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The assessment of the nutrient content in the plants of the hybrid *Sorghum bicolor* x *Sorghum sudanense* harvested in different development stages

Victor Țîței, Sergiu Coșman, Natalia Cîrlig, Valentina Coșman, Ana Guțu, Natalia Mocanu, Serghei Cozari, Alexandru Teleuță, and Nina Garștea

Abstract. The article presents the results of the research aimed at evaluating the nutrient content in the leaves, stems and panicles of the hybrid sorghum x Sudan grass "SAȘM-4" plants harvested in different development stages. It has been determined that the leaves have a higher content of crude protein, crude fat, carotene, ash, calcium and phosphorus; the stems have a high content of crude cellulose, nitrogen-free extract and sugar; while the panicles are rich in starch, with high energy value. During the growing season, in all component parts, the content of dry matter increases, the concentration of proteins decreases and the content of cellulose and nitrogen-free extract essentially increases.
Keywords: sorghum x Sudan grass hybrid "SAȘM-4", nutrients, leaf, stem, panicle.

Evaluarea conținutului de nutrienți în plantele hibridului *Sorghum bicolor* x *Sorghum sudanense* recoltat în diferite perioade de vegetație

Rezumat. În articol sunt prezentate rezultatele cercetărilor care au avut ca scop evaluarea conținutului de nutrienți în frunze, tulpini și panicule a plantelor hibridului sorg x iarba de sudan „ȘAȘM-4" recoltat în diferite faze de dezvoltare. S-a stabilit că frunzele au un conținut mai înalt de proteină brută, grăsimi brute, carotenă, cenușă și calciu și fosfor, tulpinile au un conținut ridicat de celuloză brută, substanțe extractive neazotate și zaharuri, paniculul este bogat în amidon cu o valoare energetică înaltă. Pe parcursul vegetației în toate părțile componente sporește conținutul de substanțe uscate, se diminuează concentrația de substanțe proteice și crește esențial conținutul de celuloză și substanțe extractive neazotate.
Cuvinte cheie: hibridul sorg x iarba de Sudan SAȘM-4, nutrienți, frunză, tulpină, panicul.

1. Introduction

Climate change, which affects our region and the extent of desertification and salinization of some areas, implies reconsidering the structure of agricultural crops, because maize and other traditional leguminous crops do not withstand long-term drought and heat, and if such crops as millet and sorghum will be cultivated again on a large scale, it will be easier to ensure a fodder base. Genus *Sorghum* Moench, tribe *Andropogoneae*, sub-family *Panicoideae*, family *Poaceae*, includes 31 species, native to Europe, Asia, America and Australia. In our region, in the 17th century, broomcorn *Sorghum technicum* (Körn.) Trab. was introduced, and during the last century, other species were also introduced: grain sorghum *Sorghum bicolor*, Sudan grass *Sorghum sudanense* as a fodder source, *Sorghum bicolor var. saccharatum* and *Sorghum bicolor var. oryzoidum* for the food industry, as well as the Columbus grass *Sorghum* × *almum* for forage. Research on *Sorghum* species, the identification of valuable forms and the creation of cultivars with high productivity and tolerant to environmental conditions, has been carried out over the years in several scientific centres in our country [1-8].

The hybrids of sorghum x Sudan grass (*Sorghum bicolor* (L.) Moench × *Sorghum sudanense* (Piper) Stapf.) are valuable because they inherited the advantages of both species: thinner and taller stems, high content of leaves in the harvested mass, rapid regeneration after harvest, reaching up to 3 cuts annually, forage rich in protein and carbohydrates. As compared with corn, it develops a stronger root system, and the leaves are narrower, that is why it uses water more efficiently and posesses high tolerance to drought and heat.

It is known that the quality of fodder depends on the chemical composition and biomorphological structure of the plants, whose content and structure change as they grow. Therefore, a feed poorer in nutritional elements is less consumable, less digestible and, finally, its relative feed value is lower, and it cannot ensure the well-being of animals (health, reproduction functions) and planned productivity indices (meat, milk), the low content of proteins leads to an overconsumption of feed per production unit. The research aimed at evaluating the nutrient content in leaves, stems and panicles of the sorghum x Sudan grass hybrid, harvested at different stages of development.

