Journal of Environmental Science and Engineering B 13 (2024) 86-91
doi:10.17265/2162-5263/2024.02.004

Growth Performance of Crocodile Fed with Chicken Intestine and Trash Fish at Smallholder Farm in Siem Reap Province, Cambodia

Sourloing Hor[1,3], Kanan Dim[1], Sungchang Kang[2], Kroesna Kang[1], Kouch Theng[1] and Manay Ith[1]

1. Faculty of Veterinary Medicine, Royal University of Agriculture, Phnom Penh 12400, Cambodia

2. National Institute of Education, Phnom Penh 120204, Cambodia

3. Graduate School, Royal University of Agriculture, Phnom Penh 12400, Cambodia

Abstract: The experiment was conducted at the smallholder crocodile farm at Pouk district, Siem reap province, and lasted 12 months, commenced from January 1st to December 31st, 2023. The CRBD (Completely Randomized Block Design), was used in 3 treatments, such as T1 (fed chicken intestine only), T2 (fed chicken intestine + trash fish) and T3 (fed trash fish only), with 4 replications in each treatment. The block was set by gender of crocodile, male and female. The 36 of local breed crocodiles 4 months old were allocated into each replication randomly. The result found that the length of crocodile gradually increased in the first semester, then it greatly increased from or for second semester for all treatments. In addition, the final body length of crocodile was significant different among treatments ($p < 0.001$), the treatment of T2 (fed chicken intestine + trash fish) had the longest one. Body length was also affected by gender, and male crocodile had longer body length ($p < 0.001$). However, there were no significant differences for the interaction between types of feed with gender ($p > 0.05$) (Table 1). The body weight of crocodile had gradually increased in the first semester, then it greatly increased from or for second semester for all treatments, while the final body weight of crocodile was also significant different among treatments ($p < 0.001$) and the gender of crocodile ($p < 0.001$). The average ADG (Daily Weight Gain) was significant different among treatments ($p < 0.001$). Treatment of T2 (fed chicken intestine + trash fish) had highest ADG, 11.05 g, followed by T3 (fed trash fish only), while the T1 had the lowest one. The gender of crocodile affected the ADG of crocodile, and male crocodile had higher ADG than female crocodile ($p < 0.001$). However, there were no significant differences for the interaction between type of feed with gender ($p > 0.05$). Feed intake was calculated based on amount of feed offer and measured in fresh basis. The amount of intake feed in all treatments was the same. FCR (Feed Conversion Ratio) was significant different among treatments ($p < 0.001$) and also gender of crocodile ($p < 0.001$). However, there were no significant differences for the interaction between types of feed with gender ($p > 0.05$). In conclusion, the uses of trash fish and chicken intestine are an alternative feed source for crocodile to result in higher growth performance of crocodile.

Key words: Local breed, body length, body weight, ADG, FCR.

1. Introduction

In Cambodia, there are two species of crocodiles: freshwater crocodiles (*Crocodylus siamensis*) and saltwater crocodiles (*Crocodylus porosus*). These two species are similar and can be bred on farms to produce hybrid crocodiles. However, saltwater crocodiles often live near seawater, have large body size and are more dangerous to humans than freshwater crocodiles [1].

The freshwater or mountainous crocodile is variously named as Siamese crocodile or the River crocodile and has the scientific name *Crocodylus siamensis*. The mountain crocodile is classified as the most endangered species (IUCN 2009: International Union for Conservation of Nature in 2009), and annexed to CITES appendix I (CITES: Convention on International Trade in Endangered Species of Wild Fauna and Flora). About one hundred years ago, this

Corresponding author: Souloing Hor, Ph.D., research field: animal science. E-mail: sourloinghor@gmail.com.

