

Feeding Regime and Management of Captive Saltwater Crocodile, *Crocodylus Porosus* in Kota Tinggi, Johor

Mohd Faudzir Najmuddin¹, Siti Hasmaliza Hassem¹, Nurhizatul Safikah Mohd Hauri¹, Fatin Zahari¹, Nursyuhada Othman¹, Hidayah Haris¹, Muhammad Abu Bakar Abdul-Latiff^{1,2*}

¹Faculty of Applied Sciences and Technology,
Universiti Tun Hussein Onn Malaysia, KM1 Jalan Panchor, 84600, Muar, Johor, MALAYSIA

²Oasis Integrated Group (OIG), Institute for Integrated Engineering (I²E),
Universiti Tun Hussein Onn Malaysia, 86400 Parit Raja, Johor, MALAYSIA

*Corresponding Author

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Abstract: *Crocodylus porosus* is the largest species of crocodile and can be found in estuarine and riverine area in Malaysia. Crocodile in captivity can be found in Malaysia for various purposes such as tourism, conservation and leather industry. However, the management practice in established crocodile farm varies across park for example in terms of feeding regime. Thus, this study focusses on the feeding regime of *C. porosus* in captivity and evaluation of management of crocodile of Teluk Sengat Crocodile Farm. This study was carried out for 35 days in two different ponds of Teluk Sengat Crocodile Farm, Kota Tinggi, Johor. The results show majority of the food given to crocodile were chicken (64%), followed by fish (28%) and prawn (8%). Prawn was only given to juvenile crocodile every day, while fish and whole chicken were given to adult crocodile once a week. The feeding frequency are adequate for the juvenile crocodile however, the feeding quantity for adult pond are worrying. Future research should be conducted on other captive population of *C. porosus* in other areas in Malaysia as well to better understand the overall management practices in Malaysia.

Keywords: *Crocodylus porosus*, Saltwater Crocodile, Feeding Regime, Teluk Sengat Crocodile Farm, Malaysia

1. Introduction

Crocodile belongs to the order Crocodylia that are generally huge, heavy, amphibious animals, with lizard-like appearance and carnivorous habit [1],[2]. Crocodiles have a body form that allows the eyes, ears and nostrils to be above the water surface while the rest of the animal is hidden below. They were equipped with powerful jaws with numerous sharp and conical shaped teeth, two pairs of short legs with clawed and webbed toes [1],[2]. The tail is long and massive and the skin is thick and plated. There are two families total in Crocodylia, Crocodylidae and Alligatoridae [2]. Crocodylians are geographically distributed in 91 countries and islands worldwide [3]. The saltwater crocodile, *Crocodylus porosus* is the largest species crocodile and it ranged from India to North Australia including Malaysia [1].

Wild saltwater crocodile can be found in estuarine and riverine ecosystem but hardly seen in Peninsular Malaysia nowadays [4]. Previous record in Malaysia had shown this species was apparently common and attacks on human were very frequent along the coast [4]. Based on recent surveys made in one of the waterways in Sungai Linggi-Rembau located in south of Port Dickson, Negeri Sembilan, it is confirmed that a breeding population of saltwater crocodile existed within that river system [5]. The study also mentioned a total of 60 crocodiles were distributed along the river

*Corresponding author: latiff@uthm.edu.my

with a total range of 26.3km. 10 individuals of saltwater crocodile found in Sungai Rembau and 25 individuals of saltwater crocodile in both upstream and downstream area of Sungai Linggi [5]. The information regarding saltwater crocodile's distribution in the rest of Peninsular Malaysia is limited to the news reports of crocodiles sighting or captured in different locations. Fortunately, *C. porosus* can easily found in numerous zoos or private crocodile farms in Peninsular Malaysia.

The studies on captive crocodile's feeding regime were established in the world but compliance of crocodile farm to established guideline was left to park management and authority [6]. The information on crocodile park's feeding regime is limited in term of publications as the guideline had been established and many other publications focused more on wild population of saltwater crocodile [7], [8]. This left a void in term of guideline compliance amongst crocodile farm and evaluation of these guideline can help improve their practice and ultimately conservation of the species.

