Meat Productivity of Cattle When Using in Their Diets Local Non-Traditional Feed Additives in a Sharply-Continental Climate of Yakutia

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Abstract. The article presents the research results of non-traditional feed additives' impact on cattle meat productivity in the sharply continental climate of Yakutia. There were formed three experimental groups of young cattle given the age and the live weight. Meat productivity was estimated by killing products, organoleptic and physicochemical parameters of beef. It was found that the inclusion of local mineral feed additives in animal's diet contributed to the increasing of carcass mass on 3.4 – 7.9 %, lean tissue on 8.5 – 15.7 kg, and fat tissue on 1.3 – 1.5 kg. The assessment of meat products showed that the experienced groups’ samples had high points. Thus, the researches have shown the effectiveness of local non-traditional feed additives in the sharply continental climate of Yakutia.

1. Introduction

Beef breeding is the most upcoming sector at present, so the issues of beef breeding in a different natural environment and climatic conditions have a high scientific and practical potential [1]. Researches of the Herefords breeding in Russia conducted in the northern Zauralye [2], in the Republic of Buryatia [3], in Pskov Oblast [4], in the Republic of Bashkortostan, proved the potential. The most important studies of the Herefords acclimatization belong to Zhornokley P.E., Chernov G.A. (1970) [5], and Saltykova D.L. (1968) [6]. The studies conducted in the USSR have found the possibilities of breeding the Herefords because of their adequate acclimatization. Animals were able to acclimate in a new condition, and they preserved reproductive and productive qualities.

Also, in the environment of Kazakhstan, there have been noticed various adaptive capacities of Canadian, American, and English Herefords, the latter were inferior to their North American relatives [7].

Stepanenko Ya.F. (1970) has found that distortion of the Hereford's reproductive functions was temporary, and the fertility was increasing as they acclimated [8]. Nowadays, the Herefords well adapted to the conditions of Kazakhstan, and they are widely used in selection [7].

Therefore, Kiselev Yu.A. (1971) studied the adaptive capacities of the Yakut cattle to the cold compared to other breeds [9]. Struchkov E.T. and Sidorov N.E. were engaged in a detailed study of
animal adaptation mechanisms to low temperatures of Yakutia [10]. Micronutrients included in diets of farm livestock prevent the stress and replenish the energy [11, 12]. Unbalanced diet leads to a decrease of cattle productivity and a significant increase of feed products costs per unit [13, 14].

According to the authors, productivity is possible to increase by rational feeding, where the diet is optimal by the number of proteins, fat, carbohydrates and minerals, if they are not enough, the absorption of organic will not be so useful.

Mineral nutrition is vital for livestock animals, it affects on the organism vital functions, and its imbalance results in cattle breeding losses [15, 16].

Supplementing of animal organisms by the required number of minerals increases reproductive and productive qualities and strengths the health. This can be achieved by including various local mineral feed additives in diet, which comply with the relevant mineral level and composition.

We have found more than 60 chemical elements in animals, half of which are biogenic. Chemical homeostasis is based on a complex of combined biological components, on the environment and food chains, which connect the body with the external environment.

The most effective and accessible feed additives in cattle breeding are natural resources – zeolites [17, 18, 19].

In Russia zeolite tuffs are widely represented in the Republic of Sakha (Yakutia) - Khonguruu, in Sakhalin oblast – Litogskoe, in Primorsky Krai – Vanchinsskoe and Chuguevskoe, in Amur oblast – Vanginskoe and Kulikovskoe, in Kamchatka Krai -Yagodinskoe, in Chita oblast – Shvirituiskoe and Kholinskoe, in Kemerovo oblast – Pagasskogo, etc. [20]. It should be noted that the main concentration of deposits in Russia have been found in the Far East, in Siberia, and in the Ural, it emphasizes the relevance of their application in agriculture of these federal districts. Zeolites (sorbents) have an individual molecular structure, properties, and chemical composition, which contain over 40 mineral elements.

