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Evaluation of the feeding methods of alligators kept under farm conditions (A review)

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Abstract

Understanding the diet and various feeding methods of farmed alligators is crucial to optimize growth and minimize costs. Alligator farms have shifted their income from tourist attractions to producing hides for luxury items and lean meat. By expanding the horizons of the current alligator diet, valuable knowledge regarding optimized nutrient feed, frequency of feeding, and how to house the animals has come to light. I have researched multiple articles published over the years that have shaped the alligator farming industry and been in contact with one of the pivotal researchers. Alligators have moved from consuming carcasses of dead mammals to now being fed pelletized feed formulated to control the content of the various micro- and macronutrients. The feeding methods have moved away from large storage freezers and huge electricity bills to use feed that can be stored at room temperature. There are a lot of details regarding alligator nutrition that still need to be discovered. However, current research suggests that feeding a pelletized diet with a protein content of 45%, a fat content in between 4% to 12%, and a carbohydrate concentration between 0% to 14% leads to optimal growth and health. Alligators should be fed daily until the age of one at a feeding rate of 25% of their body weight weekly, thereafter, feeding 18% of their body weight per week at a frequency of 4 to 5 times per week is recommended. It has been indicated that plant-based protein feed and utilization of other macronutrients besides protein can stimulate the same growth while lowering the economic burden for alligator farms.

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1. Background and motivation

The American alligator (Alligator mississippiensis) is extensively farmed in the southern states of the USA, especially in Louisiana and Florida. The primary product obtained from these alligator farms is hides but, to a lesser extent, also meat [1]. In addition, researchers recently detected novel compounds in alligator blood that seem to have promising antimicrobial properties. If it is established that these substances in the blood are of significant use in medicine, this could substantially increase the importance of farming alligators [2]. Alligator hides are mainly used to manufacture luxury goods such as handbags, footwear, and small leather goods. The farms thus provide the luxury industry with a reliable product source while simultaneously decreasing the issue of poaching. The meat from the alligator is still a relatively unusual commodity in most countries. However, it could be a healthier alternative to pork or beef, with an average protein content of 20% and only 3-5 % fat, most of which is unsaturated [3]. Currently, the consumption is mainly limited to the Southern American States and Asia [3].

Since compared to other large-scale animal holdings, alligator farms have a low impact on the environment while producing valuable goods, including meat, it is interesting to conduct further research to establish ideal keeping conditions for these impressive reptiles. [3]. The focus of this investigation is to examine the feeding methods of farmed alligators, as proper nutrition plays a crucial role in ensuring their desired growth and general well-being. The success of an alligator farming enterprise relies heavily on understanding and implementing effective feeding practices.

1.1 History and purpose of alligator farming

The first commercial alligator farm was established in the early 1890s in Florida. Soon after that, further farms were founded in Louisiana, Texas, Georgia, Alabama, and Mississippi. They were not producing hides and meat but operated solely as tourist attractions [1]. However, during the 1970s, substantial research and development efforts regarding intensive alligator keeping took place, leading to new farms solely dedicated to the production of hides. This marked a transformative period in the alligator farming industry, with the focus shifting from the entertainment of tourists to the commercial production of hides [1]. Additionally, in the late 1970s, the retail sale and distribution of alligator meat were permitted, which enabled farms to diversify their production and commercially utilize more parts of the alligator carcass [4].

The efforts to expand alligator farming to hide and meat production were fueled by the rapid decline in the wild population of alligators in the late 19th century. Louisiana alone witnessed an annual harvest of 64,000 alligators from the wild [5]. Hunting bans were introduced in Florida and Louisiana during the 1960s to counteract the population decline, but illegal hunting persisted. Researchers aimed to save the wild population by establishing controlled production facilities, thus eliminating the need to hunt the alligators in their natural habitat [5]. As the 1970s arrived, there were improvements and signs of recovery in the wild alligator population. A new management scheme was introduced, which permitted restricted hunting in the wild and a strictly regulated collection of alligator eggs. This administration emerged to balance the demand for alligator products and ensure that the wild alligator population was preserved [5].

In the 1990s, the alligator farming industry consisted of many moderate-sized farms throughout the alligator-producing states, with over 100 farms in Louisiana alone. However, there has been a tendency towards fewer but larger production facilities in recent years. In 2014, only 37 alligator farms were spread out in four states, producing 350,000 hides and generating a revenue of $85. Currently, the states of Florida and Louisiana dominate the industry, contributing to an impressive 98% share of the overall output [1].

1.2 Advancements in farming practices and their impacts

The first alligator farms were just fenced enclosures for breeding or displaying alligators. However, it soon became evident that these enclosures did not meet the requirements for the alligators, leading to the production of only a few hatchlings. In response to the declining population of wild alligators in the 1960s, extensive research was conducted to produce the optimal housing for these reptiles [3]. Research findings highlighted several essential factors for optimal conditions within the alligator enclosures. First, it is strongly advised that 50% of the enclosure area is covered with fresh water, which means that regular cleaning procedures are required to ensure the health and well-being of the alligators [6]. Additionally, the alligators have an optimal temperature that needs to be maintained constantly. Fluctuation in temperature can have detrimental effects on them, resulting in decreased growth and higher mortality rates. The ideal temperature for optimal growth is around 31°C [6]. Nowadays, grow-out buildings generally consist of heavily insulated concrete blocks with heated foundations that regulate the temperature. The alligators are housed together in small groups of similar size. Given that alligators are both sensitive to light and sound, research has demonstrated that stress produced by these inputs can lead to reduced feed consumption and, consequently growth retardation. As a result, many alligator farmers have chosen to keep their animals in the dark or minimally lit environments with as little noise as possible. However, a less common approach is attempting to familiarize their alligators with human voices to reduce stress from the beginning [7].

Over the years, the housing of American alligators is not the only part that has been subjected to change but also the methods of obtaining alligator eggs for hatching. In the early years of alligator farming, the farmers kept to the so-called farming concept, which entails maintaining a breeding population for egg production. However, research has shown achieving reliable and consistent egg production in captive breeding takes a minimum of 6 to 10 years [3]. Hence, implementing the farming approach results in higher investment and maintenance costs and allocation of large land areas for enclosures. Furthermore, this approach is more hazardous for the farm workers as they need to care for these fully grown, potentially dangerous reptiles. Thus, most alligator farmers are opting for the ranching approach, meaning they obtain eggs from wild nests in wetlands. However, state-issued permits are required for this procedure. Ranching has the positive side effect of also contributing to the conservation of wetlands. Since the alligator eggs are

a valuable source of income for the landowners, it serves as an initiative for them to keep their land in its natural state. For the farmers, on the other hand, it eliminates the need for egg production resulting in cheaper and less time, land, and labor-intensive production [3]. The eggs must be collected before reaching 7 days of age or after surpassing the age of 28 days since that is the period in which they are the most vulnerable. Furthermore, the eggs need to be marked and stored upright because any other position may lead to embryo detachment and death. By making the conditions optimal with proper care, a hatching rate as high as 90% can and should be achieved [8]. In the wild, for comparison, the hatching rate is only 70%. One key factor to proper care is maintaining the humidity level above 90% for the eggs. Additionally, Ferguson and Joanen (1983) made a significant discovery regarding the crucial part temperature plays in determining the sex of the alligator embryo [9]. They found that at 33^{o}C the embryos would all develop into males, while at 30^{o}C they would instead all develop into females. Hence, the optimal temperature for a healthy population of both males and females is between 30.5 to 31^{o}C [9].

