ELSEVIER

Comparative Biochemistry and Physiology, Part A 140 (2005) 151–155

CBP

www.elsevier.com/locate/cbpa

Influence of food type on specific dynamic action of the Chinese skink *Eumeces chinensis*

Zhi-Chong Pan[a], Xiang Ji[b,c,*], Hong-Liang Lu[b], Xiao-Mei Ma[b]

[a]*Department of Biology, School of Life Sciences and Biotechnology, Ningbo University, Ningbo 315211, Zhejiang, People's Republic of China*
[b]*Department of Environmental Sciences and Natural Resources, School of Life Sciences, Hangzhou Normal College, Hangzhou 310036, Zhejiang, People's Republic of China*
[c]*Jiangsu Key Laboratory for Bioresource Technology, School of Life Sciences, Nanjing Normal University, Nanjing 210097, Jiangsu, People's Republic of China*

Received 19 September 2004; received in revised form 18 November 2004; accepted 18 November 2004

Abstract

We used the Chinese skink (*Eumeces chinensis*) as an experimental model to study influence of food type on specific dynamic action (SDA) of feeding. Thirty-three adult males collected from a natural population were divided equally into three (one control and two experimental) groups. We starved all skinks at 30 °C for 3 days and then provided the experimental skinks with a single meal consisting of either mealworms or meat [the flesh of the bullfrog (*Rana catesbeiana*)]. Food ingested by skinks of the two experimental groups differed in lipid content and lean dry mass but not in total dry mass and energy. Defecation following feeding occurred slightly earlier in skinks ingesting mealworms (mean=41.7 h) than in those ingesting meat (mean=47.7 h), but the difference was not significant. Analyses of variance (ANOVAs) with repeated measures showed that temporal variation in oxygen consumption over 72 h after feeding was evident in the experimental skinks but not in the control ones. Oxygen consumption was higher in the experimental skinks than in the control ones during the time interval between 4.5 and 36 h after feeding. The peak metabolic rate was greater but occurred later in skinks ingesting meat than in those ingesting mealworms. The estimated amounts of oxygen consumed by mealworm-fed, meat-fed and unfed skinks at 30 °C over 72 h after feeding were 356.5, 393.8 and 295.2 mL, respectively. Our results provide a support for the previous prediction that SDA is affected by types of food ingested by animals as skinks ingesting mealworms and meat differed in the time to reach a peak metabolic rate, the level of the peak metabolic rate and the magnitude of the SDA effect.

Keywords: Scincidae; *Eumeces chinensis*; Food intake; Food type; Oxygen consumption; Specific dynamic action; Energy content; Lipid content

1. Introduction

Animals obtain energy through feeding, and, for those that are carrying out a normal pattern of activities, the obtained energy is used not only for basal or standard metabolism, thermoregulation, activity and production (tissue growth and offspring production) but also for the processes of digestion, absorption and assimilation of food (Kleiber, 1961; Bartholomew, 1977; Jobling, 1981, 1983; Cruz-Neto et al., 2001; Secor, 2001; Iglesias et al., 2003). The postprandial increase in metabolic rate, commonly called for historical reasons specific dynamic action (SDA), has been found in all animals so far studied (e.g., Jobling, 1981, 1983; Chapelle et al., 1994; Peck, 1996; Guinea and Fernandez, 1997; Rosen and Trites, 1997; Secor and Diamond, 1997a,b; Secor and Phillips, 1997; Cruz-Neto et al., 1999; Overgaard et al., 1999; Sievert and Andreadis, 1999; Robert and Thompson, 2000; Iglesias et al., 2003; Sigsgaard et al., 2003; Pan et al., 2004). SDA is of sufficient magnitude that it must be taken into account in all analyses

---

* Corresponding author. Department of Environmental Sciences and Natural Resources, School of Life Sciences, Hangzhou Normal College, Hangzhou 310036, Zhejiang, People's Republic of China. Tel.: +86 571 88989878; fax: +86 571 28865337.

E-mail address: xji@mail.hz.zj.cn (X. Ji).

1095-6433/$ - see front matter © 2005 Elsevier Inc. All rights reserved.
doi:10.1016/j.cbpb.2004.11.013