Kolodeznikov K. E. (2003) found that the relative weight of substances is represented by silicon oxide, aluminum, iron, calcium, magnesium, sodium, potassium, and phosphorus. From trace elements Zn, Cu, Mn, Co, Se, Mb are essential. Zeolites are used in various industries, in agriculture, and in environmental protection because of their useful properties [21].

Sapropels have important minerals, including macronutrients (CA, P, MD, S, K, Na, etc.) and microelements (Fe, si, Zn, MP, Co, J, etc.) [22].

The biologically active part of sapropels has carbohydrates, fat, vitamins (E, C, D, B1, B3, B6, B12, etc.), carotenoids, amino acids (lysine, histidine, arginine, aspartic acid, threonine, sirin, glutamic acid, glycine, alanine, valine, methionine, isoleucine, tyrosine, etc., the composition and content are characterized by a source – a reservoir), humic substances, various enzymes, and antibiotics. The authors note that the unique composition and technical capabilities of sapropels are important for practical use as feed additives.

The mineral and biological substances included in sapropels composition form a good basis for better stimulation of nutrient digestion and assimilation processes. The feed additive gets the appetite, increase cattle productivity, and reproduction.

There are some conclusions that the sapropels inclusion to the main diet improve the digestive system, which increases diseases and stress resistance.

There are some studies on the effectiveness of sapropels and zeolites' joint use. Chernogradskaya N. M. (2008) shows the results of the zeolite-sapropel mineral feed additive influence on the growth and development of the Holmogorsky heifers. The khongurin zeolite from Khonguruu of Suntarsky district and sapropel from the local lakes of the village Khatasy were used for the research. The feed additive per one head consisted of khongurin - 120 g, sapropel - 500 g, urea - 50 g, salt - 50 g, copper sulfate - 100 mg, potassium iodide - 15 mg and cobalt carbonate - 15 mg. The research results showed the positive effect of feed additive, the growth and development of heifers have improved, the live weight of experimental heifers exceeded the control heifers on 22.8%. Blood tests of the experimental animals revealed that the hematological and biochemical parameters were stable within the limits of physiological norms [23].
Chernogradskaya N. M., Stepanova S. I. (2010) studied the effect of sapropel and khongurin on milk productivity and the physiological state of the Kholmogorsky breed cows and heifers. The feed additives have shown a positive effect, the nutrients digestibility and absorption of the experimental groups improved, and the cow’s milk productivity increased on 9.6-12.85%. It normalized lactation performance and blood biochemical parameters. Thus, studies of authors have proved the sapropels feasibility as a feed additive that provides an increase the farm animals' productivity [24].

Studying the impact of local non-traditional feed additives on animals’ meat productivity has significant scientific and practical value, which is the basis of the research.

**Goal:** to study cattle meat productivity in the sharply continental climate of Yakutia when using in the diets local non-traditional feed additives.

**Tasks:**
- meat productivity of experienced bulls at the age of 15 months;
- morphological composition of experienced bulls carcass;
- assessment of meat product quality.

2. Materials and methods of the researches

We conducted the studies on Herefords fattening bulls of Siberian selection in the integrated agricultural production company “Churapcha” in Churapchinsky district of Yakutia. It formed groups of animals on the pairs-analogues method by selecting analogous indicators such as physiological state, live weight, age. Animals selected for the scientific research were healthy and medium-sized. The experiment lasted 7 months.

**Table 1.** Scheme of scientific and economic experiments.

| Name of groups | Number of animals, heads | Scheme of feeding |
|----------------|--------------------------|-------------------|
| control        | 15                       | Basic diet        |
| I experienced  | 15                       | Basic diet + zeolite 0,5 g/kg live weight + 150 g sapropel + 0,04 g potassium iodide |
| II experienced | 15                       | Basic diet + zeolite 0,7 g/kg live weight + 200 g sapropel + 10 g copper sulphate |

Conditions of the experiments were similar for all groups, feeding - double. Animals were kept free in the commercial farm of the integrated agricultural production company “Churapcha.”

