focused on the significance of maximizing ruminant forage efficiency through the use of CGF and concluded that steers fed a 20% CGF diet compared to 20% corn can increase feed efficiency by 2.5%, along with small improvements in dry matter intake and daily gains. When supplementing with forage, there is a need to increase energy consumption that is not found in those roughages. Corn gluten feed acts as a high-quality supplemental feed due to the average 22.0% crude protein, 2.0% ether extract, and 9.0% crude fiber content (Yen, Brooks, & Jensen, 1974). Forage intake is decreased after energy supplements are fed at more than 0.3% of body weight, so cost efficiency is achieved when energy supplements are fed at less than 0.33lb per head per day (Kellems and Church 2010).

Relevance to Reproduction

An increase in growth rates leads to the possibility that puberty is achieved earlier in the animal's lifetime. The main physical characteristic for determining an onset of puberty, or the ability to reproduce, is when a lamb reaches 50% to 70% of its mature body mass (Nieto et.al, 2013). This is why the use of CGF and its ability to increase growth rates deserves further investigation and the chemical characteristics of the onset of puberty must be observed. The increase in the release of the gonadotrophin-releasing hormone (GnRH) and luteinizing hormone (LH) are the main indicators of an ewe lamb coming into reproductive maturity (Redmond et al., 2011). Leptin as well increases with the onset of puberty. Leptin comes from adipose tissue and shows increased rates of fat accumulation can accelerate the onset of puberty. These maturity indicating hormones are analyzed through the blood levels. Jugular venipuncture 5mL blood samples have been taken from ewe lambs about 144, 186, 227, and 254 days old for plasma harvest to be used for hormone analysis. Leptin concentrations increase at puberty with an accumulation of muscle and fat (Nieto et al., 2013).

Nieto et al. (2013) discusses whether puberty is more influenced by genetics or how fast a ewe lamb accumulates muscle and fat. Phenotypic and genetic selection for growth or muscling is indicated as the main factors to achieve early puberty. Nieto et al.'s (2013) methods include a selection of n=136 Merino ewe lambs that were analyzed for average daily gain (ADG), phenotypic values of depth of eye muscle (EMD) for muscle gain indication, and fat. These ewe lambs were then split into two groups with *ad libitum* water and acclimated to a sheep pellet formula over seven days. Standing oestrus was then observed for each ewe lamb, and used to record approximate live weight (LW) at puberty. A Merino ram was then exposed to the ewe lambs to indicate the onset of estrus, followed by fertility and reproduction rate data collection utilizing ultrasound at the 60 days post exposure. Blood samples were then taken the four different times throughout the study to observe leptin concentrations.

Nieto et al. (2013) found a positive correlation between ADG and increased values of EMD and fat during exposure. Average daily gain results concluded without impact on a number of ewes that reached puberty. Ewe source, dam age, birth type, and teasing group were taken into consideration with no effect on puberty as well. Age and LW at the beginning of the exposure period did show a positive correlation, along with live weight at 200 days of age, or post-weaning live weight (PWT), EMD, and fat values. Of the lambs that achieved puberty, twin-born ewe lambs were 1.3 kg lighter and four days older than single-born ewe lambs. For oestrus, ewe lambs reached approximately 62% of their mature body weight. Higher eye muscle depth (PEMD) and PWT values were recorded for younger ewe lambs at puberty. Total ewe lambs bred were 75% and had a positive correlation with higher LW at the beginning of mating. Blood hormone analysis concluded ewe lambs with greater expected leptin concentrations from ewes of genetic selection for higher LW at the start of mating and the significance of higher EMD and fat for leptin production (Nieto et al., 2013)

Asmad et.al (2015) discuss how maternal sheep size and nutrition can affect the fetal ovarian development of offspring during pregnancy. This study steps away from the extreme nutritional deficiencies of anorexia and obesity and focusses on the practical nutritional management of pregnant sheep kept on a maintenance ration during early gestation. By observing nutrition during pregnancy, Asmad et al. (2015) were able to observe the effects of nutrition on ovarian follicles, and expression of how anti-Müllerian hormone (AMH) and Growth Differentiation Factor 9 (GDF9) play a part in fetus development. When compared they used a two-by-two factorial design of heavy body condition (H), light body condition (L), *ad libitum* grazing (A), and maintenance grazing (M). Results had little significant difference and concluded in an overall indication that conception body condition and nutrition during pregnancy impede minor effects on fetal ovarian cell number (Asmad et al., 2015).

