EVALUATION OF GROWTH AND PERFORMANCE OF WHITE-TAILED DEER FAWNS CONSUMING DIFFERENT MILK REPLACERS

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DEDICATION

I dedicate this thesis to all of those who have helped mold me into the woman I am today. This work is dedicated to my parents, Richard and Norma Brindza, and my brother, Anthony Brindza, I would not be where I am today without your unconditional love and support.

ABSTRACT

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In recent years, the number of ranches in the state of Texas designated for the breeding and production of white-tailed deer has risen. As the number of ranches increases, it is important for there to be a quality milk alternative for fawns rejected by their mother, fawns that are too weak to nurse, or in the event that the mother is unable to produce a quality milk. The objective of this research was to evaluate growth and performance of white-tailed deer fawns on two commercially available milk replacers as well as to determine fawn preference for these milk replacers. A total of 51 fawns were utilized in this project with 26 fawns (n = 26) consuming the control and 25 fawns (n = 25) consuming the treatment. Shortly after birth fawns received a B-12 supplement, fawn paste, and an ear tag for identification purposes. At this time, initial morphological measurements were taken and a blood sample was drawn from the fawn. Growth measurements were taken every 3 weeks and included body weight, cannon bone length, leg length, body length, and heart girth circumference. Fawns were assigned a milk replacer on a rotational basis where they consumed that specific milk replacer for the entire trial, approximately 90 days. Consumption and refusals were measured at each feeding in a specific folder for each fawn. Upon completion of the trial results indicated that fawns consuming the control had statistically larger body weights, cannon bone length, and heart girth circumference measurements compared to the fawns consuming the treatment.

KEY WORDS: White-tailed deer, Fawns, Milk replacers, Growth

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PREFACE

"The wildlife and its habitat cannot speak, so we must and we will." *–Theodore Roosevelt*

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CHAPTER I

Introduction

White-tailed deer are one of the most popular big game wildlife species in the state of Texas and within recent years, the number of ranches designated to breeding white-tailed deer has increased dramatically. With the increased interest in these animals, research regarding milk replacers has become necessary for the survival of fawns, as the majority of the research that is available is outdated. For example, a study conducted by Silver (1961) compared deer milk with a milk substitute and a study conducted by Smith et al., (1975) studied the protein requirements for white-tailed deer fawns. Both of these studies would be beneficial to white-tailed deer if they were to be conducted in present day using new methods and technologies.

Background

For years, farmers have provided milk replacers to young livestock when they become injured, are too weak to nurse, or in the event that they are rejected by their dam (mother). Milk replacers are significant to animals as well as to breeders because these supplements aid in growth, health, and overall performance of the animal while also allowing human interaction and the acclimation of the animal to handling and management processes. The process of bottle raising has become notably important in the deer breeding industry due to the significant increase in capture raising of white-tailed deer in Texas, as they are the most sought after big game animal in the state as well as being aesthetically pleasing to wildlife enthusiasts. Unfortunately, the majority of research regarding white-tailed deer is outdated and there has been little research focusing on milk replacers and how they affect the growth and development of fawns.

There is currently only one milk replacer on the market that is formulated specifically for fawns which has become the industry standard. Therefore, breeders across the state are purchasing a single milk replacer with no competition in the market. Due to the limited availability of milk replacers formulated for fawns, often times breeders offer a lamb's milk supplement or a "multi-species" supplement to the fawn which is not designed for white-tailed deer and can cause complications in their digestive system. When developing a new milk replacer, the specific needs of the fawn should be taken into consideration in order to help fawns grow to their maximum genetic potential. The introduction of a new milk replacer that is specifically for fawns would help create competition in the market, which can help lead to better prices and better products for deer breeders.

Ranchers in the state of Texas are designating land specifically for the production of deer in captivity on high-fenced ranches to increase survivability and to yield enhanced genetics. Conducting research on milk replacers would greatly benefit white-tailed deer breeders by providing information relevant to the production of healthy fawns. Keeping these fawns healthy and helping them grow to their genetic potential is important because the fawns will be used to breed and produce more fawns, as well as to be hunted for meat, sport, and trophies.

Texas state law requires one to be a permitted breeding facility or a licensed wildlife rehabilitator, both issued by the Texas Parks and Wildlife Department, in order to legally possess and bottle-raise white-tailed fawns as they are considered a native game species and the penalties for illegal possession of white-tailed deer include fines. The introduction of a new milk replacer would target and benefit a very specific but growing group of individuals as the number of permitted facilities increases.

In Texas, there are ranches that specialize solely in fawn care and rehabilitation but they can become costly for breeders, especially when a breeder requires care for more than a few fawns. For example, KDH Whitetail Nursery (2015) in Robstown, Texas charge $750 for their services including milk, colostrum, fawn pellets, hay, treats, and monthly deworming for 90 days. When considering these costs, breeders have become interested in bottle-raising fawns in their own facility to reduce expenses. Having their own bottle-feeding facility can also help to ensure that their fawns are receiving the best care possible and that their nutrition requirements are being met. It is important for breeders to be knowledgeable of the physiology of white-tailed does and fawns in order to improve overall herd health and reproduction.

White-tailed deer typically produce two fawns and are capable of providing quality care and milk for both of their fawns when environmental conditions are favorable. However, if breeders have milk replacers readily available to them, they also have the opportunity to bottle raise one of the two fawns that a doe will produce to maximize each fawn's potential even during periods of poor environmental conditions. If breeders have access to a quality milk replacer, the intention with this procedure is that both fawns will receive better quality care given the fact that the doe now only has to exert enough energy to care for one fawn instead of two. The goal of this is to maintain high quality does and produce high quality fawns.

Objective

The objectives of this research are to:

- Evaluate growth and performance of fawns consuming two different commercially available milk replacers.

- Determine fawn preference of two milk replacers by comparing consumption and refusals.

CHAPTER II

Literature Review

The White-tailed Deer

In North America, white-tailed deer are one of the most popular big game animals for hunters and wildlife enthusiasts and contribute to the financial revenue of the hunting industry (Webb, 2018). White-tailed deer (*Odocoileus virginianus*) are members of the cervidae family, referred to as cervids. Across North America, the *Odocoileus* genus, which consists of red deer, mule deer, sika, and moose, is known to have the greatest numbers and greatest economic value (Green et. al, 2017).

White-tailed deer are characterized by the presence of antlers, outgrowths of the frontal bone, in bucks (males) and their ability to shed and regrow them yearly (Mattioli, 2011). During winter months, they have a grayish-brown coat but as summer approaches, their coat will turn to a reddish-brown. Other characteristics include a white noseband and eye rings along with a chin and throat patch. Optimal habitat conditions can sustain whitetail bucks ranging in weight from 130 to 220 pounds and does ranging in weight from 100-130 pounds.

The White-tailed Deer Industry in Texas

White-tailed deer are abundant in Texas and can be found across the state. Compared to other states, Texas has the largest population of white-tailed deer with an estimation of approximately 4 million with populations concentrated in the south and central regions of the state (Leschper, 2017). Hunting deer is also a popular sport in Texas where an estimated 500,000 are harvested annually which is more than any other state (TPWD, 2019). Deer have become the most numerous big game animal in Texas while being aesthetically and emotionally pleasing to Texans (Cook, 1992).

In Texas, 97% of the land is privately owned where landowners are able to manage for wildlife at their discretion (TBGA, 2017). High-fenced ranches have become popular due to the ability of ranches to limit the natural movement of the deer by confining them to specific areas. Within these high fenced ranches, ranchers are able to obtain a permit to be granted the ability to breed, trade, and sell the deer that they have confined. The deer breeding industry is comprised of breeding does to produce fawns and the bucks are used to breed said does or to be hunted. It is estimated that deer breeding operations in Texas have an impact of $318.4 million and a total impact combining hunting and breeding of $652 million annually. The industry is comprised of approximately 1,006 permitted facilities and supports 7,335 jobs (Anderson et. al, 2007).

There are multiple ways that a permitted facility can help stimulate the economy. Breeders are responsible for all monetary aspects of their ranch such as herd management, which includes but is not limited to medications, feed, and buying, selling, or trading members of their herd. Owning a large-scale breeding operation can also open opportunities to hire employees or interns, which can both be great experiences to those interested in the industry. Due to the monetary value that these animals hold, an important part of this industry is maintaining fawn health to introduce healthy weanlings into an established herd.

Reproduction of White-tailed Deer

White-tailed deer are considered seasonally polyestrous, meaning that they go through estrus during a specific time of the year and have an estrous cycle that is approximately 28 days in length. This season of estrous is referred to as “rut” which will generally occur during the fall season of October through December, but will occasionally last through January (Green et al., 2017). The shortening of the day length or photoperiod triggers the breeding season, meaning that they are photoperiod receptive, and fawning coincides with the period of the year where there is an abundance of quality food available to meet the most demanding phase of reproduction (Lincoln, 1992). If a doe does not become pregnant during her first estrous cycle, she will cycle again in 28 days and become receptive, giving the doe another opportunity to conceive (Maryland DNR, 2019). A gestation period of approximately 200 days, around 7 months, is used to determine fawning dates (TPWD, 2018). White-tailed deer are characterized with great reproductive fertility, early sexual maturation, and a short breeding life of less than ten years.