2. Materials and Methods

The plants of the sorghum x Sudan grass hybrid 'SAȘM-4' created at the Institute of Genetics, Physiology and Plant Protection, by Gheorge Moraru, Ph.D., and grown on the experimental sector of the "Alexandru Ciubotaru" National Botanical Garden (Institute)

from Chisinau, served as subjects of study. For research, sorghum x Sudan grass plants were harvested by hand, form the stage of stem elongation until panicle formation – tassel, milk-wax kernels and wax kernels. Samples of 10 plants were taken from the harvested mass to determine the ratio per organs (component parts of the plant) by separating the leaves and inflorescences from the stem, weighing them separately and establishing the ratios of these quantities and being fixed by forced dehydration to evaluate the dry matter content and the nutrient one. According to the traditional methodical indications, in the Laboratory of Nutrition and Forage Technology of the Scientific-Practical Institute of Biotechnology in Animal Husbandry and Veterinary Medicine, the following indices were determined: moisture, hygroscopic moisture, dry matter content, nitrogen, crude protein, crude fat, crude cellulose, crude ash, nitrogen-free extract, starch, sugar, calcium, phosphorus, carotene; the nutritional and energy value of the feed were evaluated.

3. Results and Discussions

When harvesting sorghum x Sudan grass plants in mid-June, the content of leaves in the harvested mass was very high – about 55%, and in the following stages of development the structure of the crop changed essentially, the content of leaves decreased to 20.1% -23.9%, and the stem content increased to 56.4%-66.2%.

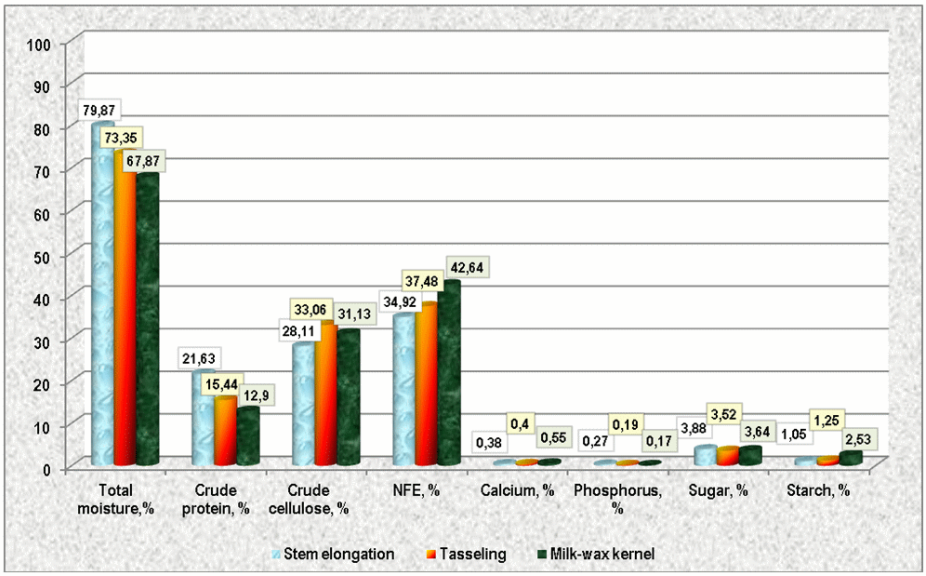

Figure 1. The nutrient content of leaves of the sorghum x sudan grass hybrid 'SAȘM-4' depending on the development stage.

The results presented in Figure 1 indicate significant changes in the chemical composition of the green mass of leaves depending on the plant development stage and harvest time. Thus, the moisture content of the leaves decreased from 79.87% in the pre-tasselling stage to 73.35% in the tasselling one and then decreased to 67.87% in the milk-wax stage of kernels. A similar trend was noticed in the crude protein content, from 21.63% in the pre-tasselling stage to 15.44% in the tasselling period and only 12.90% in the grain ripening stage. However, the amount of crude cellulose, as expected, gradually increased from 28.11% in the pre-tasseling stage to 33.06% in the tasseling stage and decreased insignificantly to 31.13% in the milk-wax stage of the grains. The crude ash content in leaves during the growing season was more constant, with small variations from 8.09 to 8.38%. Of the mineral substances, there was a substantial increase in the content of calcium – from 0.38% to 0.55% in the milk-wax stage of the grains, accompanied by a decrease in the content of phosphorus from 0.27% to 0.17%. The level of nitrogen-free extract (NFE) in the leaves increased with the age of the plant from 34.92% to 42.64%. The content of sugars in the leaves was quite constant 3.52-3.88%, and that of starch increased essentially, by more than 2.4 times (from 1.05 to 2.53%). During the growing season, a significant increase in the carotene content was observed: 94.83 mg/kg in the pre-tasselling stage, 122.5 mg/kg in the tasselling stage and 136.5 mg/kg during the grain ripening one. The leaves of the hybrid sorghum x Sudan grass are rich in fats, and their content decreased from 6.53% in the pre-tasselling stage to 4.95% in the milk-wax stage of the grains. Nutritive and energy values of the leaves harvested in the pre-tasselling stage were 0.19 nutritive units /kg and 2.08 MJ/kg metabolizable energy, in the tasselling stage being the highest – 0.26 nutritive units /kg and 2.82 MJ/kg metabolizable energy, while in the milk-wax stage of the grains, they decreased to 0.23 nutritive units /kg and 2.77MJ/kg metabolizable energy, respectively.

