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RESEARCH ARTICLE

Effect of Granulated Sudan Grass Feed on the Fattening Performance and Meat Quality of Young Cattle

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Abstract: The aim of the study was to examine the effectiveness of various methods of Sudan grass forage preparation and their impact on the meat productivity of young cattle. The scientific and economic experiment was conducted at the “Tulpar” peasant farm in the Almaty region in 2023–2024. Forty Aulie-Ata breed bulls were selected for the experiment and divided into a control group and three experimental groups, with 10 animals in each. The animals were fed Sudan grass-based feeds prepared at the stem elongation and seed formation stages in the form of hay, silage, and pelleted feed. During the experiment, pre-slaughter weight, hot carcass weight, dressing percentage, internal fat weight, and the morphological and grade composition of the carcasses were evaluated. The results showed that the highest meat productivity indicators were observed in animals fed with granulated Sudan grass feed: the dressing percentage was 57.8%, and the lean meat weight was 166.1 kg, which is 11.5 kg higher than the corresponding indicator of the control group. An advantage was also found in the content of higher-grade lean meat. Thus, it was demonstrated for the first time that the use of Sudan grass, harvested at the tillering stage and processed into granulated feed, contributes to an increase in dressing percentage and improvement in the qualitative composition of meat during the fattening of young cattle in the arid regions of Kazakhstan. This indicates the high efficiency of granulated Sudan grass feed as a promising component of rations for beef cattle production.

Keywords: Sudan Grass, Forage, Pelleted Feed, Fattening Performance, Feeding Regime, Beef Production

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Introduction

The Republic of Kazakhstan, with its vast expanses of agricultural land, possesses significant potential for the production and export of livestock products. One of the key strategies for ensuring the competitiveness of domestic livestock production is to reduce production costs by developing a robust and high-quality feed base through the intensification of the feed industry.

The primary constraint limiting livestock productivity is the underdeveloped feed base, which fails to meet nutritional requirements, ensure feed quality, eliminate deficiencies in protein and carbohydrates in animal diets, and provide balanced rations. High-yielding and drought-resistant sorghum crops, such as Sudan grass, can play a vital role as alternatives to traditionally cultivated forage crops [1].

It is also important to note that under production conditions, it is not always possible to harvest forage crops at the optimal growth stage. This is one of the main factors reducing the overall efficiency of livestock farming, as delayed harvesting significantly increases the cost of feed due to reductions in available energy and protein for animals. At the same time, systemic challenges in the country's agro-industrial sector often prevent the timely harvesting of feed crops [2].

Under these circumstances, data on the nutritional value of forage harvested in later stages of plant development becomes critically important.

Available reference literature typically contains information on the nutritional properties of green and preserved feed only for the optimal phase of plant growth. With this in mind, we conducted research and field trials to study crop formation and the feed value of Sudan grass as a promising forage crop.

Sudan grass has the ability to thrive in arid climates and regenerate quickly after mowing, making it suitable for two to three harvests per season. This leads to high yields of green mass and hay with favorable feeding characteristics [3-5].

Growing Sudan grass in grass mixtures with properly selected high-protein legumes and using appropriate seeding rates and optimal harvesting times helps to increase both yield and nutritional value of the forage [4, 6].

Sudan grass and its hybrids with sorghum are a valuable source of tender, nutritious, and easily digestible feed for livestock. They are widely used both on pasture and in the form of hay or silage, providing consistent feeding of cattle under various conditions [7].

Cattle grazing on Sudan grass pastures show good weight gain and milk production. In terms of protein content, it is second only to legumes and contains less fiber than other cereal grasses [8]. However, after the flowering stage (panicle emergence), forage quality begins to decline [9]. Despite its excellent grazing qualities, Sudan grass is deficient in certain minerals and vitamins.

Therefore, during pasture grazing or silage feeding, supplementation with mineral and vitamin additives is necessary [1, 10].

Sudan grass hay contains 9–10% protein and up to 16% sugars. The carotene content in green biomass ranges from 65 to 80 mg/kg. The digestibility coefficients are as follows: protein – 60%, fat – 45.7%, nitrogen-free extractive substances – 73.4%, and fiber – 69.1%. In terms of protein content in both green mass and hay, Sudan grass outperforms other cereal forages [11-13].

