Comparative Biochemistry and Physiology, Part B 140 (2005) 59–62

www.elsevier.com/locate/cbpb

Effects of short-term fasting on energy reserves of vampire bats (*Desmodus rotundus*)

Mariella B. Freitas, Cejana B.C. Passos, Rosângela B. Vasconcelos, Eliana C. Pinheiro*

Department of Physiological Sciences, Institute of Biological Sciences, University of Brasilia, Brasília-DF, Brazil

Received 24 July 2004; received in revised form 10 September 2004; accepted 12 September 2004

Abstract

Studies on metabolic responses to fasting in common vampire bats (*Desmodus rotundus*) have demonstrated the susceptibility of this species when subjected to long-term fasting. We investigated the effects of short-term fasting (12 h), a period similar to what they face in the field, on their energy reserves. Blood glucose (BG) levels in fed bats were similar to other mammals, but after 12 h without food, these levels were reduced. Plasma lactate and free fatty acids levels in fed bats were higher than in other mammals, although no changes in these levels were detected in response to fasting. Liver glycogen content decreased significantly following fasting. Muscle glycogen, as well as liver and muscle lipid and protein levels, remained unaltered for up to 12 h of fasting. Although BG levels decreased after short-term fasting, body energy reserves do not seem to play an important role for maintenance of glycemic homeostasis during fasting. Despite the decrease in liver glycogen, this small reserve seems insufficient to maintain adequate levels of BG, even during short periods of fasting. Because other reserves were not decreased after fasting, it is possible that the main source of glucose for common vampire bats might be the glucose content of their blood diet.

Keywords: Blood glucose; *Desmodus rotundus*; Glycogen; Lipids; Metabolism; Protein; Short-term fasting; Vampire bats

1. Introduction

Studies concerning metabolic responses to fasting in mammals with high-protein diets have shown these animals to be highly resistant to fasting compared to those who feed on high carbohydrate diets (Eisenstein and Strack, 1971; Kettelhut et al., 1980; Botion et al., 1992). However, previous studies in our laboratory have shown that vampire bats (*Desmodus rotundus*) exhibit an unusual susceptibility to starvation, despite their high protein ingestion (blood) (Freitas et al., 2003). This vulnerability is taken to the point of untimely deaths after only two to three nights of fasting (McNab, 1972; Altrigham, 1996). Our previous results showed that after 24 h of fasting, blood glucose levels decreased markedly to almost 30% of levels in fed vampires and in other mammals, including fruit-eating bats (Pinheiro, 1995). The small glycogen content, as well as lipid and protein stores, which were not mobilized, did not seem to contribute to the maintenance of glycemic homeostasis after 24, 48 or 72 h of fasting (Freitas et al., 2003). These results indicated that 24 h is likely a prolonged period of fasting for common vampire bats because blood glucose, after this short period, was reduced to levels remarkably low for vertebrate survival. In the present study, we investigated energy homeostasis during a shorter period of fasting (12 h), a period usually faced by bats in the field. We determined blood glucose, plasma free fatty acid (FFA), liver and muscle glycogen, proteins and lipid levels in fed and 12-h fasted vampire bats.

* Corresponding author. Campus Universitário UnB Depto de Ciências Fisiológicas (CFS/IB) Brasília-DF 70910 900, Brasil. Tel.: +55 61 3072294; fax: +55 61 2741251.

E-mail address: liapinhe@unb.br (E.C. Pinheiro).

1096-4959/$ - see front matter © 2004 Elsevier Inc. All rights reserved.
doi:10.1016/j.cbpc.2004.09.023

2. Materials and methods

2.1. Animals

Adult male (N=12) and non-pregnant female (N=12) common vampire bats (*D. rotundus*), weighing 21–40 g, were obtained from caves near Brasília, Distrito Federal, Brazil. Bats were housed in cages in groups of four individuals, and maintained in the dark at room temperature. All bats were fed on defibrinated bovine blood (30–40 mL of blood per bat) during the two nights following their capture. Petri dishes containing blood were offered at 1900 h and removed at 0700 h the next morning. Water was available ad libitum. The bats were randomly divided in two groups: blood dishes were offered from 1900 to 2300 h only during the third night to the experimental group (N=12; 6 males and 6 females) (12-h fasted bats). After which, only water was available. Measurements started at 1100 h the next morning. The control group (N=12; 6 males and 6 females) was fed continuously during the night, as previously described.

