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STUDIES ON THE EUROPEAN HARE XIX.

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Caloric Value and Chemical Composition of the Body of the European Hare

[With 3 Tables]

Examination was made of the caloric value and chemical composition of the bodies of 20 individuals of *Lepus europaeus*, Pallas 1778, shot in December 1966 in central Poland. It was found that the caloric value of biomass of winter hares is 1.874 kcal/g and is greater than that given for small mammals. Water 67.04%), ash in dry (12.38%) and fresh mass (4.08%) and total protein contents (64.01% in dry and 11.10% in fresh tissue) are similar to the values of these indices observed in rodents, whereas the bodies of the hares examined contain slightly more fat in comparison with small mammals (19.41% in dry and 6.40% in fresh mass), the caloric value of which is almost 9 kcal/g.

I. INTRODUCTION

The caloric values of the body of animals provide information of great importance to bio-energy investigations. It is for this reason that a relatively large amount of data on calorimetric measurements of the bodies of mammals can be found in literature. In the majority of cases, however, these are incidental data obtained from burning only a small number of individuals (Golley, 1961; Slobodkin, 1962; Davis & Golley, 1963), but studies based on extensive material and taking into consideration seasonal variations in these indices (Górecki, 1965) or their changes in the postnatal development of animals (Myrcha & Walkowa, 1968) have already appeared.

Investigations of the chemical composition of mammals' bodies were first made some time ago in respect of both laboratory (Ashworth & Cowgil, 1938; Pace & Rathbun, 1945; Fowler, 1958; Bailey *et al.*, 1960) and wild animals (Pitts, 1960; 1962; Jameson & Mead, 1964; Hayward, 1965). This question, which is of importance *inter alia* from the aspect of heat production and energy economy of the organism, has now been elaborated from both the methodical and theoretical standpoints (Brożek, 1961; Brożek & Henschel, 1961; Mitchell, 1962; Henry, 1965).

Some information on the caloric value and chemical composition of the body of *Lepus europaeus* Pallas, 1778 is given by Tilgner (1949; 1950; 1953; 1953a),

but these data refer to hare meat only. The hare is a very important animal from the economic point of view and a knowledge of its energy potential is essential to the intensive ecological studies being made of this mammal. On this account it was decided to investigate the chemical composition and caloric value of the body and some of the internal organs of this species.

II. MATERIAL AND METHODS

The chemical composition and caloric value of the body and some of the organs of *L. europaeus* were determined by examining 20 individuals (10 ♂♂ and 10 ♀♀) of this species. All the animals used for the examination were obtained from central Poland and had been shot during the first half of December 1966. Their average body weight was 4.0 kg. 10 hares were first cut up into small pieces, then passed through an electric mincer. In order to ensure that the material was thoroughly minced and mixed each hare was passed through the mincer 3 times, using an increasingly fine chopper and mixing the mince thoroughly each time. Five samples were taken from each of the hares prepared in this way. After dissecting the remaining 10 animals, the heart, lungs, kidneys, stomach, liver, brain, part of the muscles of the back of the neck and upper leg, the fat surrounding the kidneys and the skin were excised for separate investigation.

All the samples were first carefully weighed, then dried in a vacuum oven at a temperature of 65—70°C with $CaCl_2$ present. After the material had been dried it was weighed for the second time, ascertaining in this way the water content of the fresh body and organs of the hare. Caloric value was determined by burning samples 1.0—1.3 g in size in a Berthelot system KL-3 calorimeter. The ash content in the samples examined was determined at the same time from the material burnt in the calorimeter. The data obtained made it possible to calculate the caloric value of 1 g of dry mass, 1 g of dry mass without ash and also 1 g of biomass (that is, fresh mass) of the hare.