It makes the diet up by taking into account the daily gain of young animals at the age of 8 to 15 months. During the growing period, bulls were fed per 1 head: hay 860,1 kg; haylage 405,1 kg; grass 1107,5 kg; compound feedstuff 357,4 kg. Feeding of experienced animals were organized regarding the recommendations of Kalashnikov A.P., (2003) [25]. The daily allowance of experienced bulls met the required standards.

Control slaughtering on three heads from each group determined meat productivity, and it conducted assessment of morphological and biochemical indicators according to proper methodology. Also, the pre-slaughter live weight, carcass mass, and slaughter yield were considered using the method [26].

The study of feedstuff, animal tissue, physical and chemical parameters of meat, and determination of moisture, protein, fat, and ash were carried out using the method’s [27]. Belenky N.G. methods determined the assessment of commodity and technological value of muscle tissue [28].

3. Results and discussions

The natural and climatic conditions of Central Yakutia were analyzed for studying the possibility of cattle introduction.
Churapchinsky district, where the Hereford cattle were imported, is located in Central Yakutia. The relief is flat, erosive-accumulative forms are near the water bodies. On watersheds, there is a typical for the region alas relief. It is formed by subsidence of the Arctic permafrost.

The climate of the Churapchinsky district is sharply continental, as in all districts of Central Yakutia. The annual average temperature is -20 ... -22 °C, which is typical for most regions of Central Yakutia. The cold temperature starts to rise (at 0 °C) in the spring, it lasts from May to September, but constant frosts characterize these months. It should be noted that there is a high probability of frost in the vegetation period. The transition phase of grass vegetation start and end at a daily mean temperature of +5 °C is approximately between mid-May and September, and at daily mean temperature of +10 °C the vegetation period shifts to the end of May and August. The average length of this period is 90-97 days. In Central Yakutia, the maximum temperature can reach +38.8 °C and the minimum -64.4 ° with the difference 103.2 °C.

Under such conditions, it is necessary to include feed additives in diet for replenishment of macronutrients (potassium, magnesium, sodium) and trace elements (iodine, selenium and cobalt), feed additives such as sapropel and zeolite, and some salts: iodized salt, sodium selenite, cobalt chloride and calcium-sodium feed additive.

Live weight, slaughter weight, and slaughter yield are the leading indicators determining animals’ meat productivity. Slaughter weight and slaughter yield depend on the breed, age, gender, and fattiness. The pre-slaughter live weight, carcass weight, and slaughter yield were determined when slaughtering of the experimental bulls. The slaughter results of bulls at the age of 15 months show that the experienced groups had the best indicators of slaughter weight (table 2). The Slaughter weight of the I group was 202.3 kg, and the II group was 212.1 kg, which is more on 6.9-16.7 kg to compare with the control group.

### Table 2. Meat productivity of experienced bulls at the age of 15 months, kg (M±m).

| Indicators                  | Groups                  | Control     | I experienced | II experienced |
|-----------------------------|-------------------------|-------------|---------------|----------------|
| Pre-slaughter live weight, kg | 332,0±0,90              | 337,0±0,9*  | 347,0±1,0***  |
| Slaughter weight, kg        | 195,4±0,90              | 202,3±2,50*** | 212,1±2,00*** |
| Carcass mass, kg            | 189,3±1,50              | 196,0±2,20*  | 205,7±1,90**  |
| Mass of internal fat, kg    | 6,2±0,10                | 6,3±0,10    | 6,4±0,10      |
| Slaughter yield, %          | 58,9                    | 60,0        | 61,1          |

Note: *P>0.95 **P>0.99 ***P>0.999

The researches have found that the local mineral feed additives influence slaughter weight and slaughter yield indicators.