Furthermore, since the discovery that alligators can be susceptible to infection with West Nile virus, mosquito control is also an important factor in farms alongside established vaccination programs that have been developed to keep the alligators healthy [8].

It is essential to mention, that in the wild only roughly 12% of the hatchlings manage to survive. As a result, ranches collecting eggs from the wild are required to release this percentage of hatchling alligators back into the wetlands as part of conservation efforts [3].

2. Research questions

21. Purpose of the study

The aim of this thesis is to assess and determine the most suitable feeding method for alligators farmed for hide and meat production, with a focus on achieving optimal growth and health.

2.2. Importance of evaluating feeding methods for alligators

It is crucial to evaluate the most suitable feeding method for alligators kept for hide and meat production because the proper diet is essential for ensuring the desired growth and well-being of these reptiles in captivity [10]. Additionally, since the cost of the feed tends to be the largest part of the operating costs at 42% for alligator farmers, the understanding and implementation of optimal feeding methods can increase resource utilization while also minimizing waste and thus improve the economic efficiency of the farm [11].

3. Feeding behavior, requirements, and methods existing in alligator farms

3.1 Feeding habits

The key factor for effective management strategies for American alligator farms is a proper understanding of their feeding habits. The choice of feed for the alligators has a direct impact not only on their growth rate but also on body condition, behavior, and reproductive patterns. It is also hypothesized that the diet of American alligators varies depending on their habitat and geographic locations. Understanding their preference for feed and eating patterns can hence provide essential insights to provide the proper management for the alligators [12]. There is no dispute that alligators are anything but true carnivores, which is easily observed by their short gut and specialized oral cavity. In their natural habitat, their feeding habits are rather variable, which depends on factors such as age, size, and the availability of prey to feed on [13]. After reaching a certain age, the alligators remain on the top of the food chain in their natural habitats. Their nutrient intake serves various purposes, including supporting growth, meeting daily energy requirements, facilitating egg production, and storing energy in the form of fat found in muscle bundles within their tail, abdomen, and neck [14]. When the availability of prey becomes scarce, the alligators can reduce their metabolism significantly and draw energy from their fat reserves. In fact, a large adult alligator in average body condition can survive without food for up to two years or even longer [14].

The most common way of investigating the dietary patterns of alligators is to analyze the stomach contents of deceased specimens or to perform stomach flushes in alive ones since directly observing their feeding behaviors can be rather challenging [14]. In their early life stages, alligators tend to primarily feed on larval and adult insects, such as grasshoppers, dragonflies, and giant water bugs. They also feed on spiders, small worms, and other invertebrates. However, as they increase in size, so does their prey. When alligators reach a body length over 60 cm, their diets include crustaceans such as crabs, shrimp, and small fish [14]. Their ability to feed on crustaceans is mainly due to their sharp teeth, which allow them to feed on prey with hard exoskeletons. In their subadult stage, in which they measure 1.2-1.8 meters in length, they further diversify to include larger invertebrates like apple snails and blue crabs. They also consume snakes, small mammals, birds, and frogs [14].

During the alligator's development, the elongation of their snout and strengthening of their jaw muscles allow them to capture and feed on a broader range of prey. As they further mature, their teeth change. They become thicker, more durable, and blunt, which enables them to crush turtle shells as part of their feeding pattern [14]. As large subadults, alligators transition to their adult diet, which includes a variety of prey such as fish, turtles, snakes, birds, and even some large mammals like raccoons, muskrats, possums, nutria, and occasional even white-tailed deer. Humans, however, are not included in their dietary choices due to their size. When the alligators are fully grown, they can occasionally resort to cannibalism by eating hatchlings [14]. Hence, the farmed alligators are kept in groups based on their size to avoid this from occurring [11].

In the wild, alligators obtain their food mainly by hunting, but also foraging has been observed [14]. When an alligator targets small prey nearby in the water, it elevates its head, opens its jaw, and sways its open gap back and forth; this generates a small swirl in the water that lifts smaller organisms. When the prey enters the alligator’s mouth, it quickly closes its jaws, thus capturing its prey. This technique is used for eating insects, snails, and small fish. The alligators also have a very sensitive and keen olfactory sense to detect carcasses on land and in the water [14]. They have variable versatile hunting techniques since they hunt both prey in the water and on land. As ambush predators, alligators strategically position themselves in the water or at its edge, patiently waiting for their prey to approach. When this occurs, the alligators swiftly and precisely launch forward with their powerful jaws to capture their target. Some alligators have also been seen facing upstream thus utilizing the water flow to their advantage in capturing their prey [14].

Not only the capturing of their feed is a challenge faced by the alligators, but also the consumption of it. They have only limited ability to tear their prey apart, so in most cases, they must swallow it in one part. To allow this, the alligators' jaws can open almost as wide as the back of their skull, and their esophagus is elastic enough to accommodate any food that can pass through the throat [14]. Due to their relatively fixed tongue within their oral cavity, alligators have a unique swallowing technique. They elevate their heads out of the water and forcefully flip their heads up while simultaneously releasing their grip on the prey. Then, they contract their throat and squeeze, letting the prey slide down straight into their stomachs [14]. However, they attempt to adapt their approach when they capture prey too large to be swallowed. In this case, they bite onto the carcass and vigorously shake their head from side to side, trying to dismember their prey into smaller, more manageable

pieces more suitable for consumption. Another technique in their feeding behavior is the so-called “death roll” after securing a larger prey. This involves them spinning rapidly, which overpowers and confuses their prey while simultaneously enabling their consumption. This technique is also used by alligators when they try to escape a violent encounter with other alligators or when they are captured [14]. Captive alligators on the other hand, display notable differences in their dietary habits, activity levels, and hence their body condition [15]. The diets received by farmed alligators tend to be well structured, consisting of high-quality foods like chickens, pigs, cows, deer, and rodents, as well as specially formulated pelleted food such as Mazuri Exotic Animal Nutrition. This controlled feeding environment allows the alligators to receive a steady intake of nutrients and optimal nourishment, leading to optimal growth and health [15]. In contrast to farmed alligators, wild ones tend to experience a more dynamic feeding schedule with a diet that is rather unpredictable, which is heavily influenced by the availability of prey in their natural hunting grounds. Their meals can range widely in quality, sometimes including prey with limited meat content and significant indigestible components [15].