Examination was made of the fat and protein contents in the bodies of hares by means of analysing part of the material from each sample prepared for burning in the calorimeter, in order to determine the caloric value of the whole body of *L. europaeus*. The amount of fat was determined by the Puzanow method, also known as the Hannon and Badun or Besson method (Krauze *et al.*, 1966). It consists in double extraction (by steam and condensed solvent) by petroleum ether with the addition of ethyl alcohol, of material placed in a glass vessel with a foam glass bottom. The required time for adequate extraction had been determined earlier on by experiment as three hours. Longer extraction did not result in any differences in the weight of the sample. The amount of protein in the body of a hare was defined by the Kjeldahl method, mineralizing the material on electric firebrick stoves and determining nitrogen in a Parnas-Wagner apparatus.

All results were statistically elaborated, calculating the mean values and describing them by confidence intervals based on the variable t. Mean values calculated for males and females were compared by means of the t-Student test. No statistically significant differences were found in any of the cases.

III. DISCUSSION OF RESULTS

The caloric values of the whole body are given in table 1, and of the different organs of *L. europaeus* in table 2. The results obtained justify

the statement that the caloric values of the body of the hare are very high in comparison with other wild mammals. Caloric values of mammal tissues are generally very similar and therefore Golley (1961) suggests accepting the mean energy value of 1 g of biomass of the body of wild mammals as 1.4 kcal/g for ecological investigations. Górecki (1965), on the basis of his comprehensive examinations of 5 species of rodents and insectivores, postulates raising this index to 1.5 kcal/g. The caloric value of 1 g of biomass of the European hare is higher than the

Table 1.

Mean (± S. D.) caloric values of the European hare body.

No. of animals	No. of samples	Dry mass (cal/g)	Ash-free mass (cal/g)	Biomass (cal/g)
10	50	5684.82 ± 100.52	6492.60 ± 85.20	1873.85 ± 32.0

Table 2.

Mean water and ash contents and caloric values of some internal organs of European hare.

Organ	Water content	Ash content (in per cent of dry mass)	Caloric value (cal/g) of dry mass	Caloric value (cal/g) of ash-free mass
Heart	75.93 ± 0.76	4.03 ± 0.34	5944.70 ± 263.96	6188.11 ± 268.69
Lungs	75.68 ± 1.15	4.03 ± 0.79	5773.05 ± 97.16	6018.51 ± 113.44
Liver	73.06 ± 2.74	3.86 ± 0.69	5754.74 ± 187.20	5986.08 ± 110.10
Kidneys	75.47 ± 2.68	5.01 ± 0.27	5760.54 ± 304.73	6075.06 ± 213.19
Stomach	80.93 ± 1.27	3.81 ± 0.59	5867.13 ± 194.32	6104.93 ± 208.13
Muscle (neck)	73.37 ± 1.60	3.31 ± 0.48	5620.52 ± 168.79	5814.40 ± 192.40
Muscle (hind legs)	72.51 ± 1.62	3.68 ± 0.35	5601.32 ± 120.69	5815.78 ± 141.71
Brain	74.69 ± 2.81	5.99 ± 0.81	6921.47 ± 162.21	7553.27 ± 178.93
Adrenal fat	—	0.95 ± 0.57	8868.85 ± 185.67	8952.78 ± 143.68
Skin	—	1.99 ± 0.46	4960.57 ± 168.42	5063.57 ± 183.02

values given by these authors, being 1.874 kcal/g. Comparison of the data obtained for the hare and Górecki's data (1965) shows that the caloricity of 1 g of dry mass of *L. europaeus* is almost 1000 cal. higher than the analogical value calculated for rodents caught in the winter. It is true that Górecki (1965) found that there are seasonal variations in the value of this index in the species of animals he investigated, but even the maximum caloric value of dry mass of summer, adipose *Apodemus agrarius* (Pallas, 1771) is almost 300 cal/g lower than that of the hare.