### Table 3. Morphological composition of the experienced bulls carcass at the age of 15 months, kg (M±m).

| Indicators                  | Groups                  | Control     | I experienced | II experienced |
|-----------------------------|-------------------------|-------------|---------------|----------------|
| Mass of cooled carcass       | 184,3±2,1               | 192,9±2,1*  | 200,7±2,4**   |
| Lean tissue                 | 127,3±1,4               | 135,8±1,8*  | 143,0±1,9**   |
| Fat tissue                  | 14,5±1,2                | 15,8±1,3    | 16,0±1,3      |
| Bone tissue                 | 34,5±0,4                | 34,2±0,6    | 34,9±0,5      |
| Mass of cartilage and cord  | 8,0±1,1                 | 7,1±0,6     | 6,8±0,5       |

Note: *P>0.95 **P>0.99

Indicators of the carcass’s morphological composition are presented in table 3.
The data of the experimental group yield bones and meat show that muscle and fat tissue grew faster than bone tissue of the control group. Bulls of the I and the II groups were heavier, from 1 kg of bones of the I and the II groups, the edible part was obtained on 0.14-0.24 kg more than from the control group (table 4). The difference in morphological composition was valid (P>0.99).

**Table 4.** Changing the weight ratio of edible parts and bones in the carcass of experienced bulls, % (M±m).

| Group          | Edible parts of carcass, kg | % carcass | Inedible parts of carcass, kg | % carcass | Per 1 kg of edible tissue, kg |
|----------------|-----------------------------|-----------|------------------------------|-----------|-------------------------------|
| Control        | 150,8                       | 81,8      | 33,5                         | 18,2      | 4,50                          |
| I experienced  | 158,7                       | 82,3      | 34,2                         | 17,7      | 4,64                          |
| II experienced | 165,9                       | 82,7      | 34,8                         | 17,3      | 4,74                          |

Thus, at the age of 15 months, bulls of the I and II experimental groups had the absolute weight from edible carcass parts (4.64 and 4.74 kg), and the relative yield of these indicators in both groups was lower (17,7 and 17,3%).

Generally accepted methods were used to determine the carcass chemical composition (moisture, fat, protein, and ash content).

**Table 5.** Chemical composition and energy content of meat, % (M±m).

| Index                      | Group                  | Control          | I experienced        | II experienced       |
|----------------------------|------------------------|------------------|----------------------|----------------------|
| Moisture                   |                        | 69.17±0.24       | 68.22±0.22*         | 68.60±0.12           |
| Fat                        |                        | 10.16±0.70       | 10.40±0.12          | 10.93±0.30           |
| Protein                    |                        | 19.56±0.17       | 20.33±0.17*         | 19.40±0.11           |
| Ash                        |                        | 1.06±0.029       | 1.05±0.03           | 1.33±0.03            |
| Protein-fatty              |                        | 1.92 : 1         | 1.95 : 1            | 1.77 : 1             |
| Energy content of meat 1 kg, Kcal |                | 1734.3           | 1765.5              | 1815.9               |

Note: *P>0.95

The research results showed that the bulls carcasses of the I and II experimental groups had a higher fat and protein content than the bulls carcasses of the control group. In this regard, the calorific value of 1 kg bulls meat of the I and the II experimental groups was higher on 31.2 and 81.6 Kcal. The quality of feeding affects on produced products quantity, but also on the taste qualities, which determine the consumer advantages of meat products. It carried the assessment of the meat out after heat treatment (fried and boiled). We conducted the assessment of cooked meat, taking into account such indicators as tenderness, succulence, taste, flavor, and color. It shows an assessment of boiled meat quality in table 6.

Samples of experienced groups carcass meat had high indicators of tenderness, succulence, taste, flavor, color, and average score. The average scores of the I experimental group were higher than the control group on 7.69%,12.20%, 9.52%, 26.19%, 16.33% and 14.29%; bulls meat of the II experimental group was higher on 26.53%,23.40%, 19.15%, 36.73%, 36.73%, and 25.00%. The difference was valid (P>0.95, P>0.99, P>0.999).
Table 6. Assessment of boiled meat quality (M ± m).

| Group (samples) | Tenderness (toughness) | Succulence | Taste | Flavor | Color | Average score |
|-----------------|------------------------|------------|-------|--------|-------|---------------|
| Control         | 3.6±0.10               | 3.6±0.10   | 3.8±0.06 | 3.1±0.11 | 4.1±0.13 | 3.6±0.16      |
| I experienced   | 3.9±0.10               | 4.1±0.12*  | 4.2±0.03** | 4.2±0.12** | 4.9±0.03** | 4.2±0.17      |
| II experienced  | 4.9±0.08*** | 4.7±0.08*** | 4.7±0.07*** | 4.9±0.03*** | 4.9±0.15*  | 4.8±0.04**    |

Note: *P>0.95, **P>0.99, ***P>0.999

Beef carcass samples of the I and the II experimental groups had high indicators when the assessment of fried meat (table 7). The difference was valid (P>0.95, P>0.99, P>0.999).

