FOOD CONSUMPTION AND ENERGY ASSIMILATION IN THE CABRERA VOLE MICROTUS CABRERAE (RODENTIA)

S. SANTOS1, M. KLUNDER2, M.L. MATHIAS1

1Centro de Biologia Ambiental & Departamento de Biologia Animal, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, 1749-016 Lisboa, Portugal
2Department of Tropical Nature Conservation and Vertebrate Ecology, Wageningen University, Bornsesteeg 69, 6708 PD Wageningen, The Netherlands

Corresponding author: mmathias@fc.ul.pt

ABSTRACT. – Energy intake was studied for the first time in Cabrera voles (Microtus cabrerae Thomas, 1906). Experiments were carried out between June and September. Under a composite diet of carrots, apples, corn and sunflower seeds, average food consumption was 4.88 g dry mass/day, which was equivalent to 75.95 kJ/day (1.82 kJ/g/day). This corresponded to 11.7% of vole’s body mass. Voles defecated around 0.36 g dry mass/day or 6.65 kJ/day (0.16 kJ/g/day). Digestibility values averaged 92.50% of dry matter and 91.15% of energy.

INTRODUCTION

The Cabrera vole (Microtus cabrerae Thomas, 1906) is an endemic and threatened species (Cabral et al. 1990, Blanco & González 1992), distributed over the supra and mesomediterranean bioclimatic zones of the Iberian Peninsula (Rivas-Martínez 1981), from Central Portugal to the Iberian Prepyrenees (Ventura et al. 1998, Mathias 1999). This vole is one of the less known rodents in Europe. Available literature on the species is very scarce, except for a few studies on its distribution (e.g. San Miguel 1992, Mathias 1999), biology (Fernández-Salvador 1998, Ventura et al. 1998, Fernández-Salvador et al. 2001) and population dynamics (Landete-Castillejos et al. 2000). In particular, no data have ever been published on the energy requirements of Cabrera voles, and on the relationships between digestible energy or nutrient availability and the amount of food intake.

The present study, which is part of a larger one on the energetics of the Cabrera vole, provides the first information on the daily energy intake of non-reproductive adults, measured under experimental conditions. We are hoping that the measures on the species basic physiological needs can be used as indicators in indirectly assessing adaptation of voles to their habitat.

MATERIALS AND METHODS

Nine adult non-reproductive voles (five females and four males) were captured in Alentejo, Central Portugal, between June and September 2001, in two different sites: Alandroal (38°40’N, 7°23’W) and Grândola (38°05’N, 8°35’W), both associated to temporary watercourses. At capture, body mass of voles ranged from 32.9 to 55.4 g (43.0±6.8 g).

Voles were housed in individual cages (0.41×0.30×0.20 m) under natural light conditions and natural ambient temperature, averaging 24 °C during the period of captivity. A composite diet, including carrot, apple, corn and sunflower seeds in weight proportions of respectively 3:3:1:1, and water ad libitum were provided throughout this period. Food items selection was based on preferences of voles, as judged by previous studies on bait attraction (S Santos, unpubl data, J Ventura pers comm).

At the beginning of experiments voles were weighed (to an accuracy of 0.1g) and received water and food in excess. The following day, and repeatedly for six consecutive days, at the same hour, voles were reweighed,
uneaten food and faeces were collected and weighted, and fresh food was again supplied in excess. Afterwards, the uneaten food and faeces were dried at 60 °C to constant weight (24 h) and then samples were combusted in a semi-micro adiabatic calorimeter PARR 1425 for the calculation of energy contents, according to the standard techniques described in the PARR reference manual. This procedure allowed the estimation of the energy consumption (C), the energy loss in faeces (F) and the coefficient of digestibility \[ D = \frac{(C-F)}{C} \times 100 \] (e.g. Woodall 1989, Veloso & Bozinovic 1993, Speakman & McQueenie 1996). Energy assimilation \[ A = C - (F+U) \] was also calculated considering 3% of energy loss in urine (U) (Grodzinski & Wunder 1975).

Water percentage in food items was calculated through the relation between fresh and dried food, while the amounts of protein and fiber were obtained from food composition tables (Ferreira & Graça 1977, Holland et al. 1991, Holland et al. 1992). Although different food composition tables may indicate distinct values for the same measure, values are here included mainly as indicators of the relative differences in food consumption.

Differences between intakes of food items were assessed by one-way ANOVA and least significance difference tests (LSD) for post-hoc comparisons, while differences in water percentage between food items were assessed by a Kruskal-Wallis non-parametric test. The relationship between food intake and food contents was tested by the Pearson correlation coefficient (Sokal & Rohlf 1995).

All feeding experiments were carried out from June to September. Each vole was tested within a period up to 14 days since capture. All specimens were released at the end of experiments.

**RESULTS**

Cabrera voles consumed differently the four items available in terms of food mass (F=4.21, p<0.05). Apple was more consumed than corn (p<0.05) and sunflower seeds (p<0.01), and carrot was preferred to sunflower seeds (p<0.05). In average, the most consumed items were apple and carrot and the less consumed were corn and sunflower seeds (Table I), although among individuals a marked variability in the intake of corn and sunflower seeds has occurred. There were no significant differences in energy consumption among the items ingested (F=1.46, p>0.05). In addition, no significant changes in individual body mass were recorded during experiments (paired t test, r=–0.62; p>0.05).

