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The Effect of Winter Food Composition on Roe-deer Energy Budget [1]

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Perzanowski K., 1978: The effect of winter food composition on roe-deer energy budget. Acta theriol., 23, 31: 451—467 [With 5 Figs. & 5 Tables].

In order to establish relationships between the composition of natural food and the energy budget of the roe-deer (*Capreolus capreolus* L.), a number of feeding experiments were carried out with mixed diets consisting of various proportions of browse and plants of forest herb layer. The consumption of these kinds of foods ranged from about 30 g dry matter/animal × day as regards young shoots of alder buckthorn (*Frangula alnus*) to more than 550 g dry matter/animal × day in the case of herbs. The dry matter digestion coefficient appeared to be highly correlated with the herb content in the food. A similar relationship existed between the intake of digestible energy, ranging from 36 to 242 kcal/kg body weight$^{0.75}$ × day, and the food composition. It was computed that in the winter the roe-deer, keeping its energy budget balanced, takes food containing more than 50% herbaceous plants, whose digestibility coefficient exceeds 60%. Distinct relationships were found between the food composition and the digestibility of the following fractions: Cell Wall Content (*CWC*), Cell Content (*CC*), Acid Detergent Fiber (*ADF*) and Acid Detergent Lignin (*ADL*). The equation of multiple regression, describing the relationship between the digestibility of food and the content of *CWC*, *ADF* and *ADL* fractions in it, was also calculated.

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I. INTRODUCTION

Various publications on food relations in the roe-deer agree as to the fact that food taken by this animal under natural conditions consists, addition to browse, of a certain quantity of highly digestible plants of the forest herb layer (S i u d a *et al., 1969;* B o r o w s k i

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& K o s s a k, 1975; B o b e k *et al.*, 1979). Trials to construct an energy budget model for a roe-deer feeding exclusively on young twigs of trees and shrubs, using a computer, showed that in this case it is impossible to balance the energy taken by the animal with that it dissipates (W e i n e r, 1975). A particularly high energy deficit would occur in the roe-deer in winter, when strongly lignified twigs have a very low nutritive value (B o b e k *et al.*, 1974).

There are thus both empirical and theoretical indications that the roe-deer's diet must contain easily digested forest herbs. However, it is still an open question what ratio of browse to herbs in its diet permits this animal to balance its energy budget in winter. No experimental data elucidating this problem have hitherto been available. Microscopic analysés of the rumen contents always provide lower values of the proportions of components which pass quickly through the alimentary tract than the actual ones and then those of herbal plants (G a a r e *et al.*, 1977). Although observations of the direct effects of feeding in the roe-deer (B o r o w s k i & K o s s a k, 1975) give valuable information concerning the specific composition of their food, it is impossible to draw inferences from them about the relations between the food composition and the energy requirements of these animals.

The objective of the present paper has been to answer this question on the basis of a number of feeding experiments carried out by the classical balance method.

II. MATERIAL AND METHODS

Roe-deer specimens used for these experiments were caught as kids in the woods of the Cracow region and next placed and tamed in an enclosure in the Cracow ZOO, situated in a deciduous wood out of town. It is also where our experiments were made from mid-November to mid-March in the years 1974—1977. A total of 15 specimens, weighing from 15 to 22.5 kg, were used for study. Their age ranged from 6 months to 2 years.

Each single run of feeding experiments took 14 days, of which 9 days were a preparatory period, when the animals were fed *ad libitum* and isolated in individual runs about 50 sq.m. in area. In the period when faeces were gathered (5 days) the animals were kept in a balance cage (Fig. 1). Then they were given somewhat smaller amounts of food than was their free intake level determined during the preparatory period, which measure was taken to avoid uneaten remnants. In this perid foods and faeces were recorded every day. During the experiments the roe-deer were fed browse and green plants derived from the Niepołomice Forest. The length of twigs of trees, shrubs and dwarf shrubs used in experimental diets did not exceed 6 cm and thus it approached the length of growth in twigs commonly browsed by roe-deer at large (B o b e k

& Perzanowski, unpubl. data). In choosing the species of plants for experimental diets, I was directed by their frequency in local woods and the food preference of roe-deer (Bobek *et al.*, 1977) (Table 4).