Does can exhibit multiple parturitions where they can give birth to one, two, or on the rare occasion, three fawns weighing approximately 4 to 8 pounds each (Gastal et. al, 2017). Rademacher (2013) writes from a study conducted in 2009 that about half of all fawns are twins given a high quality habitat**.** Another study conducted by Verme (1969) reported that a doe bearing a single fawn may have been in sub-par condition prior to and during the rut since healthy does generally produce twins or triplets, however, if the nutrient requirements of a pregnant doe are not being met, she will not be able to maintain a healthy pregnancy. Other than exceptional nutrition, another factor affecting reproduction is the age of the doe. Older does proved to produce a larger litter size according to Green et al., (2017) who executed a successful study that demonstrated that doe fawns who were approximately 6 months of age at conception averaged 1.2 fawns per doe, yearlings that were approximately 18 months of age averaged 1.8 fawns per doe, and does considered adults or over 2 years of age averaged 2.0 fawns per doe.

Nutrition and Diet of White-tailed Deer

Deer are browsers and consume leaves, grass blades, acorns, fruits, and other items produced from plants that are high in protein. These items contain cellulose, which are carbohydrates that deer cannot directly digest. Instead, microorganisms located inside their specialized four-chambered stomach will digest their diet. Animals that have four-chambered stomachs are classified as ruminants. These four chambers include the rumen, reticulum, omasum, and abomasum, which all play significant roles in digestion.

According to the University of Missouri Extension (2019), when considering does, an ample diet is important due to lactation drawing out necessary nutrients such as protein. The suggested level of protein in the diet to produce a quality milk averaging 8.2 % protein is 11 to 15 %. Not only is protein important to does, protein is also the main nutrient responsible for antler growth in males. Once antlers have hardened, they are composed of 45% protein.

Adequate nutrition is extremely important to a doe during gestation. With conception occurring during winter, the doe requires an abundance of nutrients to create a healthy start to the new pregnancy. However, conception takes place in a period of the year where food sources can be scarce. For pen-raised deer, a breeder should supply enough feed for the doe to meet the requirements of maintaining her pregnancy. Throughout gestation, the most nutrient demanding stage is the last 90 days when 80% of the fetal growth occurs, generally early to late spring. Proper nutrition during this time is crucial for the development of the fetus and lactation (Horrocks, 2019).

White-tailed deer prefer an early successional habitat, which provides excellent cover for newborn fawns as they attempt to shield themselves from predators. This habitat mixed with mature trees provides an excellent environment to promote the production of summer browse for an increased level of nutrition (Waller and Alverson, 1997). Although there has been little research conducted on the protein requirements of newborn fawns, Wright et al., (2002) evaluated the quality of the diet of deer and found that weaned fawns can require up to 20% crude protein in their diet for adequate growth. Extensive research in other species, specifically livestock, can help companies create general guidelines for producing an adequate milk replacer.

For a breeder that chooses to bottle-raise fawns, it is important to allow the opportunity for the fawn to receive colostrum from the dam before transporting the fawn into a bottle-feeding facility. If fawns have not received colostrum within the first 24 hours after birth, the breeder should administer a supplemental colostrum to the fawn (Shipley, 2019). Typically, around 24 hours, once the gut of the fawn has closed and will no longer absorb any antibodies from the dam, a breeder is safe to pull a fawn in to be hand-reared. As fawns age, it is necessary to introduce browse, water, and feed around two weeks of age as they naturally begin to ruminate. This will encourage the young animal to browse once they complete nursing (Reichert, 1972).

Lactation of White-tailed Deer

Along with gestation, lactation is an incredibly demanding stage of reproduction in white-tailed deer and takes place during the time of the year where forage is most readily available to them (Bowyer, 1991). Does that are not meeting their nutritional requirements will have difficulty providing a quality and quantity milk for their fawns that can lead to fawns not growing to their full genetic potential. The quality of lactation can also depend on location. Regions in Texas are known to have especially hot and potentially dry summers that can cause forage crops to desiccate rapidly and prevent the doe from consuming enough to maintain lactation.

Milk replacers can help breeders during harsh summers where does are having a hard time meeting the nutritional requirements of their fawns. When comparing the composition of milk produced from domestic livestock, white-tailed deer milk is generally higher in protein and fat (Robbins and Moen, 1975). This is important when considering that there is minimal research available on milk replacers and it is common for breeders to offer a supplement that is not specifically designed for fawns such as a lamb milk supplement or a multi-species milk replacer.

Fawn Behavior

Dams do not spend a great deal of time with their fawn after birth. After initial nursing and cleaning, fawns will then choose a bedding area where they will lay and wait for their dam, who could be anywhere from 50 yards to a mile away. Nursing will usually last from 2 to 10 minutes and often only twice a day (White et al., 1972). The natural instinct of the fawn is to bed down or to hide and the limited amount of time that the dam spends with their fawn will decrease the chance of attracting predators to the area. A behavioral study conducted in south Texas by Jackson et al. (1972) produced results of fawns only being active for 8% of the entire day. In their first few days, in time spent alone, fawns will be in a curled position with the head resting against the side. Siblings are also separated from each other at birth to decrease the chance of predation. As fawns near one week of age they may spend time “playing” or even beginning to browse on their own.

Typical predators of fawns in Texas are coyotes, bobcats, and even humans. When presented with danger, fawns are known to have a “freeze” position where they often lay on the ground with their legs tucked under their flat body, neck outstretched with their chin on the ground, and their ears laid back. Their spotted coats act as a camouflage for the newborn fawn which will also aid in hiding from predators.

Fawn Care Guidelines

At birth, fawns weigh approximately 4 to 8 pounds and are expected to double in weight by approximately 2 weeks of age. In order to achieve this goal, appropriate nutrition is incredibly important. The first and most important item that a fawn must consume is colostrum from its mother. Colostrum is considered the “first milk” that the fawn receives which contains important antibodies to aid in survival. Without receiving colostrum, fawns have an extremely low chance of survival as they are not receiving antibodies to protect against pathogens. After ensuring that the fawn has had the opportunity to nurse, the fawn can then be brought into a bottle-feeding facility. These facilities should be sterilized and all humans who come into contact with newborn fawns are encouraged to wear gloves in order to minimize the transfer of pathogens in order to maintain healthy fawns.

For the first few weeks of the fawns’ life, the fawn must be stimulated in order to defecate and urinate. Breeders can closely resemble the technique of the mother by wiping the anus of the fawn with a rag or wet wipe soon after a feeding. Gloves should be worn during this procedure and should be changed between handling different fawns in order to decrease the chance of disease spread (NADeFA, 2019). Fawn feces should be examined daily to ensure they have not developed an illness and to give a general idea of fawn health.

Nutrient Content of White-tailed Deer Milk

Currently there is a limited amount of research that has been conducted on the composition of milk from white-tailed deer. Being able to understand the nutrition content will help create more efficient milk replacers that can be offered to white-tailed deer. A study by Silver published in 1961 found that milk from a live white-tailed doe averaged 68 % water, 11.9 % protein, and 15 % fat. This study also analyzed milk from a deceased white-tailed doe that averaged 66.5 % water, 11.5 % protein, and 18 % fat. A more current study by Wang et al., evaluated the nutritional value of deer milk and reported that deer milk is a rich source of minerals and is higher in calcium, phosphorus, and zinc than sheep, goat, and cow milk. The study also found that the milk from deer has the highest fat and protein content (18% fat, 11.5% protein) compared to the milk of dairy cattle that is used for human consumption (4% fat, 3% protein).

Milk Replacers for White-tailed Deer Fawns

It is significant to know the nutritional requirements of fawns before beginning to bottle feed. In the initial comparison of milk replacers planned for this study the control milk replacer has a guaranteed analysis of 33% crude protein, 30% crude fat, and 0.15% crude fiber while the analysis of the treatment milk replacer guarantees a minimum of 30% crude protein, 35% crude fat, while also being fortified with essential vitamins and minerals. It is important for deer breeders to analyze the milk replacer that they plan to feed to their fawns to ensure adequate nutritional values to promote growth. When comparing these two milk replacers, it will be important to consider the differences in crude protein and crude fat. Initial observations are that the control may keep fawns feeling full for a longer period of time due to the increase in crude protein, however the treatment may be more enticing to the fawns as there is more crude fat.

There has been little research conducted on administering milk replacers to white-tailed deer; however, extensive work has been conducted in livestock species such as cattle. Bartlett (2006) concludes from research that as the amount of protein in milk replacers increases, and by increasing the feeding rate, one can alter the efficiency on body weight gain in pre-ruminant dairy calves. Protein requirements need to be met year-round as it is an important aspect to consider in white-tailed deer due to its vital role in growth and maintenance of the fawn, reproduction and lactation in females, and antler development in males (Wright et, al. 2002). Fawns are the age group that is most susceptible to under consuming nutritionally important foods which can hinder their chances of survival, therefore in the setting of a high fenced breeding ranch, it is the responsibility of the breeder to provide the fawns with a milk replacer that meets their needs (Smith et al., 1975).

CHAPTER III

Materials and Methods

The Sam Houston State University Institutional Animal Care and Use Committee approved all care, handling, and sampling of white-tailed deer fawns (Protocol number: 17-06-28-1027-3-01). This project fell under the USDA Pain/Distress Category Column C as routine animal husbandry practices were observed. All personnel responsible for interacting with the fawns were trained in handling and hand rearing by the management at 3-S Whitetails in Bedias, Texas. Upon the completion of the project, all fawns were returned to the herd.