Impact on Industry

Finally, the need for such research in the sheep industry is justified in Lupton (2008) assessment of animal science research in the U.S. There has been a constant decline in sheep operations in the past 100 years, along with decreased flock sizes (an average of 88 sheep in 2007). Reproduction, specifically reproductive efficiency, is a significant research topic involved in improving the future of the sheep industry. Reproductive efficiency is specifically the weaned lamb's body weight (BW) per ewe exposed to a sire (Lupton, 2008). This allows for the opportunity to increase ovulation rate in order to improve reproductive efficiency. Shorter generation intervals, which result in quicker genetic gain and higher productivity, are the main benefits to sheep giving birth as yearlings (Lupton, 2008). Sheep markets are very competitive to that of pork, chicken, and beef, so achieving genetic gain is important to maintain the quality of the industry in order to stay competitive. Increasing ovulation rate can increase lifetime lamb production by 15% to 20% (Kellems and Church 2010).

Innovation is what will keep the sheep industry successful. The wool and meat productivity compete against each other with wool no longer being the main component of productivity in the niche market. Many factors such as genetics and nutrition play a role in adjusting this market in order to keep it alive. Experiments in the potential increase in reproductive efficiency can allow for the faster genetic gain required to achieve a quality product.

MATERIALS AND METHODS

This study took place at the Angelo State University Management, Instruction and Research Center in San Angelo, TX during the months of September and October 2015, and February, of 2017. Prior to the study, ewe lambs grazed native rangeland, on the breeder's land and had *ad libitum* access to fresh water. This study and methods were approved by the Angelo State University IACUC committee with AUP #: 15-18. The following methods illustrate the procedures used for analyzing the effects of dry CGF on reproductive efficiency of Rambouillet ewe lambs.

Rambouillet ewe lambs (age = six months) were selected from a local producer (Kurt Skelton) and Angelo State University seven days before the experiment began. Ewe lambs were randomly assigned to one of three treatment groups, with five animals per pen and four pens per treatment. All pen dimensions measured 3.0 m wide by 8.9 m deep. Each pen received *ad libitum* access to fresh water and Sudangrass hay twice a day to simulate low quality rangeland forages. All three treatments mirrored a 30% crude protein range supplement. Treatment diets comprised of 0% Dry CGF ration, 10% Dry CGF ration, and 30% Dry CGF ration as shown in Table 1. Diets were isonitrogenous at 30% protein levels. The rations were provided *ad libitum* the 60 day feeding period through the months of September 2015 to October 2015 using self-feeders. The feeders were monitored daily in order to make sure they stayed full and worked properly. Ewe lambs were gathered by pen and weighed every seven days to estimate average daily gain.

At the conclusion of the study, ewes were returned back to the breeder at nine months of age and exposed to two Rambouillet rams for natural conception practices. February 21st ewes were gathered and ultrasound was performed for conception rate data. Ewes that were pregnant were recorded and then put back on grazing for the remainder of the study. At the end of the study, lambing data was collected and recorded.

Average daily gain (ADG), conception, and lambing were analyzed using repeated measures of analysis of variance procedures of SAS (Allison, 1995). Treatments were considered different at ($P > 0.05$).

TABLE 1.

Ingredients (as fed basis) and Nutrient Content for Supplemental Treatments

	Percent (as fed per treatment)		
Ingredients	0%	10%	30%
Corn Gluten Feed (CGF)	--	10.0	30.0
Corn	19.1	23.6	10.6
Cottonseed Meal	62.5	61.2	54.2
Alfalfa	13.2	--	--
Molasses	5.0	5.0	5.0
Premix	0.2	0.2	0.2
Nutrient Content			
Dry Matter (DM)	90.2	90.8	93.3
Crude Protein (CP)	30.1	30.0	30.0
MEt Energy (kcal/kg)	778.3	795.0	357.9
Fiber	10.6	10.3	15.0
Total Digestible Nutrients (TDN)	68.9	70.2	69.4

RESULTS

Average Daily Gain

Average daily gain was similar (*P* > 0.05) among treatments.as seen in (FIGURE 1). There is a gradual increase of average daily gain within the first three weeks, then the fourth, fifth, and sixth weeks show similar higher average daily gain before returning to a gradual increase.

