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RESEARCHES REGARDING THE CHEMICAL COMPOSITION AND GROSS ENERGY OF SORGHUM IN COMPARISON TO OTHER FORAGES FOR FEEDING CATTLE AND PIGS

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Abstract

Sorghum is recommended to be grown in drier areas, being able to exploit the salty soils where the cereal growing is more difficult. For an efficient use in the animal organism, the grains of sorghum should be prepared by grinding, being also possible to be used in the compound feed recipes or in the mixtures of concentrates, and the sorghum plants through ensilaging. Some varieties of sorghum contain higher amounts of tannin, which negatively affects the animal performances. The purpose of the current study was to compare the chemical composition of two sorghum hybrids with other feeds for cattle or swine feeding. The recorded data showed that the chemical composition of the two analyzed sorghum hybrids was close, as there were no differences between the samples of grain or of pickled forage. The chemical composition of sorghum grains was close to that of maize, except for the crude protein, which was higher and that of crude fat, which was lower. Sorghum silage showed a higher content in ash and crude fiber, while crude protein, crude fat and N-free extractives were lower compared to maize silage. The calculated values for gross energy of analyzed forages are within the recommended values from the speciality literature.

Key words*: sorghum, grains, ensilaged forage, chemical composition, gross energy.*

INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) *Moench*) is one of the cereal species that achieves a much greater importance, because it may be considered an alternative to maize crops in dry areas as it ensures high productions even in the conditions of high temperatures during summer.

Sorghum has a high genetic variability, existing a multitude of hybrids that can be used in obtaining the necessary forage for the livestock sector and food industry, but also obtaining biofuel (Wrigley et al., 2016).

At an early phase the sorghum plants contain cyanogen glycoside called "durrhina", which through hydrolysis and in contact with the emulsin enzyme from the stomach of animals decompose and forms the hydrogen cyanide (Joshi, 2015). This toxic substance is favored by plant age, drought, low temperature, weeding, excessive fertilizing with nitrogen, irrigation. In order to avoid poisoning of animals, sorghum should not be grazed, and at the stall it is administered after the plants wilt, when the hydrogen cyanide breaks down into non-toxic compounds. Also, the sorghum grain does not contain this substance.

The purpose of the paper is to make a comparison regarding the chemical composition of sorghum and of other feed for cattle or swine feeding in the subsequent purposes of compound feed rations or recipes.

MATERIALS AND METHODS

During the undertaken research samples of sorghum were analyzed, belonging to Euralis ES Alize and Arkanciel hybrids, which were grown in the south of Romania and harvested for both grain and pickled forage. Both hybrids are mid early, very resistant to drought and shaking.

In parallel were analyzed samples of cereal grains (maize, barley, oats, triticale), as well as silage (maize), all the cultures were obtained in the same area.

To determine the raw chemical composition 90 laboratory samples have been analyzed (10 samples for each type of forage).

The preparation of samples for analysis and determination of the chemical composition (Table 1) was conducted according to the standard methods and legislation in force, namely: dry matter (DM) by drying in an oven at 105°C; crude ash by calcination at 550°C; crude protein (CP) through the Kjeldahl method; crude fat (Ether Extract EE) through the Soxhlet method; crude fiber (CF) through the method with intermediate filtration.

Table 1. Experimental scheme

Type of analyzed forage	Number of probes	Followed objectives
ES Alize sorghum hybrid	10	- Chemical composition (Dry Matter, Ash, Crude Protein, Crude Fat, Crude Fiber, Neutral Detergent Fiber, Acid Detergent Fiber, Nitrogen-Free Extract)
Arkanciel sorghum hybrid	10	
Maize	10	
Barley	10	
Oat	10	
Triticale	10	
ES Alize hybrid sorghum silage	10	
Arkanciel hybrid sorghum silage	10	
Maize silage	10	

Because the structure of the components forming the crude fiber varies greatly from one forage to another, having different nutritive effects, nutritionists take into account other categories of cellulose, respectively NDF and ADF.

NDF is the short form for Neutral Detergent Fiber, which determines the total insoluble fibers in feed after treating them with a "neutral detergent." NDF is composed of cellulose, hemicellulose and lignin in forage.

ADF is the abbreviated form for Acid Detergent Fiber, which sets the total insoluble fibers in feed and food, after treating them with an "acid detergent". ADF is composed of cellulose and lignin in forage.

