METHODOLOGY OF CALCULATING THE REQUIREMENTS OF ADULT ARCTIC FOXES IN METABOLIC ENERGY AND DIGESTIBLE PROTEIN

N.E. Kulikov and K.V. Kharlamov

Scientific Research Institute of Fur Farming and Rabbit Breeding Industries, Rodniki, Moscow Region

This paper calculates the requirements of adult arctic foxes for metabolic energy and digestible protein. The clarified monthly requirements for adult arctic foxes with the goal live weight of 8 kg on the 1st of December were given.

Key terms: adult arctic foxes, method, requirements, metabolic energy, digestible protein.

The requirements of adult arctic foxes in metabolic energy (ME) are calculated considering that they, like red foxes (of the Canidae family) use 139 kcal of metabolic energy for every 100 kcal of resting metabolism for life maintenance [5,6]. N. Sh. Pereldik *et al* [5], (p. 212) call this approach "calculation via "…reference parameters".

The data obtained by A.A. Firstov on the seasonal metabolic exchange of arctic foxes, carried out in 1964, was also used as a basis for the study (ref. [6]). In the last 50 years there was been a change in the living conditions, feeding, body size, fur structure of arctic foxes. It is also important to take into consideration the uncontrollable appetite of arctic foxes, they are known to eat their own faeces (facultative coprophagy). As a result the norms for required energy need to be revised.

By definition, the maintenance levels of feed corresponds to the daily intake of ME, at which the animal's live weight gain equals zero. In research conditions it is difficult to create this type of feeding, as the factual nutrition-value of the diet depends on various factors – the activity levels of the animal, his individual reaction, the surrounding temperature etc. As a result, considering that the weight gain is directly related to the level of consumed energy (within certain levels, close to the level required for maintenance), it is assumed possible to, when considering the specific reaction (gain) to a specific consumption of ME, to calculate the ME levels required for a zero gain (to support life).

Materials and methodology.

The experimental data was obtained in a metabolism trial, which was carried out in the end of May on four-year-old female Blue foxes.

The experiment was carried out in accordance with the methodological requirements [2]. Four groups were formed with 4 heads in each, according to the mean live weight and set into trial cages, posi-

tioned in a shed. In the preliminary period (6 days) the animals were given half the recommended daily amount of feed [6], in the rolling period (4 days) – 600 kcal of ME by diet calculation, with no feed left over (Table 1).

In this case we used the "undernutrition – satiation" method [1] with the aim to deplete the fat reserves and labile protein and achieve a reliable deposition of protein throughout the course of the experiment (this allows for the extrapolation of the results for the use of ME for one gram of weight gain for the growing young foxes).

Results.

Throughout the preliminary period, the animals on average lost 322±19 grams of live weight daily. In the test period the gain of live weight varied significantly throughout the groups (Table 2). This is related to the fact that factually, according to the results of a chemical analysis, the protein, fat and carbohydrate as well as the water content of the diets was different. The digestibility coefficient of the nutritive substances of the diets also varied for the groups.

As a result we were able to create a gradient of the actually consumed digestible protein by the foxes ranging from 38,2 to 54,7 grams per head per day, ME ranged from 413 to 657 kcal and achieve an average gain in live mass from -56,4 to +13,1 grams per day. The level of ME in the diets of the experimental groups actually varied from below maintenance level to above

Table 1.

Feed, grams per 100 kcal of ME	GROUPS			
	1	2	3	4
1. Blue whiting	51	51	33,4	33,4
2. Barley/porridge	10/30	10/-	6,7/20	6,7/20
3. Fat	4,16	4,16	3,50	3,50
4. Compound feed	1,0	1,0	15,0	15,0
5.Porzyme tp 100,%		0,1	0,1	
Digestible, grams per 100 kcal of ME: Protein	7,50	7,50	7,50	7,50
Fats	5,04	5,04	5,02	5,02
Carbohydrates	4,76	4,76	4,77	4,77

Note: 2 grams – ground grain, raw – with added 0.1% (from the mass) of microenzyme complex Porzyme tp 100, the compound feed was composed of mainly vegetable matter and only 8% fishmeal .

Table 2.

