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Productivity energy level of cows of Gray Ukrainian breeds and their reproductive qualities

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We have studied the reproductive abilities of the animals and the development of the offspring during the post-sucking period on cows of the Gray Ukrainian breed in the 1st–3rd lactations. To evaluate the cows and the offspring, in addition to traditional signs, indicators of net energy of body maintenance and net energy of growth were introduced, as integrated indicators of the state of the organism, which depend to a greater extent on the origin than on the conditions of keeping. We have established that the researched population of animals of the Gray Ukrainian breed in the ecological and fodder conditions of the steppe zone of Ukraine shows excellent maternal instincts, reproductive function and small foetus rate not lower than the standard for the breed, almost equal distribution of offspring by sex. The yield of calves per 100 cows is 97–98%, live weight of calves at birth is 25–26 kg for heifers and 27–28 kg for bulls; high milk yield: the weaning live weight at 8 months of age is 200 kg for heifers and 230 kg for bulls, the service period of cows for 1–3 lactation period is 155–91 days, the intercalving period is 433–371 days, the small foetus coefficient is 0.54–0.49, net energy for maintaining vital activity in cows is 40–45 MJ and in newborn calves — 4.5–4.6 MJ, the net energy of growth of young calves when weaned from their mothers is 19–20 MJ and for the entire period of suckling is 3800–4900 MJ. In the section of lactations, correlational dependences were established between the net energy of maintaining cows and their offspring, which makes it possible to carry out more purposeful selection and selection of animals for further breeding and preservation of the herd of this breed.

Key words: energy, breed, cows, offspring, productivity, growth, reproduction

Introduction

The Gray Ukrainian breed is characterized by high adaptation to ecological, climatic (high temperatures) and fodder (pasture-free maintenance) conditions of maintenance and productive use in the steppe zone of Ukraine, small foetus and high stress resistance [2–4, 11]. It is characterized by strong constitution, calm temperament, manufacturability, longevity (10–12 years and more), harmonious physique, long stature (over a long period, average daily gains are 1000 g/day), high conversion of feed into products, and resistance to common infectious and invasive diseases, the proportionality of the development of muscle tissue, the slaughter yield is within 58–60%, the meat index is 4.0–4.5, the ratio of protein to fat in the carcass is 1 : 1,

the obtained beef has good taste qualities (juiciness, aroma, tenderness) and culinary properties (cooking), the pH of the meat is 6.7–6.9, which contributes to the long-term storage of the product and attracts the consumer [1, 6, 13].

The use of modern breeds of cattle is mainly aimed at increasing their productivity. At the same time, the reproductive capacity of the breeding stock naturally decreases, which negatively affects the effectiveness of breeding the only gene pool of the Gray Ukrainian breed in Ukraine, which is kept in production conditions. Preservation of this autochthonous meat cattle involves the expansion of the population array, stabilization of the genetic potential of growth energy and prevention of a decrease in reproductive functions for its further reproduction, which is relevant for the breeding process in the meat cattle breeding of Ukraine and ensuring the diversity of the biocenosis in the world [5, 7, 8].

Materials and methods

In the experimental farm "Polyvanivka" of the State Institution "Institute of Grain Crops of the National Academy of Agrarian Sciences of Ukraine" from the total population of clinically healthy 266 cows of the Gray Ukrainian breed, the 189 cows with live weight 470–500 kg were selected for the first lactation. The research was conducted during three lactations: on the second lactation on 177 cows and the third lactation on 158 cows (the decrease in the number of cows occured due to the elimination of animals for various production reasons). The subjects of the study were cows and calves of the Gray Ukrainian breed. The subject of research was reproductive capacity and energy potential (status) of cows and calves.

Cows in the summer period were kept untethered on a walking and feeding area (20 m^2 per animal) with a hard surface, the feeding front was 1.2 m/animal. In the winter period cows were kept tethered and fed 2 times a day. In summer the ration consisted of green mass of cereal and leguminous herbs, hay, straw and concentrates. In winter it contained corn silage, hay, straw and concentrates. The specific weight of concentrates in the rations was 9–18%.