giant reptile was abundant throughout Southeast Asia, but due to habitat destruction and poaching, the crocodile has dramatically reduced to more than 99 percent of its habitat history. Crocodile farms in Cambodia were first established in 1956 [2]. Decree No. 33 on Fisheries Management (1987) provided an opportunity for numerous people living in the provinces around the Tonle Sap Lake, to start small-scale crocodiles farming until today [3]. Six Siamese crocodile farms in Cambodia were registered with CITES in 1998, but presently there are more than 900 farms and holding pens, and the number of crocodiles per farm is rising [4]. Industrial crocodile aquaculture had a remarkable economic growth and ecological importance for local people and producers. Crocodile farming can generate local income, job creation, environmental education programs, and biological conservation and tourists [5]. Crocodile farming focused on leather [6] that can be processed into various products such as sweaters, belts, shoes, gloves, socks, straps, handbags, suitcases, crutches, book covers, table/chair-cloths, key chains, phone cases, gun cases, etc. [7]. In the wild most crocodiles eat a wide variety of food, such as insects, fish, small frogs, lizards, crustaceans, and other small mammals. In farming, the offal animal was also used [8], while, in Cambodia, the low value fish were mainly used as feed source for farming crocodile [9], in addition, snakes, marine fish, rodents, and animal slaughter waste were used as feed source as well [10]. However, or more than that, imported culture-fish have also been used, due to the scare of local resources in Tonle Sap ecosystem [11]. For these reasons, the study on growth performance of crocodile by using trash fish and chicken intestine was conducted to reduce the dependency on natural resources.

2. Research and Methodology

2.1 Location and Duration

The experiment was conducted at the small householder crocodile farm at Pouk district, Siemreab province. The experience lasted 12 months, commenced from January 1st to December 31st, 2023.

2.2 Experimental Layout

The CRBD (Completely Randomized Block Design) was used in 3 treatments, and 4 replications in each treatment, with total of 12 experimental plots. The block was by gender of crocodile, male and female. Three crocodiles were allocated into each replication, and fed with 3 different types of feed or experimental feed as following:

- T1: Feed chicken intestine only.
- T2: Feed chicken intestine and trash fish.
- T3: Feed trash fish only.

2.3 Experimental Animal

The 36 crocodiles, fifty percent male and females of local breed, namely *Siamese crocodile*, 4 months old, were used and allocated into each replication randomly.

2.4 Feed and Feeding

At the beginning of the 3 months, the crocodiles were fed every day, at 10:00 AM. For T2 (fed chicken intestine and trash fish), these feeds were used in alternative day as the sole feedstuff. From the period of 4 months onwards, the crocodiles were fed every 2 days. The whole chicken intestine was purchased from a private company and chopped into small pieces. All the treatments were feed in the same amount.

2.5 Data Collection

Feed offer was weighted before feeding. For growing performance, the weight and length of crocodile were measured with monthly interval, at the end of each month.

2.6 Data Record and Analysis

All the data were recorded in Excel and were anlysed for difference among treatment, block and interaction of CRBD. The parameters were analysed including the body length, body weight, weight gained, ADG

(Average Daily Weight Gain) in each growing stage and also feed conversion ratio (FCR).

3. Result

3.1 The Variation of Body Length of Crocodile

According to the result in Fig. 1, it was found that the average body length of crocodile at beginning in those treatments was not significant different, ranging from 48.75 cm to 49.42 cm. It showed no sampling bias for the study. The length of crocodile gradually increased in the first semester, then it was huge increased from second semester for all treatments. However, the T2 (fed chicken intestine + trash fish) had highly increased than other treatments.

For the final body length of crocodile there was significant difference among treatments ($p < 0.001$). Treatment of T2 (fed chicken intestine + trash fish) had longest body length, 125.58 cm, followed by T3 (trash fish only), while the T1 had shortest one. The gender of crocodile also affected final body length of crocodile, and male crocodile had longer body length than female crocodile, accounting for 125.61 cm and 114.89 cm, respectively ($p < 0.001$). However, there was no significance for the interaction between type of feed with gender ($p > 0.05$) (Table 1).

Table 1 The final body length of crocodile.

	Body length (cm)	SE mean	*p* value
Treatments (feed)			
T1	114.58		
T2	125.58	53.40	< 0.001
T3	120.58		
Gender			
Female	114.89	43.60	< 0.001
Male	125.61		
Interaction (Feed ×Gender)			
T1 ×Female	106.83		
T1 ×Male	122.33		
T2 ×Female	122.33	75.52	0.056
T2 ×Male	128.83		
T3 ×Female	115.50		
T3 ×Male	125.67		

SE mean: standard error of mean.