Shoots of pine, alder buckthorn, lime and whortleberry were used as foodstuffs in experiments made separately for each of these species. Shorts of hornbeam, oak, pine and alder buckthorn were applied in mixed diets. In successive experimental diets, plants of herb layer formed 100, 75, 40, 20, 17, 14 and 7% of the dry matter of food (Table 1). A total of 11 diets were examined in 21

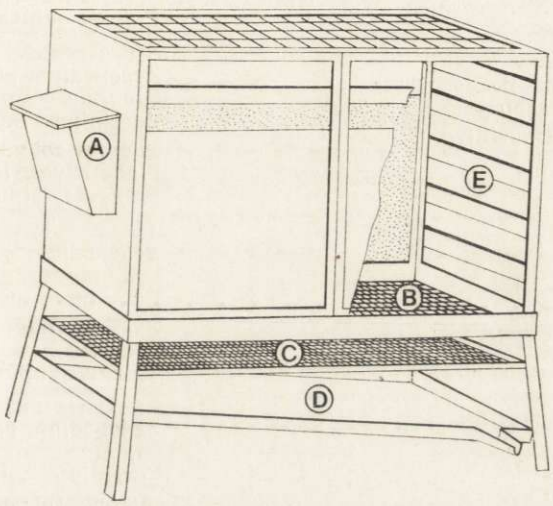

Fig. 1. The scheme of metabolic cage for roe-deer: A — feeder, B — metal net floor, C — a nylon net for feces-catching, D — a shoot for draining off urine, E — door of a cage.

feeding experiments. Digestibility was estimated for 9 diets in 17 experiments (see Results, items 2 and 3), whereas only materials derived from experiments with mixed foods were used for analyses by the detergent method (Goering & Van Soest, 1970).

To determine the dry matter of samples they were desiccated at 105°C. During experiments the faeces were preserved with chloroform and stored at about 0°C. Their dry matter was later determined separately for each one-day faeces sample. Samples of about 100 g were taken for further determinations. The caloric value of samples of food and faeces was determined in Berthelot's calorimetric bomb (Górecki, 1965) (Tables 2 and 4).

Samples of foods and faeces were analysed by the detergent method described by Goering & Van Soest (1970), permitting the determination of fractions *CC* (Cell Content), *CWC* (Cell Wall Content), *ADF* (Acid Detergent Fiber) and *ADL* (Acid Detergent Lignin).

Coefficients of regression and correlation were calculated by the least squares method.

Table 1

Specific composition of diets used in feeding experiments.

Diet	Plant species	% in dry matter of diet
1	*Pinus silvestris*	100
2	*Vaccinium myrtillus*	100
3	*Frangula alnus*	100
4	*Tilia cordata*	100
5	*Ajuga reptans*	
	Aegopodium podagraria	
	Gramineae spp.	33
	Vaccinium myrtillus	67
6	*Ajuga reptans*	
	Aegopodium podagraria	
	Gramineae spp.	
	Vaccinium myrtillus	40
	Quercus robur	
	Pinus silvestris	
	Frangula alnus	60
7	*Ajuga reptans*	
	Aegopodium podagraria	
	Gramineae spp.	
	Vaccinium myrtillus	25
	Quercus robur	
	Pinus silvestris	
	Frangula alnus	75
8	*Ajuga reptans*	
	Aegopodium podagraria	
	Gramineae spp.	
	Vaccinium myrtillus	20
	Quercus robur	
	Pinus silvestris	
	Fragula alnus	80
9	*Ajuga reptans*	
	Aegopodium podagraria	
	Gramineae spp.	
	Vaccinium myrtillus	17
	Quercus robur	
	Pinus silvestris	
	Frangula alnus	83
10	*Ajuga reptans*	
	Aegopodium podagraria	
	Gramineae spp.	
	Vaccinium myrtillus	14
	Quercus robur	
	Carpinus betulus	
	Frangula alnus	86
11	*Ajuga reptans*	
	Aegopodium podagraria	
	Gramineae spp.	
	Vaccinium myrtillus	7
	Quercus robur	
	Carpinus betulus	
	Frangula alnus	93

III. RESULTS

1. Chemical Composition of Foods and Faeces

The water content in the tested foods ranged from 45.5% in diets containing 83% browse to 62.5% for diets consisting exclusively of forest herb layer plants (Tables 1 and 2). The proportions of fractions *CC*, *CWC*, *ADF* and *ADL* changed according to the green plants content in successive food mixtures (Table 2). The caloric values of the foods tested lay within a range from 4.8 to 5.0 kcal/g dry matter (Table 2). The water content in the roe-deer's faeces, collected in experiments, ranged from 32 to 61% (Table 4). Fraction *CC* formed 13.0—28.1% in the faeces samples, while fractions *CWC*, *ADF* and *ADL* were, respectively, 71.9—81.9%, 42.1—59.4% and 25.7—30.7% (Table 4). The caloric value of faeces lay within a range of 4.33—5.27 kcal/g dry matter (Table 4).

2. Digestibility

The dry matter digestion coefficient — *DIG* (%) — appeared highly correlated with the composition of food expressed by the percentage of herbs, *VF*, in its dry matter (Fig. 2) (1)

Table 2

Nutritive value and chemical composition of diets tested in feeding experiments.