The activity levels and, thus energy expenditure of captive alligators compared to their wild counterparts also show differences. Wild males in Florida display an average movement rate of 37.5 m/h, which shows a substantial energy requirement to supply their extensive roaming, notably during courtship and breeding periods [15]. The male alligators housed in the Jacksonville Zoo and Gardens, on the other hand, show an average movement rate of only 13.5 m/h [15]. This suggests that captive alligators have a reduced caloric expenditure compared to their wild counterparts, which can also impact their overall body condition and energy balance. Interestingly, in female alligators, there is not a significant variance in the movement rate when comparing those in the wild with the ones kept in captivity [15].

3.2 Frequency and timing of feedings

Proper feeding methods and practices are essential to produce the desired growth and well-being of alligators. Their ideal feeding should occur at least five days per week. some farmers even chose to feed six or even seven days per week [7]. During their first year of life, alligators are typically fed rates equivalent to 25% of their body weight per week. But as they grow, this is gradually decreased to 18% by the time they reach three years of age or when they reach a length of about six feet [7]. One crucial fact is that it is very important to avoid overfeeding the alligators, not just for monetary reasons but also to prevent health issues such as gout. Gout can be a common concern in pen-raised alligators; however, the condition can be cured by simply withholding food from the animals for seven to ten days [7]. There are variable approaches to initiate the feeding of hatchlings in alligator farms. Some farms start feeding the hatchlings immediately after they have hatched, while others opt to incubate the hatchlings two to seven days before they start feeding them [16]. This waiting approach is believed to increase yolk utilization and allows for the detection of any seriously compromised hatchlings. Though it remains uncertain which approach is more advantageous, it is reassuring that neither of them seems to harm the hatchlings. In some cases, some hatchlings are reluctant to start feeding and are placed with other individuals to stimulate their feeding behavior [16]. Hatchlings are usually fed daily during their immediate post-hatching period, and in some instances, this feeding pattern is continued for the rest of their first year of life. However, as they grow, their feeding rate may be adjusted to four to five days per week based on their size and requirements. As they further mature, the feeding rate can be decreased to two to four times per week. For mature adult alligators, feeding once every week or every other week is even considered to be sufficient [16].

3.3 Nutrient requirements

The exact nutrient requirements of the American alligator still need to be fully researched. Estimations can be made based on observations of alligators in their natural environment and from dietary patterns of other aquatic species with already established nutritional requirements [10]. In a study, researchers examined the stomach content of two separate alligator groups to understand the dietary needs of these animals [17]. One of these groups lived on Sapelo Island, which is located off the coast of Georgia, while the other group inhabited the Shark River, an estuary in Florida. Close to 7000 alligator stomach contents were collected from both groups using a method called hose-Heimlich. The alligators from Sapelo Island were examined from 2008 to 2009, while the other group from Shark River was observed from 2009 to 2011. It is important to note that the animals examined during this study were solely adult males. From the stomach contents, the researchers managed to make an estimation of the average protein, fat, and carbohydrate content of the alligators' diets [17]. The diet of the Sapelo island alligators consisted of 69.4% protein, 30.6% fats, and nearly 0% carbohydrates [17]. Interestingly, the group located in the state of Florida had a different diet, which consisted of 55.8% protein, 12% fat, and 32.2% carbohydrates [17]. It is likely that these different percentages of macronutrients in the separate groups can be explained simply by their different habitats. The alligators from Georgia live in an environment further up north with colder temperatures and hence may need to eat a diet containing more lipids to be able to withstand the cold temperatures during the winter. On the other hand, the natural habitat of the group living in the state of Florida had a higher percentage of carbohydrates in their diet. This may be explained by their thermally challenging environment, given that they are ectotherms [17]. Studies indicate that when an ectotherm is in an environment in which the temperature is high enough to cause thermal stress, then the animals will increase their metabolic rate and hence carbohydrate consumption to have more energy available for the elevated respiration rates [17].

Furthermore, a research program was initiated in Louisiana to support the farming industry by increasing the effort to understand the nutritional requirements of captive alligators more closely [18]. Naturally, the importance of dietary protein was highlighted since it provides the essential amino acids required for proper tissue growth. Interestingly, the type of protein turned out to be just as important as the quantity of protein provided to the alligators. Even a small amount of high-quality protein provided from fishmeal resulted in

the same growth rate as a large amount of lower-quality protein such as soybeans, this is due to the differences in amino acid composition [18]. The result of this study indicates clearly that the amount and type of protein need to be carefully considered when providing the optimal diet for alligators to promote growth and health [18]. As a part of the above-mentioned research program, Reigh et al. (2013) conducted a study with 88 alligators below the age of one. They fed them a commercial diet with high-quality protein in various concentrations. The protein concentrations fed were 37%, 41%, 45%, and 50%, alongside a control group that received 55% [18]. The study did not only focus on the growth of the alligators but also on the implication the protein concentration had on the quality of both water and air within the farming environment [18]. The diets that varied in protein concentration between 41% and 55% yielded no different results in chest girth and body weight. However, a notable difference was that the tanks housing the alligators fed a 55% protein diet showed an increased concentration of ammonia in water and air compared to the groups receiving the other diets. Additionally, the alligators provided with a diet with a lower protein concentration of 37% resulted in a significantly reduced body weight and chest girth. In conclusion, this study found that an optimal concentration of protein in an alligator diet should be around 45% to yield great growth results while at the same time maintaining equivalent or even improved water quality [18].

In addition, Reigh and Williams (2022) conducted a 10-month growth trial to investigate the importance of varying levels of lysine and its effect on growth in alligators [19]. This was evaluated by measuring the body length, weight gain, and free lysine concentration in the plasma. The study involved 192 hatchlings fed a pelletized diet containing 50% crude protein with varying lysine concentrations. The hatchlings in the study were reared and fed under carefully regulated laboratory conditions, and the results indicated that a minimum of 2.25% dietary lysine (which is approximately 4.5% of protein content) is needed to achieve the desired growth [19]. This indicates a resemblance in the lysine requirements of the American alligator and those observed in other aquaculture species like fishes, crustaceans, and amphibians [19].

However, a further study conducted by Staton et al. (1990) indicated that lipids and carbohydrates can also have an importance in the diet of the American alligator [20]. In this study, alligators less than one-year-old were fed different diets formulated with various concentrations of protein, fat, and carbohydrates to determine the optimal concentrations for growth. The results of the study indicated an optimal amount of fat content ranging from 4% to 12%, which then aids in the breakdown of dietary protein by slowing down the

alligator's digestion rate, thus allowing it to have more time for digestion. As for carbohydrates, the study indicated that 11% is the appropriate amount of carbohydrates to stimulate growth. This is because alligators are not often exposed to carbohydrates in their natural habitat. Hence, their pancreas does not produce an adequate amount of insulin to utilize higher levels of carbohydrates [20].