Tilgner (1949; 1950; 1953) gives some information on the caloric value of the hare but they refer only to hare meat. The author states that the caloric value of 100 g pure hare meat is about 100 kcal, but calculations made on the basis of burnt muscles of the upper leg and back of the neck (Table 2) point to the energy value of the meat of this mammal being higher. The caloric value of 100 g of meat of the animals examined is about 146 kcal, whereas Tilgner (1949; 1950; 1953) gives 136 kcal for roasted hare meat, that is, meat containing far less water.

The remaining data describing the caloricity of some of the organs of *L. europaeus* (Table 2) cannot unfortunately be compared with the corresponding indices for other species of wild mammals, as there is no relevant information on this subject in the literature to which I had access. The caloricity of the majority of the organs of the hare which I examined is very similar, being approximately 5.6—5.7 kcal/g of dry mass. The myocardium is distinguished by a higher energy value (5.9 kcal/g) while that of the brain (6.9) is even higher but the caloricity index of the skin integument is lowest (about 5.0 kcal/g).

Table 3.

Gross body composition of *Lepus europaeus*.

No. of animals	No. of samples	Water content (in per cent)	Dry mass content (in per cent)	Dry mass composition (in per cent)		
				Ash	Fat	Protein
10	50	67.04 ± 0.59	32.96 ± 0.31	12.38 ± 1.00	19.41 ± 1.71	64.01 ± 2.99

Data describing the chemical composition in percentages of body of winter hares are given in table 3. When these results are calculated for fresh mass we find that the body of a 4 kg hare contains 2681.6 g of water (67.04%), 163.2 g of ash (4.08%), 255.9 g of fat (6.40%) and 844.2 g of protein (21.1%). Unidentified components form only 1.38% of the body weight of the animals examined.

Water content in the body of *L. europaeus* is very similar to the amount of water observed by Górecki (1965) in 5 species of small European mammals, and by Hayward (1965) in 6 geographical American breeds of *Peromyscus*. The percentage of ash content in the dry mass of hare is also very similar to the value obtained by Górecki (1965) for rodents. Fat content in the body of the animals examined is relatively high, forming 19.5% of dry mass, that is, 6.4% of the fresh body of a hare. This fat has at the same time a high caloric value of approximately 9 kcal/g. This large amount of highly caloric fat may account for the high value of the

caloric equivalent of 1 g of biomass of the animals examined. This is probably a store of fat accumulated earlier and used to produce heat during the winter conditions unfavourable to this species. This is indicated by its distribution which is almost entirely confined to the kidneys. The fat content observed in the body of *L. europaeus* is slightly greater than that given by Hayward (1965) for *Peromyscus* and far higher than the values obtained earlier by Tilgner (1949; 1950) when examining the bodies of hares. Conversely the percentage of protein content in the body of whole hares (21.1%) is slightly lower than that observed by Tilgner (1949; 1950) in the bodies of hares. On the other hand the amount of protein obtained in the present investigations in the body of *L. europaeus* is very similar to the data obtained by Pace & Rathbun (1945), Mitchell (1962) and Hayward (1965) for both wild and laboratory animals.

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WARTOŚĆ KALORYCZNA I SKŁAD CHEMICZNY CIAŁA ZAJĄCA SZARAKA

Streszczenie

Zbadano wartość kaloryczną i skład chemiczny ciała 20 osobników *Lepus europaeus* Pallas 1778, odstrzelonych w grudniu 1966 r. na terenie Polski Centralnej. Stwierdzono, że wartość kaloryczna biomasy zajęcy zimowych wynosi 1,874 kcal/g i jest większa od podawanej dla drobnych ssaków. Zawartość wody (67,04%), popiołu w suchej (12,38%) i świeżej masie (4,08%) oraz białka całkowitego (64,01% w suchej i 21,10% w świeżej tkance) są podobne do wartości tych wskaźników obserwowanych u gryzoni. Ciało badanych zajęcy zawiera natomiast nieco więcej, w porównaniu z drobnymi ssakami, tłuszczu (19,41% w suchej i 6,40% w świeżej masie), którego wartość kaloryczna wynosi prawie 9 kcal/g.