Diet	Caloric value of dry matter, in kcal/g	Water content, in %	Percentage of fractions in diet			
			CC	*CWC*	*ADF*	*ADL*
1	5.0	48.0	49.1	50.9	38.6	16.7
2	4.9	49.0	60.0	40.0	37.0	17.0
5	4.8	62.5	63.0	37.0	26.0	10.0
6	4.9	60.0	57.1	42.9	33.7	14.4
7	4.9	52.0	53.9	46.1	33.9	15.0
8	4.8	46.6	50.2	49.8	37.1	17.4
9	4.8	45.5	49.3	50.7	37.8	17.6
10	4.9	49.8	45.0	55.0	39.2	18.6
11	4.9	47.9	42.8	57.2	40.8	19.6

CC — Cell Content, *CWC* — Cell Wall Content, *ADF* — Acid Detergent Fiber, *ADL* — Acid Detergent Lignin

The strongest relationship, however, occurred between the digestibility of dry mass (*DIG*) and the percentage content of *CC* and *CWC* in the diet fed.

$$DIG = -80.8 + 2.63\ CC \qquad r = 0.99 \qquad (2)$$

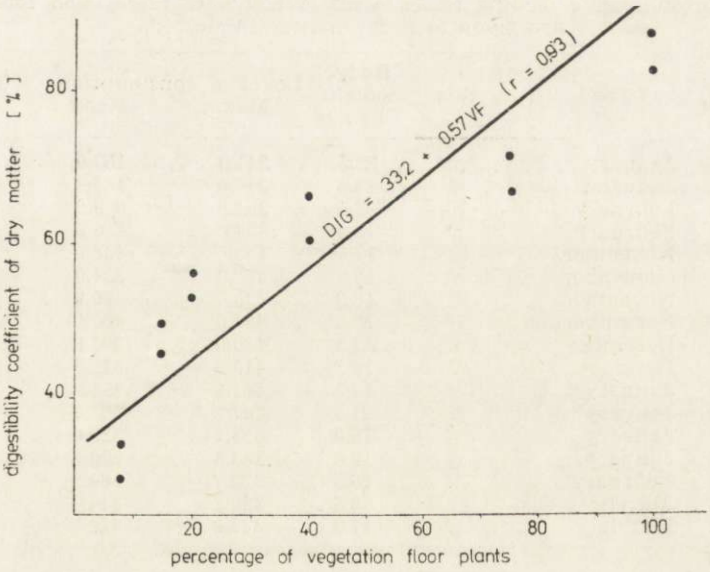

Fig. 2. Relationship between digestibility of dry matter and percentage of vegetation floor plants in dry matter of diet.

On the other hand, the correlation between the digestibility coefficient and the content of fractions *ADF* and *ADL* in the dry matter of food appeared somewhat lower:

$$DIG = 193.4 - 4.00\ ADF \qquad r = -0.95 \qquad (3)$$
$$DIG = 150.5 - 5.88\ ADL \qquad r = -0.96 \qquad (4)$$

A detergent analysis of the samples of both foods and faeces made it possible to determine the digestibility of particular fractions of diets tested. They turned out to be closely related to the composition of the diets fed, according to the following equations:

$$DIG\ CC = 75.9 + 0.17\ VF \qquad r = 0.94 \qquad (5)$$
$$DIG\ CWC = 5.9 + 0.62\ VF \qquad r = 0.94 \qquad (6)$$
$$DIG\ ADF = 17.7 + 0.51\ VF \qquad r = 0.92 \qquad (7)$$
$$DIG\ ADL = 8.0 + 0.44\ VF \qquad r = 0.91 \qquad (8)$$

where *DIG CC, CWC, ADF* and *ADL* represent the digestibility of respective fractions expressed in percentages of dry matter and *VF* is the percentage content of forest herb layer plants in the dry matter of diets tested.

3. Consumption of Substances and Energy

The level of consumption showed a marked dependence on the composition of the food offered to the roe-deer. The lowest daily consumption was found in the roe-deer fed only with alder buckthorn

Table 3

Consumption of natural diets by roe-deer in winter and weight of faeces collected in successive feeding experiments. Weights of faeces and food consumed are given in g dry matter/animal×day.