Teluk Sengat Crocodile Farm is one of the established *ex-situ* sites for conservation of captured crocodile in nearby river especially in Sungai Johor. While serving for conservation of saltwater crocodile, it also opens for visitor for experiencing saltwater crocodile inside enclosure. The objectives of this study are to investigate the feeding regime of crocodile in Teluk Sengat Crocodile Farm in essence to understand their practice for saltwater crocodile captivity management. The feeding regime is different from feeding ecology study as feeding ecology of a species is completely linked to its population dynamics, but this study aims to understand the practice of the park management and compare it with other established guidelines [9], [10].

2. Methodology

2.1 Study site

This study was carried out in Teluk Sengat Crocodile Farm (1.5651066°N, 104.0241387°E) in Kota Tinggi, Johor (Fig. 1). There are eight breeding enclosures, 37 small enclosures and 37 individual enclosures (Fig. 2) where the crocodile were kept in captivity. However, only six breeding enclosure, 27 small enclosure and 37 individual enclosure were open to public. The other two breeding enclosure and ten small enclosure were restricted only for management purposes. There are estimated around 1000 individuals of saltwater crocodile in this facility. This study was carried out simultaneously with agnostic behaviour of captive *C. porosus* in captivity that is available in this volume as well.



Fig. 1 - Location of Teluk Sengat Crocodile Farm, Kota Tinggi, Johor



Fig. 2 - (a) individual enclosure; (b) small enclosure; (c) breeding enclosure inside Teluk Sengat Crocodile Farm

2.2 Intensive observation

The observation for feeding management was carried out for 35 days from 9:00 AM till 6:00 PM following *ad libitum* method [11]. 82 crocodile enclosures were examined during observation. Feeding time normally scheduled on Monday or Tuesday, once every week by the management. Data collected was on the crocodiles were as follows: (1) type of food given (etc. fish, whole chicken, prawn), (2) quantity of food given (no. of item: whole chicken, skipjack tuna and prawn), (3) the feeding frequency and (4) cage/enclosure cleaning frequency.

3. Results

The saltwater crocodile in Teluk Sengat Crocodile Farm were fed mainly with chicken (64%), followed by fish (28%) and prawns (8%) (Figure 3). Prawns were given to juvenile crocodile while the adult crocodile were given chicken and fish. The type of fish that they give is Skipjack Tuna (*Euthynnus affinis*) and whole chicken.

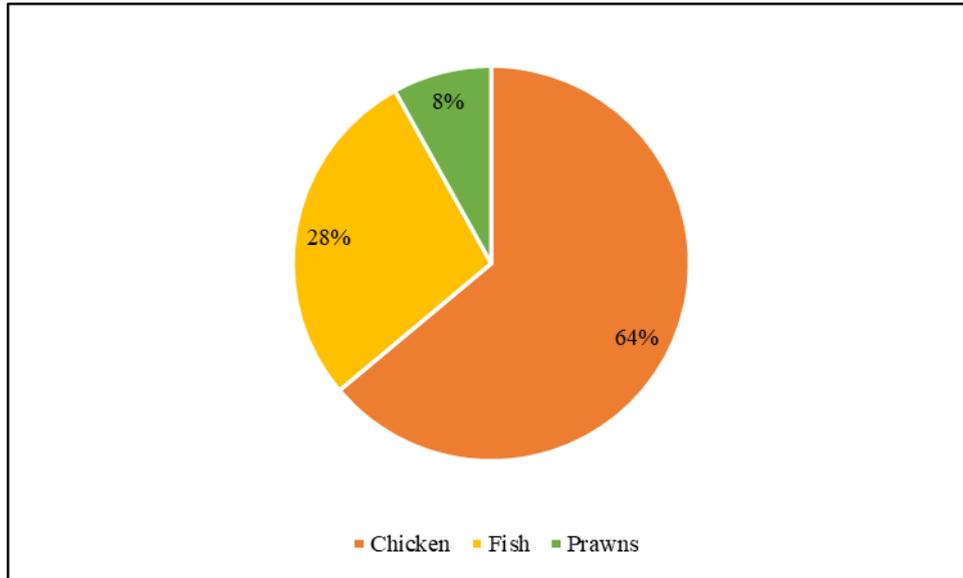


Fig. 3 - The total consumption percentages of food in Teluk Sengat Crocodile Farm

