Professional Agricultural Workers Journal

Volume 7
Number 2 *Professional Agricultural Workers Journal (PAWJ) - Volume 7, Issue 2*

Article 6

4-30-2021

Sustainable Winter-Feeding Practices for Meat Goats Within The Southeastern United States

Nikisha Ryan
Tuskegee University, nryan5624@tuskegee.edu

Nar Gurung
Tuskegee University, ngurung@tuskegee.edu

Jeremy Byrant
Tuskegee University

Frank Abrahamsen
Tuskegee University

Wendell McElhenney
Tuskegee University

SUSTAINABLE WINTER-FEEDING PRACTICES FOR MEAT GOATS WITHIN THE SOUTHEASTERN UNITED STATES

***Nikisha Ryan[1], Nar Gurung[1], Jeremy Byrant[1], Frank Abrahamsen[1], and Wendell McElhenney[1]**
Tuskegee University, Tuskegee, AL
***Email of the lead author: nryan5624@tuskegee.edu;**
****Email of corresponding author: ngurung@tuskegee.edu**

Abstract

Winter feeding systems were evaluated on male Kiko meat goats against the traditional practice of raising goats in the winter months. Forty-Five Kiko bucks were randomly assigned to one of three treatments; Treatment 1, Treatment 2, and Treatment 3 consisted, respectively, of Cosaque Oats, annual Ryegrass, Crimson Clover mix, and 1.0% of BW concentrate supplementation with free choice hay. Forage clippings were analyzed for dry matter, crude protein, and neutral detergent fiber. Body weights were monitored over the grazing period. Blood samples were collected during the experiment, and animals were slaughtered for the evaluation of carcass traits. Data were analyzed as a completely randomized design using the General Linear Model. Results showed that average daily gain and ribeye area were significantly lower for the control group compared to the other treatments. However, there was no difference in dressing percentage among treatments. Winter forages evaluated performed better than traditional feeding practices.
Keywords: Kiko Meat Goats, Winter Forage, Ryegrass, Crimson Clover

Introduction

Goat meat demand is increasing in the U.S., mainly because of the influx of immigrants whose choice of meat is goat meat. Goats can also be used for many purposes, including vegetation management for improving the quality of rangelands, to control weeds (Glimp, 1995), and to be a source of meat, milk, and fiber (Dhanda et al., 2003). Goats are popular with smallholders because of their efficient conversion of feed into edible and high-quality meat, milk, and hide (Devendra and Solaiman, 2010). Goat meat, when compared to other proteins, has the advantage of no religious taboos and, in some cultures has a unique role in religious and traditional family events (Meat and Livestock Australia, 2019). With interest in increasing the goat meat market, the goat industry has a unique opportunity. Research has demonstrated that nutrition can enhance the quality and quantity of meat goat produced. One area of feed management practices that is lacking occurs during the winter season. During the winter season, the nutritional values of most forages and pastures decline and are not adequate to provide the required amount of nutrients for healthy goat production. In the late fall and winter months, most livestock farmers purchase feed with supplemental hay for their herds. The Southeastern region, known for its generally mild winters can support year-round grazing systems. Many different types of grasses and legumes, both annuals and perennials, can be produced in the winter as well as during the summer months. Successful identification of such forages could enhance goat meat production.

The two main objectives of this study were to (1) evaluate and identify sustainable winter-feeding practices for meat goats within the Southeastern U.S., and (2) examine growth performance, blood chemistry, and carcass quality of meat goats grazed on Cosaque Oats, Annual Ryegrass and Crimson Clover mix compared to the traditional system of feeding goats during the winter months.

Literature Review

According to Anaeto et al., (2010), goat meat is a healthier alternative compared to other red meats because it contains low levels of saturated fatty acids and cholesterol. Therefore, the American Heart Association recommends goat meat to people with heart-related problems. However, goats generally have a lower carcass yield; thus, limiting the efficiency of meat goat production in the U.S. This has restricted monetary returns to producers because of the high cost of maintaining reproducing females throughout the year with the marketing of the progeny at relatively low body weight. Although the demand for goat meat has increased in popularity, the popularity is not usually seen with mainstream Americans. Many people who consume goat meat in the U.S. are from a variety of religious/ethnic groups. Previous research indicates that the main religious/ethnic groups who consume goat meat in the U.S. are Muslim, Hispanic/Latino, Caribbean, Asian, Italian, and Greek populations(Glimp, 1995). The predominantly white, middle-class population consumes relatively little goat meat (Pinkerton et al., 1991). The consumption of goat meat rises dramatically during traditional religious holidays such as Christmas, Easter, and Ramadan in areas where certain religious/ethnic populations exist.