3.2 The Variation of Body Weight of Crocodile

It was similar to the body length of crocodile, the average body weight of crocodile at beginning in those treatments was not significant different, ranging from 405.83 g to 416.67 g. It showed no sampling bias for the study. The body weight of crocodile had gradually increased in the first semester, then it was huge increased from second semester for all treatments. However, the T2 (fed chicken intestine + trash fish) had highly increased than other treatments (Fig. 2).

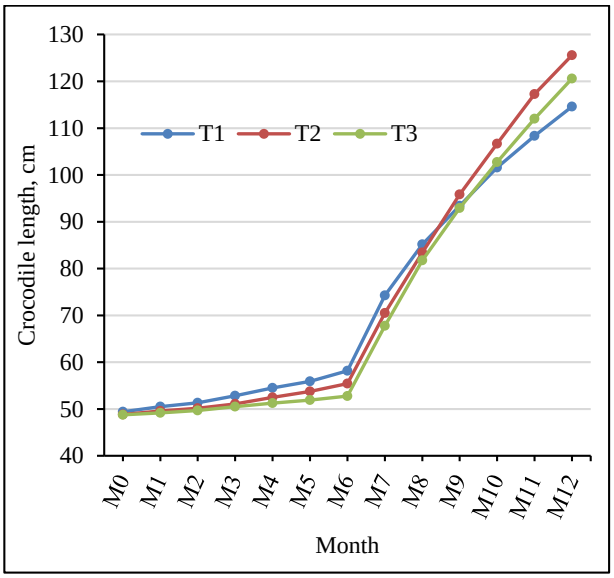

Fig. 1 The variation of body length in the whole period.

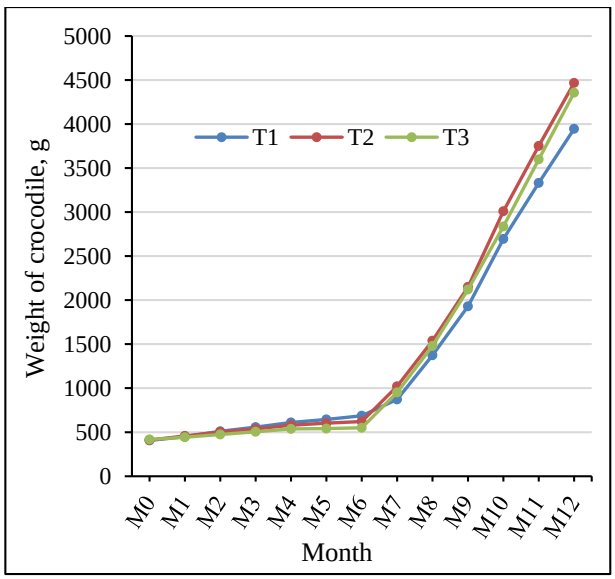

Fig. 2 The variation of body weight in the whole period.

Table 2 The final body weight of crocodile.

	Body weight (g)	SE mean	*p* value
Treatment			
T1	3,945.83		
T2	4,466.67	53.40	< 0.001
T3	4,356.67		
Gender			
Female	3,861.11	43.60	< 0.001
Male	4,651.67		
Interaction (Feed×Gender)			
T1×Female	3,541.67		
T1×Male	4,350.00		
T2×Female	4,033.33	75.52	0.553
T2×Male	4,900.00		
T3×Female	4,008.33		
T3×Male	4,705.00		

SE mean: standard error of mean.

For the final body weight of crocodile there was also significant difference among treatments ($p < 0.001$). Treatment of T2 (fed chicken intestine + trash fish) had highest body weight, 4,466.67 g, followed by T3 (fed trash fish only), while the T1 had lowest one. The gender of crocodile also affected final body weight of crocodile, and male crocodile had higher body weight than female crocodile, accounting for 4,651.67 g and 3,861.11 g, respectively ($p < 0.001$). However, there were no significant differences for the interaction between type of feed with gender ($p > 0.05$) (Table 2).

3.3 ADG

For the result of ADG it showed lower gaining in the first semester, then it was huge increased from second semester for all treatments. However, the peak ADG was at 10th moth of experimental period, then slightly diseased in 11th and 12th month (Fig. 3).