One hundred kilograms of green mass contains 19.0 feed units and 2.3 kg of digestible protein, while 100 kg of hay contains 52.0 feed units and 6.5 kg of digestible protein. Depending on the stage of growth, one feed unit contains 110–136 g of digestible protein, which meets zootechnical standards [14].

The nutritional value of forage mass can be further improved when Sudan grass is grown in mixtures with annual legume crops [15-17].

Materials and Methods

At the Tulpar farm in the Almaty region, scientific and practical experiments were conducted in 2023-2024 to study the effectiveness of using various Sudan grass feeds, harvested at the booting stage and at the end of flowering, on the meat productivity of young beef cattle during their fattening period. To explore methods for the most complete utilization of this crop, field trials were conducted on pure sowings, where the yield and chemical composition of the plants were determined.

For the experiment, 40 Aulieatin breed bulls aged 9 months were selected. According to the principle of analogs, the animals were divided into four groups: one control and three experimental groups (10 heads in each).

The design of the scientific and economic experiment is shown in Table 1.

Table 1: Design of the Scientific and Economic Experiment

Group Designation	Number of Animals	Feeding Conditions
Control	10	Basic diet + Sudan grass hay (tillering phase)
Experimental I	10	Basic diet + Sudan grass hay (seed formation phase)
Experimental II	10	Basic diet + Sudan grass silage
Experimental III	10	Basic diet + Sudan grass pellet feed

The preparatory period of the experiment lasted 30 days, and the main period lasted 150 days. The main diet consisted of: silage – 40%, concentrates – 30%, oilcake - 15%, molasses - 5%, and hay from mixed herbs - 10% (by nutritive value).

Animals in all groups were kept under identical conditions of care and housing. The diets were formulated according to the standards outlined in the guide by V.K. Pestis and were designed to achieve an average daily weight gain of 1000 -1100 g. The quality and nutritional value of the feeds were evaluated based on the main indicators - moisture, crude protein, and fiber content - in accordance with generally accepted zootechnical standards. The chemical composition of pelleted and conventional feeds was determined according to reference data [18].

To study the formation of meat productivity, a control slaughter of animals was carried out at 15 months of age (3 animals from each group) according to the methodology.

Slaughter traits were determined using the following parameters: pre-slaughter weight, weight and yield of the carcass, weight of internal fat, slaughter weight, slaughter yield, morphological composition of the carcass (weight of chilled carcass, muscle, bones, tendons, and ligaments), and meatiness index.

The primary data obtained from the experiment were analyzed using methods of variance statistics, including analysis of variance (ANOVA), followed by Tukey's post-hoc test for multiple comparisons between groups [19-21] using Microsoft Excel software. Differences were considered statistically significant at $p < 0.05$.

Discussion

Field trials covered the vegetation period of this crop from the stem elongation stage to the milk ripeness stage of the grain. The structure of the green mass and the chemical composition of its individual components were studied, followed by the determination of the chemical composition and nutritional value of the whole plant.

The results of the scientific and economic experiment showed that the largest portion of the Sudan grass green mass yield was represented by stems, which are the least valuable part of the plant in terms of feed quality. Stems accounted for 60 to 70% of the total biomass yield of this crop, with their proportion significantly decreasing from 70% at the stem elongation stage to 60% at the milk ripeness stage. Against this background, the dynamics of the relative content in the total green mass yield appeared more stable.

It is worth noting a statistically significant decrease of 5.4% ($P<0.001$) in the proportion of leaves from the stem elongation stage to the flag leaf sheath stage, followed by stabilization of this indicator at a level of 18.6–48.6% in the later stages of plant development.

A significant increase of 3.2–4.7% ($P<0.001$) in the share of panicles between each growth stage was also recorded. As a result, at the milk ripeness stage of the grain, the relative share of panicles reached 19.6%, which exceeded the share of leaves by 0.7%.

Changes in the structural composition of the green mass determined the dynamics of its chemical composition. Primarily, this was reflected in the dynamics of dry matter accumulation in whole plants.

A steady increase in dry matter content was observed in the plants of this crop: from the stem elongation stage to the beginning of panicle emergence, it rose from 15.00% to 17.31%, and from flowering to the milk ripeness stage of the grain, it increased from 38.62% to 43.53%.

To provide a more comprehensive and objective assessment of the nutritional value of feed derived from Sudan grass, various types of forage were prepared from this crop. Specifically, hay was harvested at the stem elongation stage, and hay, haylage, and silage were prepared at the end of flowering to the beginning of the seed formation stage.