American Goat imports

The demand for goat meat exceeds the supply in the U.S. (Glimp, 1995). More than 70% of goat meat consumed in the U.S. is imported (Hart et al., 2018). Over 98% of goat meat is imported from Australia, and therefore it implies that the U.S. is the largest importer while Australia is the largest exporter of goat meat in the world (Meat and Livestock Australia, 2019). As mentioned earlier, America's demand for goat meat has drastically risen due to immigration, which leaves the supply in America struggling to compete with Australian and New Zealand imports. However, domestic goat meat production has steadily declined in the U.S. since 2008, when there was an economic downturn (Hart et al., 2015).

Cost of production

The retail price for domestic goat meat is much higher than the price of Australian imports (Hart et al., 2018)). One cost of goat production that exceeds most is feed cost. Feed cost is the single most significant variable cost in any livestock operation and averages about 64% of the variable costs, not including labor cost, and it is about 45% including labor cost (Devendra and Solaiman, 2010). The issue of feed management extends not only to production and labor costs but has also become a more specific issue when the winter season approaches (Karki and Karki, 2019). Most goat producers are small producers in the U.S.

Winter Feeding Systems in the Southeastern U.S.

Feeding goats in the winter months is expensive because of the use of stored feeds such as hay and supplemental feeds. However, the Southeastern U.S. is ideal for growing different winter forages due to mild winters. Raising goats on forages is more sustainable because the quality of meat is better, and goats harvest their own feeds. One of the major challenges is that the growing forages in the winter is weather dependent.

Materials and Methods

Institutional Animal Care and Use Committee approval (IACUC) Approval

Goats used in this experiment were purchased from an approved vendor. Upon arrival at the farm, goats were dewormed with Cydectin (Moxidectin, Fort Dodge Animal Health, Iowa, USA)

and vaccinated with *Clostridium perfringens* type C and D-Tetani Bacterin-Toxoid (Bayer LLC Shawnee Mission, KS, USA). This study was conducted at the Caprine Research and Education Unit (**CREU**), Tuskegee University, Tuskegee, AL. Animals were cared for according to the "Guide for the Care and Use of Agricultural Animals in Research and Teaching" (FASS Ag Guide, 2010). The Tuskegee University Institutional Animal Care and Use Committee approved the protocol.

Study Site, Seeding and Stocking Rates

This study was conducted at the Tuskegee University Caprine Research and Education Unit grazing sites. Cosaque Oats, Annual Ryegrass, and Crimson Clover were planted through seeding. The seeding rate for Cosaque Oats was 45 kg/acre; that for Annual Ryegrass was 20 kg/acre, and that for Crimson Clover was 6 kg/acre. All plots were applied with 6.8 kgof nitrogen using the no-till method. The stocking rate for the goats was 10 goats/acre. The grazing started in March when average heights were higher than 4 inches tall.

Experimental Design

This study was organized as a completely randomized design, where each of the 45 Kiko Bucks, was randomly assigned to each of three treatments. Treatment 1, consisted of Cosaque black oats (*Avena sativa*), Treatment 2, consisted of a mix of Annual Ryegrass (*Lolium multiflorum L.)* and Crimson-clover *(Trifolium incarnatum)*, and Treatment 3, served as the control, consisting of 1.0% of body weight concentrate supplementation and free-choice hay. The initial average weight of the bucks was 19.9 $\mp$2.93 kg and age 4 to 5 months. The stocking rate was 10 goats/acre with 3 replications per treatment. The study lasted 90 days, with no rotational placement implemented. Each of the treatments had access to freshwater and minerals. Throughout the study, each group was observed for any unexpected issues, such as BCS and other health conditions. Forages were also observed for continual regrowth to ensure goats had adequate forages to consume. The initial and final body weights were used to calculate average daily gain (ADG).

Forage Sampling for Heights and Nutrient Estimation

Forage samples were collected three times during the study using measuring sticks as well as the quadrat method. Forages were clipped approximately 4 inches above the ground to simulate the appropriate grazing heights of meat goats because grazing animals pick up infective larvae on forages that are relatively short (less than 4 inches). A quadrat was randomly thrown 5 times within each plot to select the area to be measured. Once selected, the forage height was documented and in each of the 5 spots the forage was clipped from 4 in above the ground and stored in brown paper forage bags; where fresh weight was taken and then dried in the oven for 72 hours at approximately 60 degrees Fahrenheit.