Rate of Conception

Based on conception rates, a significant difference (*P* > 0.05) between treatment groups fed 0% and 30% Dry CGF rations (FIGURE 2) were observed. More than twice as many lambs fed 30% DCGF rations were bred compared to that fed 0 % (FIGURE 2).

Lambing Percentage

Lambing rates were observed at the conclusion of the study, resulting in a significant difference (*P* > 0.05) between the 0% and 30% treatment groups (FIGURE 3). The 30% treatment mean represents a much higher lambing percentage compared to the 0%.

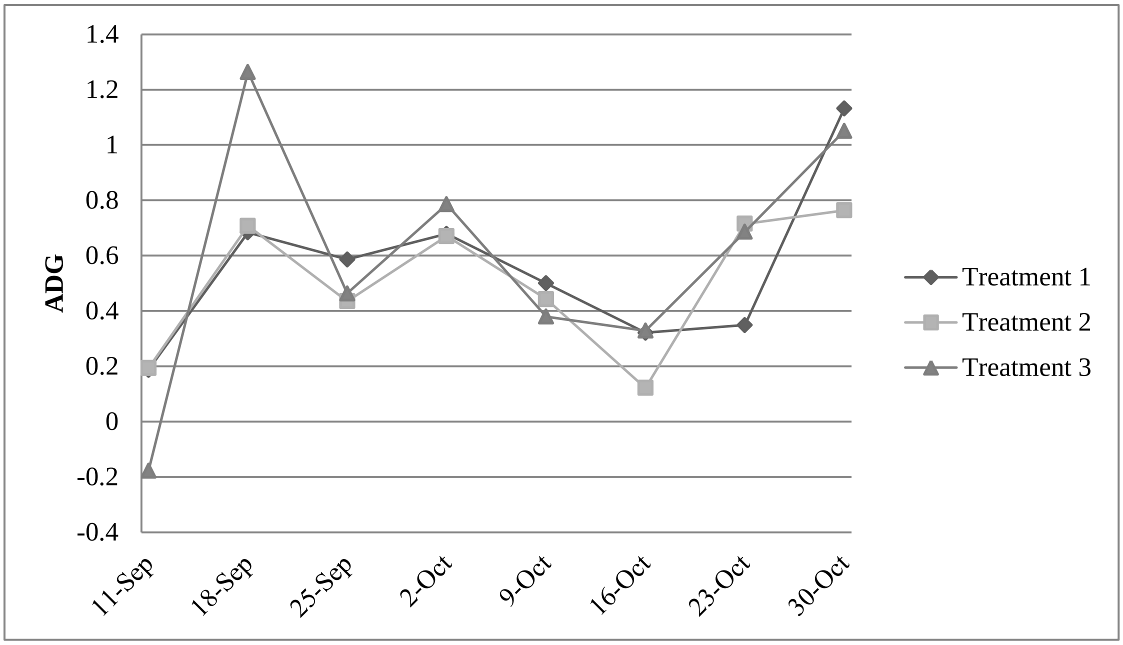

FIGURE 1. A comparison of treatment groups for average daily gain fed varied percentages of Dry CGF. The Dry CGF ranged from 0% to 30%. All sheep were fed roughage twice daily.