Additionally, it is important to remember that alligators, as opposed to mammals, are ectothermic animals and hence do not require many calories to maintain their body warmth [14]. They also do not have a narrow body temperature range that needs to be constantly maintained. Thus, their body temperature can range from freezing cold to very warm. To compensate for their inability to adjust their body temperature, their bodies can instead conduct biochemical reactions that function in both warm and cold temperatures. So since they don't need to use an enormous number of calories to maintain a body temperature, an alligator only needs a tenth of the number of calories that a human of the same body size needs [14]. Staton et al. (1990) concluded in their study exploring the energy requirements crucial for optimal growth in young alligators that the ideal amount lies in a range between 8.2 and 10.9 kcal of digestible energy per gram of crude protein [20].
On another note, if alligators are fed solely frozen fish as their diet, it is crucial to include vitamin B as a supplement to prevent thiamine deficiency [13], and calcium supplementation is also essential if bone is not part of the alligator diet [16]. Red meat, for example, contains a high concentration of phosphorus, and spongy bone syndrome (rickets) can develop in the alligators without adequate calcium supplementation. An additional source of vitamin D3 (cholecalciferol) should be given to alligators that are kept away from direct sunlight to promote appropriate calcium homeostasis [16].

3.4 Nutritional considerations and diet formulation

On most farms, it typically takes about 14 months for hatchling alligators to reach the desired length of around 1.5 meters [3]. That means that these farmed alligators have a growth rate of almost 150 cm per year; this stands in sharp contrast to the 30 cm per year growth rate of wild alligators observed in the state of Louisiana [21]. To achieve this impressive growth rate, several factors need to be considered, such as temperature, air and water quality, and, importantly, nutritional considerations. Since alligators are carnivores, protein is a crucial component of their diet. While kept under ideal conditions, the growth rate correlates directly with the protein consumed up to a specific biological threshold [18]. However, if protein consumption exceeds this threshold, the surplus protein is transformed into adipose tissue, and the excess nitrogen is excreted as waste. This lost nitrogen is not utilized for growth and thus represents a wasted resource and a financial burden on the alligator farm. In addition, the excreted nitrogen creates additional expenses for the holding as it necessitates additional cleaning procedures [18]. As mentioned previously, an alligator's optimal dietary protein content should not exceed 45% as a higher protein content only leads to increased nitrogen excretion. Still, it also should not fall below 37% as this results in halted growth [18]. While some studies suggested that the use of vegetable protein such as dietary corn would lead to a reduced digestion rate [20], more recent research conducted in a laboratory setting has indicated that it is possible for alligators to utilize plant-based material. The alligator's gastrointestinal tract is indeed capable of processing proteins, fats, and carbohydrates found in vegetables into easily absorbable sugars [14]. In fact, Staton et al. (1990) specifically investigated the impact of proteins from various sources on alligator growth and examined the effects of fat and carbohydrates on their digestive system [20]. They discovered that alligators can efficiently digest isolated soybean protein, even when it makes up more than 40% of their dietary protein. Regarding fats, it was established that a concentration of 4-12% lipids in a diet is ideal to break down dietary protein efficiently. This is because the incorporation of fat in the diet slows down alligators' digestion rate, thus allowing them more time to digest and absorb their feed [20]. Another study by Staton et al. (1990) indicated the importance of arachidonic acid in an alligator diet. This fatty acid is found in large amounts in tissues such as the liver, muscle, heart, and skin, and it leads to increased membrane fluidity, thus influencing the basic membrane-based cell function necessary for growth [22].

Regarding digestible carbohydrates, there is an optimal range from 0% to 14% in the feed [20]. However, when this threshold is exceeded, it can result in neutral or even potentially negative effects on the alligator's body weight. The limit is because the alligators' exposure to carbohydrates in the wild is next to none in most cases, and hence, their pancreas cannot supply them with enough insulin and amylase [20]. It is also worth mentioning that, unlike many other animals, alligators do not consume multiple meals daily. Their digestion process spans several days instead of only hours. Consequently, it is not advised to introduce large amounts of indigestible feeds to their diet as this would lead to an even further decreased digestion rate, resulting in a drop in feed utilization and decreased growth [20]. On another note, alligators are ectothermic carnivores and, hence, have a low physiologic need for glucose to support maintenance and optimal growth. Unlike endotherms, they do not have a fast dietary energy requirement for heat generation and maintenance of a core temperature. The physiological process of gluconeogenesis, which produces internal glucose, is energetically inefficient in alligators, and thus, their glucose and glycogen levels are maintained at modest levels [20]. When fed a well-balanced diet, 11% of digestible carbohydrates are enough to meet the alligators' limited glucose requirement. Furthermore, this efficient nutrient allocation ensures that protein is not used as a substrate for gluconeogenesis [20].

In a further study by Staton et al. (1990), it was indicated that adding a glucose supplementation to a diet primarily composed of nutria meat (very common feed for alligators) could drastically improve the alligator's weight gain [23]. However, in this same study, growth was severely halted when the alligators were fed a pure protein diet with glucose. This growth-inhibiting influence of carbohydrates is not restricted to only alligators but can also be seen in carnivorous fish such as rainbow trouts. Again, it is believed that these animals have not developed the ability to efficiently release insulin in response to a sudden large intake of carbohydrates to regulate their blood sugar levels. Thus, the boost in growth observed in the alligators fed nutria meat and glucose might be due to the fact that glucose readily dissolves from the meat when in contact with water during the feeding in this study [23]. As a result, the alligators that ingested the glucose-added nutria meat might have taken up significantly less glucose than those that consumed a glucose-added purified protein diet. This reduced intake of glucose could have been in the range that alligators can tolerate and thus they utilized the extra calories for growth without experiencing the inhibiting effects [23]. However, not only the macronutrients but