The results of the evaluation of the chemical composition of the sorghum x Sudan grass SAȘM-4 plant stems are presented in Figure 2. We would like to mention that the stems had a lower content of dry matter as compared with the leaves in the pre-tasselling and tasselling stages. The stems of this plant in the pre-tasselling stage had very high moisture content – 90.68%. Along with the development of the plant, this index gradually decreased to 79.14% during the tasselling stage and to 69.05% in the milk-wax stage of the grains. These indices are important in order to determine the optimal time for harvesting the given plants for ensiling. The amount of crude protein in the absolutely dry matter dropped very quickly and quite sharply from 13.45% in the pre-tasselling stage to only 4.03% in the tasselling stage and to only 2.42% in the wax-milk stage of the grains. The crude cellulose content increased with age from 29.29% in the first stage to

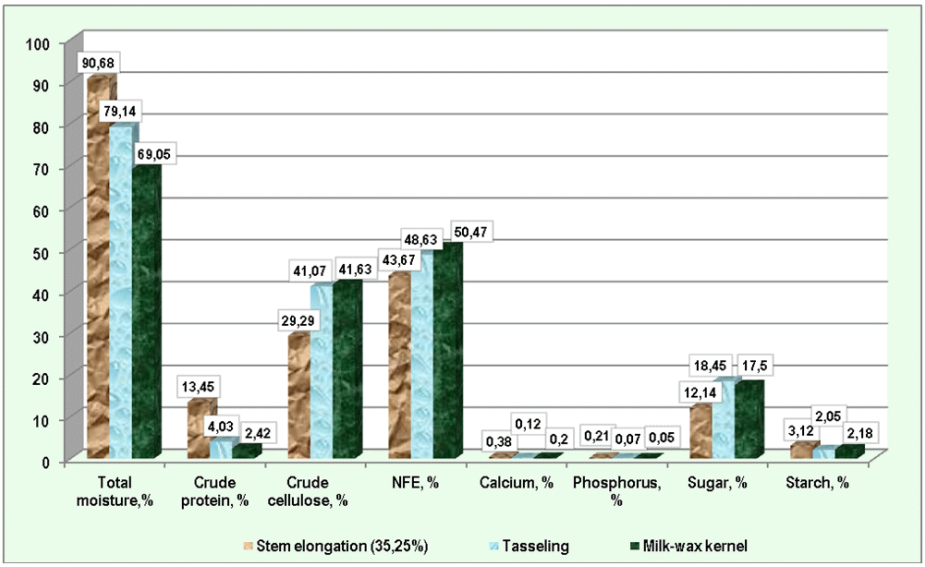

Figure 2. The nutrient content of stems of the sorghum x sudan grass hybrid 'SAȘM-4' depending on the development stage.

