

Study of the chemical composition and feed value of pasture grass

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Abstract. This study presents a comparative analysis of two distinct pasture grasslands, designated as No. 1 and No. 2, evaluating their nutritional and physicochemical properties based on content measured in naturally moist feed. The parameters assessed include dry matter, organic matter, moisture, crude ash, protein content, digestible protein, fats, fibers, carbohydrates (starch and sugars), carotene, and mineral content (calcium and phosphorus). Additionally, the study quantifies the metabolizable energy, energy feed units (EFU), and feed units to determine the overall nutritional value of the feeds.

1 Introduction

In the Akmola region during 2023, production of live-weight meat totaled 203.7 thousand tons (107.2%), milk - 404.6 thousand tons (99.5%), and chicken eggs - 711.7 million units (96.6%). As of January 1, 2024, the total livestock population across all farm categories was 453.2 thousand heads (98.8% compared to the same period in 2023), including 233 thousand cows (101.8%). The horse population reached 255.6 thousand heads (101.9%), poultry - 8,385 thousand heads (86.2%), sheep and goats - 605.8 thousand heads (99.4%), and pigs – 57.9 thousand heads (76.8%) [1].

For feed preparation for organized wintering of livestock, comprehensive collections included: 1,312.3 thousand tons of hay, 260 thousand tons of haylage, 190 thousand tons of silage, and 375.3 thousand tons of straw.

Regarding farm establishment, in 2023, within the framework of developing the meat livestock sector, 46 farms were established with the acquisition of 2.5 thousand heads of cattle (costing 1,073.3 million tenge). In the dairy livestock sector, 5 farms were implemented housing 801 heads (costing 592 million tenge) [1].

In terms of agricultural product processing in the Akmola region, the capacities include: 15 meat processing facilities with a production capacity of 122.8 thousand tons per year; 14 dairy product manufacturing enterprises with a capacity of 141.5 thousand tons per year; 36 flour-milling facilities with a capacity of 794.8 thousand tons per year; and 8 oilseed

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processing enterprises with a capacity of 101.4 thousand tons per year. From January to December 2023, food products were produced valued at 223.2 billion tenge, reflecting a growth of 106.8% compared to 2022. The primary share in the food production structure includes the meat processing industry at 49%, dairy at 15%, grain processing at 10%, bakery and baked goods at 2%, and other industries at 24% [1].

Meat processing plants and workshops produced 93.2 thousand tons of meat, marking a 15.4% increase compared to the same period in 2022, while sausage product output totaled 3 thousand tons, a decrease of 21.6%. The production volume of processed milk was 96.4 thousand tons, up by 14.2% compared to 2023, with 2.3 thousand tons of butter produced showing a growth of 25.9%, cheese and curd production at 1.7 thousand tons increased by 31.8%, and fermented dairy products at 7.6 thousand tons, a growth of 5.8% [1].

In today's conditions, complicated by economic difficulties and changes on the international stage, innovative methods are being studied, aimed at sustainable development in the sectors of the agricultural industry, including dairy production. The dairy livestock and dairy industry sector plays a key role in the agro-industrial complex of the Akmola region. This sector includes enterprises engaged in the collection and processing of milk for the production of pasteurized milk, fermented milk products, cream and melted butter, various types of cheeses, including brined cheese, as well as powdered milk and other dairy products [2-4].

Spring-summer and summer-autumn surveys of agricultural crop contamination show that conducting regular agrotechnical and chemical protection measures allows keeping the crops in a satisfactory condition. The dairy industry largely depends on the quality and quantity of feed [5-6].

Feed lands in various farms vary widely in terms of both the mix of grasses and their yields during different periods of the grazing season. When calculating the need for green mass, it can be assumed that 30-40 kg per day is necessary for juveniles aged 10-12 months, and 40-45 kg per day for juveniles older than a year, which will ensure an average daily gain of 550-600 grams without supplementary feeding with concentrates [7].

The technology of cattle farming is based on the skilled use of pastures for as long a period of the year as possible. With sufficient pasture areas, an effective system for raising young stock is free-range grazing. The efficiency of grazing depends on the scientifically based organization of the use of natural and improved pastures [7].