No. Exp.	No. Diet	Time	Sex	Body weight in kg	Level of consumption Max.	Level of consumption Mean	Mean weight of faeces
1	1	January	♂	22.5	241.0	163.9	111.8
2	1	January	♂	21.5	217.0	154.3	94.4
3	2	February	♂	22.0	351.0	309.9	94.2
4	2	February	♂	18.0	304.0	215.9	108.4
5	5	November	♀	17.0	552.0	403.0	53.1
6	5	November	♂	15.0	482.0	334.0	62.9
7	6	November	♀	18.0	490.0	440.0	145.0
8	6	November	♂	18.5	480.0	400.0	112.0
9	7	December	♀	17.5	465.0	390.6	133.2
10	7	December	♀	16.5	410.9	312.3	124.0
11	8	January	♀	19.5	447.2	294.2	136.8
12	8	January	♀	21.5	497.8	363.7	158.2
13	9	January	♂	18.0	353.1	325.0	170.0
14	10	January	♂	18.0	380.3	290.5	181.3
15	10	February	♀	16.5	322.7	269.2	163.2
16	11	March	♀	19.5	390.2	244.7	164.2
17	11	March	♂	17.0	333.8	212.7	150.6

browse. In two following experiments the mean daily consumption was 26.5 and 32.5 g dry matter/animal×day. The roe-deer offered exclusively lime twigs utilized only little more, on the average 38.3 and 49.7 g dry matter/animal × day. Despite such low ingestion of food, after five days the roe-deer utterly stopped eating the food supplied and for this reason after four further days the experiments were given up. The course of experiments in which the roe-deer were given pine twigs was also characteristic. In both cases the highest daily consumption fell at the beginning of the experimental cycle (241 and 217 g dry matter/animal to 98—90 g dry matter/animal consumed by them during the last day of experiment). On the other hand, the highest daily consumption, 552 g dry matter/animal × day, was noted in experiment No. 5 (Table 3), in which the roe-deer was fed only with forest herb layer plants

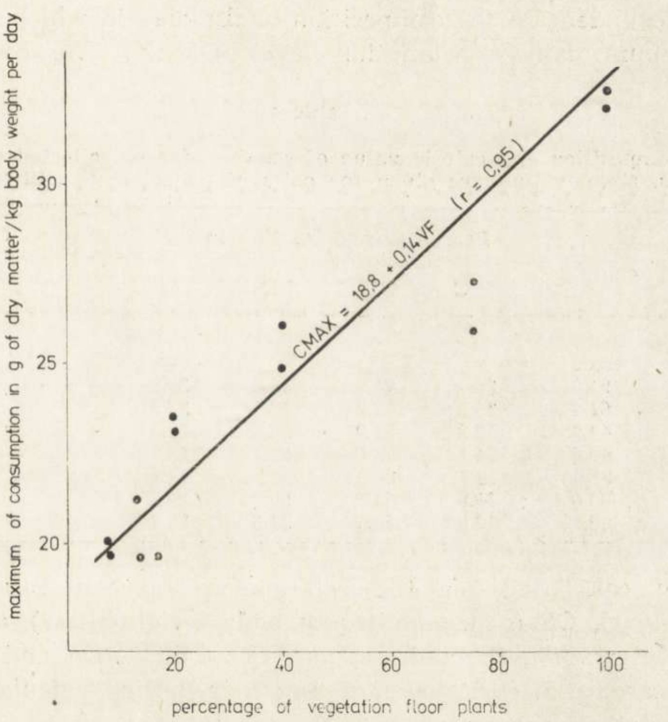

Fig. 3. Relationship between food intake, expressed in grams of dry matter/kg $^{0.75}$ and percentage of vegetation floor plants in dry matter of diet.

Both the mean and the maximum daily consumption, expressed in g dry matter/kg body weight appeared highly correlated with the herb content in the food examined. The regression describing the dependence of the maximum consumption level, *CMAX*, in g dry mater/kg body weight × day on the percentage contribution of herbs to the dry matter of food, *VF*, is (9) (Fig. 3).

The consumption level was found to be highly correlated with the proportion of fraction *CC* in the food offered ($r=0.96$), whereas a high negative correlation was observed between the consumption of dry matter expressed in g/kg body weight×day and the content of the *CWC*, *ADF* and *AFL* fractions in the food (in all these cases $r-0.95$).

Similarly, the relationship between the maximum consumption level, *CMAX* (g dry matter/kg body weight×day), and the digestibility coefficient, *DIG* (%), of the diets examined showed a high correlation described by the equation

$$CMAX=9.8+0.26\ DIG \qquad r=0.95 \qquad (10)$$

The average amount of food ingested by the roe-deer during a day, *CS*, was dependent on the composition of the diet, in which it resembled the maximum daily consumption level, *CMAX*. The coefficients of

Table 4

Chemical composition and caloric value of roe-deer faeces collected during feeding experiments. Mean values are given for pairs of experiments with the same diet.