Eighty pen-raised white-tailed does, ranging in age from one to eight years, from an established herd (3-S Whitetails, Bedias, Texas) were impregnated via embryo-transfer, laparoscopic artificial insemination, and natural service. Does were housed in high-fenced pens and had ad libitum access to a diet formulated to meet or exceed their nutritional needs to maintain a healthy pregnancy. Upon completion of the gestation period of approximately 200 days, the 2017 fawn crop totaled 128 fawns. Of this total, 51 fawns were selected to be hand-reared and were bottle-fed one of two different milk replacers. Fawns were selected to be bottle-raised based on body weight, litter size, and health status at birth while also considering genetic lineage (dam and sire). Dams that gave birth to twins had one fawn at their side and the other fawn was brought into the facility to be hand-reared. This practice helped to decrease the stress on the dam by not having to care and provide quality milk for two fawns.

Upon first discovery after birth, each fawn had a panel tag placed in the ear for identification purposes which was labeled with an assigned number and unique identification number. General comments were recorded regarding vigor and health status of the fawn. Next, each fawn was administered 7.5 grams of fawn paste (C&E Wildlife, Wellborn, Texas), a paste used to increase protection against bacterial pathogens, and 2 mL of vitamin B-12. Initial morphological measurements were taken in the field using a soft measuring tape, in centimeters (cm). Initial morphological measurements consisted of body length (measured from the point of the shoulder to the point of the hip), heart girth circumference (body circumference immediately behind the shoulder), cannon bone length (measured from the point of the hock to the point of the pastern), and leg length (measured from the point of the hock to the distal tip of the hoof). Initial body weight was measured in kilograms (kg) by placing the fawn in a portable hanging scale. Twelve hours later, blood samples were collected via jugular venipuncture from all fawns using a 23 gauge butterfly needle and extension kit into sterilized 2 mL vacutainer tubes. Immediately upon retrieval, using a digital refractometer and a pipette, one drop of blood was analyzed to determine a Brix score and total protein (TP) concentration to determine success of passive transfer of immunity. The remaining blood sample was transported from the field to the laboratory where it was centrifuged at 2000 revolutions per minute for 15 minutes. Serum was harvested from the sample and was analyzed for Brix score, total protein, and Immunoglobulin Gamma (IgG) concentration. The remaining serum sample was labeled and stored at -20^{o}C.

Fawns remained with their mother for another 12 to 24 hours to nurse and ensure they received colostrum. If fawns were in immediate danger (inclement weather, rejection from mother, extremely underweight) they were brought into the fawn care facility to begin receiving a milk replacer and any other necessary medical treatment.

At approximately 24 to 48 hours after birth, the fawns selected for the trial were brought into a fawn care facility where they were bottle-fed one of two different milk replacers for 13 weeks (approximately 91 days). The control group received a commercially available fawn milk replacer (Superior, Waterloo, Indiana) and the treatment group received a recently developed product not yet on the market. Fawns were grouped based on birthdate, with all fawns in a group being within one week of age of each other. On rotational basis, half of the fawns to be bottle-fed were placed on the control milk replacer and half were placed on the treatment milk replacer.

Phase 1

Initially, bottle-fed fawns were placed in pairs within 1.2 x 3 m pens with a bed of gravel and a portable crate for shelter. This was considered Phase 1 of the trial. All fawns were offered 73.93 mL of milk replacer four times daily, at 7 AM, 11 AM, 3 PM, and 7 PM. The milk replacer was offered to fawns in individual bottles specifically labeled for each fawn. Fawns were also assigned individual file folders where milk consumption was recorded up to 4 times daily. Throughout the entire trial, fawns had an equal opportunity to consume the amount offered to them. Once the fawn walked away from the handler with their bottle, the remaining amount was deemed a “refusal”. Once fawns consecutively consumed the entire amount of milk replacer offered, the amount offered was increased by 14.79 mL. During the first few weeks of their life, all fawns were stimulated to defecate and urinate at each feeding using a wet wipe while wearing gloves. At 2 weeks of age, fawns were introduced to a commercially available pelleted starter ration (Fawn Starter, Cargill, Minnetonka, Minnesota) with a guaranteed analysis of 22%

crude protein and 5% crude fat. Fawns were also offered alfalfa hay once daily to promote browsing.

Once fawns were moved to the bottle-feeding facility, weights were taken by allowing fawns to walk through alleyways of a handling facility into a specific box with a scale. The closed system allowed for limited light and helped reduce the stress of being handled by humans. As the fawns aged and moved into larger pens, the fawns became difficult to handle so allowing them to walk through the facility was the safest and most effective option for both the handler and the fawn. Cannon bone length, leg length, body length, and heart girth circumference measurements were taken by using a soft measuring tape while being offered a bottle of water to minimize stress level without compromising milk consumption records.

Phase 2

At four weeks of age, fawns were moved from their small pens to larger pens that measured 3 x 9 meters and feeding was decreased to 3 times per day at 7 AM, 12 PM, and 7 PM. This was considered Phase 2 of the trial. The amount of milk replacer offered continued to increase, as fawns were consistent in consuming the entire amount offered. Moving fawns to larger pens allowed for the interaction between fawns of similar ages, promoted their ability to browse, and minimized the interaction with humans. Fawns were also offered 0.11 kg per day of pelleted fawn starter diet per fawn and this was increased by 0.11 kg as they consumed the amount offered.

Phase 3

At ten weeks of age, fawns were moved to different pens measuring 20 x 20 meters where feedings were decreased to twice daily, offered at 7 AM and 7 PM. This was considered Phase 3, the final stage of the trial where fawns were weaned off of the milk replacer. This phase also allowed for the interaction of fawns similar in age and decreased the amount of human interaction as they were being prepared to return to the herd. During this time, the amount of pelleted feed offered was increased to 0.23 kg per fawn per day and continued to increase as the fawns consecutively consumed the amount that was offered to them. At 12 weeks of age, fawns only received one feeding of milk replacer at 7 AM. Throughout this trial, a single offering of milk replacer never exceeded 473.18 mL.

Measurement and Medical Information

Fawns were evaluated daily for health status and were administered treatment when necessary. Other processes included cleaning eyes, nose and navel for young fawns in order to promote health. Each group had growth measurements, including body weight (kg), cannon length, leg length, body length, and heart girth circumference taken every three weeks which included at birth, and then at 3, 6, 9, 12, and 13 weeks of age. The 13th week measurement represented the final measurement before being weaned and returned to the herd.

CHAPTER IV

Results

Fawn Data

A total of 128 fawns were born between May and July of 2017. Of this total, 26 fawns were placed on the control milk replacer (n = 26) and 25 were placed on the treatment milk replacer (n = 25). It should be noted that during the course of the trial, there were fawn deaths with both treatments, which is why there was an additional fawn added to the control group. Fawns were assigned to the treatment or control group using a random rotation while also considering fawn genetics, health status, and birth date.

Body Weight

Results from weight measurements indicate that, on average, fawns in the treatment and control groups weighed exactly the same at birth and at 21 days. Body weights were similar between fawns in the treatment and control groups through day 84 of the study. However, on day 91 of the study, fawns receiving the control milk replacer had a greater ($P < 0.02$) mean body weight than fawns receiving the treatment milk replacer. Table 1 contains mean body weights of fawns by treatment for days 0 through 91 of the study.

Table 1. Least squares means for body weight (kg) of fawns bottle-raised on milk replacer by day and treatment.

Day	Control	Treatment	Standard Error	P-value
0	2.64	2.64	0.33	0.66
21	4.04	4.04	0.33	0.66
42	6.16	5.79	0.34	0.23
63	8.66	8.32	0.34	0.23
84	11.80	11.40	0.34	0.21
91	13.01[a]	12.05[b]	0.34	0.02

[ab] Means within days with different superscripts differ at $P < 0.05$

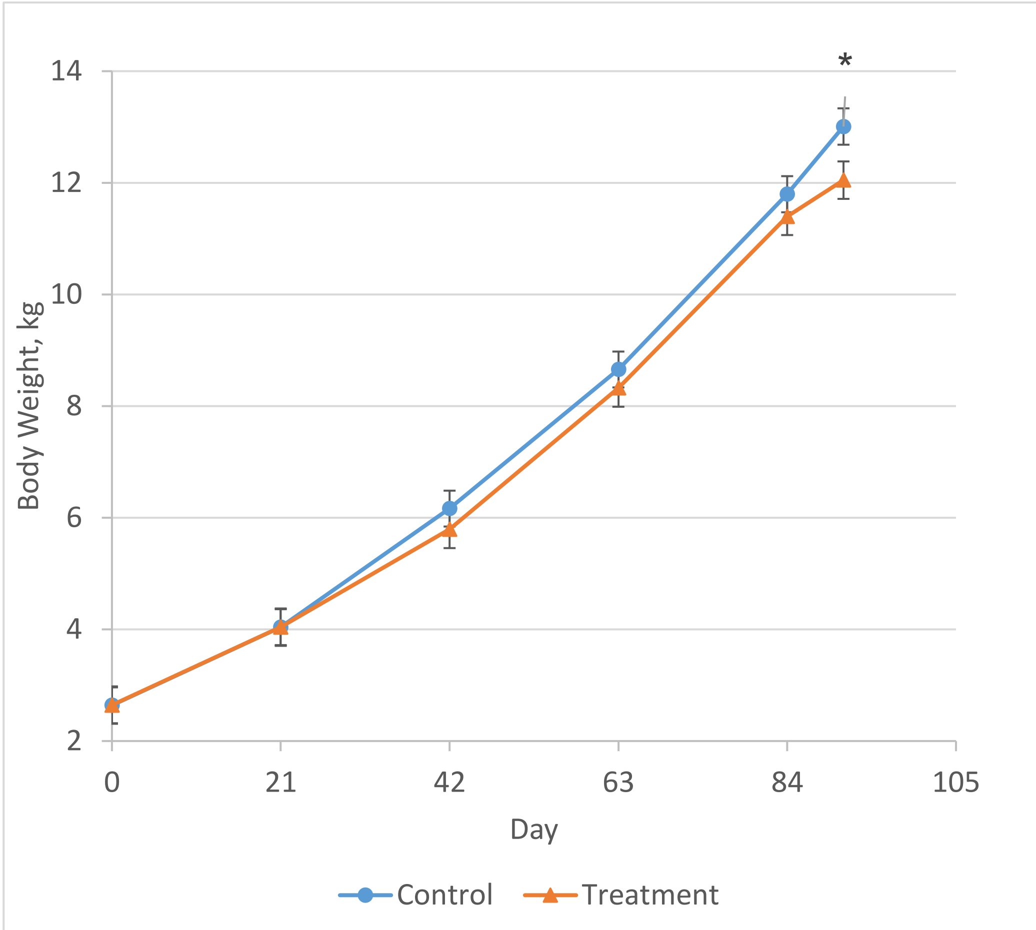

Figure 1. Mean body weight (kg) of fawns bottle-raised on milk replacer by day and treatment.