In the pasture grasslands of Northern Kazakhstan, prevalent plants include crested wheatgrass, blue alfalfa, common wormwood, Welsh fescue, and true madder [8]. Livestock nutrition is significantly influenced by the quality of pasture grassland, which varies based on numerous physical, chemical, and nutritional factors. This study aims to elucidate the differences between two pasture grasslands to guide optimal feed selection.

2 Materials and methods

Samples of pasture grass were collected from a farm (Akmola region, Kazhymukan village). Feed quality was assessed based on GOST 32040-2012, which covers feedstuffs, compound feeds, and feed raw materials. This standard describes the method for measuring crude protein, crude fiber, crude fat, and moisture content using spectroscopy in the near-infrared region, utilizing the InfraXact infrared analyzer from FOSS Electric, Denmark [9-11].

Samples from two pasture grasslands were analyzed for their content in grams and percentage compositions. Parameters such as dry matter, moisture, organic matter, and various nutritional components were measured and compared. An InfraXact infrared spectrometer (FOSS Electric, Denmark) was used, which provides rapid and accurate assessment of the chemical composition of various feed components such as compound

feed, fish meal, rapeseed meal, soy meal, sunflower meal, and grain. This device analyzes the content of protein, moisture, fat, crude fiber, ash, and other components without the need for reagents and solvents, making it suitable for both production and laboratory conditions. The operation of the device is based on near-infrared spectroscopy (570...1848 nm) [9].

Benefits of using InfraXact include the ability to quickly check the quality of raw materials, effective sorting, precise determination of nutritional value for recipe formulation, and improved production quality control. The spectrometer does not require complex sample preparation for most products and offers analysis in one minute, minimizing operator errors and enhancing productivity.

Calibrations transferable between devices increase accuracy and allow the creation of device networks at various levels. The spectrometer's management system is implemented through the "ISIScan" software, operating under Windows, ensuring convenience and accuracy in conducting measurements and saving results [9].

3 Results and Discussion

The energy efficiency of feeds and diets predominantly depends on their chemical composition, which determines the availability of energy. The chemical characteristics of a feed are a limiting factor for its energy value. The interaction of components in a complete ration and the consumption volume of dry matter significantly influence digestibility and, consequently, the energy value of the feed. Feeds that do not facilitate efficient rumen fermentation are often assessed as having a high energy value. For example, changes in digestibility and nutrient assimilation can be limited due to a lack of rumen-accessible protein or due to a decrease in pH caused by feeding diets low in fiber or high in non-protein nitrogenous extracts. Under such conditions, the calculated energy values may be incomplete or unreliable. In cases where high-fiber feed is added to a diet with an overall fiber deficiency, the energy value of such feed may be higher than anticipated based on standard calculations, thanks to improved rumen digestion [12].

The results of the experiment are shown in Table 1. Grassland No. 2 exhibited a higher dry matter content at 53.13% compared to 51.00% in grassland No. 1. Grassland No. 1 contained more moisture, with a percentage of 49.00%, against 46.87% in grassland No. 2. Organic matter was only quantified in grams, showing higher values for grassland No. 2. Conversely, grassland No. 2 also had higher mineral content (5.01%) than grassland No. 1 (4.80%). Crude protein and digestible protein were both higher in grassland No. 2, suggesting a richer protein source. Slight increases were noted in grassland No. 2 for both crude fat and crude fiber. While starch levels were higher in grassland No. 2, sugar levels were significantly higher in grassland No. 1. Notable differences were observed in carotene and phosphorus content, with grassland No. 2 leading in both, while calcium was higher in grassland No. 1. Grassland No. 2 generally provided higher energy values, as evidenced by metabolizable energy and energy units.

The comparative analysis indicates that pasture grassland No. 2 generally offers higher nutritional benefits, particularly in protein, fat, fiber, and energy content. However, the higher moisture and sugar content of grassland No. 1 might be beneficial under certain conditions. These findings suggest that the selection of pasture grassland should be tailored based on the specific nutritional requirements of the livestock, considering both the macro and micronutrient profiles presented. The use of spectrometric methods for determining the chemical composition of feed can facilitate the work of specialists in formulating diets in specific situations, as they provide more precise information on the metabolizable energy and nutritional value of the feed [12].