A significant positive correlation was found between dry mass intake and water content of food (n=36, r=0.510, p<0.05), while a significant negative correlation was found with protein (r=–0.48, p<0.05) and fiber contents (r=–0.41, p<0.05), indicating that the most consumed food items contained more water (H=36.00; df=3; p<0.0001) and less protein and fiber (Table I).

During the 6-day feeding experiment, average daily food consumption was 75.95 kJ/day (1.82 kJ/g/day). Voles defecated 6.65 kJ/day (0.16 kJ/g/day). The coefficient of food digestibility amounted in average to 92.50%, in terms of dry matter, and to

| Table I. – Mean values of dry mass (g/day), energy intake (kJ/day) and contents of water (%), protein and fiber (g/100 g of food) of food items consumed by Cabrera voles (minimum and maximum values within brackets). |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|
| **CARROT**                                     | **APPLE**       | **CORN**        | **SUNFLOWER SEED** |
| Dry mass (g/day)                                | 1.51            | 1.83            | 0.83            | 0.71            |
| (0.57-3.25)                                     | (1.10-2.70)     | (0-2.36)        | (0-1.77)        |
| Energy intake (kJ/day)                          | 21.82           | 25.17           | 13.47           | 15.49           |
| (7.91-49.66)                                    | (16.43-38.34)   | (4-39.24)       | (40-0.9)        |
| Water (%)                                      | 87.59           | 84.02           | 5.78            | 4.85            |
| (86.26-89.60)                                   | (82.70-85.89)   | (4.92-6.31)     | (4.41-5.45)     |
| Protein (g/100g food)*                         | 0.6             | 0.3             | 9.3             | 19.8            |
| (4.92-6.31)                                     |                 |                 |                 |
| Fiber (g/100g food)*                           | 2.6             | 1.9             | 2.9             | 6.0             |
| (4.41-5.45)                                     |                 |                 |                 |

91.15%, in terms of energy. Energy assimilation was 67.22 kJ/day (1.61 kJ/g/day) (Table II).

**DISCUSSION**

Most consumed food items by voles were, in general terms, rich in water and poor in protein and fiber.

Daily food intake of Cabrera voles, maintaining constant body mass, represented 11.7% of body mass. Deriting & Bogue (1993) reported a food intake of 15% of body mass in non-reproducing *M. pennsylvanicus*. Similarly, Gross *et al.* (1985) referred a corresponding value of 11% in *M. ochrogaster* fed with a high-quality diet (low fiber) at favourable ambient temperature, a value increasing to 19% when a low-quality diet (high fiber) is offered instead, while under a high-fiber diet and at low temperatures, food intake increased to 33% of voles mass, suggesting the influence of both energy availability (diet quality) and energy needs (cold exposure) on rates of food intake.

Furthermore, values of digestibility measured were 92.50% and 91.15% for dry matter and energy, respectively, which are clearly above the range values (52.4%-73.7%) reported for wild *M. cabrerae* under a natural low-quality diet, mostly constituted by leaves and stems of grasses and analyzed from May to December (Soriguer & Amat 1988). However, values are similar to those found in *Microtus pinetorum* fed on a low-fiber diet of apples – 91.6% (dry matter) and 90.1% (energy) (Servello *et al.* 1983). Identically, Gebczynski & Gebczynska (1984) found values of 89.2% of digestibility in *M. subterraneus* fed on oat grain, carrot and parsnip and Yahav *et al.* (1988) referred to values of 95.6% of dry matter digestibility in xeric populations of the subterranean mole rat *Spalax ehrenbergii*, fed on carrots.

Increased digestibility may also allow conserve water (e.g. Kronfeld & Shkolnik 1996). This mechanism may be relevant during summer, when the availability of preferred food and water are expected to decrease.

Considering that 3% of the energy digested was loss in urine (Grodzynski & Wunder 1975), energy assimilation in *M. cabrerae* averaged around 3xRMR – resting metabolic rate at the lower limit.
of the thermoneutral zone (approximately 33.5 °C): 1.13 ml O₂/g/h (0.55 kJ/g/day) – in association with a conductance value of 0.16 ml O₂/g/h/°C (Mathias et al. 2003). In many rodents, costs of maintenance are referred as twice or three times the basal metabolic rate (e.g. Wunder 1985), which means that energy requirements of Cabrera voles fall within these standard values. However, RMR at thermoneutrality is low while conductance is high, in comparison with other rodents, confirming a physiological ability of voles for both energy and water economy in a Mediterranean environment characterised by high ambient temperatures and drought during the summer (e.g. Yahav et al. 1988, Veloso & Bozinovic 1993, Mathias et al. 2003 and references therein).

Acknowledgements. – Authors are indebted to A C Nunes for laboratory support and to C Figetredo and M J Santos for fieldwork assistance. Thanks are also due to A Almeida and M Alfredo of the Laboratório Marítimo da Guia (Faculty of Science of Lisbon) for facilities in obtaining calorimetric data. This work was partly developed under the Internship of MK in the Centro de Biologia Ambiental (Faculty of Science, University of Lisbon), supported by the University of Wageningen and the Dutch Government.

References


Reçu le 10 juin 2003; reçu 10 juin 2003
Accepté le 16 janvier 2004; accepted January 16, 2004.