Table 7. Assessment of fried meat quality (M ± m).

| Group (samples) | Tenderness (toughness) | Succulence | Taste | Flavor | Color | Average score |
|-----------------|------------------------|------------|-------|--------|-------|---------------|
| Control         | 3.7±0.06               | 4.2±0.12   | 3.9±0.06 | 3.9±0.06 | 4.2±0.17 | 3.9±0.09      |
| I experienced   | 4.1±0.03**             | 4.6±0.03*  | 4.2±0.08* | 4.3±0.06 | 4.2±0.08  |               |
| II experienced  | 5.0±0.00*** | 4.8±0.09*   | 4.6±0.06** | 4.7±0.08*** | 4.7±0.07 | 4.7±0.06**    |

Note: *P>0.95 **P>0.99 ***P>0.999

The data of meat product quality show that after two types of organoleptic processing indicators of the II experimental group distinguished. The total sum of indicators such as succulence and tenderness of the control group was 7.9±0.18 points, the I experimental group – 8.7±0.06, and the II experimental group - 9.8±0.09 points. The difference was valid (P>0.95, P>0.99, P>0.999).

The data of assessment of broth quality by strongest, hearty, flavor, color, taste, limpidity, and their average value are shown in table 8.

Table 8. Assessment of broth quality in points (M ± m).

| Samples | Strongest | Hearty | Flavor | Color | Taste | Limpidity | Average score |
|---------|-----------|--------|--------|-------|-------|-----------|---------------|
| Control I experienced | 4.27±0.14 | 2.76±0.03 | 3.76±0.12 | 3.70±0.15 | 3.96±0.18 | 3.80±0.17 | 3.70±0.23 |
| II experienced | 4.33±0.08 | 2.93±0.03* | 4.10±0.05 | 4.33±0.14* | 4.47±0.12 | 4.13±0.08 | 4.04±0.25 |

Note: *P>0.95 **P>0.99 ***P>0.999

Organoleptic assessment of broth quality showed that transparency and color are directly related to the richness. The broth of control sample was less rich, and the indicator was 2.76 points, it also had insufficient transparency and had an average taste – 3.96 points. The broth of the II experimental group had the best organoleptic parameters – 4.71 points.
As a result of the meat products' organoleptic assessment, the II experimental group got the highest scores (cooked and fried meat broth). The final average score of the control group was 3.7 points, which was lower compared to the I group on 8.4% and the II group on 21.4%.

Thus, the inclusion of local mineral feed additives in the experienced group's diet increased meat taste: tenderness, succulence, and flavor.

4. Conclusions
Local mineral feed additives have a positive effect on slaughter quality. So, the Hereford bulls carcass weight was higher on 3.4-7.9% than the control group, and the slaughter yield of these groups was 60.0-61.1%.

The study of carcasses' morphological composition of the experimental animals showed that carcasses' muscle tissue was higher on 8.5-15.7 kg and fat tissue on 1.3-1.5 kg. In this regard, the caloric value of bulls meat of the I and the II experimental groups was 1765.5 and 1815.9 Kcal.

Assessment of boiled and fried meat showed that the samples of experimental groups were higher. Organoleptic assessment of meat products established that (cooked and fried meat, broth) the II experimental group's bulls got the higher scores, which received a local mineral feed additive 0.7 g of zeolite per kg of animal live weight and 200 g of sapropel with copper sulfate. The average score of assessment was 4.74 points, which is higher to the control on 21.31% and the experimental group on 12.45%.

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