of energy metabolism (Bartholomew, 1977). The general pattern of SDA seems to be similar in most animals and is characterized by a rapid increase in metabolic rate soon after feeding to a peak followed by gradual decreases to the prefeeding values (e.g., Jobling, 1981; Chapelle et al., 1994; Guinea and Fernandez, 1997; Secor and Phillips, 1997; Robert and Thompson, 2000; Iglesias et al., 2003; Pan et al., 2004). However, the time it takes to reach a peak metabolic rate, the level of the peak metabolic rate and the duration and the magnitude of the SDA effect may vary, in various degrees, among and within species primarily because the traits involved in the SDA effect are affected by numerous external and internal factors such as temperature, reproductive condition, size, quantity and composition of the meal and forage mode (and thus, feeding frequency) (Bennett and Dawson, 1976; Greene, 1983; Jobling, 1983; Schwarzkopf, 1991; Secor and Diamond, 1995; Andrade et al., 1997; McKinon and Alexander, 1999; Robert and Thompson, 2000; Wang et al., 2001, 2002; Whiteley et al., 2001; Iglesias et al., 2003; Toledo et al., 2003). For example, an increased food intake prolongs the duration of SDA in *Pygoscelis adeliae* (Adélie penguin; Janes and Chappell, 1995), increases the magnitude of the SDA effect in *Python molurus* (Albino Burmese python; Secor and Diamond, 1997a,b) and *Crotalus durissus* (Neotropical rattlesnake; Andrade et al., 1997) and postpones the time it takes to reach a peak metabolic rate in *Pleuronectes platessa* (European plaice; Jobling and Davies, 1980). Animals that ingest food containing more proteins have a greater magnitude of the SDA effect (Bartholomew, 1977; Coulson and Hernandez, 1979; Janzen, 1981; Blaxter, 1989; Houlihan, 1991; Chakraborty et al., 1992; Secor and Diamond, 1997b).

As the metabolic response of fasted animals to a single meal often accurately reflects energetic costs of digestion, absorption and assimilation of food, measuring temporal variation in oxygen consumption after feeding is a commonly used method to test for the SDA effect in animals (Jobling, 1981; Janes and Chappell, 1995; Sievert and Bailey, 2000). In the present study, we investigate the differential postprandial metabolic response (SDA) of Chinese skinks (*Eumeces chinensis*) to different food. Our experimental model is a medium-sized (up to 134 mm SVL) ground-dwelling oviparous scincid lizard, which is one of most conspicuous lizard species in the southern provinces (including Taiwan and Hainan) of China (Zhao and Adler, 1993; Lin and Ji, 2000; Ji et al., 2002). Our aims are (1) to show the general pattern of SDA in *E. chinensis*, (2) to examine influence of food type on SDA and (3) to compare our data with those collected in other parallel studies.

2. Materials and methods

Thirty-three adult male *E. chinensis* were collected in early August 2003 from a population in the vicinity of Lishui (Zhejiang, eastern China), with body mass varying from 21 to 38 g and snout-vent length from 100 to 110 mm. The captured skinks were transported to our laboratory at Hangzhou Normal College, where they were divided equally into three [one (unfed) control and two (fed) experimental] groups of which each was housed in a 1000×600×500 (length×width×height) mm^3 glass cage. We placed the cages in a constant temperature room at 30 °C, thereby controlling the mean body temperature of skinks at the corresponding level (Ji et al., 1995). Room lights were set to a cycle of 12 light:12 dark. Prior to measuring oxygen consumption, we starved all skinks for 3 days to ensure a uniform postabsorptive state (Ji et al., 1995; Xu et al., 1999). At the end of the 3-day fast, we housed skinks individually in 300 mL closed-system respiratory chambers inside which the temperature was controlled at 30 °C, and then measured oxygen consumption (VO_2) for each skink based on the reduced air space in a calibrated tube during 10 min (Wang and Ji, 1997). After measurements, we provided the experimental skinks with a single meal consisting of either mealworms (larvae of *Tenebrio molitor*) or meat [the flesh of the bullfrog (*Rana catesbeiana*)]. Our skinks need not to be trained to eat mealworms and frog meat, although the two types of food are novel to them. We allowed the experimental skinks to eat voluntarily as much as they wanted for 1 h, thereby avoiding force-feeding. The first two pieces of food ingested by the experimental skinks each contained a 3-mm blue plastic thread (diameter 0.2 mm), which was used as a mark. The food passage time was defined as the lapsed time from swallowing to appearance of the first plastic thread (Ji et al., 1995). We measured oxygen consumption of both experimental and control skinks over 72 h at time intervals varying from 4.5 to 12 h after the event of feeding using the same respiratory chambers described above.

We extracted nonpolar lipids from dried samples of food in a Soxhlet apparatus for a minimum of 5.5 h using absolute ether as solvent. The amount of lipids in each sample was determined by subtracting the lipid-free dry mass from the total sample dry mass. We determined energy density of dried samples of food using a WGR-1 adiabatic bomb calorimeter (Changsha Bente Instruments, China). Titrations were performed on the residue after calorimetry to correct for nitrogenous wastes. Further corrections were performed for fuse wire burning.

All data were tested for normality (Kolmogorov–Smirnov test) and homogeneity of variances (Bartlett test), and Log_e transformations were performed when necessary to satisfy the assumptions for parametric tests. We used one-way analyses of variance (ANOVA) and repeated-measures ANOVA to analyze the corresponding data when the assumptions of parametric analyses were met. Nonparametric analyses (Mann–Whitney *U*-test) were used when these assumptions were violated. The magnitude of the SDA effect was estimated to be equal to the area under the curve from a fit of least squares on the original data of the experimental group (i.e., total oxygen consumed) minus the area under the curve of the control group (i.e., oxygen