41.07% in the tasselling stage and to 41.63% in the milk-wax stage of the grains, so in the last two stages this index stabilized and was practically at same level, i.e. a very high level for green mass. A very high amount of nitrogen free extract is characteristic of the stems of this plant throughout their entire development 43.67-50.47%. A feature, which is characteristic only for the chemical composition of the stems of this hybrid, is the high content of sugars from 12.14% in the pre-tasselling stage, 17.50% in the milk-wax stage of the grains and up to 18.45% in the tasselling stage. The starch content was much lower and varied between 2.05% and 3.12%. The sugar content of the leaves was quite constant at 3.52-3.88%, and the amount of starch increased essentially by more than 2.4 times, i.e. from 1.05% to 2.53%. The amount of carotene and fats in the green mass of stems was low. During the growing season, there was a decrease in the ash content from 11.84% to 4.48%, in the calcium content from 0.38% to 0.12% and in phosphorus – from 0.21% to 0.05%. The nutritive and energy values of the stems harvested in the pre-tasselling were 0.08 nutritive units /kg and 0.88 MJ/kg metabolizable energy, during the tasselling stage there were 0.20 nutritional units /kg and 2.10 MJ/kg metabolizable energy, and the milk-wax stage of the grains had 0.21 nutritional units /kg and 2.64 MJ/kg metabolizable energy, respectively.

The results regarding the content of nutrients in the panicles of the hybrid sorghum x Sudan grass SAȘM-4 depending on the development stage are shown in Figure 3.

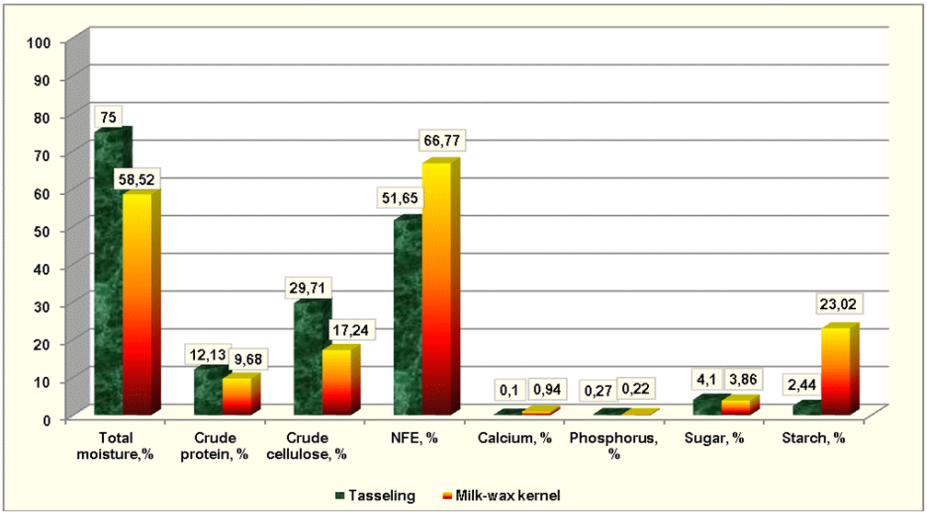

Figure 3. The nutrient content of panicles of the sorghum x sudan grass hybrid 'SAȘM-4' depending on the development stage.

An increase in the content of dry matter was observed along with the changes in its composition, thus, there was a decrease in the crude protein amount from 12.13% to 9.68% and in the crude cellulose from 29.71% to 17.24%, an essential increase in the crude fat content from 2.17 % to 4.14% and in the nitrogen-free extract from 51.65 to 66.77%. The most significant increase was observed in the content of starch – from 2.44 to 23.02% and in calcium – from 0.1% to 0.94%, which is more than nine times. The carotene content in panicles was low – 10.33-12.33 mg/kg. The nutritive and energy value of the fresh mass of panicles was of 0.08 nutritive units/kg and 0.88 MJ/kg metabolizable energy, during the tasselling period being 0.25 nutritive units/kg and 2.69 MJ/kg metabolizable energy, while in the milk-wax stage of the grains – 0.35 nutritive units/kg and 3.87 MJ/kg metabolizable energy, respectively.

4. Conclusions

During the growing season, in the plants of the hybrid sorghum x Sudan grass 'SAȘM-4' the content of dry matter increases, the concentration of proteins decreases and the amount of cellulose and nitrogen-free extract essentially increases. Leaves have higher content of crude protein, crude fat, carotene, ash, calcium and phosphorus, and the stems have high content of crude cellulose, nitrogen-free extract and sugars, and the panicle is rich in starch and provides the feed with high energy value.

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(Victor Țîței, Natalia Cîrlig, Ana Guțu, Natalia Mocanu, Serghei Cozari, Alexandru Teleuță, Nina Garștea)
"Alexandru Ciubotaru" National Botanical Garden (Institute) of Moldova State University

(Sergiu Coșman, Valentina Coșman) Scientific-Practical Institute of Biotechnologies in Animal Husbandry and Veterinary Medicine, Republic of Moldova