After the 72 drying period, the samples were taken out of the dryer and the dry weight was measured. The samples were then each ground using a Willy Mill grinder with a 1mm sieve. This method was repeated 3 times throughout the length of the study. Fifteen random samples of each treatment were collected in total. These samples were then sent to the Auburn University Soils lab for nutrient analysis. The tests included Crude protein (CP), Dry Matter (DM), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), Ash (CF), and Crude Fat (AOAC, 1990).

Blood Sample Collection

Blood samples were taken at the beginning and towards the end of the study. Collections were completed using 20-gauge 1-inch needles. Blood was separated into two blood tubes with different colored tops, red and purple, to distinguish between them. Red topped tubes were used to analyze serum, while purple topped tubes containing an anticoagulant called ethylenediamine tetra acetic acid (EDTA) were used to analyze whole blood. Blood samples were analyzed at the Tuskegee University Veterinary School. The samples were analyzed for blood glucose (GLU), creatinine (CREA), blood urine nitrogen (BUN), total protein (TP), and albumin (ALB).

Body Weights, Body Condition Score (BCS), and FAMACHA Scoring

Body weights were taken every two weeks for feeding adjustments for concentrates fed at 1% BW. The BCS and FAMACHA scores were recorded at the beginning, middle, and end of the study.

Carcass Evaluation

Following the completion of the study, goats were slaughtered at the Fort Valley State University Meat Laboratory located in Georgia, according to the USDA approved guidelines. The carcass characteristics evaluated included live weight, hot carcass weight, dressing percentage, as well as the ribeye area. During processing, each animal from each treatment was weighed before slaughter to record their live weights. Hot carcass weight was then taken right after slaughter. With these two values, the dressing percentage was calculated. Ribeye area was measured after slaughter using the Longissimus Dorsi muscle exposing between the 12 and 13th rib.

Calculating Biomass/Dry Matter

The method developed by Robel et al. (1970) was used to estimate available forage Dry Matter by measuring stick. With Crimson Clover requiring a seeding rate of 90 kg/inch, and Marshall Ryegrass requiring a seed rate of 113 kg/inch, and our fields being 20% clover, and 80% rye, we used a formula to assess DM. Clover: 200 (.20) = 40; Rye: 250 (.80) = 200. The resulting numbers were recorded and added (200 + 40 = 240). The average forage height for each treatment, represented by (X) was taken and multiplied by 240 to obtain the DM percent (X *240 = DM).

Statistical Analysis

Data were analyzed as a completely randomized design using the Proc General Linear Model and Proc Mixed Procedure of SAS (SAS Inst., Inc, Cary, NC). Significance level was set at $P > 0.05$ level of significance.

Results

Forage Information

The control group diet, Treatment 3, consisted of a 16% concentrate mixture (© 2019 Cargill, Inc.) fed at 1% BW with free choice hay, water, and minerals. Table 1 shows the nutritional composition of the concentrate feed given to the control treatment and hay. The amount given was adjusted every two weeks due to the difference in weights recorded throughout the study. The control treatment standard feeding amounts were averaged at about 1% of body weight of concentrate feed per goat. The hay used in the current study compared with the average Alabama hay in nutrition composition (Dillard et al., 2018).

Table 1. Chemical Composition of Feed Components given to Meat Goats in the Control treatment for a 90-day grazing study.

ITEM	Control (Free Choice-Hay)	Nutrena© Country Feeds All Stock 16% Textured (MG)
Dry Matter (%)	93.6	-
Crude Protein (%)	8.7	16.0%, minimum
Crude Fat (%)	1.9	3.0%, minimum
ADF (%)	21.5	15.0%, maximum
NDF (%)	46.3	-
Ash (%)	6.3	-

The nutrient composition evaluated for each of the forages included dry matter, crude protein, acid detergent fiber (ADF), neutral detergent fiber (NDF), ash, and crude fat. Measurements analyzed for the nutritional values were taken 3 times during the beginning, middle, and at the end of the study.