Experiments	Water content %	Percentage of fraction in diet				Caloric value, kcal/g dry matter
		CC	*CWC*	*ADF*	*ADL*	
1 & 2	40.0	—	—	—	—	5.27
3 & 4	52.0	—	—	—	—	4.89
5 & 6	54.0	28.1	71.9	59.4	29.8	4.53
7 & 8	61.0	26.9	73.2	42.1	28.5	4.70
9 & 10	48.0	18.2	81.9	55.3	30.7	4.73
11 & 12	49.0	24.4	75.6	51.1	28.8	4.93
13	32.0	19.7	80.3	50.5	28.1	4.92
14 & 15	35.0	18.9	81.2	50.8	27.7	5.04
16 & 17	38.0	13.0	80.7	51.6	25.7	5.10

correlation calculated for the relationship beween the mean consumption level, *CS* (g dry matter/kg body weight×day), and the percentage content of herbs and fractions *CC*, *CWC*, *ADF* and *ADL* in the diets appeared however lower than their tallies calculated for the maximum daily consumption.

The amount of energy taken during the process of consumption was also markedly related to the composition of the diet. The energy consumption determined ranged from hardly about 15 kcal/kg body weight$^{0.75}$×day in the roe-deer nourished with alder buckthorn twigs to nearly 310 kcal/kg body weight$^{0.75}$×day consumed by the animals fed exclusively with herb layer plants (Table 5).

The intake of digestible energy, *DE*, which had been calculated on the basis of the mean values of daily energy consumption, also showed a high correlation with the food composition. The relationship between the intake of digestible energy (kcal/kg $^{0.75}\times$ day) and the percentage

Table 5

Utilization of food energy by roe-deer relative to various composition of diet.

Diet	Digestibility coefficient, %	Energy consumed, kcal/kg $^{0.75}\times$day	Energy digested, kcal/kg $^{0.75}\times$day
1	35.3	112.7	36.4
2	59.7	169.7	89.3
5	84.0	310.2	242.4
6	69.5	268.6	172.1
7	63.1	251.6	147.8
8	55.0	237.6	121.6
9	47.7	193.9	86.0
10	38.5	203.5	72.7
11	31.1	200.3	58.0

content of herbs, *VF*, in the dry mater of food is expressed by the following equation:

$$DE=40.0+1.52\ VF \qquad r=0.95 \qquad (11)$$

The intake of digestible energy, *DE*, was correlated ($r=0.97$) with the percentage content of fraction *CC* in the food, whereas it showed a negative correlation with the content of fractions *CWC*, *ADF* and *ADL* ($r=-0.97$, -0.92 and 0.94).

Analogous calculations in which the data on the maximum consumption level had been used, revealed that the intake of digestible energy thus estimated is still more highly correlated with the content of particular components in the foods tested. Also the relationship between the intake of digestible energy (*DE*) and the digestibility of the foods, as might be expected, turned out highly significant ($r=0.98$). The regression equation describing this relationship is

$$DE=-54.7+2.79\ DIG \qquad (12)$$

where *DE* is the digestible energy (kcal/kg body weight $^{0.75}\times$day) and *DIG* the dry matter digestion coefficient (%).

All the coefficients of regression and correlation given here are significant at the level of 0.001.

IV. DISCUSSION

1. Chemical Composition of Food and Its Digestibility

The elaboration of the method for the estimation forages digestibility of foods on the basis of their chemical composition permits the elimination of numerous difficulties connected with experimentation on wild animals. Knowledge of these simple and easily managed methods for the estimation of food digestibility is for understandable reasons particularly useful in studies on non-domesticated animals. The detergent method (Goering & Van Soest, 1970) has proved very helpful to the estimation of food digestibility in cattle and sheep. It makes it possible to break up food samples into fractions, within which all the components, often chemically heterogeneous, behave uniformly in the digestive processes. As a result, digestibility can be presented as a function of high and low digestible fractions tent in the food examined (Robbins & Moen, 1975). The equations thus calculated for domestic ruminants, while applied for computing the digestibility of natural foods of roe-deer, give results which deviate considerably from the empiric data obtained in feeding experiments.

The application of detergent analysis for food samples previously tested in feeding experiments in this study permitted the computation of the equations which make it possible to estimate the digestibility of natural foods of roe-deer on the basis of their chemical composition.

The closest relationship was found between the dry matter digestion coefficient of the food and the content of fraction *CWC* (%) in it (Fig. 4) (cf. equation 3). The equation of multiple regression was also calculated for the relationship between the dry matter digestion coefficient and the content of fractions *CWC*, *ADF* and *ADL* in the food:

DIG = 228.5 *CWC* − 3.02 *ADF* + 0.[illegible]3 *ADL* (13)

This regression is highly significant ($p < 0.001$), although the introduction of the values of *ADF* and *ADL* fractions into the equation did not improve the adjustment of the results. Naturally, the equations presented were based on feeding experiments given to the testing of roe-deer's winter food. For this reason they can be correctly interpreted only for foods that have similar parameters (relatively low content of fraction *CC*).