* Within day, means differ at $P<0.05$

Cannon Bone Length

Table 2 indicates that fawns on both treatments had extremely similar cannon bone lengths from birth to day 21 (P = 0.29). On day 42 and 63, fawns on the control milk replacer had a greater (P > 0.05) mean cannon bone length than fawns consuming the treatment milk replacer. However, there was no difference between the treatment and control groups for the remainder of the trial.

Table 2.

Least squares means for cannon bone length (cm) of fawns bottle-raised on milk replacer by day and treatment.

Day	Control	Treatment	Standard Error	P-value
0	18.00	17.76	0.29	0.29
21	19.12	18.88	0.29	0.29
42	20.52[a]	20.00[b]	0.29	0.05
63	21.90[a]	21.22[b]	0.29	0.02
84	23.92	23.54	0.29	0.11
91	24.41	24.00	0.29	0.15

[ab] Means within day with different superscripts differ at $P < 0.05$

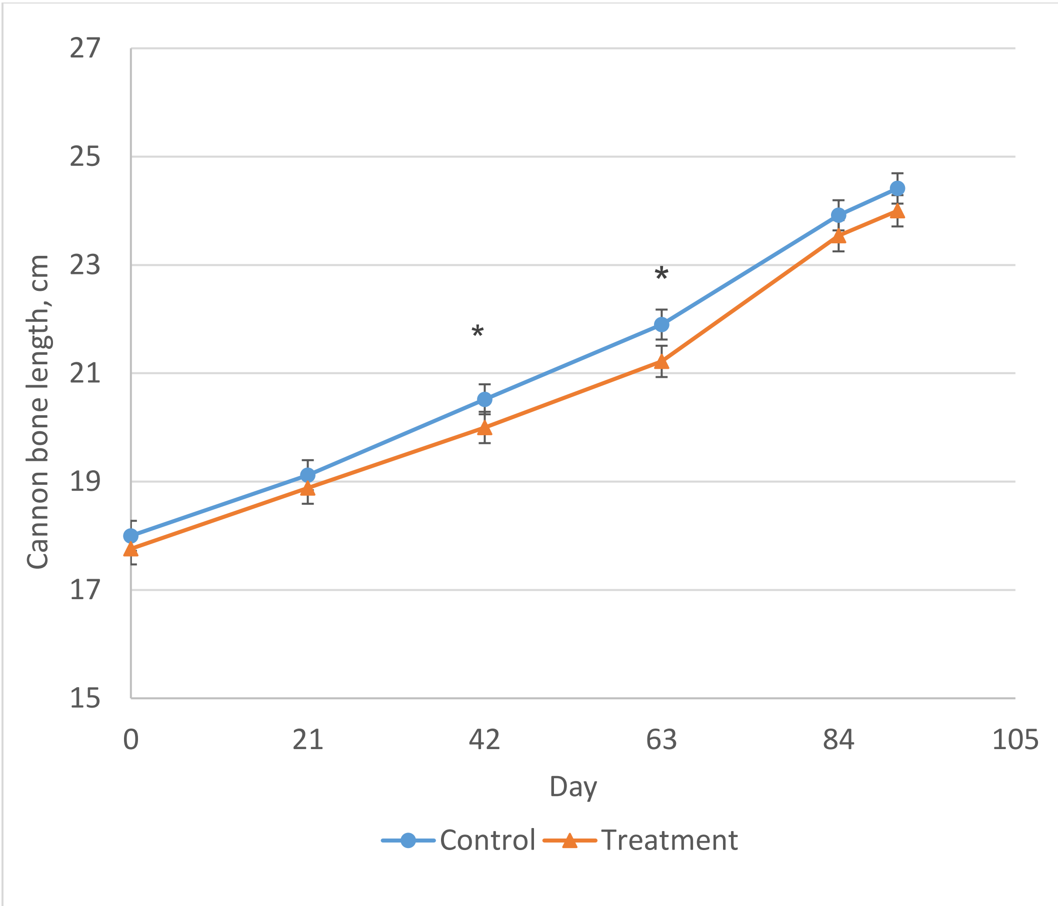

Figure 2. Mean cannon bone length (cm) of fawns bottle-raised on milk replacer by day and treatment.
* Within day, means differ at P<0.05

Leg Length

Table 3 displays the results of leg length measurements. Leg length measurement includes the cannon bone and also extends past the pastern to the tip of the hoof. On day 84 there was a tendency ($P = 0.08$) for fawns on the control milk replacer to have a greater leg length compared to fawns on the treatment milk replacer. However, mean leg length was similar between the treatment and the control groups throughout the trial.

Table 3.

Least squares means for leg length (cm) of fawns bottle-raised on milk replacer by day and treatment.

Day	Control	Treatment	Standard Error	P-value
0	22.92	22.80	0.38	0.42
21	25.30	25.16	0.38	0.40
42	27.56	27.48	0.38	0.49
63	29.94	29.68	0.38	0.28
84	32.29	31.72	0.38	0.08
91	32.83	32.42	0.38	0.23

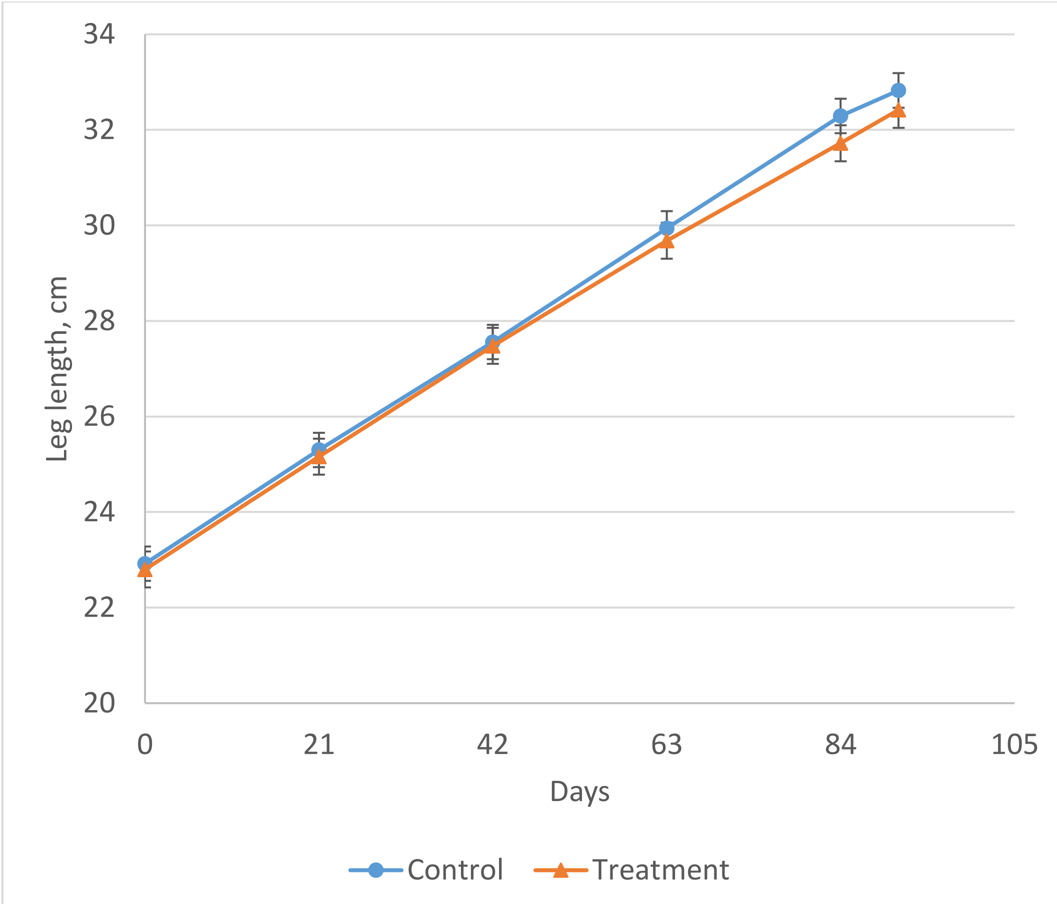

Figure 3. Mean leg length (cm) of fawns bottle-raised on milk replacer by treatment and day.