2.2. Experimental procedures

Bats were killed by decapitation and blood, which was flowing from the trunk, was directly collected into a test tube. Plasma glucose concentration was determined by the glucose-oxidase enzymatic method (Trinder, 1969; Barham and Trinder, 1972). Plasma FFA were determined using a NEFA C kit (WAKO). Liver and breast muscle glycogen concentrations were obtained from portions of these tissues, then placed in 2 mL of KOH (30%), according to the method of Sjörgren et al. (1938). In order to establish total tissue protein concentrations, portions of the liver and muscles from breast and limbs were homogenized in NaCl solution 0.9% and determined with a protein assay kit (Pierce). Portions of the liver and muscles from breast and limbs were also homogenized in a chloroform–methanol (2:1) solution in accordance with Folch et al. (1957) for total lipid concentrations, determined gravimetrically. Carcass fatty acid levels were quantified after removal of the mentioned tissues (liver, breast and limbs muscles) and of the digestive tract from its terminal esophagus section to the anus. Carcasses were completely digested in 100 mL of KOH (6 N), filtered and added to the same volume of absolute alcohol, yielding a KOH–ethanol (50% v/v) solution. After extraction with chloroform, total carcass fatty acids concentrations were determined gravimetrically.

2.3. Statistics

Data are presented as the mean±standard error of the mean (S.E.M.). Statistical analyses, after data were checked for their normal distribution, were performed using analysis of variance (ANOVA), followed by the Tukey test for subsequent comparisons. A non-parametric Kruskal–Wallis test was also conducted on data that did not exhibit normal distributions. P<0.05 was taken as the criterion of significance.

3. Results

3.1. Plasma glucose, lactate and FFA

Because gender showed no significant influence on the results of any of the variables tested, data obtained from male and female bats were pooled. Blood glucose levels in fed vampire bats were significantly greater (93.72±5.47 mg/dL) than in 12-h fasted bats (63.16±5.05 mg/dL) ($F_{(1,21)}$=19.39; P=0.001) (Fig. 1A). Plasma lactate concentration was found

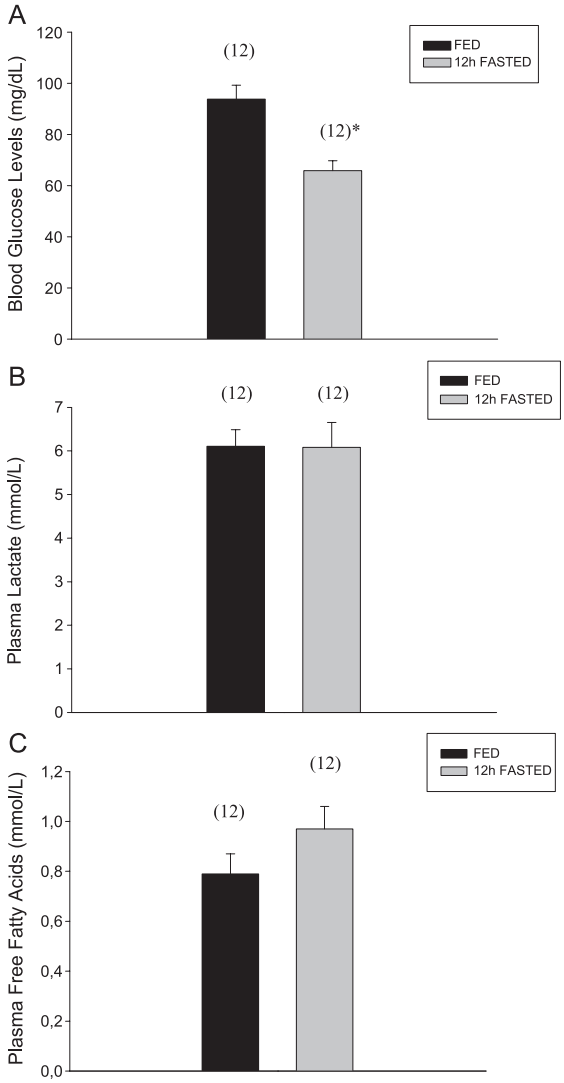

Fig. 1. (A) Blood glucose levels (mg/dL) in fed and fasted vampire bats. Values are means±S.E.M. The number of bats is given in parenthesis. *P<0.05 lower than fed values. (B) Plasma lactate levels (mmol/L) in fed and fasted vampire bats. Values are means±S.E.M. The number of bats is given in parenthesis. (C) Plasma free fatty acid levels (μmol/dL) in fed and fasted vampire bats. Values are means±S.E.M. The number of bats is given in parenthesis.