The digestibility of fractions *CC*, *CWC*, *ADF* and *ADL* showed also a distinct relationship with the food composition, namely, a high correlation with the content of herbs in its dry matter. Variation in the digestibility of fraction *ADL* appeared particularly interesting. Lignin is generally regarded as utterly indigestible component of food and in this connection it was even proposed as a marker in the marking method (Kleiber, 1961). The ability to digest lignin, reaching the level of 30%, was described only in European bisons (Kowalczyk *et al.*, 1976). On the other hand, the digestibility of lignin in roe-deer, as estimated in the present paper, reached 50% for the diet composed exclusively of forest herb layer plants, although in the diet made up of winter browse it was estimated at only 10%.

So high a relationship between the digestibility of lignin and the food composition may point to the heterogeneous nature of this fraction (*e.g.* its various chemical composition). This would explain the different levels of digestibility of lignin derived from herbs and browse. The marked dependence of lignin digestibility on the composition of food consumed may also be due to the mutual influence of different food constituents as regards their digestibility (food digestibility does not equal the arithmetic mean of the digestibility levels of its constituents — Kleiber, 1961). Naturally, it may well be that lignin is

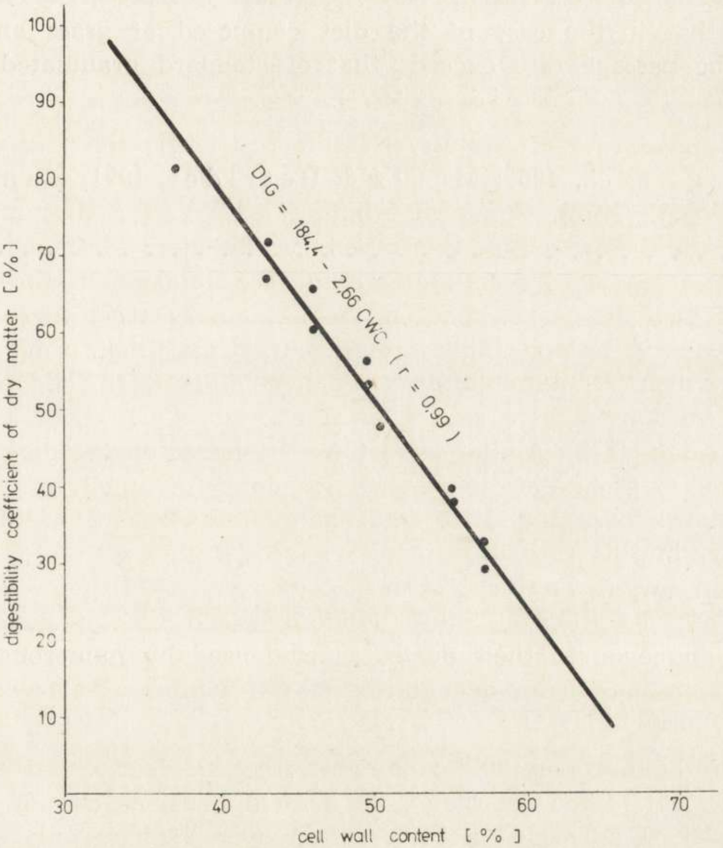

Fig. 4. Relationship between digestibility of dry matter and Cell Wall Content.

not digested at all, only its chemical composition somewhat changes during its passage through the alimentary tract. This would cause a decrease in the lignin content in faeces. It is however impossible to settle this problem definitively on the basis of the results obtained by the detergent method.

2. Influence of Food Composition on Energy Balance in Roe-deer

Not all energy taken in food is used to meet the energetic requirements of the animal. The quantities of energy lost both in faeces and in fermentation gases are dependent on the digestibility of food consumed (Maynard & Loosli, 1962; Blaxter & Clapperton, 1965). It is also known that the rate oi passage through the alimentary tract varies from food to food. For example, an inverse relation has been described between the digestibility of organic matter and the time of retention of food in the rumen of sheep fed with grass (Thornton & Minson, 1973). A study on *Odocoileus virginianus* showed that in the case of the diet composed of grass and poplar leaves the passage rate exceeds that of standard granulated food by 30% (Mautz & Petrides, 1971).