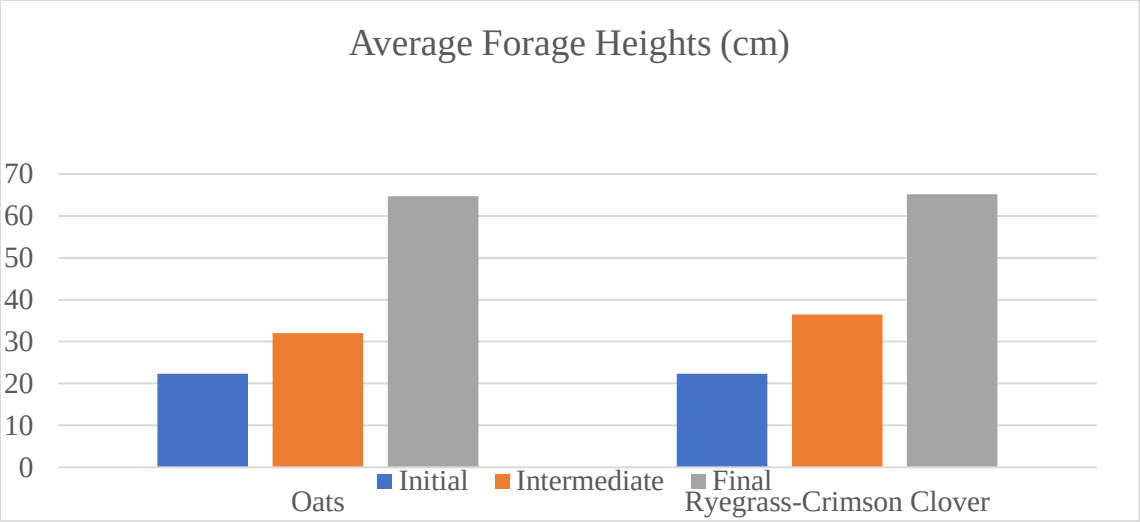

Figure 1. Average Forage Heights of grazing Ryegrass-Crimson Clover, and Cosaque Oats during Initial, Intermediate, and Final State for over 90 days

Both types of forages increased in height as the season progressed. The height measurements were only collected after the forages were above 4 inches to simulate the recommended grazing heights for meat goats to avoid parasitic infections. Figure 1 shows a visual representation of the amount of increase in growth over the entire growing period. Treatment 1 consisted of Cosaque Oats and Treatment 2 consisted of Annual Ryegrass and Crimson Clover mixture, results for the nutrient analysis of the forages over the 90-day grazing period is displayed in Table 2.

Table 2. Nutritional Composition of Cosaque Oats and Ryegrass/Crimson Clover Sampled in Three Different Periods over a grazing period of 90 days.

Item	**Winter Forages**					
	Cosaque Oats			Ryegrass/Crimson Clover Mix		
	Period 1	Period 2	Period 3	Period 1	Period 2	Period 3
Dry matter, %	43.8	38.5	37.8	48.2	43.9	56.4
Crude Protein, %	15.0	6.2	5.0	22.4	12.3	10.7
Crude fat, %	3.4	3.2	2.5	3.4	2.8	2.7
ADF, %	18.9	27.9	39.9	16.9	31.4	31.4
NDF, %	30.3	38.8	53.3	29.8	42.6	43.3
Ash, %	11.2	7.9	7.6	12.5	9.7	7.5

Table 3 shows a comparison of the FAMACHA and Body Condition Scores of the three treatments for each of the 3 collection periods taken throughout the 90-day study. Within Table 3 it was observed that collection 2 showed a significant difference (P<0.01) between treatments within the component of body condition score.

Table 3. FAMACHA and Body Condition Scores Analyzed throughout the Study (90 days).

	ITEMS	**Treatments**			**SEM***	***P*-VALUE**
		Cosaque Oats	Ryegrass-Crimson Clover	Control		
Collection 1	FAMACHA	3.9	3.5	3.2	0.15	0.01
	Body Condition Score (BCS)	2.6	2.7	2.4	0.1	0.3
Collection 2	FAMACHA	3.4	3.3	3.6	1.6	0.02
	Body Condition Score (BCS)	2.7	3.1	1.9	0.1	0.0001
Collection 3	FAMACHA	3.3	3.2	2.6	0.2	0.006
	Body Condition Score (BCS)	2.4	2.4	2.5	0.2	0.8

*SEM= Standard Error of Mean.

Within Table 4. Results showed that while initial body weight held no significant differences, final body weights between treatments displayed some noticeable changes. The control treatment in comparison with the Cosaque Oats and Ryegrass-Crimson Clover Mixture was significantly lower (P<0.05), reaching a final weight of 23.7 kg with approximately 6.7-7.2 kg difference between the other two non-traditional treatments.

Table 4. Body Weights (kg) and average daily gain (ADG, g/d) of meat goats at the beginning and the end of the study (90 days) grazing Ryegrass-Crimson clover, Cosaque Oats, and the Traditional Method of Feeding.