For the final body weight of crocodile there was also significant difference among treatments ($p < 0.001$). Treatment of T2 (fed chicken intestine + trash fish) had highest body weight, 4,466.67 g, followed by T3 (fed trash fish only), while the T1 had lowest one. The gender of crocodile also affected final body weight of crocodile, and male crocodile had higher body weight than female crocodile, accounting for 4,651.67 g and 3,861.11 g, respectively ($p < 0.001$). However, there were no significant differences for the interaction between type of feed with gender ($p > 0.05$) (Table 3).

3.3 FCR (Feed Conversion Ratio) in Fresh Basic

Feed intake was calculated based on amount of feed offer and measured in fresh basis. The amount of intake feed in all treatments was the same, and the amount will be changed every two months, in average of the first 2 months it was 13 g/head/day, then to 15 g/head/day, 20 g/head/day, 30 g/head/day, 40 g/head/day and 55 g/head/day.

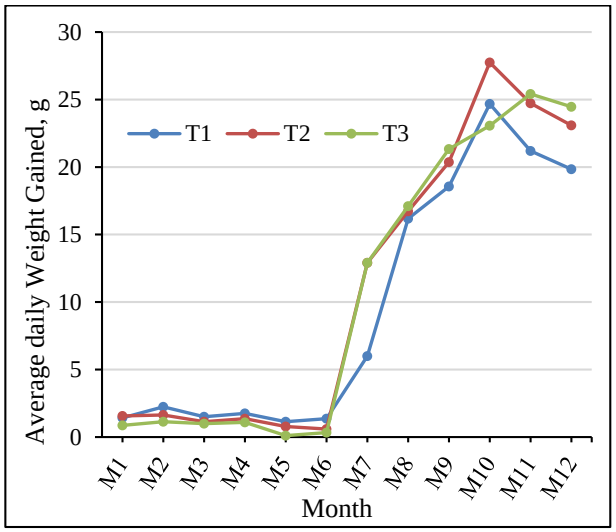

Fig. 3 The variation of ADG in the whole period.

Table 3 The Average Daily Gained (ADG).

	ADG (g)	SE mean	*p* value
Treatments (feed)			
T1	9.65		
T2	11.05	0.150	< 0.001
T3	10.73		
Gender			
Female	9.41	0.122	< 0.001
Male	11.55		
Interaction (Feed×Gender)			
T1×Female	8.56		
T1×Male	10.75		
T2×Female	9.89	0.212	0.625
T2×Male	12.21		
T3×Female	9.78		
T3×Male	11.69		

SE mean: standard error of mean.

Table 4 The Feed Conversion Ratio (FCR).

	FCR	SE mean	*p* value
Treatments (feed)			
T1	3.03	0.040	< 0.001
T2	2.64		
T3	2.71		
Gender			
Female	3.08	0.032	< 0.001
Male	2.51		
Interaction (Feed ×Gender)			
T1 ×Female	3.70	0.056	0.258
T1 ×Male	2.68		
T2 ×Female	2.92		
T2 ×Male	2.36		
T3 ×Female	2.95		
T3 ×Male	2.47		

SE mean: standard error of mean.

FCR was significant different among treatments ($p < 0.001$). Treatment of T2 (fed chicken intestine + trash fish) had lowest FCR, 2.64, followed by T3 (fed trash fish only), 2.71, while the T1 had the highest one. The gender of crocodile also affected the FCR of crocodile, and male crocodile had lower FCR than female crocodile, accounting for 2.51 and 3.08, respectively ($p < 0.001$). However, there were no significant differences for the interaction between type of feed with gender ($p > 0.05$) (Table 4).

4. Discussion

The crocodile farming for commercial purpose aimed to grow crocodiles to marketable size as quickly and cheaply as possible. However, the nutrition requirement of crocodiles was still poorly understood, since they could not make use of vegetable-based proteins. Therefore, the rearing crocodile for commercial aims depended upon a reliable supply of animal protein, which competed with human consumption [8] and other domestic animals, especially the use of fish by-products as feed source [12]. The recommendation for the amount of offered feed was based on their length, where our study followed it. For feeding the crocodile, in our study, the chicken intestines were copped into the piece small enough to be swallowed without difficulty, especially for young crocodile, and normally fed at 10:00 AM, when temperature is warm enough for crocodile, otherwise they will refuse to eat, especially when the air or water temperature falls below 15.6 ℃ [13]. The male crocodiles grew significantly faster than females which was 11% faster in male than female [8, 14], however our study found 5.67% faster in male in 16 months old. For the types of feed, this study found that the alternative use of chicken intestine with trash fish had the highest growth rate, followed by trash fish, while it was similar to what Bolton [8] reported.