The passage rate of food is a factor restricting the free intake of food (Nagy *et al.*, 1969; Mautz & Petrides, 1971; Langlands & Bennet, 1973). Thus, an animal feeding on a diet marked by low digestibility cannot freely compensate the energy lost in faeces and fermentation gasses by an increase in food intake. On the contrary, the time of retention of food in the alimentary tract increases with the decrease of the digestibility coefficient. It may then come to a situation in which the alimentary tract will be filled with food preventing further consumption (Mautz & Petrides, 1971; Thornton & Minson, 1973). At the same time the losses during digestive processes are so great that the digestible energy obtained from the food already taken does not satisfy the energy requirements of the animal. Naturally, in this case the animal can cover the energy deficit with its depot fat (Kleiber, 1961; Weiner, 1973). However, long periods of food shortage must inevitably lead to the emaciation of animals and even to their death, as evidenced by numerous cases of fatal terminations in roe-deer during severe winters (Padaiga, 1968; Bobek, unpubl.).

Out of the Europen wild ruminants, the roe-deer seems to be the least resistant to food shortage. Its body dimensions do not permit it successfully to surmount a thick snow cover. If it is only when the snow cover exceeds 80 cm in thickness that the red deer is impeded from moving about, the 50-centimetre layer of snow stops the penetration of roe-deer in a great measure (Borowski & Kossak, 1975). Thus, the snow cover can not only cut off the access to the plants of the forest herb layer for the roe-deer but also prevent it from reaching a feeding rack or areas covered by a thinner snow layer (Gilbert *et al.*, 1970).

As can be seen from the past studies, the roe-deer is an animal »morphologically« adapted to consumption of light food. In contradistinction to other *Cervidae* roe-deer have the largest abomasum and, at the same time, comparatively small rumen in relation to their body weight. This indicates their adaptation to food with a low fibre content and rich in easily digested carbohydrates (Eisfeld, 1974; Nagy & Regelin, 1975). On the other hand, in winter the base of roe-deer's food undergoes a considerable deterioration as regards its both quantity and quality (Bobek *et al.*, 1974; Mydlarz, 1975; Siwanowicz, 1975). The leafless browse material then contains a large quantity of fibres and lignin, its protein content being lowered. Also the supplies of herb layer plants shrink markedly and their nutritive value decreases considerably (Short, 1974). When a thick snow cover prevails in forests, cutting off access to the herb layer plants, browse remains the only potentially accessible foodstuff. To be sure, roe-deer have been observed to eat up moss or evergreen creepers from tree trunks (Prior, 1968), but the supply of these plants in forests is relatively small, they may therefore be at the most a small addition to the winter diet of these animals.

In view of the low nutritive value of browse in winter it seems doubtful that it should serve as the only foodstuff of roe-deer, whose food requirements are so high. Even though microscopic studies provide too low values of the real content of easily digested herbs in the food consumed regard to their short retention time of in the alimentary tract, their results always show a certain contribution of herbs to the stomach contents (Siuda *et al.*, 1969; Gaare *et al.*, 1977; Matuła, unpubl.). The accurate determination of the proportions of food constituents in the roe-deer should however be performed on the basis of feeding experiments.

The roe-deer's intake of digestible energy in winter, determined in this study for diets containing from 0 to 100% herbs, ranged from 36 to more than 240 kcal/kg $^{0.75}\times$day (Table 5). Thus, is attained decidedly higher values than 70—102 kcal/kg $^{0.75}\times$day given by Drożdż & Osiecki (1973). The main cause of such great divergencies is the varied composition of the diets tested in the studies mentioned. The authors cited above used diets void of any forest herb layer plants in the winter season and thus diets differing greatly from the food taken by roe-deer under natural conditions. In addition, their results may have been distorted by the fact that collection of faeces and uneaten food was done in aviaries and not in balance cages. The intake of energy determined in the present study contains the value of the roe-deer's energy requirements estimated independently by the respiratory methods (W e i n e r, 1977). It reaches about 150 kcal/kg $^{0.75}\times$day of assimilated energy, corresponding to the requirements for about 160 kcal/kg $^{0.75}\times$day of digestible energy.

On the assumption that the roe-deer is fed *ad libitum* and then that its feeding as much resembles that under natural conditions as possible, the equation of rectilinear regression has been calculated for the relationship between the intake of digestible energy and the composition of the diet consumed (Fig. 5).