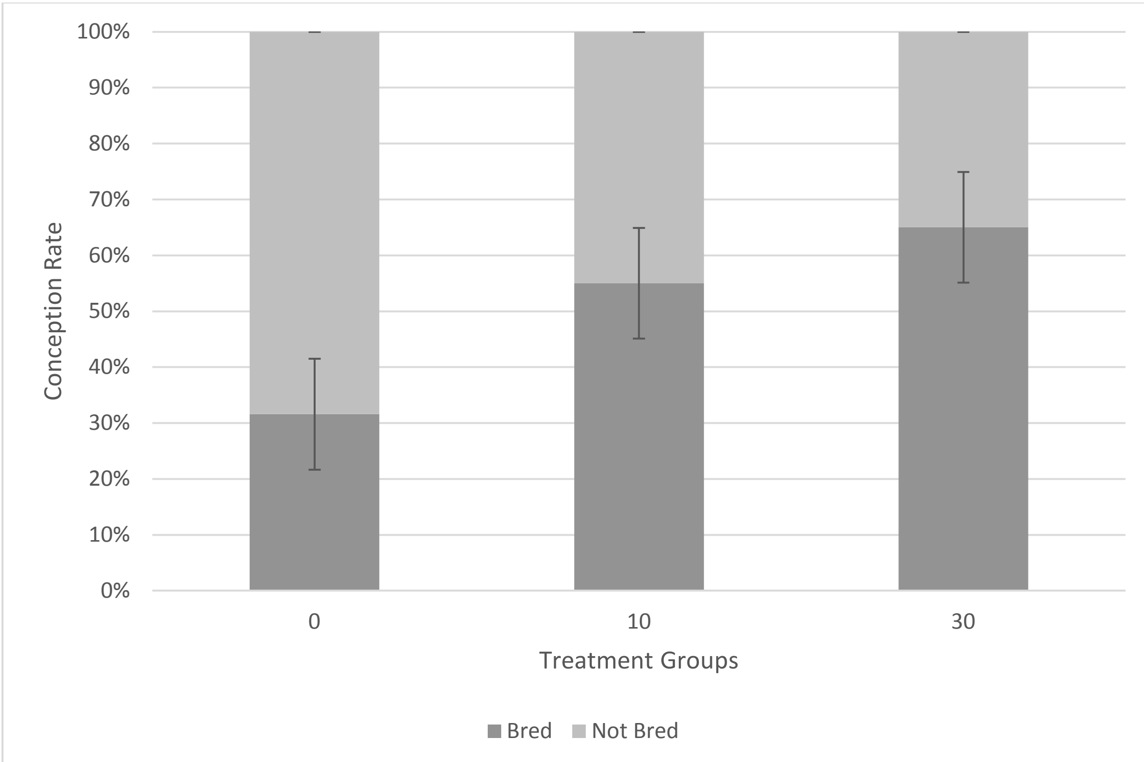

FIGURE 2. Conception rates based on treatment groups fed 0%, 10%, and 30% Dry CGF.

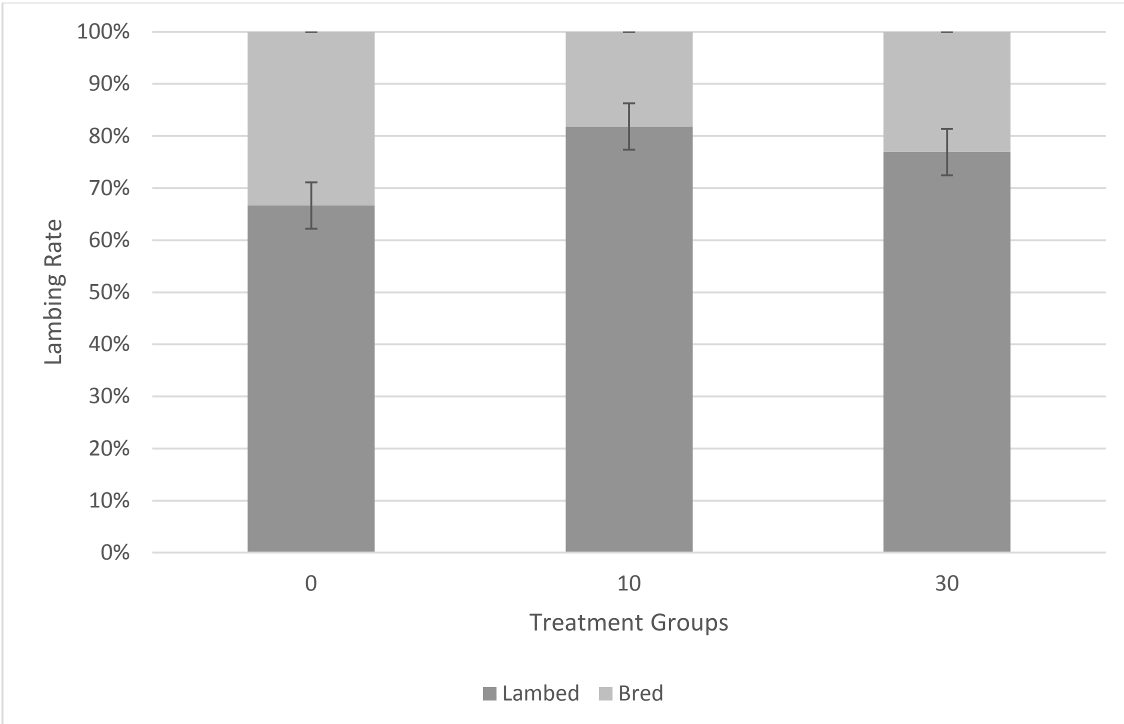

FIGURE 3. Lambing percentage based on treatment groups fed 0%, 10%, and 30% Dry CGF.