The juvenile saltwater crocodile in Teluk Sengat Crocodile Farm were fed every day while adult crocodiles were just feed once a week which is on Monday or Tuesday (Figure 4). Out of 82 enclosures 19 were left starving during the weekly feeding time so that they can be fed using feeding package by visitors. The quantities of prawns given to the juvenile crocodile are consistent every day which are 10 prawns. For the adult crocodile, they were fed once a week with different quantity of food. The total quantity of food given to all adult crocodiles varied from 611 to 807 pieces of food.

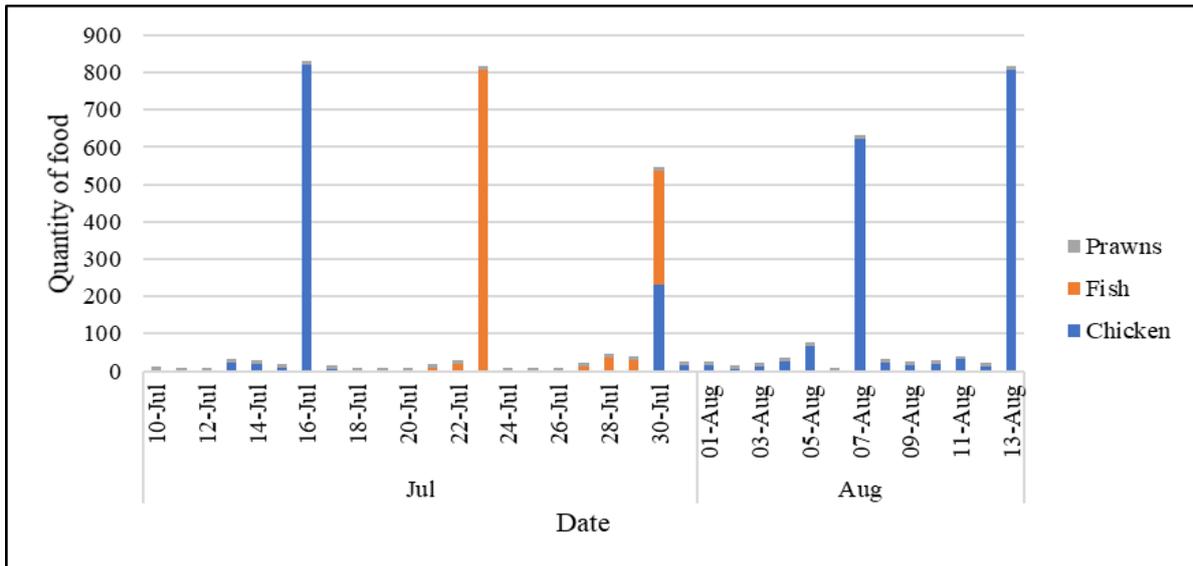


Fig. 4 - The total consumption of food Teluk Sengat Crocodile Farm in during study

4. Discussion

Based on the results, the provision provided for juvenile crocodile is adequate and complied with other records [3], [6]. To maintain similar growth rates, a wild juvenile *C. porosus* requires food equivalent to four percent of its body weight per week where the captive saltwater crocodile require four times from that amount. The normal mechanisms related with digestion and adjustment may not function as efficiently when the stomach is repeatedly filled to capacity, as occurs in captivity [6].