ITEM	Treatments			Values	
	Control	Cosaque Oats	Ryegrass-Crimson Clover	SEM*	*P*-VALUE
Initial BW, kg	19.7	19.7	20.3	2.93	0.91
Final BW, kg	23.7[a]	30.9[b]	30.4[b]	3.00	0.05
ADG, g/d	67.2[a]	187.2[b]	168.4[b]	0.17	0.001

*SEM=Standard Error of Means, ADG=Average Daily Gain

With the same general parameters between treatments, Average Daily Gain (ADG) displayed generally higher results for the Cosaque oats at 187.2 g and Ryegrass-Crimson Clover at 168.4 g but there was no significant difference between forages (P>0.05). However, both forages gained significantly higher (P<0.001) compared to the control group(traditional feeding practice) both in terms of final gain (kg), and ADG (g/d) (Table 4).

Blood Characteristics

Table 5. Initial Collection of Blood Components of Meat Goats Raised on Winter Forages during a 90-day grazing period.

Parameters	Treatments			SEM*	Significance Level
	Cosaque Oats	Ryegrass-Crimson Clover	Control		
Albumin (ALB), g/dL	2.3	2.2	2.8	0.17	NS
Total Protein (TP), g/dL	6.6	6.3	6.9	0.35	NS
Blood Urea Nitrogen (BUN) mg/dL	8.2	11.3	9.9	1.04	NS
Creatine (CREA)mg/dL	0.4	0.4	0.4	0.03	NS
Glucose (GLU) mg/dL	75.1	64.1	82.6	4.27	P<0.05
Eosinophils (EOS) %	0.004	0.01	0.5	0.17	NS

Basophils (BASO) %	0.01	0.02	0.6	0.24	NS

*SEM= Standard Error of Mean.

Table 6. Final Collection of Blood Components of Meat Goats Raised on Winter Forages during a 90-day grazing period.

Blood Component Levels of Meat Goats Raised on Winter Forages, Final Collection					
Parameters	Treatments			SEM*	Significance Level
	Cosaque Oats	Ryegrass-Crimson Clover	Control		
Albumin (ALB), g/dL	2.1	2.0	2.2	0.17	NS
Total Protein (TP), g/dL	5.6	5.7	6.6	0.35	NS
Blood Urea Nitrogen (BUN) mg/dL	11.0	15.8	20.7	1.04	$P < 0.05$
Creatine (CREA)mg/dL	0.3	0.3	0.4	0.03	NS
Glucose (GLU) mg/dL	54.7	55.4	55.1	4.27	NS
Eosinophils (EOS) %	1.0	3.2	1.4	0.17	NS
Basophils (BASO) %	1.0	1.6	0.6	0.24	NS

*SEM= Standard Error of Mean.

Throughout the 90-day study, blood was collected two separate times;an initial collection was done at the beginning of the study and a final collection was done at the end of the study. When analyzing blood parameters, the components tested were Albumin, Total Protein, Blood Urea Nitrogen, Creatine, Glucose, Eosinophils, and Basophils. Tables 5 and 6 display the analyzed blood constituents towards the beginning and end of the study. Comparison of these tables shows that during the initial collection there were no differences between a majority of the blood chemistry constituents, except for blood glucose which was shown to be significantly different between treatments ($P<0.05$). Similar trends were observed for the final collection except, Blood

Urea Nitrogen which exhibited a significant difference between treatments (P<0.05) (Tables 5 and 6).

Carcass Traits

Main carcass characteristics that were measured include the hot carcass weight, total dressing percentage, and ribeye area (Table 7). The following table presents the means for each treatment along with their standard errors. The means with their different superscripts differ between treatments (P<0.05). The dressing percentage for Ryegrass-Crimson clover was significantly higher (P<0.05) than for Cosaque oats and the control treatment. With regards to the rib eye area, Cosaque Oats and Crimson Clover Ryegrass mixture results were higher than that of the control group (P<0.05) while there were no noticeable differences (P>0.05) between the individual Cosaque Oats and Crimson Clover Ryegrass mixtures.

Table 7. Carcass Characteristics of Meat Goats raised under different Winter-Feeding Practices over a period of 90 days.

Item	Cosaque Oats	Ryegrass-Crimson Clover mix	Control
Live Weight, kg	52.7±3.32	49.5±3.21	32.6±3.21
Hot Carcass Weight (HCW), kg	24.8±1.12^{b}	24.7±1.12^{b}	18.1±3.21 ^{a}
Dressing percent (DP%)	39.4±0.99^{b}	41.1±0.96 ^{a}	39.8±0.96^{b}
Rib Eye Area (REA), cm ^{2}	1.32±0.06^{b}	1.33±0.09^{b}	1.07±0.06 ^{a}

* Means followed by different superscripts within the same rows differ (P < 0.05).