also micronutrients such as vitamins and minerals play a vital part in ensuring proper growth and health in farmed alligators. Metabolic Bone Disease (MBD) is a common nutritional disorder seen in reptiles with signs including weakness, lethargy, bone deformities, and, to some extent, even fractures [13]. This condition is often linked to an imbalance of calcium and phosphorous, leading to an increase in the breakdown of bones. The main deficiencies behind MBD are calcium and vitamin D3. The cause for the lack of vitamin D3 is often insufficient exposure to UVB light, which the alligators usually get from sunlight [13]. Interestingly, MBD is a condition that is more commonly seen in herbivorous and omnivorous reptiles rather than commercial crocodilian operations; this may be because alligators can get the necessary source of vitamin D3 from their diet without exposure to UVB light. Special light bulbs providing the UVB light needed by reptiles can be purchased, but supplementing an adequate amount of calcium is the higher priority [13]. In alligator operations that keep their animals in the dark to avoid the seasonal effect on the alligator metabolism, adding calcium to the diet is especially important [24]. Some observations suggest that an adult alligator can grow without MBD in a lightless environment if fed a diet that includes bones [13]. However, some farmers have stated that allowing exposure to sunlight generally leads to better health in these animals. More research needs to be conducted in this area to properly understand the importance of UVB and calcium requirements of crocodilians and their impact on growth and health [13]. Another micronutrient that is of particular importance is vitamin E. A deficiency in this vitamin can result in steatitis and fat necrosis [25]. This problem arises when alligators are fed a diet primarily composed of polyunsaturated acids (especially those with 2-3 double bonds) that simultaneously lacks vitamin E. This scenario is particularly common in farmed alligators that are raised in outdoor ponds feeding on a diet consisting mainly of freshwater fish. Thus, these operations need to pay attention to adequate vitamin E supplementation [25]. Furthermore, in addition to ensuring that the alligators receive all their micro- and macronutrients in their diet, it is also important not to overfeed them since this can lead to the development of gout. Other risk factors for developing this disease in reptiles are dehydration, improper diet, and kidney damage. Additionally, the misuse of certain antimicrobials like aminoglycosides and sulfonamides can lead to kidney problems, thus increasing the likelihood of hyperuricemia and gout in reptiles [25].

The diets formulated for farmed alligators have become more sophisticated over time. In the early stages of alligator farming, mainly frozen meat from sources such as nutria, beef, horse, chicken, and deer was used to feed these large reptiles. This required the farms to build extensive walk-in freezers to store substantial amounts of meat [7]. Furthermore, waste products such as expired poultry meat, residual meat from processing plants, and nutria remains from fur trappers were deemed as adequate nutrient sources for alligators. In later years as the alligator farming industry was further developed and expanded, big feed companies saw the demand for readily available hassle-free alligator feed and started developing formulated feed specifically for alligators [26]. These pelleted diets have removed the need for large walk-in freezers and thus make building a farm and storing feed less costly. These commercial diets are composed of various proteins such as fish meal, meat, bone meal, blood meal, and plant-based proteins. Furthermore, they are enriched with essential vitamins and minerals [7]. Nowadays, most alligator farmers opt to use these commercially available diets but there is also a portion of farmers that choose to combine both meat and commercial feeds. In the latter-mentioned feeding approach, commercial alligator pellets are mixed with around 30-50% raw meat.

During the growth of alligators, their feed conversion rate gradually decreases until settling at approximately 40% until a length of around 1.8 meters is reached [7].

This means that as they grow, the amount of food required annually increases significantly alongside their body growth. This metabolic and feed conversion change needs to be accounted for with a modulated diet for different ages. The difference in metabolic rate between a hatchling and a fully grown male adult is staggering with the hatchling having a 25 times higher metabolic rate [24]. This means that a young alligator requires a substantial amount of food per gram of body weight to maintain itself, more precisely around 25 times more, and even more than that when it is in a growth phase [24]. In addition to the metabolic rate, the digestion process is also functioning at a faster pace in young alligators, which allows them to efficiently process and absorb all the nutrients provided in their food. This extreme difference in metabolism and digestion is understandable since an adult male alligator must only maintain its weight while the young alligator is in a state of rapid growth [24]. When formulating an alligator diet the key factors are to consider how much protein and energy is required to achieve the desired growth. As mentioned previously, protein makes up a significant part in animal growth in which both the quantity and the amino acid make-up of the protein greatly impact how the various tissues are built [10]. When environmental conditions are optimal for the alligator,

feeding high-quality protein leads to faster growth, but only until reaching the alligator's metabolic limit [10]. If the feed exceeds this metabolic limit, then the excess protein will be converted into adipose tissue and the produced nitrogen excess is converted and excreted as ammonia, which is essentially wasted protein that comes with the price of increased cleaning efforts [10]. A study conducted by the Louisiana State University indicated that a diet in which 80% was composed of plant-based elements turned out to be sufficient for young-of-year alligators, especially when the composition of the diet was made up of essential amino acids that mirrored the amino acids that are found within the alligator's overall physiology [10]. Further findings from this study highlighted that the American alligator has the capability can adapt to metabolize plant-based carbohydrates, even though the extent of this finding is yet to be more precisely established [10]. These outcomes indicate that when formulating a diet for captive alligators it is possible to substitute animal protein for plant-based protein. This in turn could help farms to reduce the feeding cost while still achieving good growth.

As for now, alligators kept in captivity have a range of commercially made formulated feeds available consisting mainly of animal protein in the form of dry pellets. The protein content in these products tends to range from 45% to 56%, with a fat content of less than 11% and a fiber content of roughly 3% [13]. The most common brand of alligator feed is Mazuri, in which the main ingredients in their Crocodilian Large Diet are porcine meat and bone meal, ground corn, spray-dried animal blood cells, and fish meal [27] . The nutritional composition of this brand follows the optimal diet researched by Reigh et al. (2013) [18] and Staton et al. (1990) [20], with a concentration of 45% protein, 9.5% fat, and 3% fiber [27]. Though these refined commercial diets are widely utilized in alligator farms, they are not necessarily cost-effective and suitable for long-term use. As alternatives, feeding whole prey such as chicken, nutria, and fish are recommended. However, if a farm is opting to use nutria as its feed source, it is imperative to ensure they have not been killed with a lead shot as this could result in the alligator suffering a toxicosis [13]. Furthermore, if a farm feeds mainly frozen fish, it is advised to add vitamin B or another meat source supplement to avoid thiamine deficiency [13]. Like all holdings keeping livestock, alligator farms must address bacterial concerns, although only to a lesser extent. Two antibiotics that are popular to be incorporated in feeds are oxytetracycline and virginiamycin, Research has demonstrated adding these antibiotics can lead to a 15% growth enhancement in distressed hatchlings [7].

In addition to the feed, it is also necessary to supply the alligators with clean and purified water to promote optimal growth [28]. This is especially a crucial factor for hatchlings. Using water sourced from regions that are the natural habitat of wild alligators can pose a risk since it can contain pathogens specific to alligators. When water quality is a concern, it is strongly advised to purify the water to ensure its safety. Inadequate facility design that enables water movement between enclosures or easy staff movement between the pens can lead to the spread of disease and should be avoided [28].

