

The Nutritional Value of Toothless' Meals

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Abstract

In the 2010 film, *How to Train Your Dragon*, Toothless is struck down during a dragon raid and loses his left tail-fin, leaving him trapped in The Cove. A previous paper determined that it was unfeasible that Hiccup would be able to carry the amount of fish depicted in the film, however this paper assumes otherwise. This paper investigates the nutritional value of the same amount of fish, and whether this could sustain Toothless and his metabolism. Provided that Toothless receives 13 Icelandic cod and 56 Atlantic Salmon, he takes in 2.95×10^6 kJ of energy and 1328 kg of protein every day. Toothless uses 1.33×10^5 kJ in a day, so the amount of fish Hiccup brings would be sufficient to maintain his metabolism.

Introduction

Toothless is a Night Fury dragon who appears in the *How to Train Your Dragon* franchise, which is loosely based on the novels by Cressida Cowell [1]. Toothless is the only known dragon of the Night Fury species, and is arguably the fastest and rarest known dragon. He is depicted as smart and playful, and is bonded with a human Viking, Hiccup. Toothless' left caudal fin is severed in a dragon raid in the opening scene of the film. This leaves him trapped in The Cove, which is a sunken area in the woods of Berk [2]. A previous paper determined that Hiccup could theoretically supply 716 kg of fish [3].

This paper investigates whether the fish Hiccup brings contains enough nutritional content to maintain Toothless' metabolism.

Assumptions

Several assumptions and simplifications must be made to calculate the required values. During the time lapse montages in the film, it is taken that Toothless is in The Cove for a total of twelve days [4]. It is assumed that Hiccup visits the clearing once a day for the duration of Toothless' stay. From the findings of the previous paper, Hiccup brings 13 Icelandic cod and 56 Atlantic salmon every day, totalling 716 kg [3].

In this paper, it is assumed that Toothless relies solely on Hiccup for nutrition. The fish considered in Toothless' diet are Atlantic salmon, *Salmo salar* [5],

and Icelandic cod, *Gadus morhua* [6]. This is because they are the only named species that Toothless is shown eating in the film. Toothless' diet consists of only fish [7], therefore only the nutritional values of these fish have been considered.

Toothless' energy expenditure

The Basal Metabolic Rate (BMR) of an organism is the minimum amount of energy used by endothermic animals at rest [8]. A more accurate prediction of the average daily metabolic rate is the Field metabolic rate (FMR), which considers free-living animals in the wild [9]. The metabolism is calculated by measuring the O_2 -in/ CO_2 -out volumes during respiration. FMR uses a doubly labelled water (DLW) system whereby oxygen isotopes (^{18}O) are used to detect the exhaled CO_2 and water loss, while hydrogen (deuterium) is used to detect water loss only [10].

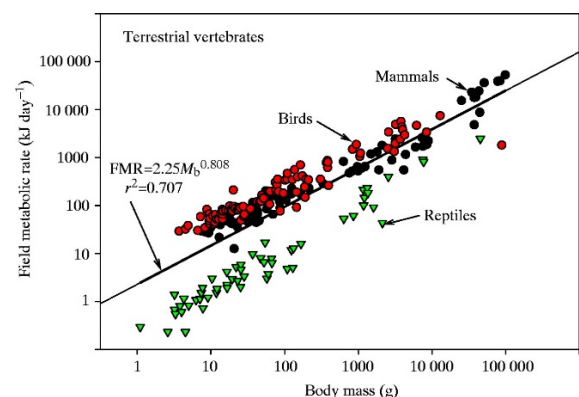


Figure 1 – Relationship of field metabolic rate to body mass of terrestrial vertebrates [10]

The FMR is therefore [10]:

$$FMR = aM_b^b \quad (1)$$

Where a = intercept, M_b = body mass in grams and b = allometric slope [10].

Toothless is said to be 7.9 m tall, weighs 805.6 kg and has a wingspan of 14.6 m [11]. For reptiles, $b \approx 0.889$ [9]; using Figure 1 and Equation 1 then:

$$FMR = 2.25(805\,600\,kg)^{0.889} \approx 1.33 \times 10^5\,kJ\,day^{-1} \quad (2)$$

Therefore Toothless uses 1.33×10^5 kJ of energy every day. This seems appropriate considering the large size and mass of Toothless.

Nutritional information

Toothless' diet consists of only Atlantic salmon and Icelandic cod; the nutritional values of each species are summarised in Table 1.

Nutrients	Atlantic salmon [12]	Icelandic cod [13]
Calories	142 kcal	82 kcal
Total fat	6 g	1 g
Cholesterol	55 mg	43 mg
Sodium	44 mg	54 mg
Carbohydrate	0 g	0 g
Protein	20 g	18 g

Table 1 – Nutritional value of fish per 100 g serving of raw fish

Please note that a kilocalorie (kcal) is equal to one Calorie (C), which is also equal to 4.184 kJ. This is the amount of energy required to raise the temperature of 1 kg of water by 1°C.

Portion size

The values from Table 1 are for 100 g portions; these have been scaled up for Icelandic cod which weighs 40 kg and Atlantic salmon which weighs 3.5 kg [3].

Species	Atlantic salmon	Icelandic cod
Calories	4970.0 kcal	32800 kcal
Protein	7.0 kg	72 kg

Table 2 – Nutritional value of each fish

The number of each fish is multiplied by the calories from Table 2 to give the calorific intake of salmon, C_S , and cod, C_C :

$$C_S = 56(4970) = 278\,320\,kcal \approx 1.16 \times 10^6\,kJ \quad (3)$$

$$C_C = 13(32800) = 426\,400\,kcal \approx 1.78 \times 10^6\,kJ \quad (4)$$

Similarly, the protein intake from the salmon, P_S , and cod, P_C , are:

$$P_S = 56(7.0\,kg) = 385\,kg \quad (5)$$

$$P_C = 13(72\,kg) = 936\,kg \quad (6)$$

So, in total Toothless receives 2.95×10^6 kJ of energy and 1328 kg of protein from the 69 fish every day.

Importance of proteins

Proteins are made from amino acids, which contain essential components for survival. For example, they are vital for cell signalling and have many structural functions. Also, amino acids which cannot be synthesised in the body must be acquired as part of a diet [14]. Since Toothless' diet consists of only fish, it is important that the cod and salmon are able to provide him with the necessary nutrients. Otherwise he may be susceptible to protein-energy malnutrition (PEM), which may lead to growth problems and infections [15].

Conclusion

In the film, it appears that Toothless was in The Cove for twelve days, and during this time it is assumed that he was solely dependent on Hiccup for nutrition. It was previously calculated that Hiccup brought 56 Atlantic salmon and 13 Icelandic cod every day. The total nutritional intake is 2.95×10^6 kJ and 1328 kg of protein. Toothless uses 1.33×10^5 kJ in a day, so the daily food intake is able to sustain his metabolism. In a previous paper, it was determined that Hiccup would be unable to carry the required amount of fish to The Cove. However, if Hiccup made several trips, used different, less heavy fish, or didn't fully fill the sack he would be able to transport the calculated amount of fish. If Toothless also hunted for fish while he was in The Cove, he would be more than capable of sustaining his metabolism. Since Toothless was injured, he was not as active, so the FMR seems appropriate.

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