Body Length

Results for body length are displayed in Table 4. There was no difference (P > 0.28) in mean body length between the treatment and control groups throughout the trial.

Table 4.

Least squares means for body length (cm) of fawns bottle-raised on milk replacer by day and treatment.

Day	Control	Treatment	Standard Error	P-value
0	26.48	26.50	0.93	0.79
21	34.08	33.64	0.93	0.52
42	38.68	39.14	0.93	0.87
63	43.12	42.94	0.93	0.71
84	47.85	46.86	0.93	0.28
91	47.78	48.20	0.93	0.86

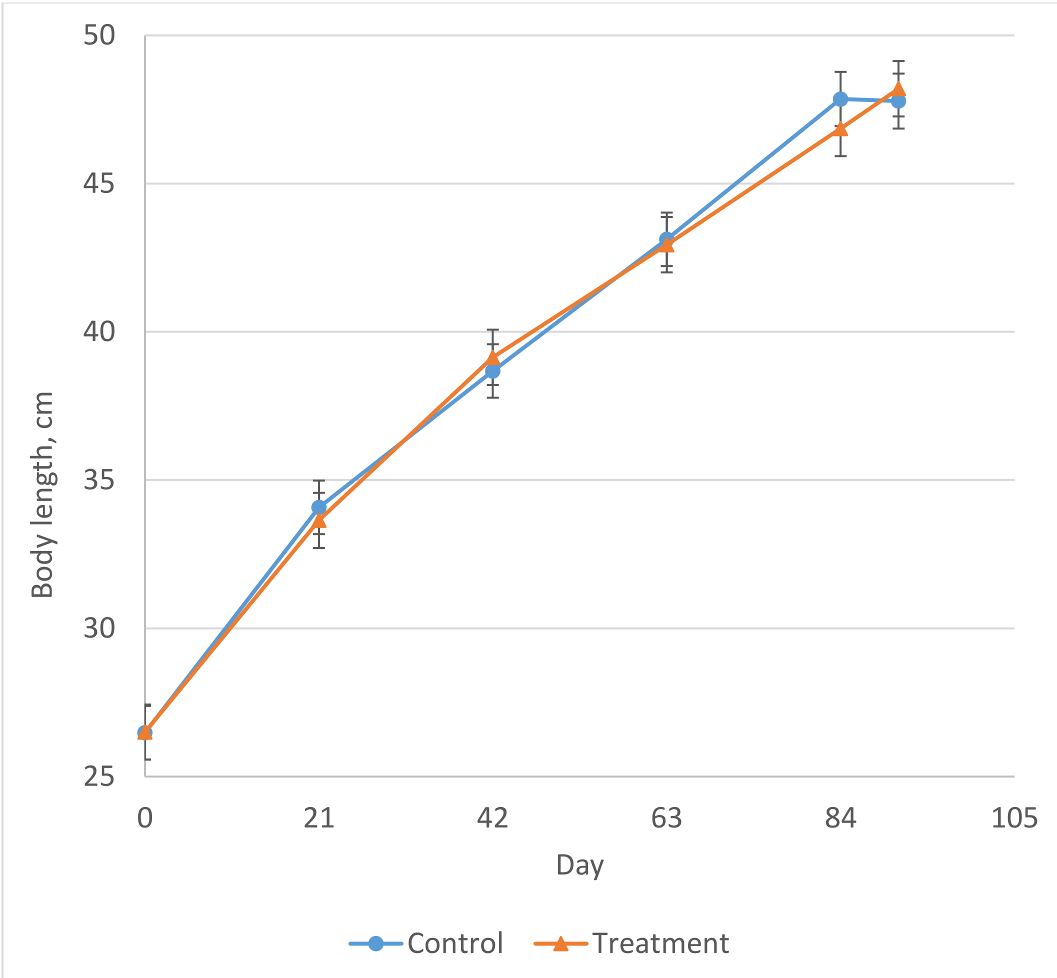

Figure 4. Mean body length (cm) of fawns bottle-raised on milk replacer by treatment and day.

Heart Girth Circumference

Means for heart girth circumference are displayed in Table 5. Heart girth circumference was similar between the treatment and control groups with differences less than 1 cm until day 84. On the final measurement date of the trial, day 91, the control group had a greater ($P > 0.03$) heart girth circumference than the treatment group.

Table 5.

Least squares means for heart girth circumference (cm) of fawns bottle-raised on milk replacer by treatment and day.

Day	Control	Treatment	Standard Error	P-value
0	30.52	30.36	0.71	0.57
21	33.40	33.82	0.71	0.94
42	38.86	38.7	0.71	0.65
63	43.20	42.74	0.71	0.43
84	48.13	47.02	0.71	0.14
91	49.80[a]	47.84[b]	0.71	0.03

[ab] Means within days with different superscripts differ at $P < 0.05$

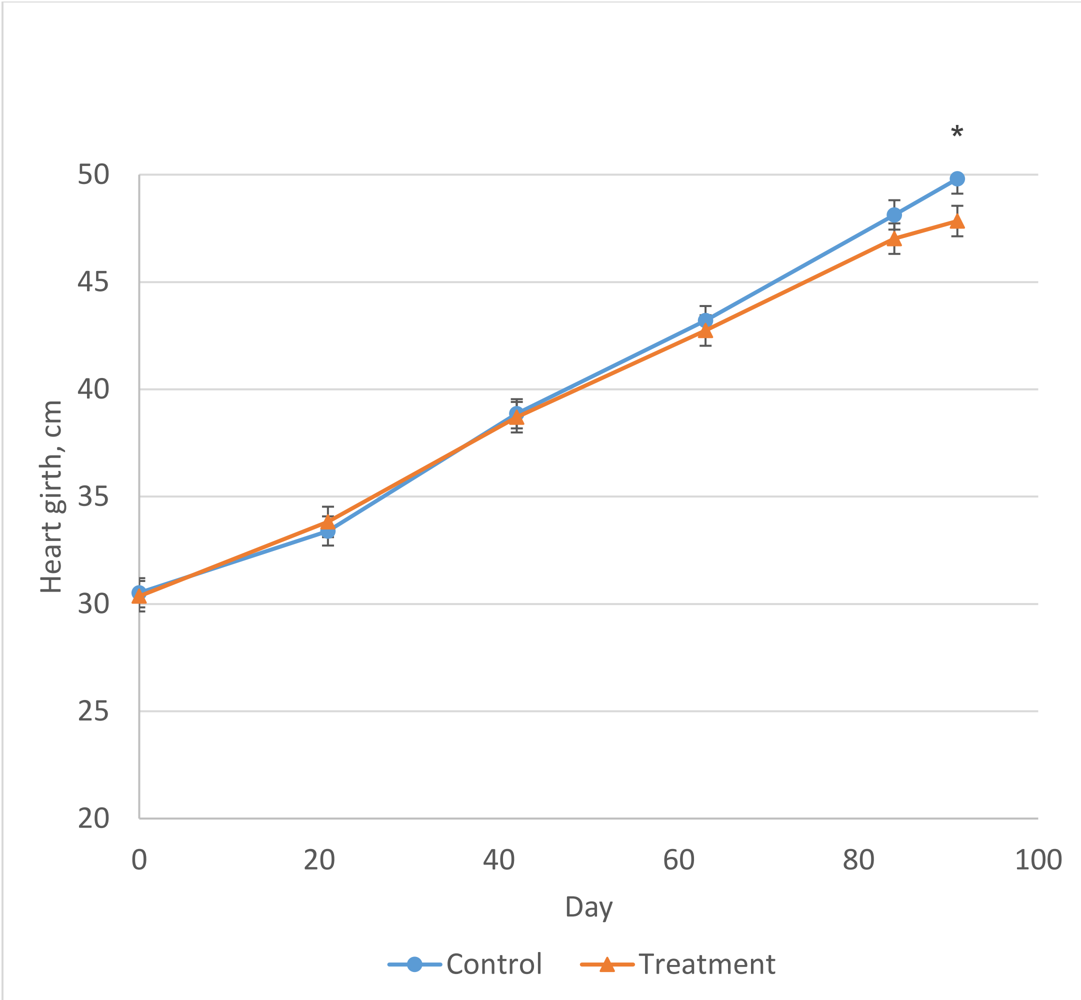

Figure 5. Mean heart girth circumference (cm) of fawns bottle-raised on milk replacer by treatment and day.
* Within day, means differ at P<0.05

Milk Replacer Consumption Data

Fawns all began the trial receiving 73.9 mL at each feeding and the amount offered increased by 14.8 mL as they consecutively consumed the entire amount that was offered. Figure 6 illustrates the mean consumption for all fawns throughout the trial by treatment. When beginning the trial, Phase 1, all fawns were housed in small pens with two fawns per pen. This limited the amount of contact between fawns while their immune system was developing and allowed for a controlled environment for human handling. Figure 7 illustrates milk consumption for fawns by treatment from day 0 to day 30. The mean consumption remains consistent across both milk replacers through the first few weeks of age and begins to show a difference nearing 30 days on the trial.

During Phase 2, at approximately 4 weeks on the trial (25-30 days), fawns were moved to larger pens. These pens allowed for the interaction between fawns of a similar age, less human interaction, and fawns were offered three feedings per day. At this point, fawns were also offered a fawn starter pelleted ration. Figure 8 demonstrates that mean milk consumption was significantly different between fawns consuming the control and the treatment milk replacers during this time period.