3.5 Advantages and limitations of different feeding methods

Alligators kept in farming conditions are mainly fed with dry pellets, meat, animal byproducts, or a mixture of meat and pellets. The primary source of feed for the farm-raised alligator used to be fish meat, but nowadays, it also includes nutria, beef, muskrat, fish, beaver, deer, and even horse [7]. One feeding method utilized mainly for financial reasons is called re-feeding. It is a process in which raw carcasses are used as a whole or cut up and fed to another species [29]. This is thus a salvaging technique for an otherwise lost product. A common example of this method is the use of poultry mortalities from poultry farms for re-feeding. This technique is used for a range of livestock, including pigs and fish. This way of salvaging definite economic losses is so popular that the National Contract Poultry Association has stated that alligator farming has become a side project for Georgia's poultry industry to process the hundreds of thousands of poultry that perish before arriving at the processing plant [29]. An estimate of 6% of poultry can be expected to be lost before reaching the processing plant, which is usually around 21000 out of 350000 on most poultry holdings [29]. The disadvantage of feeding the lost specimens from other animal holdings to alligators is the potential transmission of pathogens to the alligators. Also, if the carcasses for re-feeding are kept in the open, there is a chance that rodents and birds could spread these pathogens further [29]. An example is the West Nile virus, which can easily amplify in farmed alligators and spread in the tanks where they are kept [30]. Given the potential risks of using the carcasses from other production facilities, Alligator farms in the United States of America most often choose to feed their alligators with dry pellets, which consist of fish and poultry by-products, as well as extruded corn and soybeans [20]. This method of feeding has several advantages. First, the dry feed does not need to be stored in a freezer or refrigerator and has a longer shelf life. This saves the

farm the cost of purchasing and operating a cooling system, which can be quite costly in warm regions such as Florida [16]. Compared to fresh or frozen meat, the pellets are less likely to decompose and thus have a decreased potential of becoming a health hazard. In addition, the pellets are 20% lighter than wet meat, thus making it easier to handle for the personnel [16]. Furthermore, these commercial pellets contain a more accurate mix of macronutrients, vitamins, and minerals needed by the alligators. This makes it easier for the farmers to ensure adequate nutrient intake and to control and manage their diet to achieve optimal growth [16]. However, there are still some disadvantages to this feeding method. It is evident that alligators grow faster and with a greater feed conversion rate if fed a diet consisting of nutria carcasses [31]. Additionally, this ready-made alligator feed is not available in all regions as it is a niche product, and not all alligators immediately accept this form of feed as their nutrition [16]. Furthermore, there is another issue regarding cleanliness and waste of resources with the pellets. As described in a study by Brisbin et al. (1990) the pelletized can be flattened into the feeding tray due to the alligators' tendency to crawl back and forth over the feeding area and into the water [32]. This transformation of the food's shape makes it unavailable for the alligator to feed on, resulting in wasted resources. Also, the alligators often take a mouthful of pellets and then return to the water, where portions of the feed are washed out of their mouth again. This leads to further waste of feed as well as decreased water quality [32]. On another note, there are also disadvantages when feeding the alligators with nutria carcasses. Nutria is a large South American rodent that was introduced to the state of Louisiana as an attempt to stimulate the fur industry. These animals used to be hunted and harvested using steel traps and then killed by a blow to the head. However, as the price of nutria fur has dropped, so has the interest in hunting them, leading to the overpopulation of these rodents [33]. This high population of nutria has led to them just being shot with a .22 caliber rifle instead of going through the lengthy process of trying to trap them. This entails that when they are used as feed for alligators, they now often contain lead fragments from the bullets, which can be toxic to these reptiles. In the case of lead poisoning, alligators display a spectrum of symptoms such as weight loss, anorexia, poor growth, lethargy, and ultimately death [33]. Regarding the amount fed to the alligators, some opt for ad libitum feeding, meaning that the alligators have access to food constantly without any restrictions. The alligators can feed whenever they want, thus maintaining optimal plasma amino acid levels, promoting protein synthesis and fast growth. However, one condition evident in commercial and

laboratory enterprises is that this tends to result in overfeeding and gout. This is a condition in which urate crystals develop in the joints and in the kidney, resulting in limb paralysis, kidney failure, and eventually death [24]. In addition, feed that was not consumed leads to a faster deterioration of the water quality in the enclosure and to a higher feeding cost since not necessarily all of the offered feed is utilized [24]. Furthermore, there are also advantages and disadvantages to how the alligators are housed in their enclosures. A huge part of the alligator physiology is explained by the fact that they are ectotherms and do not burn calories to maintain a narrow body temperature like mammals. However, this means that they have developed an innate response to cold weather in which their appetite essentially drops to nonexistent during the winter months [28]. This is because they need some heat from the environment to aid them in catalyzing reactions to break down their feed for digestion and absorption [28]. Hence, keeping the animals in an enclosure in which the temperature is maintained at 30 to 32°C results in an increased metabolic rate as well as enhanced growth and a higher rate of survival [28]. The disadvantage is the higher costs when building the enclosure with the heating system and the cost of maintaining the optimal temperature. Outdoor pens without any heating are much less costly to set up and hence, an easier option to start an alligator farming business. This type of housing allows alligators to be in more natural conditions. However, this will lead to a decreased appetite during the colder months and hence a reduced growth rate, increasing the time from hatchling to slaughter substantially and thus resulting in reduced productivity [24]. It can also lead to economic loss in food waste since it is more difficult to determine how much the reptiles will eat at the given temperature. This can also have an impact on the re-feeding synergy as well with the disposal of noninfectious mortality of livestock such as poultry [24].

4. Method of evaluation

As I began searching for various sources of peer-reviewed articles that pertained to my thesis topic, I quickly realized that the names Reigh, Staton, Nickum, and Masser came up frequently in the study of farmed-raised alligators. These individuals have made substantial contributions in the field of nutritional development and husbandry of farm-raised alligators, and by reading and gathering information from their work and other research articles that cited their work, I could gather enough information for my thesis. My primary source of articles started with simple searches on Google Scholar. Still, as I got further into my topic, I found scientific publications by the World Aquaculture Magazine made by the World Aquaculture Society. This is a non-profit organization that is dedicated to promoting and advancing research in the field of aquaculture. Another important source of scientific publications is the Crocodile Specialist Group (CSG), an organization of biologists, wildlife managers, and researchers dedicated to the study and conservation of crocodilians. My final methodology to attain research material was to contact the researchers myself, and they were happy to send copies of their work to me digitally.

5. Results and discussion

5.1 Feeding habits

Alligators are obligate carnivores and skilled hunters. Their diet changes with their growth and development. Hatchlings consume small prey such as insects, spiders, and small invertebrates. As they get bigger, they expand their diet to include crustaceans, small fish, birds, frogs, and small mammals. As the alligators grow, their snouts elongate, their jaw muscles strengthen, and their teeth become thicker and blunter. This enables them to broaden their diet to include turtles and even larger mammals such as nutria, raccoons, and even white-tailed deer. As they have only a very limited ability to tear prey apart, they mostly need to swallow it in one piece. In addition to hunting the above-mentioned prey, larger alligators occasionally exhibit cannibalistic behavior. Excess nutrients not required for growth, weight maintenance, or breeding are stored by the alligators in muscle bundles in the form of fat. If there is a lack of feed sources, they can significantly reduce their metabolism and utilize the stored fat.