Cows consumed 2.2–2.5 kg of dry substance (DS) per 100 kg of live weight with an energy concentration 8.5–9.2 MJ/kg DS and 10–12 g of crude protein in 1 kg of DS. The particle size of coarse (hay, straw), juicy (silage) and green feed was 5–7 cm. The animals had constant free access to mineral feed (table salt, tricalcium phosphate, monocalcium phosphate, chalk). Watering was carried out freely from troughs with fresh water every day.

Calves up to 8 months of age were kept on free suckers with free access to hay and concentrates after one week of age. Calves were weighed every month to determine average daily gains. Before 5–10 days calving, at the beginning of the suckling period (35–45 days) and after 70–80 days, the condition (fatness) of cows was determined according to the author's 5-point method [9]. In order to find non-traditional methods of assessing the individual development of young animals and the reproductive capacity of animals of various origins, the energy status of cows was determined by the net energy of support of the cows themselves and the net energy of support and growth of the offspring according to the method of V. V. Tsyupko et al. [12].

The energy needs of animals for support are determined by the heat output of the animal's body in thermoneutral conditions. In numerous experiments, it was established that heat losses for animals of different live weights, especially within the boundaries of animals of the same species, are the same or close in terms of a unit of live weight to the degree of 0.75 ($LW^{0.75}$), which may be determined by the features of the form body, as well as participation in the heat transfer of the lungs. Based on this, it is customary to call $LW^{0.75}$ the exchangeable or metabolic body weight. The need for energy for the basic (starvation) metabolism of any living organism without the costs of receiving and processing food can be considered a primary need for energy.

It was established that, on average, for all species of animals, the basic metabolism is about 70 kcal or 293 kJ per 1 kg of $LW^{0.75}$. The basic metabolism in heifers and castrated bulls is 15% higher and amounts to 335 kJ, and in cows and non-castrated bulls it is about 400 kJ per 1 kg of $LW^{0.75}$ [12].

The net needs for the increase in live weight represent the energy content in the daily increase. The energy content of 1 kg of gain depends mainly on the live weight of animals, with a much smaller influence of the level of this gain.

The calculation of energy deposition in the daily gain of castrate bulls was determined by the equation:

$$NEFD = \frac{LWG\ (4.1 + 0.0332LW - 0.000009LW^2)}{(1 - 0.1475LWG)},$$

where NEFD — net energy of fat deposition (gain), MJ/day;
LWG — live weight gain, kg per day;
LW — live weight, kg.

The energy content in the growth of heifers is 15% higher, and in uncastrated bulls it is 15% lower than in castrated bulls.

According to the given method, based on the live weight of cows and young animals, the expenses for basic metabolism (net maintenance energy) were determined per decade, and the net energy of growth was determined once a month. Data for the entire period of suctioning were calculated by summing up the monthly results. In the section of 3 lactations, the correlations between the energy of the basic metabolism of cows and offspring were calculated.

The research results were processed statistically according to Plokhinsky [10].

Results and Discussion

Long-term studies of the reproductive capacity of the Gray Ukrainian breed of cattle of the experimental farm "Polyvanivka" (over 40 years) testify to the consolidation of this population, and the coefficient of variation of individual traits confirms the possibility of effective selection and breeding work in the herd.

Each calving took place in good sanitary conditions. During the first 2–3 months, a newborn heifer (future cow) received at least 500 liters of milk, and from the age of one week it was given enough hay and concentrated fodders. Special attention was paid to puberty and fertilization, which are influenced by the environment, stresses, microclimate, feeding, drinking, diseases — controlled management (planning and regulation) of appetite, service and intercalving periods in each lactation was established.

It was established (table 1) that with an increase in the number of lactations, the duration of the service period decreases, which contributes to a more complete manifestation of the genetic potential, reproductive function of the brood stock and an increase in the coefficient of variability.

The increased duration of the service period (*lim* 29–161 days), and, therefore, the intercalving period in 2021 in cows of different ages of 1–3 lactations (*lim* 312–443 days), convinces of the need to inseminate them as soon as possible after calving. This will increase the rate of utilization of the genetic potential of the reproductive capacity of the population and ensure the stable development of the gene pool for its further use in selection work.