Table 1. Physical and chemical parameters and nutritional value of feed.

Indicator name	Pasture grassland №1		Pasture grassland №2	
	In natural moisture of feed		In natural moisture of feed	
	Content, g	Content, %	Content, g	Content, %
Dry Matter	510.02	51.00	531.31	53.13
Organic Matter	461.99	-	481.21	-
Moisture	489.98	49.00	468.69	46.87
Crude Ash	48.03	4.80	50.10	5.01
Crude Protein	48.57	4.86	56.71	5.67
including digestible protein	25.34	2.53	30.21	3.02
Crude Fat	17.27	1.73	18.72	1.87
Crude Fiber	200.77	20.08	208.12	20.81
Nitrogen-free extract (NFE), g incl.	195.37	19.54	197.66	19.77
Starch, %	1.50		1.80	
Sugar, %	8.13		2.80	
Carotene, mg	15.60		18.90	
Calcium, %	1.13		0.87	
Phosphorus, %	0.72		0.27	
Nutritional value of feed:				
Metabolizable Energy MJ	4.47		4.66	
Energy Feed Unit (EFU)	0.45		0.47	
Feed Unit	0.33		0.35	

Compiled by the authors.

For example, authors [13] conclude that a specific mixture of grasses—brome, cat's tail grass, red fescue, and lucerne—outperformed others in a study evaluating the productivity and nutritional content of perennial legume-grass plants used for pasture. This particular combination showed superior results in yielding green mass, collecting dry matter, and producing feed units over three grazing cycles, marking it as the most productive mixture for pasture purposes. Author [14] indicates that the highest average hay yield was achieved through a combination of basic fertilization, two applications of nitrogen, and harrowing. These agricultural practices not only improved the quality of feed but also significantly increased hay yield, with a peak performance that was 44% better than that of the control group. This suggests that these specific farming techniques are highly effective in enhancing both the quantity and quality of hay production. The researchers [15] highlight that the mineral composition of mixed alfalfa-cereal and alfalfa-grass stands is more suited to meet the physiological needs of animals than that of cereal-based perennial plant communities (phytocenoses). Furthermore, the application of nitrogen fertilizers significantly influences the chemical composition of these cereal grass stands. Despite these alterations, the nitrate levels in the dry matter of the grass stands studied remained below the maximum permissible concentration (MPC), indicating that they are safe for animal consumption and maintain a balance that supports animal health. Authors [16] suggests that the lack of legumes in most permanent grasslands represents a significant opportunity for enhancing both the production and quality of fodder. The study categorizes these grasslands based on their species composition and feed value, noting that introducing legumes through additional seeding could potentially improve the nutritional value and productivity of these grasslands.

Thus, the chemical composition and feed value of pasture grass are influenced by various factors, including the type of grass, grazing cycle, and composition of the mixture [13]. Agricultural practices such as harrowing, fertilizing, and harvest time can also impact the botanical composition and nutritional value of natural grassland [14]. Technological growing factors, such as the use of sown grass stands, play a role in the mineral

composition of grass feed [15]. The potential feed value of permanent grasslands can be improved through the addition of legumes and grass-clover mixtures [16]. Improving the quality of feed will lead to an improvement in the diet of cows and an increase in dairy productivity.

4 Conclusion

A variety of factors—from specific grass mixtures to agricultural techniques—that can profoundly affect pasture management. The integration of these insights could lead to optimized pasture compositions that not only meet the immediate nutritional requirements of grazing animals but also enhance overall agricultural productivity and sustainability.

The chemical composition of feed or diet is a key element that determines its effectiveness in providing animals with the necessary nutrients to maintain their vitality and productivity. This is particularly important in terms of energy provision, which is achieved through the processes of digestion and metabolism of the organic components in the feed. Pasture grassland No. 2, with its higher levels of most nutritional parameters and energy values, appears to be superior in nutritional quality compared to grassland No. 1. However, the choice between these grasslands should consider specific livestock health requirements and environmental conditions, thereby optimizing livestock nutrition management.

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