DISCUSSION

Similar trends in ADG among treatment groups were observed in this study. Observations agree with Ham et al. (1995) in a study to determine net energy value of wet and dry corn gluten feed in beef growing and finishing diets. Kellems & Church 2010 discuss the nutritional management of breeding ewe lambs, especially in a range setting, and their requirement of 0.18 kg to 0.23 kg per day. Typically Rambouillet ewes are slower maturing than other breeds and achieve optimum maturity at 70% mature body weight (Lupton, 2008). In order to achieve this goal, supplementation is highly recommended for ewes on range quality hay. However, sheep's ability to recycle dietary and metabolic nitrogen have led to conclusions of similar ADG between supplementing daily and every third day (Kellems & Church 2010). Higher energy values of CGF in Ham et al. (1995) signify the opportunity for greater conception through nutrition of 30% CGF. Similar results in our study show 30% supplementation to have the same nutritional benefits in ADG as a 10% ration. Our results also concluded the 30% ration to have the higher conception rate. This gives an opportunity to supplement more Dry CGF in order to achieve optimum results in nutrition and ultimately reproduction.

Lambs fed 30% Dry CGF rations have greater opportunity for conception. Though crude protein (CP) levels were similar in all rations, the protein source of the processed CGF proposes greater ability to increase the supply of microbial amino acids, due to its higher fibre content, which allows the unfermented dietary protein to be carried on to the duodenum for absorption (Kellems & Church 2010). This implies the ability to utilize Dry CGF as a winter supplement to increase conception and potential lambing crop.

Lambing rates showed a significant difference (*P* > 0.05) between the 0% and 30% treatment groups (FIGURE 3). Though some lambs died after conception, the 30% treatment group produced a much higher lambing score to show confidence in higher percentage supplementation of Dry CGF. This could be due to increased gain and intake similar to Ham et al (1995)'s illustration of the usage of CGF in steer finishing diets for maximizing gain and intake. By continuing supplementation of ewe lambs bred at an early age they can maintain their body condition scores higher in order to carry the lamb to full term. Lambs were taken back to the breeder, so supplementation after the 60 day feeding period was not an option. Drewnoski et.al, (2011) conducted a feeding trial that supported the stability of performance was still an option when supplementing CGF as little as twice a week after conception. With less frequent supplementation, comes another opportunity for increased economic efficiency within production.

IMPLICATIONS

The present study shows greater conception and lambing rates for 30% dry CGF supplemented ewe lambs who were bred as yearlings. Studies support conception can be beneficial to producers with an extra lambing crop and faster turnover. This study shows benefits to Dry CGFP as a winter supplementation in order to achieve greater conception rates and lambing crop compared to standard supplementing diets. The present study can be mimicked for future studies. If future research would incorporate time of puberty through plasma analysis then results could narrow the window of inducing conception for greater reproductive efficiency.

LITERATURE CITED

Allison, P.D., 1995. Survival analysis using SAS: A practical guide. Cary, NC: SAS Institute.

Asmad, K., P. R. Kenyon, S. J. Pain, K. C. Perera, T. J. Parkinson, N. Lopez-Villalobos, and H. T. Blair. 2015. Effects of dam size and nutrition during pregnancy on fetal ovarian development of their offspring in sheep. Livestock Science 181:256-262.

Blasi, D. A., M. J. Brouk, J. Drouillard, and S. P. Montgomery. 2001. Corn gluten feed, composition and feeding value for beef and dairy cattle. Kansas State University Extenion. http://www.ksre.ksu.edu/bookstore/pubs/mf2488.pdf. (Accessed 12 November 2015.)