It is believed that ADF refers more to ration digestibility and NDF to the intake of dry matter, respectively the workload of rumen.

NDF and ADF are determined by applying the Van Soest method, using the FOSS Fibertec systems.

Nitrogen-Free Extract was determined by calculation: NFE = DM - (ash + ether extract + crude protein + crude fiber).

Based on the chemical composition of forages, it was computed the amount of gross energy expressed in kcal or kj gross energy, in terms of per kg of forage or kg of dry matter.

Gross energy (GE) refers to the total energy in feed, which is determined by complete oxidation (burning) of the feedstuff and measurement of the heat produced in bomb calorimeter. Common feedstuffs are similar in gross energy content, but differ in feeding value because of the differences in digestibility. Thereby the amount of gross energy is exclusively dependent on the chemical composition of the feed, but it cannot help to predict the energetic transformation efficiency, gross energy as such is meaningless in animal production, because it does not take into account any losses of energy during ingestion, digestion and metabolism of feed.

Gross energy of various organic substances is different, the values were: 4.2 kcal/g for carbohydrates; 5.7 kcal/g for protein; 9.5 kcal/g for lipids.

Taking as standard these values, there have been proposed several ways of calculating GE of feed based on their chemical composition. The researchers from the Institute O. Kellner of Rostock formulated the following relationship calculation, which was adopted by INRA in France (Stoica, 2001).

GE (kcal/kg) = 5.72 x CP + 9.5 x EE + 4.79 x CF + 4.17 x NFE,

where CP, EE, CF, NFE (g/kg) represents protein, ether extract (fat), fiber and nitrogen free extract resulted from the chemical analyzes.

RESULTS AND DISCUSSIONS

The chemical composition of sorghum grains, compared to the cereal grains, is presented in Table 2, and in Table 3 the obtained values are expressed as percentage of dry matter.

From the presented data it is seen that the two sorghum hybrids showed similar values in terms of content in the main raw nutrients. The crude protein content ranged between 10.25 and 10.75%, which is superior to the maize grains (8.75).

Crude fat of sorghum hybrids fat was located at an average value between the analyzed cereals, being of 2.52-2.88%.

Brute cellulose registered values close to those of maize grains (2.49-2.74%). Also, the content

of ADF and NDF was relatively similar to that of maize (3.33% ADF and 9.05% NDF for the ES Alize sorghum hybrid, 3.20% ADF and 8.88% NDF for the Arkanciel sorghum hybrid compared to 3.11% ADF and 8.75 % NDF for maize).

Considering the obtained values it can be appreciated that the sorghum grain can substitute maize in compound feed recipes, being mostly used as a cereal grain energy source and is a good feedstuff for poultry, pigs and ruminants.

Similar values were obtained by Heuze et al. (2015), who estimates that crude protein content in grain sorghum ranges from 9 to 13% DM and is slightly higher than that of maize, though much more variable depending on growing conditions. Also, similar results were obtained by other researchers (Stoica, 2001; Pop et al., 2006; Dragotoiu et al., 2014).

To assess the possible use of sorghum at ruminants harvesting of sorghum was done to achieve the ensilaged forage in the wax phase of grains.

The chemical composition of sorghum silage compared with that of corn silage is presented in Table 4.

Table 2. The chemical composition of sorghum grains and cereal grains (%)

Forage type	Dry matter	Ash	CP	EE	CF	ADF	NDF	NFE
Sorghum								
Hybrid ES Alize	85.44 ±10.21	2.18 ±0.09	10.75±1.27	2.88 ±0.08	2.74 ±0.04	3.33 ±0.09	9.05 ±2.01	66.89 ±7.11
Hybrid Arkanciel	84.35 ±9.11	2.05 ±0.11	10.25±2.64	2.52 ±0.06	2.49 ±0.07	3.20 ±0.12	8.88 ±2.54	67.04 ±5.89
Maize	86.58 ±13.09	1.42 ±0.12	8.75 ±1.76	4.36 ±0.09	2.51 ±0.05	3.11 ±0.07	8.75 ±1.88	69.54 ±6.58
Barley	85.76 ±11.75	2.36 ±0.08	9.15 ±1.85	1.87+0.03	5.02 ±0.10	5.84 ±0.21	14.75 ±2.78	67.36 ±8.11
Triticale	86.36 ±10.54	1.95 ±0.10	11.72±1.64	1.55 ±0.05	3.95 ±0.08	4.22 ±0.18	12.35 ±3.12	67.19 ±7.43
Oat	87.25 ±15.03	2.83 ±0.14	10.19±2.38	3.86 ±0.08	10.42 ±0.12	12.55 ±1.12	24.98 ±2.97	59.95 ±6.94