Variables	GROUPS			
	1	2	3	4
1.Consumed:				
Raw feed, grams	538	474	620	620
Dry matter, grams	160	136	165	156
Digestible protein, grams	54,7±0,2	48,0±0,5	45,7±1,0	38,2±0,1
Digestible energy, kcal	741± 12	549±9	503±17	463±7
Metabolic energy, kcal	657	495	451	413
2. Energy lost with urine: kcal	84	54	52	50
% from digested	11,3	9,8	10,3	10,8
3.Energy lost for every gram of digested protein, kcal	1,52±0,02	1,12±0,01	1,14±0,03	1,32±0,00
4.Grain, gram/daily	+13,1±0,6	-29,4±23,5	-16,6±14,7	-56,4±45,1

Note: the energy lost in urine is calculated through the digested and metabolic energy, calculated using the calorific value of fat, protein and carbohydrates respectively 9,3; 4,5; 4,1 [4,5].

maintenance level, giving good (for adult animals) weight gain (deposition of nutritious substances and energy).

The energy loss through urine varied throughout the groups from 9,8 to 11,3% from digested, which makes up from 1,12 to 1,52 kcal for every 1 gram of digested protein (dp).

The lowest loss of energy for 1 gram of dp was in Groups 2 and 3. Which means that in the even that metabolic energy is lower than maintenance levels (495 kcal) a compensatory metabolic mechanism is "switched on" with enable the animal (fox) to use digested energy (and protein) more economically when they are consumed in levels lower than maintenance levels (the addition of a microenzyme complex may also have a role to play). The loss of 1 gram of dp consistently increase, which indicates an exhaustion of compensatory reserves in the body (Group 4) and protein is used.

An equation of linear regression was used for the purpose of defining the amount of ME and dp for maintenance $y = a+bx$ and parabolic regression $y = a + bx + cx^2$, where x – gain, grams per head/day, y – accepted ME and digestible protein, kcal or grams per head/day (Table 3).

In this case, with the interpolation of X 0 (towards zero) the coefficient "a" corresponds to the maintenance level of ME (or protein) during zero gain of live weight (Table 3). Table 3 shows that the requirements of ME for maintenance level is better illustrated through parabolic relation (r=0,95),

than linear (r=0,89), while protein is better shown through linear (r=0,95), coefficient C=0,000.

The calculations show that maintenance levels of ME are 570 kcal per head/day or 129 kcal for 1 kg of metabolic size of animal. Foxes from Groups 2 – 4 received ME lower than maintenance levels by 13-28% and digestible protein by 7-26%, which explains the negative gains -16,6 – -56,4 grams/day.

Animals from the first group received more ME by 15% and digestible protein - by 6%, which explains the daily gain in live weight by 13,1grams.

These results allow us to calculate:

1. The cost of 1 gram of gain: ME (657 kcal – 570 kcal) : 13,1 g = 6,6 kcal, and digestible protein (54,7 – 51,6) : 13,1 = 0,237 g., so the gain is 23,7% protein (or 22,7% protein), which shows that after a period of "starvation", in a period of "satiation" the first to regenerate is muscle mass and liable protein deposits.

2. The necessary energy-protein ratio (for 100 kcal of ME): for maintenance (51,6:5,70) = 9,05 g or 40,7%, considering expenditure for weight gain = (0,237 õ 100):6,6 = 3,59 g or 16,2%, on average (54,7:6,57) = 8,33 g or 37,5%.

3. For life maintenance in May adult arctic foxes use 84,8 % of consumed ME and only 15,2% for gain.

The acquired data do not contradict but clarify the opinions of other scientists. Samkov Yu.A. [6] considers the maintenance levels of ME for adult arctic foxes to be 139 kcal for 1 kg of metabolic weight, the expenditure of ME for 1 gram of gain in summer is 6 kcal ME.

Table 3.

Variable	Metabolic energy	Digestible protein
Number of foxes, heads	16	16
Live weight (W), average, grams	7268 ± 238	7268 ± 238
Metabolic size, $W^{0,75}$, kg	4,43	4,43
Coefficient of linear correlation	0,89	0,95
Coefficient of parabolic correlation	0,95	0,95
Regression coefficient, b	5,44	0,233
Regression coefficient, c	0,05	0,000
Maintenance levels required (coefficient a):		
Per head/day	570 kcal	51,6 g
Per 1 kg of live weight	78,4 kcal	7,1 g
Per 1 kg of metabolic size	129 kcal	11,6 g
Resting metabolism [6]	100 kcal	
Effectiveness of ME use	1,29	

According to Predelnik N.Sh. *et al* [4] and in Scandinavian countries the norm for adult arctic foxes is 7,5 – 8,5 grams digestible protein for 100 kcal ME.

