



GROWTH AND DIGESTIBILITY FOR THE GREEN TURTLE (*Chelonia mydas*) FED DIETS CONTAINING VARYING PROTEIN LEVELS

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ABSTRACT

INTRODUCTION

METHODS AND MATERIALS

RESULTS AND DISCUSSION

ACKNOWLEDGEMENTS

REFERENCES

ABSTRACT

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Green turtles (*Chelonia mydas*), age 14 or 44 months were fed commercially prepared pelleted diets containing 25, 30 or 35% protein. Growth among the younger turtles was significantly different for the three protein levels. Growth was significantly different for the older turtles only between the 25 and 35% protein rations. Maximum observed gains were 0.5 kg and 1.0 kg per month for the 14 - month and 44-month-old turtles, respectively. Dry matter digestibility of the rations and protein digestibility ranged between 80 and 90%. Protein digestibility increased with increasing protein in the diets, Analyses of gut material demonstrated that 75% of the digestion occurred in the first half of the digestive tract.

INTRODUCTION

The hatchling green turtle requires the amino acids lysine, tryptophan, methionine, valine, leucine, isoleucine, phenylalanine, histidine and threonine. Arginine is semi-essential (Wood, 1974). The quantitative requirements for these amino acids with the exception of histidine, threonine and arginine have been determined (Wood and Wood 1977; Wood and Wood 1977). Other than the amino acids requirements little is known about the nutritional requirements of the green turtle or any sea turtle species other than observational data on natural populations (Hirth, 1971). The green turtle appears to be carnivorous during its first year and then gradually becomes herbivorous as it matures, although animal matter has frequently been found in the stomach contents of wild caught adult turtles (Lewis, 1940; Carr, 1952; Hughes et al., 1967; Ferreira, 1968). Recent reports suggest that the adult green turtle digests cellulose as efficiently as many ruminants (Bjomdal, 1979; Fenchel et al., 1979).

At Cayman Turtle Farm Ltd. (an intensive green turtle culture and research facility, Cayman Islands, B.W.I.) hatchlings, to the age of approximately 12 months, are fed a commercially prepared ration (Central Soya, Decatur, IN) containing 45% protein. Growing stock, from 12 to 60 months are fed a commercially prepared ration (Ralston Purlna Company, St. Louis, MO) containing 35% protein. As with any aquaculture endeavour, a primary research goal is to develop a ration that

balances growth and health of the animals with cost and supply of the feed. The information reported in this paper is the result of feed trials investigating growth and digestibility with rations containing different levels of protein.

METHODS AND MATERIALS

Partial feed compositions for the 25, 30 and 35% rations as prepared by Ralston Purina Company, St. Louis, MO are given in

Table 1. The rations are supplied as extruded, floating pellets in approximately 1.2 cm cubes. The pellets are 85-86% dry matter. Green turtles (*Chelonia mydas*) hatched and reared at Cayman Turtle Farm Ltd. (Cayman Islands, B.W.I.) were used for these trials. One hundred and fifty turtles, 14 months old at the start of the experiments were individually tagged, weighed and placed in three tanks, 50 turtles per tank. One hundred and fifty turtles, 44 months old at the start of the experiment, were also individually tagged, weighed and placed in 15 tanks, ten turtles per tank. Circular fibreglass tanks 3 m in diameter and 0.5 m deep, are located outdoors without cover. The tanks contain approximately 3000 L of unfiltered sea water pumped directly to the tanks from an inflow channel cut through the coral rock into the sea. Water exchange time is approximately 20 mm. The experiments were conducted between June to October 1979 and water temperature ranged from 26.5 to 31.5°C, with an average of 29.9°C. The tanks are drained completely every other day and scrubbed and cleaned with a chlorine solution as needed. The turtles in each tank were weighed every 4 weeks. Upon termination of the experiment (week 16) the turtles were again individually weighed. The turtles were fed in five equal feedings per day between 08.00 and 16.00, 7 days a week. The 14-month-old turtles were fed 1.2% body weight per day and the 44-month-old turtles were fed 0.8% body weight per day of either the 25, 30 or 35% protein ration.

TABLE I

Partial feed composition "as is" basis of 25, 30 and 35% protein rations.
(Values supplied by Ralston Purina Company, St. Louis, MO)

Protein (%)	Ration		
	25	30	35
Fat (%)	4.62	4.27	3.90
Fibre (%)	3.22	3.39	8.58
Total digestible nutrient (%)	75.9	76.0	76.0
Metabolizable energy (Kcal/g)	3.07	3.07	2.98
% crude protein (N x 6.25) of dry diet *	29.7±0.2	36.0 ± 0.2	41.3 ± 0.4
Chromic oxide (%)	0.2	0.2	0.2

* Determined by Kjeldahl nitrogen analysis of dry diet on triplicate samples.

Following termination of the feeding trial fecal samples were collected. To collect fecal samples, individual turtles were removed from a tank and secured on a rack with ropes tied to each of the four flippers. A container was placed below the turtle to collect the feces. If a turtle did not defecate within 24 hrs, it was returned to the tank. Five fecal samples were collected from each protein level (except 35% protein - age group 14 month - only three samples were collected). Each turtle's fecal sample was analyzed separately and then the results were pooled for each protein level. Samples were frozen until analyzed. Fecal samples were partially dried at 60°C for 48 to 60 hours and ground in a Wiley Mill with a size 20 mesh screen. The samples were then analyzed for dry matter, crude protein (Kjeldahl nitrogen determination) and chromic oxide (Edwards and Gillis, 1959; Harris, 1970). Triplicate tests were performed when the quantity of material permitted. Feed samples were also analyzed for dry matter, crude protein and chromic oxide.