Bowman, J. G. P., and J. A. Paterson, 1988. Evaluation of corn gluten feed in high-energy diets for sheep and cattle. J. Anim. Sci. 66:2057-2070.

Cordes, C. S., K. E. Turner, J. A. Paterson, J. G. P. Bowman, and J. R. Forwood. 1988. Corn gluten feed supplementation of grass hay diets for beef cows and yearling heifers. J.Anim. Sci. 66:522-531.

Drewnoski, M. E., M. H. Poore, and G. A. Benson. 2011. Effect of frequency of supplementation of a soyhulls and corn gluten feed blend on hay intake and performance of growing steers. Animal Feed Science and Technology. 164:38-44.

Firkins, J.L., L.L. Berger, and G.C. Fahey, Jr. 1985. Evaluation of Wet and Dry Distillers Grains and Wet and Dry Corn Gluten Feeds for Ruminants. J. Anim. Sci. 60: 847-860.

Green, D. A., R. A. Stock, F. K. Goedeken, and T. J. Klopfenstein. 1987. Energy value of corn wet milling by-product feeds for finishing ruminants. J. Anim. Sci. 65:1655-1666.

Ham, G. A., Stock, R. A., Klopfenstein, T. J., and Huffman, R. P. 1995. Determining the net energy value of wet and dry corn gluten feed in beef growing and finishing diets. J. Anim. Sci. 73:353-359.

Hannah, S. M., J. A. Paterson, J. E. Williams, and M. S. Kerley. 1990. Effects of corn vs corn gluten feed on site, extent and ruminal rate of forage digestion and on rate and efficiency of gain. J. Anim. Sci. 68:2536-2545.

Kellems, R. O., D. C. Church. 2010. Livestock feeds and feeding – 6^{th} edition. Pearson. 20:398-425.

Lupton, C. J. 2008. ASAS Centennial Paper: Impacts of animal science research on United States sheep production and predictions for the future. J. Anim. Sci. 86:3252-3274.

Nieto, C. A. Rosales, M. B. Ferguson, C. A. Macleay, J. R. Briegel, G. B. Martin, and A. N. Thompson. 2013. Selection for superior growth advances the onset of puberty and increases reproductive performance in ewe lambs. Animal, 7, pp 990-997

Nieto, C.A. Rosales, M. B. Ferguson, C. A. Macleay, J. R. Briegel, D. A. Wood, G. B. Martin, and A. N. Thompson. 2013. Ewe lambs with higher breeding values for growth achieve higher reproductive performance when mated at age 8 month. Elsevier. 80:427-435.

Oliveros, B. A., T. J. Klopfenstein, F. K. Goedeken, M. L. Nelson, and E. Hawkins. 1989. Corn fiber as an energy supplement in high-roughage diets fed to steers and lambs. J. Anim. Sci. 67:1784-1792.

Scott, T. L., C. T. Milton, G. E. Erickson, T. J. Klopfenstein, and R. A. Stock. 2003. Corn Processing Method In Finishing Diets Containing Wet Corn Gluten Feed. J. Anim. Sci. 81:3182-3190.

ANGELO STATE UNIVERSITY
College of Graduate Studies & Research
Institutional Animal Care & Use Committee

20 October 2015

Dr. Will Dickison and Ms. Jaye Chasteen
Department of Agriculture
Angelo State University
San Angelo, TX 76909

Dear Dr. Dickison and Ms. Chasteen:

Your proposed project titled, "Corn Gluten Feed Supplementation and its effects on maturation rates in Rambouillet ewe lambs" was reviewed by Angelo State University's Institutional Animal Care and Use Committee (IACUC) in accordance with the regulations set forth in the Animal Welfare Act and P.L. 99-158.

This protocol was approved for three years, effective 20 October 2015 and it expires three years from this date; however, an annual review and progress report form (www.angelo.edu/content/files/22583-iacuc-annual-review-progressreport) for this project is due on 15 August of each year. If the study will continue beyond three years, you must submit a request for continuation before the current protocol expires.

The protocol number for your approved project is 15-18. Please include this number in the subject line of all future communications with the IACUC regarding the protocol.

Sincerely,

Robert Dowler, Ph.D.
Chair, Institutional Animal Care and Use Committee

Dr. Robert Dowler, IRB Chair | ASU Station #11025 | San Angelo, Texas 76909
Phone: (325) 486-6639