The effectiveness of using ME for life maintenance in arctic foxes was not investigate but assumed it was the same as for red foxes (1,39). Our data confirms this coefficient – 1,29 and it should be used for the calculation of the expenditure of ME for life maintenance by data of resting metabolism research. Such a calculation was carried out (Table 4).

The calculations were based on the methodology of calculations using the factorial method. The calculations were used from the "starvation" metabolism in adult arctic foxes [6]. Addition of ME for 1 gram of gain in September to November according to Pereldik *et al* [5], (Table 4) for arctic foxes with the goal live weight of 8 kg in December.

So, the following conclusions can be drawn:

1. Expenditure of metabolic energy for 1 gram of gain in adult arctic foxes in the summer months is 6,6 kcal.

2. The effectiveness of the use of metabolic energy for the maintenance of life is 7,2% higher for arctic foxes than for red foxes and equals 1,29:1.

3. A clarified monthly requirement in metabolic energy for adult arctic foxes with the goal live weight of 8 kg in December.

4. The requirement of digestible protein for arctic foxes is 8,33 grams for 100 kcal of metabolic energy.

Table 4.

Month	Live weight, kg	Metabolic weight, kg $W^{0,75}$	Resting metabolism for 1 kg $W^{0,75}$,kcal	Maintenance feed for 1 kg $W^{0,75}$	Maintenance feed per animal, kcal	Daily gain, grams	Addition for the gain of 1 gram, kcal	Addition for entire gain, kcal	Total required ME per animal	
									kcal	MJ
1.	7,70	4,62	86,1	111,1	513,1	-11,3	-	-	513	2,15
2.	7,35	4,46	87,2	112,5	501,5	-19,6	-	-	502	2,10
3.	6,80	4,21	101,9	131,5	553,4	-12,9	-	-	554	2,32
4.	6,40	4,02	103,5	133,5	53,5	3,3	6,6	21,8	558	2,34
5.	6,50	4,07	99,0	127,7	520,0	6,5	6,6	42,9	563	2,36
6.	6,70	4,16	99,6	128,5	534,0	6,5	6,6	42,9	578	2,42
7.	6,90	4,26	93,4	120,5	513,4	4,8	4,6	22,1	535	2,24
8.	7,05	4,33	95,6	123,3	534	4,8	4,6	22,1	556	2,33
9.	7,20	4,40	86,8	112,0	492,9	10,0	4,6	46,0	539	2,26
10.	7,50	4,53	88,7	114,4	518,3	11,3	6,4	72,3	591	2,47
11.	7,85	4,69	89,7	115,7	543,1	5,0	6,4	32,0	575	2,41
12.	8,00	4,76	84,7	109,3	520,3	-9,7	-	-	520	2,18

Note: Recalculation of data [4,5,6]for resting metabolism and maintenance levels of ME for W to the power of 0,75 was carried out by the authors.

References:

1. *Delor-Laval Jr.* Biological criteria for protein analysis // In book Protein exchange and nutrition / – Ì.: Kolos, 1980. – Pp. 162-171.

2. *Kladovshikov V.F., Samkov Yu.A.* The study of digestibility of nutrients from feed, nitrogen balance and energy in fur-bearing animals // Methodological recommendations – Ì. VASKHNIL. 1975. – 60 p.

3. Feeding norms and the norms for feed use for fur-bearing animals and rabbits. Advisory book – Ì. Russian Academy of Agricultural Sciences. 2007 – 185 p.

4. *Pereldik N.Sh., Milovanov L.V., Erin A.T.* Feeding of fur-bearing animals – Ì.: Kolos, 1981. – 335 p.

5. *Pereldik N.Sh., Milovanov L.V. Erin A.T.* Feeding of fur-bearing animals –Ì. Agropromizdat,1987. – 351 p.

6. *Samkov Yu.A.* Rate setting of protein and energy-rich feeding of fur-bearing animals // Recommendations. Ì.: Rosselkhozisdat. 1979. – 33 p.