Table 3. Chemical composition of cereal grains (% of dry matter)

Forage type	Ash	CP	EE	CF	NFE
Sorghum					
Hybrid ES Alize	2.55	12.58	3.37	3.21	78.29
Hybrid Arkanciel	2.43	12.15	2.99	2.95	79.48
Corn	1.64	10.10	5.03	2.90	80.33
Barley	2.75	10.67	2.18	5.85	78.55
Triticale	2.26	13.57	1.79	4.57	77.81
Oat	3.24	11.68	4.42	11.94	68.72

Table 4. Chemical composition of sorghum silage and maize silage (%)

Forage type	Dry matter	Ash	CP	EE	CF	NES
Sorghum silage						
Hybrid ES Alize	28.11 ±3.45	2.07 ±0.06	2.55 ±0.05	0.75 ±0.002	8.57 ±0.65	14.17 ±0.09
Hybrid Arkanciel	29.56 ±3.85	2.22 ±0.05	2.46 ±0.04	0.85 ±0.001	8.83 ±0.54	15.20 ±0.11
Maize silage	35.35 ±2.28	1.98 ±0.06	3.62 ±0.06	1.52 ±0.002	7.15 ±0.62	21.08 ±0.08
% of dry matter						
Sorghum silage						
Hybrid ES Alize	100	7.36	9.07	2.67	30.49	50.41
Hybrid Arkanciel	100	7.51	8.32	2.87	29.87	51.43
Maize silage	100	5.60	10.24	4.30	20.23	59.63

It is observed that sorghum silage is characterized by a higher content in ash and crude fiber compared to maize silage (7.36% vs. 5.60% ash of the dry matter, respectively 30.49% compared to 20.23% crude fiber of dry matter), while the content in crude protein was higher (9.07% vs. 10.24% crude protein of dry matter).

Similar results were obtained by Podkowka (2011) who investigated the sweet sorghum (*Sorghum saccharatum*) silage, corn (Zea mays) silage, and sorghum and corn (1: 1) silage and observed that in sorghum silage, the concentration of crude ash and crude fiber was higher, and that of crude protein, crude fat and N-free extractives were lower compared to the maize silage.

Oliveira et al. (2013) analyzed the varieties of sorghum (*Sorghum bicolor* L. *Moench*) with low and high tannin content, that were ensilaged, having a moisture content of 29.32 and 30.73%.

The values for gross energy of analyzed forages are presented in Table 5. The calculated values are within the recommended values from the speciality literature (Jarrige et al., 1988; Stoica, 2001).

Table 5. Gross energy of analyzed forages

Forage type	GE (kcal/kg forage)	GE (kcal/kg DM)	GE (MJ/kg forage)	GE (MJ/kg DM)
Grains				
Sorghum:				
Hybrid ES Alize	3790	4435	15.85	18.55
Hybrid Arkanciel	3740	4434	15.65	18.54
Corn	3930	4539	16.44	18.99
Barley	3740	4361	15.64	18.24
Triticale	3810	4412	15.94	18.45
Oat	3950	4527	16.52	18.94
Silage forages				
Sorghum silage:				
Hybrid ES Alize	1210	4303	5.06	18.00
Hybrid Arkanciel	1270	4296	5.31	17.97
Maize silage	1560	4413	6.52	18.46

CONCLUSIONS

The chemical composition of the two analyzed sorghum hybrids was relatively similar, as there are no significant differences, both in the case of grains and that of ensilaged forage.

The chemical composition of sorghum grains is roughly similar to that of maize, but it is particularly rich in crude protein.

Fat content of sorghum grains is slightly lower than in maize, so its utilization can request a addition of vegetal oils or animal fat in the compound feed recipes.

Sorghum silage presented a higher content in ash and crude fibre, while crude protein, crude fat and N-free extractives were lower compared to maize silage.

The calculated values for gross energy of analyzed forages are within the recommended values from the speciality literature.

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