Based on the 35 days of observations, the adult crocodile in Teluk Sengat Crocodile Farm the farm had been fed with insufficient quantity of food in relation to their estimated weight. With only 611 to 807 quantity of food given to 900 adult crocodiles found there, and it is not enough if they were be distributed to each of the crocodiles. The individual's enclosure was normally not fed during the feeding time, even with the feeding packages brought by the

visitor, it is still insufficient based on the quantity of food that should be given to adult crocodile [1], [9]. The nutrient consumption levels reflect the size related changes in diet which is larger prey for larger crocodiles [6], [12].

Though this report showed inadequate provision to the captive crocodiles, the main objective of the establishment of Teluk Sengat Crocodile Farm balance the bigger need for conservation by providing refugee area for the captured wild crocodile in neighboring Sungai Johor river. Wild crocodile in Sungai Johor can harm boatmen and fishermen that work and commute along the Sungai Johor. On top of that, all crocodiles in Teluk Sengat Crocodile Farm the farm were tagged with RFID tag to detect any escapee from the farm. It is recommended for different government agencies and NGOs to help providing incentives for Teluk Sengat Crocodile Farm to improve their management and practices.

5. Conclusion

Teluk Sengat Crocodile Farm management can improve their management and feeding regime practices with available guideline especially on the frequency and total feeding item in each feeding session for adult crocodile. The variation of foods selection can fulfil the nutrition intake needed for the crocodile in all stages if the frequency of food given to the crocodile was more frequent. More research needs to be conducted in captive facilities in Malaysia for us to better understand the dynamic and needs to improve the regulations and practices for *C. porosus* management in Malaysia.

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References

- [1] Webb, G. J. W., Manolis, S. C., & Brien, M. L. (2010). Saltwater Crocodile *Crocodylus porosus*. (pp. 99-113) in Crocodiles. Status Survey and Conservation Action Plan. Third Edition, ed. by S.C. Manolis and C. Stevenson. Crocodile Specialist Group: Darwin.
- [2] Hoser, R. T. (2012). A review of the taxonomy of the living Crocodiles including the description of three new tribes, a new genus, and two new species. *Australasian Journal of Herpetology*, 9-16.
- [3] Britton, A. (2002). Crocodilian Biology Database. Crocodilians: Natural History & Conservation. Retrieved on 24th January 2018, from <http://www.crocodilian.com>.
- [4] Wilkinson, C. (2010). What is feeding ecology. Bird feeding ecology and diversity. Cornell University
- [5] Nazli, M. F., & Hashim, N. R. (2009). Preliminary survey of *Crocodylus porosus* in Rembau Estuary, Peninsular Malaysia.
- [6] Morpurgo, B., Gvaryahu, G., & Robinzon, B. (1993). Aggressive behaviour in immature captive Nile crocodiles, *Crocodylus niloticus*, in relation to feeding. *Physiology & Behavior*, 53(6), 1157-1161.
- [7] Grahame, J., W. W., Gregory, J. H., & Manolis, S. C. (1991). Feeding, Growth, and Food Conversion Rates of Wild Juvenile Saltwater Crocodiles (*Crocodylus porosus*). *Journal of Herpetology*, 25(4), pp 462-473.
- [8] Evans, L. J., Davies, A. B., Goossens, B., & Asner, G. P. (2017). Riparian vegetation structure and the hunting behavior of adult estuarine crocodiles. *PLoS One*, 12(10), e0184804.
- [9] NRMCC, Natural Resource Management Ministerial Council (NRMCC). (2009) Code of Practice on The Humane Treatment of Wild and Farmed Australian Crocodiles. Department of the Environment, Water, Heritage and the Arts Australia, Canberra, Australia.
- [10] Campbell, H. A., Dwyer, R. G., Irwin, T. R., & Franklin, C. E. (2013). Home Range Utilisation and Long-Range Movement of Estuarine Crocodiles during the Breeding and Nesting Season. *PLoS One* 8(5): e62127.
- [11] Altmann, J. (1974). Observational study of behavior: sampling methods. *Behaviour*, 49(3-4), 227-266.
- [12] McCann, K. S., Rasmussen, J. B., & Umbanhowar, J. (2005). The dynamics of spatially coupled food webs. *Ecology Letters* 8, pp. 513–523.