Alligators kept in captivity do not need to show their hunting skills, and they are less active than their wild counterparts. These findings implicate that alligators kept in farm conditions need to be fed a diet containing animal protein with an appropriate size depending on the size of the alligators fed so they can swallow it. Furthermore, it is optional to feed larger alligators daily as they can easily survive without nutrition for prolonged periods and are not used to daily feeding in nature. The fact that larger alligators also consume smaller alligators requires them to be separated according to size to avoid this. However, it is unclear if this cannibalistic behavior only occurs due to lack of prey or also in conditions where they are being fed regularly. In farms, alligators cannot showcase their natural hunting behavior, but no data is available to determine whether this has any negative implications on their health and well-being. The difference between the captive and wild alligator is a more consistent diet of optimal nutrition instead of a dynamic diet in which the wild alligator eats whatever it can lock into its jaws.

5.2 Frequency and timings of feedings

The frequency of feeding is a vital part of alligator farming. The growth can be severely impacted if the alligators are not receiving enough calories, but if they are fed too much and too frequently, they can develop gout. The frequency of feeding is dictated based on the age of the alligator since their metabolism declines as they grow older. Alligators in the first year of their life, require a feeding rate equivalent to 25% of their body weight weekly, which later declines to 18% when they reach three years of age. Furthermore, there are separate theories about when to initiate the feeding of hatchlings. Some choose to wait two to seven days after they have hatched to facilitate increased utilization of their yolk, while others start to feed the day of hatching. Additionally, sometimes the hatchlings need to be placed among other young alligators to stimulate feedings if they are reluctant to start. This daily feeding is continued throughout their first year of life and then reduced to four to five days a week as they grow older. However, the main determinant of their feeding schedule is their body condition.

5.3 Nutrient requirements

Even though the exact nutrient requirements of alligators are still unknown, there are estimations that are good guidelines for alligator farms. One study indicated that the average macronutrient content in the prey depends on the location of the alligators. The Sapelo Island alligators showed to have a diet containing 30.6% fat, 69.4% protein, and 0% carbohydrates, while the Florida group's feed contained 55.8% protein, 12% fat, and 32.2% carbohydrates. The discrepancy between the diet is thought to be due to the fact the Georgian environment is colder, and hence the alligators require more lipids, while the Floridian alligators are in a much warmer environment and hence require carbohydrates to have more energy to increase their respiratory rate. However, this study was limited by the fact that they used the stomach contents of male alligators solely, and they used nutritional data from a closely related species in the U.S. Department of Agriculture whenever they could not find the nutritional data of a certain prey. Furthermore, the optimal diet for farm-raised alligators would be one that provides all the necessary macronutrients to maximize growth while being as low as possible in protein concentration. Protein is the most expensive part of the alligator's diet, and by using a better quality of protein, one can use less quantity. The study by Reigh et al. (2013) indicated that the optimal amount of protein concentration is 45%, and by going past this threshold, the nitrogen excretion will increase

while the body weight does not. Declining water quality due to the increased ammonia concentration because of the wasted protein leads to additional cleaning costs. An additional important factor is the amino acid configuration of the alligator diet, in which lysine is essential for alligator growth. In another study by Reigh and Williams (2022), it was evident that a diet with 2.25% lysine is enough to stimulate growth in the American alligator. However, the study was limited because there was no observation of the individual consumption of the alligators and whether some alligators also ate the feed portions of others. The study was also conducted over ten months, which is not enough to grow an alligator for meat or hide production completely. Besides protein concentration, there is an optimal content for lipids and carbohydrates. In a study by Staton et al. (1990) it was indicated that a lipid content of 4% to 12% in a diet is enough to slow down the alligator's digestive tract to have more time for digestion. As for carbohydrates, the limit indicated in the study was 11%, given that as true carnivores, alligators do not possess a pancreas that can manage higher levels of blood glucose. Furthermore, the data indicated that the ideal caloric intake for young alligators is within a range of 8.2 to 10.9 kcal of digestible energy per gram of crude protein. Since alligators do not require a lot of calories to maintain a narrow body temperature but have physiologic reactions that function in both very warm and cold environments. The limit to this study is that these alligators had been used in one or two previous experiments before this one, which could have an impact on the obtained data. Lastly, supplementation of micronutrients to the alligator diet is also important. Such as adding vitamin B to prevent thiamin deficiency in alligators fed frozen fish or calcium supplements for alligators kept in an enclosure without sunlight.

5.4 Nutritional considerations and diet formulation

The commercial pelleted alligator diet is, without a doubt, a cornerstone in terms of optimal growth and health of the alligator, as well as the resources spent by the alligator farm. By overfeeding, there will be a waste of food and the potential development of gout in the livestock. By underfeeding, the alligators will have stunted growth and potentially develop diseases if the diet is missing essential micronutrients or minerals. To lower the financial burden of feed, a study by Staton et al. (1990) indicated that farmed-raised alligators can eat and digest protein from isolated soybeans, even when it makes up more than 40% of their dietary protein. Additionally, lipids play an important part in the diet formulation due to arachidonic acid. It is believed to play an integral part in membrane

fluidity and membrane-based cell functions in the liver, muscle, heart, and skin tissue. In the study conducted by Staton et al. (1990) it was shown that alligators fed a diet deficient in essential fatty acids grow at a slower rate and converted feed to body mass less efficiently. However, it is also speculated that the temperature that the clutch was kept in can influence the hatchling's diet and could have altered the growth rate in this study. Carbohydrates have an optimal range from 0% to 14% in the alligator feed. If this threshold is exceeded, then the growth of the alligator can be inhibited, which is detrimental since their digestion speed is already slow. Thus, it is essential to avoid undigestible feed for the alligators. Contradictory findings were indicated in a study conducted by Staton et al. (1990) in which glucose supplementation to a meat diet did drastically improve the growth of alligators. However, one alligator group received nutria meat alongside glucose while another received pure protein with glucose supplementation in the study and the pure protein group did have reduced growth. This could be because the dry diets were mixed with water to make a moistened cake that then could be divided into bite-sized pieces, while the nutrias were just covered in sugar, which could have been easily dissolved in water, thus leading to the alligators fed the nutria and glucose diet to ingest less sugar than the other group. In the same experiment, it was also indicated that protein derived from vegetable origin had a feed conversion that was very similar to those from animal protein, which promotes the notion that plant protein should not be dismissed as viable feed for alligators. Furthermore, micronutrients need to be supplemented to avoid nutritional diseases in the farmed alligators. Alligators can develop metabolic bone disease if the calcium and phosphorous balance is disrupted due to the lack of vitamin D supplements or lack of sunlight. Several alligator farms opt to keep their livestock in the dark to avoid the seasonal impacts on the alligators' appetite. However, without sunlight, the synthesis of vitamin D is halted, and inappropriate calcium absorption is initiated. However, this can be avoided if the alligators receive bone or another type of calcium supplement in their diet. Additionally, vitamin E needs to be supplemented for alligators raised with fish as their primary food source to avoid steatitis and fat necrosis. Furthermore, it is imperative that overfeeding is avoided since gout is a prevalent disease in overfed reptiles. Hence, ad libitum feeding is not recommended for farm-raised alligators. However, the feed conversion to body weight needs to be accounted for as well since as the farmed alligators age, their metabolism and feed conversion rate decrease to finally settle at 40% when the alligator is roughly 1.8 meters. Young alligators need approximately 25 times more food compared to adult alligators. Commercial feeds