With an increase in the number of lactations, the coefficient of small foetus also decreases, that is, calves are born with a live weight close to the standard of the breed. Obviously, the age of the cows contributes to the involution of the reproductive organs for the development of the fetus according to the breed standard.

The condition of cows (fatness) in general characterizes the health state in animals and their energy status. For cows in the last month of pregnancy, it is desirable that it should be at the level of 3.5–4.0 points. During the experiment, it was established that 5–10 days before calving, the condition of cows (n=16) was 2.61±0.102 points (Cv=15.6%), 30–35 days after calving — 2.30±0.164 points (Cv=16%), and on the 70–80th day of the suckling period — 2.23±0.096 points (P>0.95; Cv=14.8%).

The energy of cows to some extent determines not only their viability, but also creates prerequisites for the energy formation in the offspring (table 2).

The energy to support the vital activity of suckling cows increased dynamically with the next calving as their live weight increased (continued growth of the firstborns). So, compared to the first lactation, it was 7.7% more in the second, and 11.4% in the third. At the same time, with an increase in the number of lactations of cows, there was no increase in the net energy of life support in newborn calves, which indicates that their live weight is balanced regardless of the age of the cows, and that the parents' low fertility is consolidated. In this regard, in order to preserve the gene pool of the Gray Ukrainian breed, it is advisable to select young animals for further use, one-third from cows of each of the first three lactations. Data on the net energy of calf support are presented in table 3.

In general, the energy of the mother has a positive effect not only on the development of the fetus, but also on the further life of newborn calves during the weaning period, on their growth energy. However, the net energy of progeny maintenance during the suckling period practically did not depend on the age of the cows during

Table 1. Reproductive capacity of cows

Lactation	Biometric data			
	X±Sx	σ±Sx	lim	Cv±Sx
Service-period, days				
I	155.4±8.26	113.6±5.84	36–161	73.1±3.76
II	130.5±9.34	123.6±6.61	33–142	94.7±5.06
III	91.3±7.47	124.1±6.69	29–102	95.6±5.44
Intercalary period, days				
I	438.6±8.26	113.8±5.83	388–443	25.9±1.32
II	412.3±9.38	124.8±6.63	359–417	30.2±1.60
III	354.1±8.73	129.1±6.74	312–361	31.4±1.68
Coefficient of small fertility, unit				
I	5.4±0.04	0.56±0.029	3.8–7.7	10.4±0.53
II	4.9±0.04	0.55±0.031	3.4–7.4	11.2±0.64
III	5.0±0.04	0.55±0.032	3.5–7.3	10.9±0.49

Table 2. Energy of cows and newborn calves, MJ/day

Lactation	Biometric data			
	X±Sx	σ±Sx	Lim	Cv±Sx
Net energy to support vital activity of cows, MJ/day				
I	40.3±0.14	2.00±0.102	34.7–54.7	4.9±0.25
II	43.4±0.19	2.49±0.140	37.1–57.7	5.7±0.32
III	44.9±0.22	2.51±0.144	39.4–59.1	5.8±0.34
Net energy to support vital activity of newborn calves, MJ				
I	4.5±0.03	0.53±0.027	3.0–5.4	11.7±0.60
II	4.6±0.02	0.27±0.014	3.6–5.2	13.8±0.30
III	4.5±0.03	0.31±0.019	3.5–5.1	12.4±0.41

Table 3. Net energy of growth of calves

Lactation	Biometric data			
	X±Sx	σ±Sx	lim	Cv±Sx
Net energy to support vital activity of calves at weaning, MJ/day				
I	19.3±0.08	1.17±0.062	14,5–22,7	6.0±0.31
II	19.4±0.11	1.30±0.076	14,0–22,6	6.7±0.31
III	19.6±0.17	1.36±0.081	14,2–21,9	6.6±0.42
Net energy of growth of calves during the suckling period (240 days), MJ				
I	3779.8±26.6	352.31±21.287	2325–4825	9.3±0.56
II	3789.8±32.45	386.70±23.811	2400–4875	10.2±0.62
III	3805.3±33.12	391.42±21.639	2421–4816	10.9±0.74

the first three lactations (r = –0.05…+0.13), which is obviously related to the optimal conditions of feeding and maintenance during the period of the mothers' body and the standard for breeds with calf weight at birth. There is a slight correlation of net energy expenditure for the maintenance of vital activity of young animals at birth and at weaning (r=0.185).