Three turtles each from age groups 14 and 44 months were sacrificed and the digestive tract from stomach to rectum was removed. The tract was laid out flat and measured. Sections of the gut were opened and the contents removed and frozen. Sections varied in length because of content differences. Gut contents were expectedly much more fluid in the first part of the tract and quantities obtained in various sections varied considerably. As with the fecal and feed samples, the gut contents were partially dried, ground and analyzed for dry matter, crude protein and chromic oxide.

Apparent digestibility of the rations and apparent protein digestibility were calculated according to Maynard and Loosli (1969). Single classification analysis of variance was used to compare sample means and for multiple comparison, where applicable, a Student Newman Keuls multiple range test was used (Sokal and Rohlf, 1969).

RESULTS AND DISCUSSION

Table II summarizes the growth of 14 - and 44 -month-old green turtles fed rations containing 25, 30 or 35% protein. Gain is significantly different ($P < 0.05$) among the 14-month-old turtles at the three protein levels. Gain is significantly different ($P < 0.05$) only between the 25 and 35% protein level rations for the 44 -month-old turtles. Differences in gain may be directly due to the different protein levels. However, the respective ingredient breakdown and quality of the available protein in the rations may also affect the gain. The calculated percent amino acid composition of each ration was equal to or above the determined levels for the essential amino acids. Maximum gains observed for the 14 - and 44 -month turtles were 0.5 kg/month and 1.0 kg/month, respectively. Optimum observed feed conversions for each age group were 3.5 and 5.5, respectively. (Feed conversion is expressed as units of feed fed to one unit live weight gain).

Table III summarizes the digestibility coefficients of the rations for both groups of turtles. The dry matter digestibilities of the whole diets appear unaffected by the protein level of the diet or the age of the turtles. Protein digestibility, however, appears to improve with increasing protein level in the diet and appears dependent upon the age of the turtle. Improved protein digestibility with increasing protein level may be attributable to the use of higher quality protein sources in high protein diets. Gut analysis of three 14 - month and three 44 - month turtles, each receiving the 35% protein ration, indicate that most of the digestion occurs in first part of the digestive tract, the stomach and the small intestine.

TABLE II Growth data for turtles fed rations containing varying levels of protein

Turtle group	Initial weight (kg)	Final weight (kg)	Weight gain (%)	Feed conversion

14-month-old turtles				
25% protein (4)	4.1±0.3	4.9± 0.8	18.7 ±18.2a	8.1
30% protein (6)	4.1±0.2	5.6 ±0.8	35.4±16.8b	4.4
35% protein (3)	4.1±0.3	5.9 ± 0.9	44.1 ± 18.6c	3.5
44-month old turtles				
25% protein (1)	21.6 ± 0.1	28.7±0.5	8.7 ±3.4d	10.1
30% protein (0)	21.5 ± 0.1	24.3 ± 0.9	12.8 ± 4.7d,e	8.1
35% protein (0)	21.5 ±0.2	25.1± 0.5	16.8 ± 1.1e	5.5

Number of mortality in group is given In parentheses. Initial weights corrected for mortality. Weight gain is expressed as percent of initial weight. Data presented as mean ± S.D. Values with different superscripts are statistically different at $P = 0.05$.

TABLE III Digestibility coefficients of protein level rations

Turtle group	Dry matter digestibility of ration* (%)	Protein digestibility ** (%)
14-month-old turtles		
25% protein (5)	82.9 ±3.2	82.4 ± 3.1
30% protein (5)	83.4 ± 0.9	85.1 ±1.2
35% protein (3)	83.8 ± 2.4	88.3 ± 1.5
44-month-old turtles		
25% protein (5)	84.0 ± 2.4	85.7± 3.0
30% protein (5)	83.8 ± 1.9	86.2 ± 2.8
35% protein (5)	85.9 ± 2.1	89.4 ± 2.3

Number of fecal samples analyzed in triplicate given in parentheses for each turtle group. Data presented as means ± S.D. Values* not significantly different, ** significantly different, $P = 0.05$, single classification analysis of variance.

For the 14-month turtles dry matter digestibility is $33.0 \pm 15.2\%$ in the 5 $70.0 \pm 11.0\%$ for the first half of the digestive tract. For the 44-month old turtles, dry matter digestibility is $11.1 \pm 6.6\%$ in the stomach and 2.6% for the first half of the digestive tract. Comparison of these dry matter digestibility of the ration as given in **Table III** shows less than 20% of the observed digestion occurs in the large intestine. Protein digestibility is $45.1 \pm 23.7\%$ and $84.3 \pm 4.8\%$ respectively, for the stomach and first half of digestive tract for the 14-month turtles. For the 44-month turtles protein digestibility is $34.7 \pm 20.9\%$ and $84.9 \pm 1.5\%$ for the respective sections. Bjorndal (1979) reports that the majority of the organic matter is digested in the cecum and large intestine of two wild turtles whose gut contained turtle grass (*Thalassia testudinum*). The commercially prepared, high protein rations used in this experiment are highly digestible and opportunity for cellulose digestion as observed by Bjorndal (1979) and Fenchel et al. (1979). For the six turtles examined here, dry

matter and protein digestibility or regions of maximum digestibility between two age groups, 14- and 44-month-old turtles, are not significantly different ($P < 0.05$).

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