When the fawns reached approximately 10 weeks on the trial (65-70 days), fawns were moved again to larger pens where they could continue to interact with fawns of a similar age range. This promoted browsing and encouraged them to interact with animals of a herd as they would be released upon the completion of the trial. Figure 9 demonstrates milk consumption during this period of the trial. Compared to Figure 8 where there was a significant difference in consumption between the treatment and control groups, Figure 9 illustrates that mean consumption was similar between groups near the end of the trial.

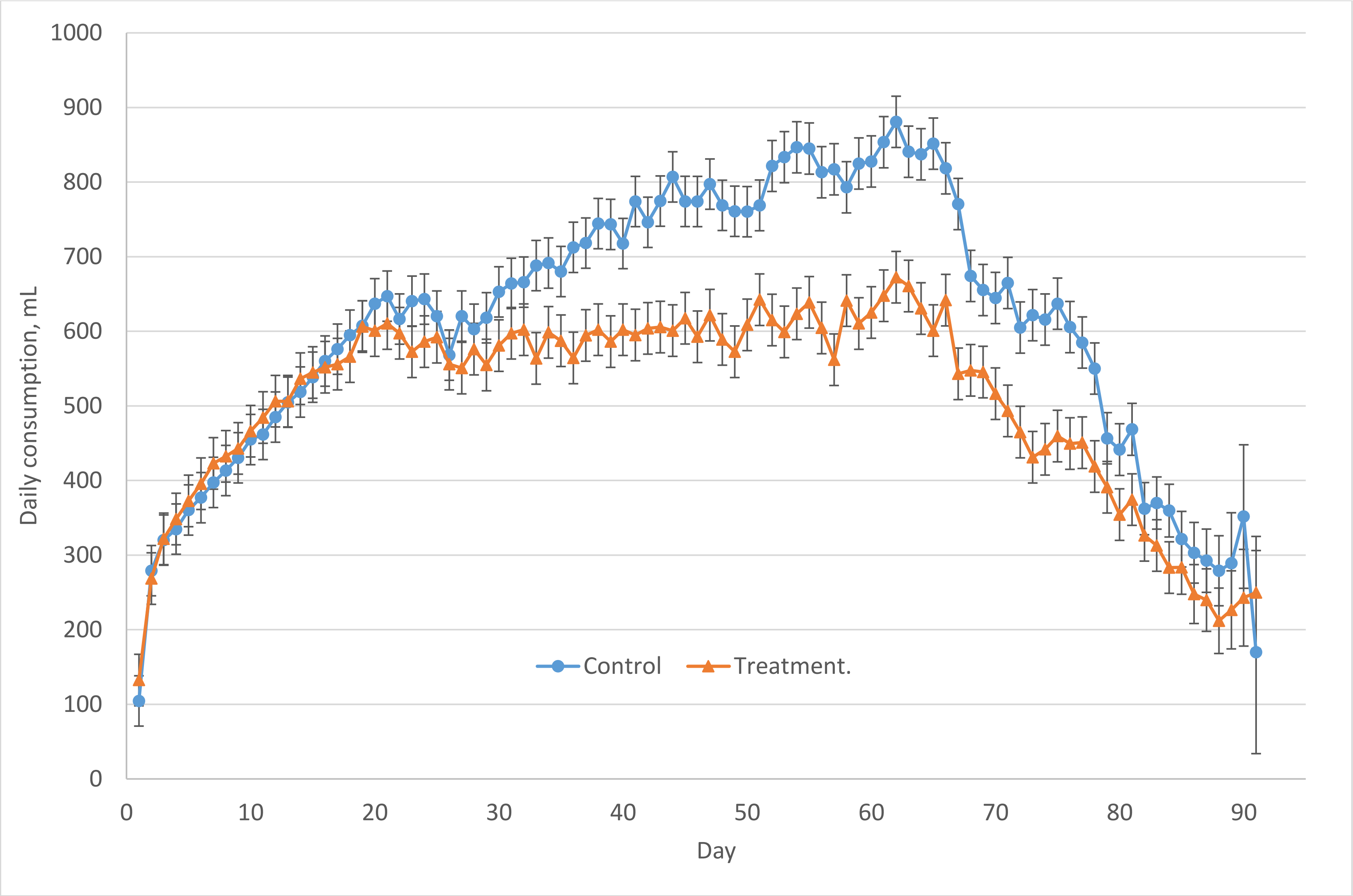

Figure 6. Mean daily consumption of milk replacer (mL) by treatment during the 90-day trial.

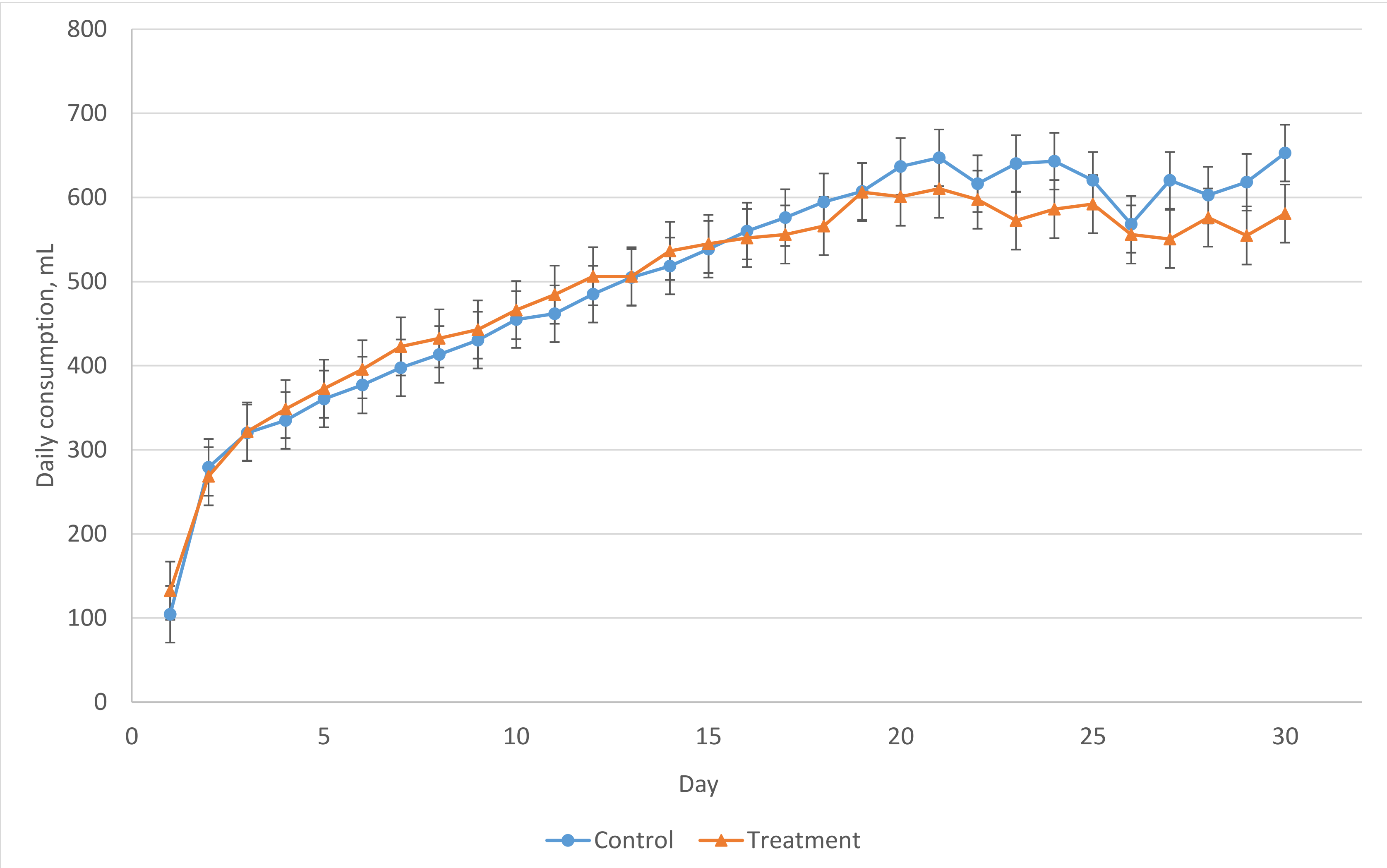

Figure 7. Mean daily consumption of milk replacer (mL) by treatment during Phase 1 (day 0 – 30) of the trial.