nowadays try to account for all these factors that are essential for optimal growth in farm-raised alligators. Mazuri feed is the most common one, and its macro- and micronutrient concentrations are consistent with the findings of the mentioned studies. However, some alligator farms still opt to use whole prey feeds instead of formulated feeds as it can reduce cost, especially if the re-feeding model is used. Finally, adding antibiotics to the feed is indicated in some cases to avoid bacterial infections and promote the growth of distressed hatchlings. Furthermore, if the water used on the farm is sourced from the habitat of wild alligators and thus there is a risk of pathogens being transmitted in the water, it should be purified before coming into contact with the farmed alligators.

5.5 Advantages and limitations of different feeding methods

The methods developed to advance feeding methods over the years come with both advantages and disadvantages. Re-feeding is a prevalent method by alligator farmers operating a poultry business and alligator farm at the same time as they can use the mortalities from the poultry farm for their alligators. However, the drawback is that pathogens can travel from the poultry farm to the alligators, which could potentially infect the alligators. Furthermore, pelletized feed has been getting more attention over the years as it provides a lot of benefits. Walk-in freezers are no longer necessary, electricity costs are reduced, the pellets are lighter and easier to handle for the personnel, and more importantly, the macro- and micronutrients are contained in sufficient amounts, and no thoughts must be put into supplementation. However, the drawback is that alligators seem to still grow at a faster rate when utilizing a feed composed of nutria carcasses. In addition, the pelletized feed tends to change shape and dissolve in contact with water, rendering it unusable for feeding. The nutria diet also has its drawbacks. Firstly, it does not necessarily contain the required minerals and vitamins that the pelletized feed can provide, and lately, due to the nutria overpopulation, hunters have opted to shoot them instead of using traps, which leads to lead bullets being left in the carcass that can cause lead poisoning in the alligators. Ad libitum is another feeding method that allows the alligators always to have access to food and allows them to feed whenever making it easier to manage for the personnel. However, as explained before, alligators are opportunistic feeders and, when provided with a lot of food, will eat as much as they can, which then leads to a higher likelihood of developing gout, wasting protein by excreting nitrogen, and polluting the water in the enclosure leading to economic losses. Finally, the question is whether it is

more efficient to house and feed the alligators in enclosures with or without sunlight. Keeping them indoors inhibits the seasonal effect on their appetite, and they can grow normally during winter. However, the living costs and technology for such an enclosure are much more expensive, and the likelihood of developing vitamin D deficiency and calcium and phosphate imbalances is much higher.

6. Conclusion

Alligator farming is a growing industry with ongoing developments regarding feeding methods. To achieve optimal growth and health, feeding frequency and diet formulation are important factors.

Newly hatched alligators can either be fed right away, or they can be left without food for up to seven days to allow for complete yolk utilization. However, after the first week of life it is essential to feed the hatchlings daily to achieve the desired growth. For adult alligators a feeding frequency of 4 to 5 days a week is ideal as more frequent feeding and overfeeding can lead to the development of gout. The ideal timing of the feeding has not yet been established.

The exact nutritional requirements of alligators are not fully understood but studies indicate an optimal protein content of 45%, a fat content between 4% to 12%, and a carbohydrate concentration between 0% to 14%. Furthermore, 2.25% lysine should be incorporated into the diet for ideal growth and development. In addition, calcium supplementation is required for alligators kept away from sunlight.
Until the age of one, alligators need to be fed at a rate equivalent to 25% of their body weight weekly due to their high metabolic rate and rapid growth. This feeding rate needs to be reduced to 18% of their body weight when they are adults as their metabolic rate as well as their feed conversion rate declines.

The most used diet formulation for alligators is pelletized feed consisting mainly of animal protein sources such as porcine meat and bone meal, spray-dried animal blood cells, and fish meal. Alligators can also utilize plant proteins, but further research is required to establish if one protein source outweighs the other in terms of growth and health.

The commercial pelleted alligator feed has the advantage that the macro- and micronutrient requirements of the alligators are met very closely, and it can be ingested easily even by the hatchlings. However, some alligators do not accept this feed and it sometimes occurs that the alligators compress the feed when walking over it, thus rendering it inedible. The feeding of whole carcasses such as nutria or chicken is often economically more efficient if the re-feeding method is used, and it results in faster growth rates. However, this feeding method requires large walk-in freezers and comes with a risk of lead toxicity from bullet fragments in the nutria carcass and pathogen transmission.

For optimal growth and health, alligators should be fed a commercial pelleted diet daily at a feeding rate of 25% of their body weight weekly until the age of one. For adult alligators 4 to 5 feedings per weeks at 18% of their body weight with a pelleted diet is ideal. Additional research is required to further specify the feeding recommendations for optimal growth and health in farmed alligators.

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I hereby confirm that I am familiar with the content of the thesis entitled

Evaluation of the feeding methods of alligators kept under farm conditions (A review)

..... written by Sophia Jousson

(student name) which I deem suitable for submission and defence.

Date: Budapest, 15 day 11 month 2023 year

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..... Supervisor name and signature

Animal Nutrition and Clinical Dietetics

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Thesis progress report for veterinary students

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Department: **Animal Nutrition and Clinical Dietetics**

Thesis title: **Evaluation of the feeding methods of alligators kept under farm conditions**

Consultation – 1st semester

	Timing			Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2023.	02.	12.	Review of literature.	
2.	2023.	03.	26.	Structure of the thesis.	
3.	2023.	04.	20.	Citation of the authors.	
4.	2023.	05.	24.	Research questions.	
5.	2023.	06.	19.	Food safety concerns.	

Grade achieved at the end of the first semester: 5 (very good)

Consultation – 2nd semester

	Timing			Topic / Remarks of the supervisor	Signature of the supervisor
	year	month	day		
1.	2023.	07.	31.	Advantages and limitations of different feeding methods.	
2.	2023.	09.	25.	Conclusions.	
3.	2023.	10.	12.	Discussion about the first version.	
4.	2023.	10.	17.	Corrections.	
5.	2023.	11.	08.	Development of the final version.	

Grade achieved at the end of the second semester: 5 (very good)

The thesis meets the requirements of the Study and Examination Rules of the University and the Guide to Thesis Writing.

I accept the thesis and it is found suitable to defence,

.....
signature of the supervisor

Signature of the student: .....

Signature of the secretary of the department: .....

Date of handing the thesis in: 17. 11. 2023