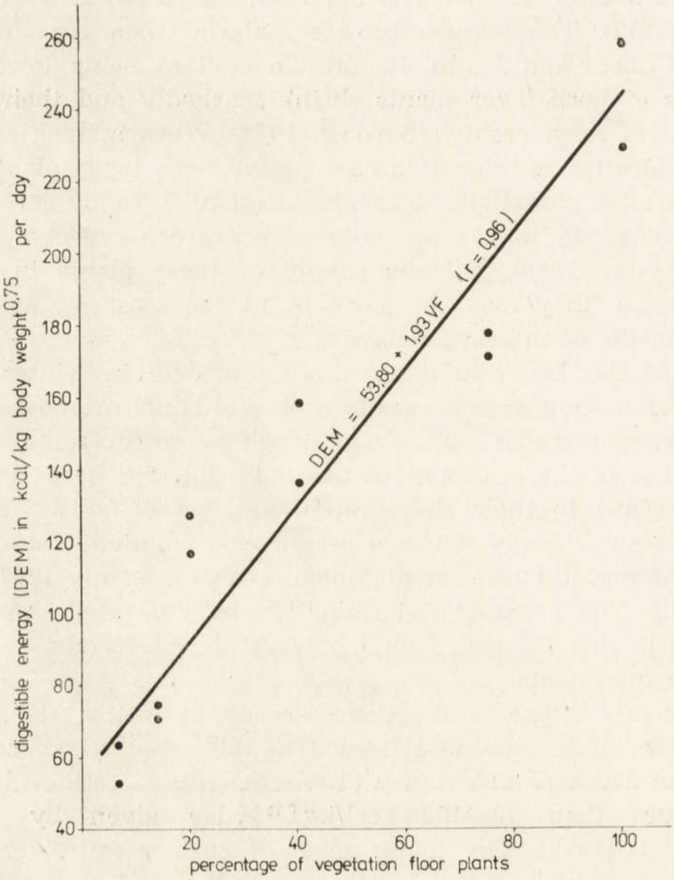

Fig. 5. Relationship between daily digestible energy intake expressed in kcal/kg $^{0.75}$ and percentage of vegetation floor plants in diet.

Substituting the value of 160 kcal of digestible energy/kg body weight $^{0.75}\times$day in this equation, we obtain the 55% herb layer plants content in the diet. This means that in order to maintain the energy balanced the roe-deer must pick out its food in such a way that the forest herb layer plants shall constitute more than half of it.

Equation (1) was used to calculate the digestibility coefficient for such a diet with herbaceous plants constituting 55%; it was 64% and agreed with the value of the food digestibility coefficient needed to balance the winter energy budget of the roe-deer.

All this strongly confirms the hypothesis that the roe-deer, the smallest species of the European wild ruminants, has the highest demands as regards the quality of food. The greater part of the winter diet of the red deer, elk and European bison consists of young shoots of trees and shrubs and even their bark, which at this time contains a high percentage of lignin and is poor in protein (Dzięciołowski, 1970; Morow, 1973; Ahlen, 1975; Kowalczyk *et al.*, 1976).

On the other hand, in winter the roe-deer's food selectivity must be focused mainly on plants of the herb layer, which differs this species decidedly from the remaining wild ungulates. This means that in winter the roe-deer is compelled to apply a specific feeding strategy, aiming at attaining the maximum gain of energy by active selection of available food. Thus the results of the present study change the past opinions on the structure of the food base of roe-deer by demonstrating that the most important constituent of the diet of these ungulates are plants of the forest herb layer. The roe-deer cannot therefore be considered to be a typical browser. This statement is particularly important to game management, since it formulates the basic criterion for establishing the correct standard capacity of hunting grounds. In the light of the present study this criterion is the abundance of the forest herb layer and its accessibility to the roe-deer in winter.

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WPŁYW SKŁADU NATURALNEGO POKARMU SARN NA ICH BUDŻET ENERGETYCZNY W SEZONIE ZIMOWYM

Streszczenie

W oparciu o doświadczenia żywieniowe, przeprowadzone metodą bilansową, określono zależność pomiędzy składem naturalnego pokarmu a budżetem energetycznym sarn *(Capreolus capreolus)*. W kolejnych eksperymentach stosowano pasze zawierające rośliny runa leśnego i żer pędowy wymieszane w różnych proporcjach (Tabela 2). Konsumpcja tych zestawów paszowych wahała się od ok. 30 g suchej masy/zwierzę na dobę dla pędów kruszyny *(Frangula alnus)* do ponad 550 g suchej masy/zwierzę na dobę dla roślin runa (Tabela 3). Współczynnik strawności suchej masy wykazał silną dodatnią korelację z zawartością roślin runa w zjadanej paszy (Fig. 2). Podobny związek ze składem pokarmu posiada pobranie energii strawnej, które wahało się od 36 do 242 kcal/kg ciężaru ciała$^{0.75}$ na dobę (Tabela 5).

Obliczono iż w okresie zimowym, sarna utrzymująca swój budżet energetyczny w równowadze, zjada paszę zawierającą ponad 50% roślin runa leśnego o współczynniku strawności wyższym niż 60%. Stwierdzono wyraźną zależność pomiędzy składem paszy a strawnością frakcji treści komórkowej (*CC*), ścian komórkowych (*CWC*), kwaśnego włókna (*ADF*) i ligniny (*ADL*). Wyliczono również równanie regresji wielokrotnej, opisujące związek pomiędzy strawnością paszy a zawartością w niej frakcji *CWC*, *ADF* i *ADL*.