5. Conclusion

In conclusion, the use of trash fish and chicken intestine as alternative feed source for crocodile had provided good performance of crocodile both body weight and ADG, since exchangeable feed had increased the palatability and useable feed. In addition, it will contribute to reduction in sharing feed with other domestic animal and also contribute to natural fish conservation. In term of growth performance, the male crocodile provides higher rate than female.

References

[1] Ratankorn, P. 1992. "Crocodiles in Cambodia." In *Crocodile: Proceeding of the 11th Working Meeting of the Crocodile Specialist Group of the Species Survival of the IUCN* (Vol. 2). Gland, Switzerland: The World Conservation Union, pp. 64-76. ISBN: 2-8317-0133-3.

[2] Sandab, H. 2010. "Research on the Distribution of Siamese Crocodiles in the Wild in Sre Ambel District, Koh Kong Province." Graduated thesis, the Royal University of Agriculture.

[3] Moniroth, V. 2000. "Reproduction and Hatching of Farmed Crocodile Eggs." Graduation thesis, Royal University of Agriculture.

[4] Daltry, J. C., and Thorbjarnarson, J. T. 2004. "Siamese Crocodile Conservation in Cambodia." https://www.researchgate.net/publication/261109486_Siamese_Crocodile_Conservation_in_Cambodia.

[5] Tosun, D. D. 2013. "Crocodile Farming and Its Present State in Global Aquaculture." *J. Fish Sci.* 7: 43-57.

[6] Ashton, P. J. 2010. "The Demise of the Nile Crocodile (*Crocodylus niloticus*) as a Keystone Species for Aquatic Ecosystem Conservation in South Africa: The Case of the Olifants River." *Aquat Conserv: Mar Freshw Ecosyst* 20: 489-93.

[7] Thuok, N. 2014. *Simple Techniques for Raising Crocodiles for Export*. Fisheries Administration.

[8] Bolton, M. 1989. *The Management of Crocodiles in Captivity*. Rome: Food and Agriculture Organization of the United Nations. https://www.fao.org/3/T0226E/t0226e00.htm#cont.

[9] So, N., Tong, E., Norng, S., and Hortle, K., 2005. "*Use of Freshwater Low Value Fish for Aquaculture Development in the Cambodia's Mekong Basin* (Consultancy Report for Mekong River Commission). Cambodia: Assessment of Mekong Capture Fisheries Project.

[10] Brooks, S. E., Allison, E. H., Gill, J. A., and Reynolds, J. D. 2010. "Snake Prices and Crocodile Appetites: Aquatic Wildlife Supply and Demand on Tonle Sap Lake, Cambodia." *Biological Conservation* 143: 2117-35.

[11] Lamberts, D. 2006. "The Tonle Sap Lake as a Productive Ecosystem." *Water Resources Development* 22 (3): 481-95.

[12] Luthada-Raswiswi, R. W., Mukaratirwa, S., and O'Brien G. 2019. "Nutritional Value of the Nile Crocodile (*Crocodylus niloticus*) Meal for Aquaculture in South Africa." *Journal of Fisheries Sciences* 13 (2): 20-5. https://doi.org/10.36648/1307-234x.132.162.

[13] Pooley, A. C. 1979. "Crocodile Rearing and Restocking." In *Crocodile: Proceedings of the First Working Meeting of Crocodile Specialists*. New York: International Union for Conservation of Nature and Natural Resources (IUCN), pp. 104-30.

[14] Manolis, S. C., and Webb, G. J. W. 2016. "Best Management Practices for Crocodilian." In *Farming* (Version 1). Darwin, Australia: IUCN-SSC Crocodile Specialist Group. http://www.iucncsg.org/365_docs/attachments/protarea/227c50b2e92bf796cbb1573bdd348b12.pdf.