The results of the chemical analysis are presented in Table 2.

Table 2: Chemical composition of Sudan grass forages (% of dry matter)

No.	Forage type	Total moisture	Crude protein	Crude fat	Crude fiber	Nitrogen-free extractives (NFE)
1	Sudan Grass Hay (tillering phase) Sudan grass hay (stem elongation stage)	15.91	13.54	3.00	24.16	45.19
2	Sudan Grass Hay (seed formation phase)	16.03	10.19	2.33	28.19	39.03
3	Sudan grass ensilage	46.23	11.25	2.64	24.76	39.54
4	Sudan grass silage	98.90	10.59	2.45	26.55	39.50

The results of the chemical analysis indicate that the harvesting method had a certain impact on both the chemical composition of the tested forages and the preservation of the nutrients in the original raw material.

The most favorable nutrient ratio was observed in hay harvested at the stem elongation stage. Among the forages prepared at later stages of vegetation, haylage demonstrated the most advantageous parameters. In terms of crude protein content, it exceeded hay harvested at the seed formation stage and silage by 1.06% and 0.66%, respectively; in crude fat content by 0.31% and 0.19%; and in nitrogen-free extractive substances by 0.51% and 0.04%, respectively. It also had a favorable crude fiber content compared to the other forages.

The tested forages, including pelleted feed based on Sudan grass, were studied against the background of a basal diet consisting of 7.0 kg of hay, 6.0 kg of corn silage, 2.0 kg of concentrates, 0.2 kg of sunflower meal, and 0.8 kg of molasses. In the experimental groups, hay harvested at the stem elongation stage was replaced with various types of Sudan grass-based forage. Specifically, animals in the control group I and experimental groups II and III received Sudan grass hay, haylage, and pelleted feed, respectively, as part of their diet.

Table 3: Main Results of Fattening Young Cattle (n=3; $X \pm m_x$)

No.	Group Designation	Pre-slaughter Weight, kg	Hot Carcass Weight, kg	Carcass Yield, %	Internal Fat Weight, kg	Internal Fat Yield, %	Slaughter Weight, kg	Dressing Percentage, %
1	Control	373.8±4.2	199.6±3.1	53.5±0.4	11.7±0.3	3.2±0.1	211.6±3.5	56.7±0.4
2	Experimental Group I	364.9±3.9	196.0±3.0	53.4±0.3	10.9±0.2	3.1±0.1	205.7±3.3	56.3±0.3
3	Experimental Group II	384.7±4.4	207.7±3.2	53.9±0.4	13.5±0.4	3.5±0.1	220.9±3.7	57.4±0.5
4	Experimental Group III	394.6±4.5	213.9±3.5	54.2±0.4	13.8±0.3	3.6±0.1	227.6±3.8	57.8±0.5

As shown by the data presented in Table 3, the results of the experiment indicate that the harvesting method of Sudan grass had a significant effect on the meat productivity of the experimental animals. At the beginning of the study, animals in all groups exhibited approximately similar parameters; however, by the end of the fattening period, differences between the groups became clearly pronounced, particularly in the bulls receiving pelleted feed.

The pre-slaughter weight of animals in the III (pelleted feed) and II (silage) experimental groups was higher than that of the control group by 20.8–30.7 kg ($P<0.05$), indicating more intensive growth with these types of feed. In contrast, the weight of the I experimental group, which received Sudan grass hay at the seed formation stage, was slightly lower than that of the control group (364.9±3.9 kg vs. 373.8±4.2 kg). The hot carcass weight in the II and III groups was 207.7±3.2 kg and 213.9±3.5 kg, respectively, which was significantly higher than that of the control group (199.6±3.1 kg; $P<0.05$). The difference between the II and III groups was not statistically significant ($P > 0.05$).

The carcass weight and dressing percentage also tended to increase with the administration of pelleted feed: 57.8±0.5% compared to 56.7±0.4% in the control group (P<0.02). The lowest dressing percentage was observed in the I experimental group (56.3±0.3%).

The internal fat content significantly increased with the use of pelleted feed, reaching 13.8±0.3 kg, which is 2.1 kg higher than in the control group (11.7±0.3 kg; P<0.05). The corresponding internal fat yield was 3.6%, compared to 3.2% in the control animals.