Discussion

Nutrient composition

The crude protein levels in the free choice hay given to the control group were reported to similar levels in a current study by Hill et al. (2019). Although according to the NRC, (2007) the crude protein level that classifies hay as poor quality is 8%; the majority of other studies have similar crude protein levels within hay(Hill *et al.*, 2019). In relation to a study done by Terrill et al., (2004) crude protein, NDF, and ADF values although differed slightly, still stayed within a similar range and followed the decreasing pattern for the clover mixtures that were evaluated in both studies. While Terrill et al. (2004) evaluated cool-season clovers their effects and results were similar to this current study.

While examining the results of the nutritive values, the Ryegrass-Crimson Clover mix showed similar trends with the Cosaque Oats in each of the aspects measured. In reference to the nutrient charts listed; as the grazing season progressed, Dry Matter, ADF, and NDF increased, while

Crude Protein, Crude Fat and Ash decreased. This was expected because many studies have shown similar results. For instance, Young-Mathews (2018) evaluated black oats along with two other forages as a cover crop. According to Young-Mathews (2018), winter survival was high for all three varieties of oats tested and had few observed pests and moderate disease susceptibility. This is similar to the results that was observed during the current study. The recorded winter survival rate of the Young-Mathews, (2018) study was 100%. This is similar in the manner that throughout our current study none of the forages examined yielded to winter kill, nor had any noticeable pests or diseases.

Forage heights recorded in Table 5 display a clear increase over time throughout each collection of the study. Due to the Southeastern region's relatively mild climate during the cool season, a study reviewed by Mullenix and Rouquette (2018) explained that cool season forages have a better chance of not only surviving but thriving, which can result in the consistent growth that was recorded within this study. The higher forage heights indicate higher forage biomass availability (NRC, 2007). Average biomass or forage yield, which was recorded via measuring sticks, as well as with a standard quadrat. The Ryegrass-Crimson clover mixture held a steady increase as time continued. With a 590 kg /ha difference between the two forages during collection 2 and a 997 kg /ha difference between collection 3, this study displays the dense yield that Ryegrass and Crimson Clover had when grown together.

Production Performances

Table 3 shows the average FAMACHA along with Body Condition Scores (BCS) for each of the collection periods. There were significant differences between treatments ($P<0.01$) pertaining to BCS within collection 2; with the lowest average of 1.9 belonging to the control group. This means that Treatments 1 and 2 of Cosaque Oats and Ryegrass-Crimson Clover Mix, respectively, had better outcomes than Treatment 3 which is typical of the traditional winter-feeding method. An animal's body condition indicates the amount of lipid and protein reserves available for maintenance reproduction and production (Ghosh *et al.*, 2019). It is helpful to detect changes and sudden losses in a condition which are difficult to observe from the external appearance of an animal. BCS is used for evaluating the current and past feeding program, judging the health status of individual animals. (Ghosh *et al.*, 2019). A Study by Ghosh et al. (2019) explained that many factors play a role in shaping BCS. Those factors include, but are not limited to, parasitic load, viral, bacterial, or metabolic diseases along with age. This is typical and consistent with our current study, as age increases body fats fluctuate until consistency occurs later. The FAMACHA scores were significantly different among treatments in all collection periods with the control group showing better scores. Since there was no rotational grazing practiced with forage groups, goats on winter forages may have higher worm loads compared to the control group.

When examining the data pertaining to body weight, and ADG (Table 4) the values favored the non-traditional methods of grazing, while the control treatment was significantly lower ($P<0.05$) in comparison to the other treatments. Results display the significant differences within ADG ($P<0.001$)**.** Initial BW showed no significant differences ($P>0.05$); however, final BW between treatments showed significant differences ($P<0.05$) between treatments. The values for the average daily gain evaluated for this study were favorable and were similar to the final weight gain presented in the study completed by Lu and Potchoiba (1990). The aforementioned study utilized different breeds of goat, 45 Nubian and 45 Alpine goats were evaluated using different

protein diets to determine weight gain and various levels of energy. Final Weights recorded within the Lu and Potchoiba (1990) study ranged from 30.3 kg to 32.5 kg. With our current study, the non-traditional treatments were within a similar range, leaving the traditional feeding method, the control group, with a lower range.