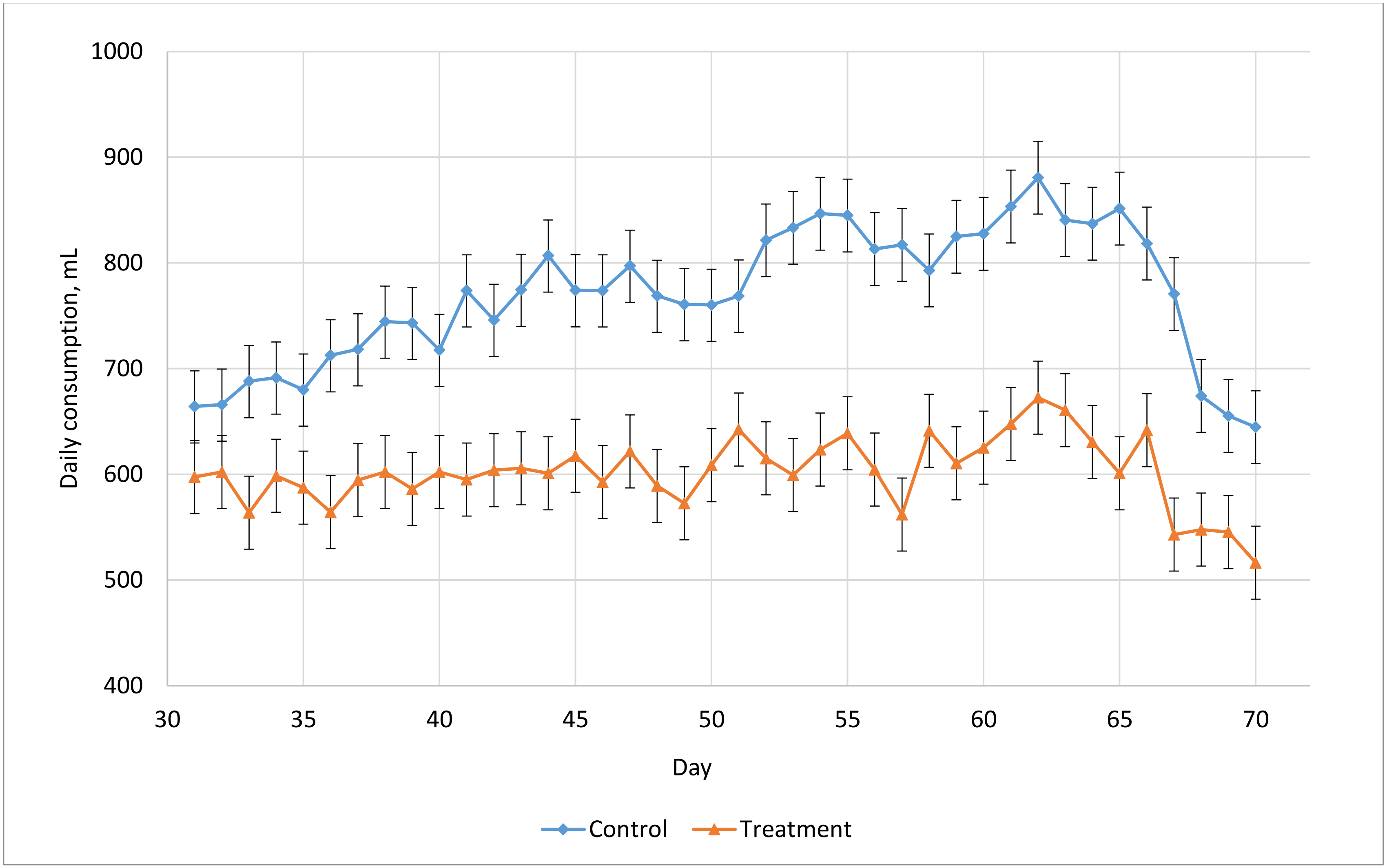

Figure 8. Mean daily consumption of milk replacer (mL) by treatment during Phase 2 (day 31 – 70) of the trial.

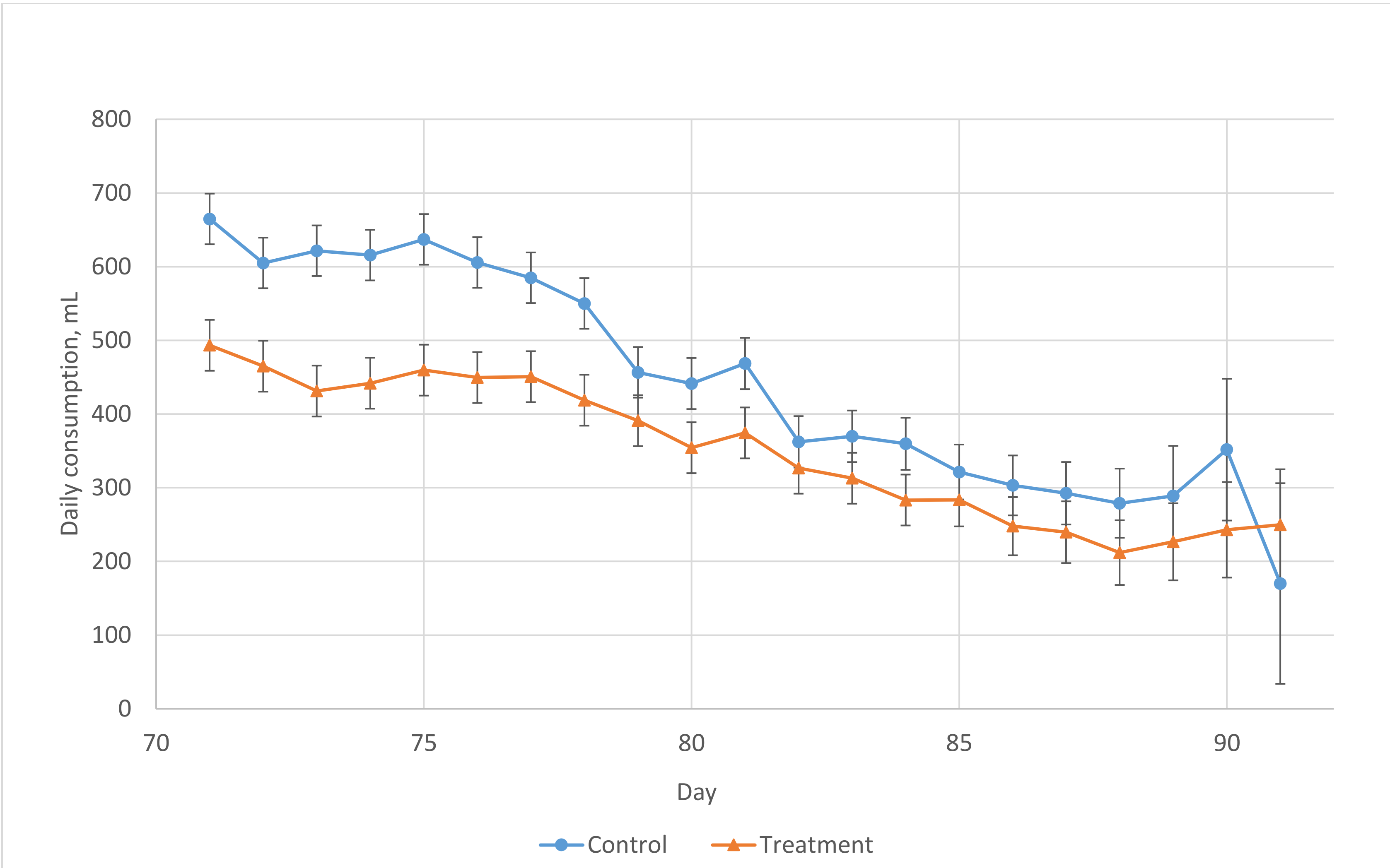

Figure 9. Mean daily consumption of milk replacer (mL) by treatment during Phase 3 (day 71 – 91) of the trial.

Feed Consumption

During Phase 2 of the trial, fawns were offered 0.11 kg of pelleted fawn starter at every 7 PM feeding. This ration allowed the fawns to consume the feed as desired. The amount of feed offered increased by 0.11 kg once the fawns consecutively consumed the amount offered to them. During Phase 3, fawns were initially offered 0.22 kg of feed per fawn per day. This amount increased by 0.22 kg if the entire amount was consumed.

Table 6 demonstrates the mean consumption of the pelleted fawn starter feed by phase of the trial. During both Phases 2 and 3, fawns in the control group consumed a considerably greater ($P > 0.001$) amount of feed than fawns in the treatment group. It is important to note that although consumption of milk replacer and the pelleted fawn starter diet was greater for the control group, all growth measurements were similar throughout the trial between the two groups.

Table 6.

Mean consumption of pelleted fawn starter feed by fawns during Phases 2 and 3 of the trial by treatment.

Phase	Control	Treatment	P-Value
2	0.18 ± 0.10	0.09 ± 0.06	$P < 0.001$
3	0.37 ± 0.08	0.22 ± 0.09	$P < 0.001$

Average Daily Temperature

Table 7 demonstrates the average monthly high and low temperatures for the months of May, June, July, August, September, and October as these were the months where fawns were on the trial. As shown, the month of May had an average high temperature of 28.3 degrees Celsius. The average daily high and low temperature continued to rise as July approached averaging 34.3 degrees Celsius. As July ended, temperatures began to decline. All fawns were released and returned to the herd by October where the average daily high temperature for the month declined to 21.6 degrees Celsius.