Thus, the use of pelleted feed from Sudan grass significantly increased live weight, carcass weight, and slaughter yield, as well as enhanced internal fat deposition in young cattle. These data, presented in Table 3, confirm the high efficiency of pelleted feeds in promoting more complete nutrient utilization and improving meat quality. The results indicate that optimizing the pelleting technology of Sudan grass can substantially increase the nutritional value of rations and the efficiency of cattle fattening.

Changes in the total carcass weight and internal fat content do not fully reflect the nutritional value of the edible portion. Therefore, in addition to carcass weight and yield, an important indicator of meat productivity is the morphological composition of the carcass (Table 4).

Table 4: Morphological Composition of Carcasses of Experimental Animals

No.	Group Designation	Chilled Carcass Weight, kg	Lean Meat, kg	Bones, kg	Tendons and Ligaments, kg	Meatiness Index, %
1	Control	197.0	154.6	35.1	7.3	4.40
2	Experimental Group I	192.2	150.7	34.2	7.3	4.41
3	Experimental Group II	204.4	160.9	36.0	7.5	4.47
4	Experimental Group III	210.8	166.1	37.1	7.6	4.48

At the beginning of the experiment, the morphological composition of the carcasses in all experimental animals was characterized by virtually identical indicators. Subsequently, the best morphological characteristics of the carcasses were observed in bulls from experimental groups III and II, which received, respectively, pelleted feed based on Sudan grass and haylage harvested at a later stage of vegetation as part of their diets.

The carcasses of bulls from experimental group III contained slightly more lean meat compared to their counterparts in group II and the control group. The difference in this indicator averaged 5.2–11.5 kg (P<0.05). At the same time, the young animals in experimental group I had the lowest value, amounting to 150.7 kg, which was 9.3% lower than in group III. The absolute amount of bone was also highest in the aforementioned animals, although the difference compared to the other groups was not statistically significant. Regarding the meatiness index, which reflects the ratio of lean meat to bone mass, no significant differences were found between the experimental animals. It should be noted that the differences between the control group and group III were minor and, in some indicators, statistically insignificant.

When analyzing the morphological composition of carcasses, particular attention should be given to the grade composition of the lean portion. The highest content of premium-grade meat was observed in bulls from experimental group III. In terms of the amount of premium-grade meat, they exceeded their counterparts from experimental groups I and II by 5.6 kg (P<0.01) and 5.1 kg (P<0.05), respectively. The difference between the control group and group III was less pronounced, amounting to 2.6 kg (P<0.001) in favor of the experimental group III.

Conclusion

The conducted scientific and economic experiment showed that the structure of the green mass of Sudan grass significantly changes during vegetation: the proportion of stems decreases from 70% at the tillering stage to 60% at the milk ripeness stage (P<0.05), while the leaf content decreases by 5.4% (P<0.001), and the proportion of panicles increases to 19.6%. The harvesting technology has a significant impact on the chemical composition of the feeds: hay collected at the tillering stage contains 13.54% crude protein and 45.19% nitrogen-free extractives, whereas silage from the seed formation stage is characterized by a more balanced nutrient composition. The use of various Sudan grass feeds influenced the meat

productivity of young cattle. The highest indicators of pre-slaughter weight (394.6 kg) and carcass weight (213.9 kg) were recorded in animals receiving the pelleted feed (P<0.05). The slaughter yield in this group reached 57.8%, which is 1.1% higher than that of the control group. Morphological analysis of carcasses showed that bulls fed with pelleted feed had meat weight higher by 5.2–11.5 kg (P<0.05), and the content of top-grade meat exceeded that of other groups by 5.1–5.6 kg (P<0.05). Based on the obtained data, it is recommended to harvest Sudan grass at the stem elongation stage for hay preparation, and at the seed formation stage for silage. Pelleted feed from Sudan grass should be considered the most effective feed product for fattening young cattle in terms of both meat productivity and economic feasibility.

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Authors Contributions

Zhanseric Ilmaliyev: Contributed to the conception and design of the study, performed data analysis and interpretation, and drafted the manuscript, including the abstract and discussion.

Shokhan Alpeisov: Supervised and managed the project, contributed to the study design, and participated in manuscript writing and revision.

Lyaila Bupebayeva: Contributed to data acquisition, coordinated the provision of materials and equipment, and critically reviewed the manuscript for important intellectual content.

Daniyar Tursunbekov: Conducted the literature review, edited, and revised the manuscript for important intellectual content.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all other authors have read and approved the manuscript and that no ethical issues are involved.

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