Correlation analysis shows that the relationship between the live weight of cows, the net energy of their body and the net energy of maintaining the organism with the growth intensity of offspring in the embryonic and post-embryonic periods and their net energy is weak, and in the connection of the reproductive function with the energy of the offspring, it is even negative.

At the same time, according to most indicators, there is a certain tendency to improve relations with the age (lactation) of cows. This regularity can be used in further selection and breeding work with the population.

Table 4. Correlation between the net energy of maintaining cows and calves and reproductive functions of cows (n=134)

Correlation relationship	Lactations		
	1	2	3
ES — net energy of support, — service-period	0.07±0.086	0.13±0.092*	–0.07±0.099
NE of cow — ICP	0.07±0.086	0.13±0.092*	–0.07±0.099
Service-period — NE growth of the calf during the suckling period	–0.03±0.086	0.14±0,092*	0.02±0.099
ICP — NE growth of the calf during the suckling period	–0.03±0.086	0.14±0.092*	0.02±0.099
Service-period — NES at the birth of the calf	–0.03±0.086	–0.05±0.094	0.04±0.099
ICP — NES at the birth of the calf	–0.03±0.086	–0.05±0.094	0.04±0.099
Service-period — NES when the calf is weaned	–0.04±0.086	0.13±0.092*	0.03±0.099
ICP — NES when the calf is weaned	–0.04±0.086	0.13±0.092	0.03±0.099

Note. LM — live mass, NE — net energy of the body, NES — net energy of support, SP — service-period, ICP — inter calvings period; * — P<0.2.

Conclusions

1. Long-term research into the reproductive capacity of Gray Ukrainian cattle at the "Polyvanivka" research farm shows the consolidation of animals of this population and the possibility of effective selection and breeding work in the herd.

2. A decrease in the duration of the service period with an increase in the number of calving cows implies impregnation of most cows in the first heat.

3. There is a weak correlation between the reproductive function of cows and the intensity of offspring growth with some tendency to improve with the age (lactation) of their mothers.

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Енергетичний рівень продуктивності корів сірої української породи та їхні репродуктивні якості

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На коровах сірої української породи у 1–3-й лактацій вивчали відтворювальні здатності тварин і розвиток молодняку впродовж підсисного періоду. Для оцінювання корів і молодняку, крім традиційних ознак, ввели показники чистої енергії підтримки тіла і чистої енергії приросту як інтегрованих показників стану організму, які більше залежать від походження, ніж від умов утримання. Встановлено, що досліджуване поголів'я тварин сірої української породи в екологічних і кормових умовах степової зони України проявляє відмінні материнські інстинкти, відтворну функцію і дрібноплідність, не нижчу від стандарту породи, практично рівнозначну розподілу приплоду за статевою ознакою: вихід телят на 100 корів становить 97–98%, маса тіла телят при народженні — 25–26 кг (телички) і 27–28 кг (бугайці); а також високу молочність: маса тіла молодняку при відлученні у 8-місячному віці становить 200 кг для телиць і 230 кг для бугайців, сервіс-період корів за 1–3-ю лактації — 155–91 днів, міжотельного періоду — 433–371 день; коефіцієнт дрібноплідності — 0,54–0,49, чиста енергія підтримки життєдіяльності корів — 40–45 МДж, новонароджених телят — 4,5–4,6 МДж, чиста енергія приросту молодняку за відлучення від матерів — 19–20 МДж і за весь період підсосу — 3800–4900 МДж. У розрізі лактацій встановлено кореляційні залежності між чистою енергією підтримки корів і їхнього приплоду, що дає можливість цілеспрямованіше проводити відбір і підбір тварин для подальшого розведення та збереження стада цієї породи.

Ключові слова: енергія, порода, корови, приплід, продуктивність, приріст, відтворення

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