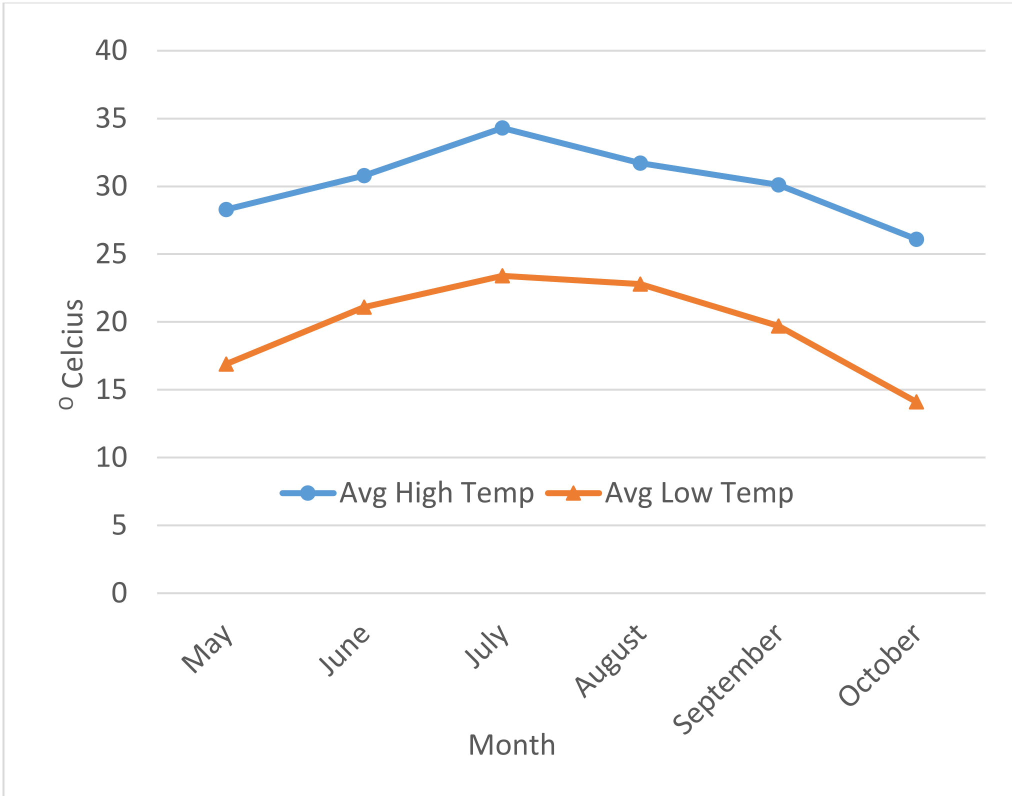

Figure 10. Average daily high and low temperatures for the months of May through October 2017.

CHAPTER V

Discussion

Growth Measurements

When considering all of the growth measurements taken over the course of the trial, all fawns on both treatments grew at an extremely similar rate. Leg length and body length measurements showed no significant difference throughout the trial. When considering cannon bone length, fawns in the control group had a longer cannon bone at day 63, however at day 84, there was again no difference in cannon bone length. Lastly, when considering body weight and heart girth circumference, the fawns did not begin to have a significant difference in measurements until the final measurement at 91 days. It is important to consider that until day 82 (week 12), there was no significant difference between fawns on the control milk replacer compared to fawns on the treatment milk replacer.

Milk Consumption

When considering the initial observation made regarding milk replacers, the control gave the impression that fawns would feel fuller on this milk replacer due to the higher protein content and that fawns consuming the treatment would be more enticed to consume the milk replacer due to the higher fat content. After reviewing the results of this trial, fawns on the control on average consumed more than fawns on the treatment. This creates a theory that fawns consuming the control where not as full as expected, instead fawns on the treatment seemed to stay full as they refused the milk replacer more often than fawns on the control.

Although fawns on the treatment milk replacer consumed significantly less than fawns on the control, fawns grew at an astonishingly similar rate and were able to maintain leg and body measurements that were not different from fawns on the control. Breeders may be interested in knowing that cannon bone length was greater during the middle of the trial and body weight and heart girth circumference were greater at the end of the trial for the control group; however, these differences were small. A large majority of the fawns on both milk replacers tended to be healthy and free of disease or pathogens which is also an important consideration for breeders.

Average Daily Temperature

A consideration to make when reviewing this research as well as for future research would be to take into account the average daily temperatures in the area where the research will take place. As fawning takes place in summer months in Texas, the average temperatures remain high which can lead to fawns having a low desire to eat. During Phase 2, fawns that were on the treatment milk replacer were housed in a large pen that did not have natural cover. They were forced to find shade under metal buildings which could have been hotter than the pen where fawns on the control milk replacer were housed.

The hot temperatures throughout the summer could have been a factor when considering milk consumption of fawns. As the temperatures rose, fawns were in search of cover in order to keep their body temperature at a normal level of 38.5 degrees Celsius. The natural vegetation of the pen where fawns on the control milk replacer were housed served as cover for them when receiving bottles which could have made their bottles more enticing. Whereas fawns that were on the treatment milk replacer were in pens that did not have much natural vegetation to serve as cover. It was observed that fawns on the treatment milk replacer often "refused" most, if not all, of their bottle offered at noon.

Cost Analysis of Milk Replacers

After analyzing how the milk replacers affect the growth and development of the fawns, it is also necessary to compare the cost of the milk replacers in order to determine which cost would best benefit the specific breeder. Prices were found on the online store "Whitetail Supplies" and will be used as reference for this research. When referring to milk replacers, one pail generally weighs 9.07 kg and is designed to feed one fawn until it is weaned which is around 90 days of age. While prices of milk replacers vary by supplier, when purchasing from "Whitetail Supplies" one pail of the control would cost a breeder $114 while the treatment would cost a breeder $89.95, a $24 difference in price between the two milk replacers.

When considering growth and development of the fawns on both milk replacers, a recommendation based off of this research would be for large-scale operations feeding a large number of fawns to purchase the treatment milk replacer at a lower cost. This research has demonstrated that there was no main effect of treatment for any of the morphological measurements and fawns on both milk replacers grew at an acceptable rate. For a large-scale breeder, such as rehab facilities or large operations with enhanced genetics, it may be more cost effective to feed the treatment to numerous fawns.

If a producer is feeding a limited number of fawns, then the savings due to the price difference may not be a significant factor in deciding which product to use. In this situation, the decision to feed one product over the other may simply be due to personal preference or product availability.

CHAPTER VI

Recommendations

Conclusions

Conclusions from this research include that both of the milk replacers produce fawns with growth measurements that are extremely similar. Although there were three measurements (weight, cannon bone length, and heart girth circumference) that were significantly different on particular days of the trial, overall the fawns remained similar in body size and health indicating that both of the milk replacers produce quality fawns. In regard to health status, both milk replacers produced fawns of good health to introduce a healthy fawn crop to the existing herd.

Recommendations

It is the hope of the author that there will continue to be further research regarding the growth and development of white-tailed deer fawns. There are over 1,000 deer breeding operations in the state of Texas alone and further research involving how to help fawns grow to their maximum genetic potential can increase profitability and performance of said operations. Being able to identify specific nutrient needs of fawns can help sustain fawn crops being introduced into an established herd.

It would be beneficial for breeders to obtain milk samples from does in their herd in order to establish which nutrients and at what levels are most important when choosing a milk replacer for fawns in their operation. Selecting a milk replacer for an operation should be based on nutrient content of the milk replacer, cost of the milk replacer, acceptance of the milk replacer by fawns, and production goals of the breeder.

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VITA

Education

Master of Science in Agriculture

Sam Houston State University

- Concentration in Wildlife Management – Thesis
- Start Date: August 2017
- Expected Completion Date: August 2019
- Related coursework: Advanced Biosecurity, Advanced Animal Diseases & Public Health, Agricultural Advocacy.

Bachelor of Science

Sam Houston State University

- Start Date: August 2014
- Completion Date: August 2017
- Major: Animal Science
- Minors: Wildlife Management & Agricultural Business
- Related coursework: Wildlife Ranch Management, Game Animal Production, Cervid Management

Experience

Graduate Teaching Assistant | SHSU Department of Agricultural Sciences

August 2017 - Present

- Prepare, coordinate, and teach two PLSC 2399 - Floral Design laboratories.
- Responsibilities include classroom order, purchasing flowers, student travel, and assisting with all lab activities
- Coordinated lecture, course materials, and travel for the summer session of the Upland Game Bird course.

Student Assistant | SHSU Department of Agricultural Sciences & Engineering

Technology

October 2016 - August 2017

- Managed research project evaluating the effects of different milk replacers on whitetail fawns.

- Conducted research on the interaction between penned and native whitetail deer.
- Assisted professors with various projects throughout the department.

Involvement

- Collegiate FFA, Member August 2014-April 2015
- Block and Bridle, Member August 2014-April 2015
- Sigma Alpha - Beta Pi, Member
  August 2014-April 2015
- Sigma Alpha - Beta Pi, Social Chair
  April 2015-August 2016
- Sigma Alpha - Beta Pi, 1st Vice President
  August 2016 - April 2017
- Wildlife Society, Secretary
  August 2015 - April 2017

Activities and Awards

- Chosen to represent Sigma Alpha at the 2016 Leadership Seminar in Atlanta, Georgia.
- Chosen to represent Sigma Alpha at the 2017 Leadership Seminar in Nashville, Tennessee.
- Coordinated a research project involving the interaction between penned and native white-tailed deer at the 3-S Ranch in Bedias, Texas.
- Assisted in a research project studying parasite levels in penned versus white-tailed deer at the 3-S Ranch in Bedias, Texas
- Presented at the 2017 Undergraduate Research Symposium on the interaction of native whitetail deer with penned deer.
- Conducted Thesis Project on the Evaluation of Growth and Development of Whitetail Fawns on Two Different Milk Replacers at 3-S Whitetails in Bedias, Texas.
- Assisted in all aspects of the 2017 fawning season.
- Represented Sam Houston State University and 3-S Ranch at the 2017 Texas Deer Association Annual Convention.
- Recipient of the Texas Deer Association Scholarship (2017 and 2018).
- Presented in the SHSU 3-Minute Thesis competition and selected as a finalist.
- Coordinated and helped teach the Summer 2018 mini session of the Upland Game Bird course at Sam Houston State University.
- Organized the Area and State FFA Floriculture contest hosted by Sam Houston State University (2018 & 2019).