Blood Parameters

As seen within Table 5 and 6 the blood components (Tables 5 and 6) examined included Albumin (ALB), Total Protein (TP), Blood Urea Nitrogen (BUN), Creatine (CREA), Glucose (GLU), Eosinophils (EOS), and Basophils (BASO). Blood results showed that there were no significant differences ($P>0.05$) between treatments except for GLU levels in the initial collection and BUN in the final collection ($P<0.05$). The measurement of BUN may be useful as a tool for making real-time adjustments in protein supplementation (Hammond et al., 1994). BUN is a by-product of protein metabolism. The average levels of BUN for goats fall within 12-28 mg/dL. The Goats offered Ryegrass-Crimson Clover mix had a BUN level of 15.8 mg/dL, and those offered Cosaque Oats had BUN levels of 11.0 mg/dL during the final collection period (Table 6). Turner et al. (2005) reported similar findings within their study and noted that ruminants are not efficient utilizers of dietary protein. In ruminants, BUN can be influenced by dietary N-to -energy ratio level of forage intake and protein degradability in the rumen (Hammond et al., 1994). The other blood parameters evaluated in the current study were similar between treatments and the numbers were within the range for normal goats.

Carcass Characteristics

The forages Cosaque Oats and the Ryegrass-Crimson Clover mix did significantly better ($P<0.05$) than the traditional feeding method in the majority of the aspects measured. In Table 7, the control treatment live weight recorded was significantly lower ($P<0.05$), which therefore resulted in the lower marks in regard to the hot carcass weight and dressing percentage. Interestingly enough, the control treatment and the Cosaque Oats treatment had no significant difference ($P>0.05$) between dressing percentages, which seems to imply that there could be a possibility that dressing percentage may not be solely dependent on forage type. The ribeye area for the control treatment was expected to be low due to the nature of the traditional feeding method. The rib-eye area is directly related to the amount of muscle in the carcass, especially in the loin and round, and should be considered in animal studies as an indicator of muscle development and yield of high valuable cuts (Williams, 2002).

In a study completed by Solaiman et al. (2011), fourteen Boer-cross whethers and intact male goats were randomly selected to evaluate growth performance, carcass characteristics, and meat quality raised on Marshall Ryegrass. According to them, dressing percentages were 51.0% and 47.0% for whethers and bucks, respectively, while our current study resulted in levels much lower per treatment with 39.4%, 41.1%, and 39.8% for the Cosaque Oats, Ryegrass-Crimson Clover mix, and the control, respectively. Solaiman et al. (2011) demonstrated that carcass fat content is highly variable and can be influenced by breed, age, sex, nutrition, BW, physiological condition, and physical activities. Goats tend to deposit most of their fat in the visceral rather than carcass depot and produce leaner carcasses (Solaiman et al., 2011).

Conclusion

The results of the current study have demonstrated that winter forages such as Cosaque oats and Ryegrass-Crimson Clover mix have potential as suitable forages for meat goats in the winter

months in the Southeastern U.S. While feed costs were not estimated in the current study, forages were higher in terms of growth performance and better in carcass traits compared to the traditional method of raising goats during winter months. Additional studies are warranted to compare these feeding practices so a sustainable winter-feeding practice can be recommended to small and limited resource goat producers in the Southeastern U.S.

References

AOAC. (1990). Official Methods of Analysis, 15th ed. Arlington, VA: Association of Official Analytical Chemists.

Anaeto, M., J. Adeyeye, G. Chioma, A. Olarinmoye, and G. Tayo. (2010). "Goat Products: Meeting the Challenges of Human Health and Nutrition." Journal of *Agriculture and Biology Journal of North America* 1: 1231–1236.

Devendra, C., and S. Solaiman. (2010). "Perspectives on Goats and Global Production." S. G. Solaiman (ed.). *Goat Science and Production.* Ames, IA: Wiley-Blackwell, Blackwell Publishing.

Dhanda, J.S., D.G. Taylor, P.J. Murray, R.B. Pegg, and P.J. Shand. (2003). "Goat Meat Production: Present Status and Future Possibilities." *Journal of Asian-Australasian Animal Sciences* 16: 1842–1852.

Dillard, S.L., D.W. Hancock, D.D. Harmon, M.K. Mullenix, P.A. Beck, and K.J. Soder. (2018). "Animal Performance and Environmental Efficiency of Cool- and Warm-Season Annual Grazing Systems." *Journal of Animal Science* 96: 3491–3502.

FASS Ag Guide. (2010). *Guide for the Care and Use of Agricultural Animals in Research and Teaching*. 3rd ed. Champaign, IL: Federation of Animal Science Societies.

Ghosh, C., S. Datta, D. Mandal, A.K. Das, D.C. Roy, A. Roy, and N.K. Tudu. (2019). "Body Condition Scoring in Goat: Impact and Significance." *Journal of Entomology and Zoology Studies* 7: 554–560.

Glimp, H.A. (1995). "Meat goat Production and Marketing." *Journal of Animal Science* 73: 291–295.

Green, L.R., and L.A. Newell. (1982). "Using Goats to Control Brush Regrowth on Fuel breaks." *USDA General Technical Report* PSW-59: 1–13.

Hammond, A.C., E.J. Bowers, W.E. Kunkle, P.C. Genho, S.A. Moore, C.E. Crosby, K.H. Ramsay, J.H. Harris, and H.W. Essig. (1994). "Use of Blood Urea Nitrogen Concentration to Determine Time and Level of Protein Supplementation in Wintering COWS1,2." *Journal of The Professional Animal Scientist* 10: 24–31.

Hart, S., R. Merkel, and T. Gipson. (2018). "Current Situation and Future Prospects of the U.S. Goat Industry." In Olga Bolden-Tiller and U. Karki (eds.), *Proceedings of the 3rd National Goat Conference*. Tuskegee University, AL.

Hart, S. (2015). "Meat Goat Nutrition." In R.C. Merkel, T.A. Gipson, and T. Sahlu (eds.), *Meat Goat Production Handbook.* 2nd ed, Langston University, Langston, OK.

Hill, T.M., T.S. Dennis, F.X. Suarez-Mena, J.D. Quigley, K.M. Aragona, and R.L. Schlotterbeck. (2019). "Effects of Free-Choice Hay and Straw Bedding on Digestion of Nutrients in 7-week-old Holstein Calves." *Journal of Applied Animal Science* 35: 312–317.

Karki, L., and U. Karki. (2019). "Impact of an Educational Program on a Year-Round Forage Production and Grazing Management System in Alabama." *Professional Agricultural Workers Journal* 7 (1): 49-64.

Lu, C.D., and M.J. Potchoiba. (1990). "Feed Intake and Weight Gain of Growing Goats Fed

Diets of Various Energy and Protein Levels." *Journal of Animal Science* 68: 1751–1759.
Meat and Livestock Australia. (2019). "Global Snapshot 1Goatmeat." 1–8.
Mullenix, M.K., and F.M. Rouquette. (2018). "Review: Cool-Season Annual Grasses or Grass–Clover Management Options for Extending the Fall–Winter–Early Spring Grazing Season for Beef Cattle1." *Journal of Professional Animal Scientist*.
National Research Council (NRC). (2007). *Nutrient Requirements of Small Ruminants: Sheep, Goats, Cervids and New World Camelids*. National Research Council, National Academy of Science, Washington, DC.
Pinkerton, F., B. Pinkerton, and D. Scarfe. (1991). "Meat Goat Production and Marketing." *(Kika) de la Garza Institute for Goat Research Fact Sheet No. M-01*. Langston University, Langston, OK.
Robel, R.J., J.N. Briggs, A.D. Dayton, and L.C. Hulbert. (1970). "Relationships between Visual Obstruction Measurements and Weight of Grassland Vegetation." *Journal of Range Management* 23: 295.
Sahlu, T., L.J. Dawson, T.A. Gipson, S.P. Hart, R.C. Merkel, R. Puchala, Z. Wang, S. Zeng, and A.L. Goetsch. (2009). "ASAS Centennial Paper: Impact of Animal Science Research on United States Goat Production and Predictions for the Future." *Journal of Animal Science* 87: 400–418.
Solaiman, S., C. Kerth, K. Willian, B.R. Min, C. Shoemaker, W. Jones, and D. Bransby. (2011). "Growth Performance, Carcass Characteristics and Meat Quality of Boer-Cross Wether and Buck Goats Grazing Marshall Ryegrass." *Journal of Asian-Australasian Animal Sciences* 24: 351–357.
Solaiman, S.G. (2007). "Assessment of the Meat Goat Industry and Future Outlook for U . S . Small Farms" 1–29.
Terrill, T.H., W.F. Whitehead, G. Durham, C.S. Hoveland, B.P. Singh, and S. Gelaye. (2004). "Preference of Grazing Goats for Cool-Season Annual Clovers." *Journal of South African Animal Sciences* 34: 92–94.
Turner, K.E., S. Wildeus, and J.R. Collins. (2005). "Intake, Performance, and Blood Parameters in Young Goats Offered High Forage Diets of Lespedeza or Alfalfa Hay." *Journal of Small Ruminant Research* 59: 15–23.
Young-Mathews, A. (2018). Cover Crop Variety Adaptation Trials in Corvallis, OR Second Year Progress Report. Corvallis, OR.
Williams, A. R. (2002). "Ultrasound Applications in Beef Cattle Carcass Research and Management." http://asas.org/symposia/esupp2/jas2278.pdf [Retrieved June 10, 2020].