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THE QUALITY INDICES OF FODDERS FROM *SESAMUM INDICUM* L. GROWNING UNDER THE CONDITIONS OF MOLDOVA

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Abstract

The main objective of this research was to evaluate the quality indices of fodders prepared from the non-native ecotype of sesame Sesamum indicum, grown in monoculture in the experimental plot of NBGI, Chisinau, Republic of Moldova. We found that the dry matter of sesame whole plants harvested in flowering period contained 190 g/kg CP, 114 g/kg ash, 239g/kg CF, 296 g/kg ADF, 479 g/kg NDF, 72 g/kg ADL, 224 g/kg Cel, 183g/kg HC with 10.6 MJ/kg ME, 6.52 MJ/kg NEl. The fermentation characteristics and quality indices of sesame haylage was: pH =4.33, 0.67% acetic acid, 3.45% lactic acid, 0.02% butyric acid, 161g/kg CP, 151g/kg ash, 212 g/kg CF, 285 g/kg ADF, 520 g/kg NDF, 70 g/kg ADL, 210g/kg Cel, 235 g/kg HC with 66.7% DMD, RFV= 120, 9.75-11.73 MJ/kg ME, 6.75 MJ/kg NEl. It has been determined that the sesame plant residue contained 104 g/kg CP, 110g/kg ash, 411g/kg CF, 83 g/kg ADL, 363 g/kg Cel, 175g/kg HC with 8.90 MJ/kg ME, 4.90 MJ/kg NEl. The fodders from Sesamum indicum have optimal nutrient content and energy value of forage, can be used as alternative forages for livestock

***Key words*:** *green mass, haylage, nutrient content, plant residue, Sesamum indicum*

INTRODUCTION

Livestock farming is an indispensable sector for contributing considerably to food security and sustainable development of agriculture of any country. Under the conditions of climate aridization, in order to provide farm animals with feed, it is necessary to diversify the range of fodder crops, by adding plants with high adaptive and productive potential.

Sesame *Sesamum indicum* L. is the earliest known oleaginous plants, belonging to the *Pedaliaceae* family, which originated in Africa, but has been cultivated in many areas of the world. It is an annual herbaceous plant; the stem is erect, quadrangular, stout, branched, bright pale green, covered with short soft hairs, reaching up to 2.0 m in height. The leaves are hairy, ovate, 7.5–12.7 cm long and 1-7 cm broad, and dull green in colour. White to pale pink bell-shaped flowers develop at the leaf axils along the stems. Flowers are mostly self-pollinated. The fruit is a deeply grooved capsule, 2.5-3.5 cm long, parallelepipedic in shape and containing 8 rows of seeds. The seeds are flattened ovoid, 2-3 mm in diameter, 0.5-1 mm thick, are variable in colour, yellow, white, brown or black. Sesame is deep-rooted and will scavenge nutrients from below most crop root zones. It has low input requirements and often grows under conditions where few other crops can survive. Sesame is a short-day plant, crops require 90 to 120 frost free days and warm conditions above 23 °C favor its growth and yield. Sesame is one of the most valuable oilseed plants due to the special quality of the oil in the seeds for human health, high in antioxidants such as sesamolin and sesamin, which keep them from becoming rancid, unsaturated fatty acids constitute 80% of the total fatty acids, oil meal is a protein rich by-product, a valuable protein and energy source for ruminants [10, 15, 21, 22, 25].

Currently, *Sesamum indicum* is studied as fodder plant in several research centers [3, 4, 5, 6, 9, 12, 19, 23, 24, 26].

The main objective of this research was to evaluate the quality indices of green mass, prepared haylage and collected plant residue from sesame, *Sesamum indicum* cultivated under the conditions of the Republic of Moldova.

MATERIALS AND METHODS

The non-native ecotype of sesame, *Sesamum indicum,* which was cultivated in the experimental plot of the National Botanical Garden (Institute) of Moldova, Chișinău, N 46°58′25.7″ latitude and E 28°52′57.8″, served as subject of research and the traditional crop alfalfa, *Medicago sativa,* common oat *Avena sativa* and corn, *Zea mays*, were used as control variants. The experimental design was a randomised complete block design with four replications, and the experimental plots measured 10 m^2. *Sesamum indicum,* was sown in the middle of May, at 45-cm row spacing and a rate of 1 g/m^2, at a depth of 2-3 cm. The sesame green mass was harvested manually at 5 cm cutting height, in the flowering period. The alfalfa green mass samples were collected in the second growing season, the first cut – in the flowering stage, common oat plant samples were collected in the pre-flowering stage, corn plants were collected in the wax stage of grains. The corn silage was prepared from harvested fresh mass. The sesame, alfalfa and common oat haylages were produced from wilted whole plants, cut into small pieces and compressed in glass containers. The containers were stored for 45 days, and then, they were opened and the organoleptic assessment and the determination of the organic acid composition of the persevered forage were done in accordance with the Moldavian standard SM 108*. The sesame and common oat plant residue were collected after harvesting the seeds. The dry matter content was detected by drying samples to constant weight at 105°C. For biochemical analysis, the fresh and ensiled mass were dried in a forced air oven at 60°C, milled in a beater mill equipped with a sieve with mesh diameter of 1 mm and some of the main biochemical parameters, such as crude protein (CP), crude fibre (CF), ash, acid detergent fibre (ADF), neutral detergent fibre (NDF), acid detergent lignin (ADL), were determined by near infrared spectroscopy (NIRS) using PERTEN DA 7200. The concentration of hemicellulose (HC), cellulose (Cel), digestible energy (DE), metabolizable energy (ME), net energy for lactation (NEl), digestible dry matter (DDM) and relative feed value (RFV) were calculated according to standard procedures.

RESULTS AND DISCUSSIONS

As a result of the study on the biological peculiarities of sesame, *Sesamum indicum,* the emergence of the seedlings was observed on the 3rd-4th day after sowing, the development of the stem – in 10-12 days after seedling emergence, the growth rates were faster at the middle of June and during July, the formation of the flower buds occurred in the end July, the flowering period lasted 28-31 days, ripening of the seeds occurred in the middle September.

At the harvested period, the sesame plants reached 152.6 cm, the green mass productivity was 55.9 t/ha green mass or 12.3 t/ha dry matter with 59.7 % leaves and flowers.

The fact that green fodder plays a major role in the supply of natural feed for animals, and the quality of animal products (meat, dairy) is considerably determined by the nutritional value of forage, thus, the evaluation of quality is necessary and mandatory. The biochemical composition, nutritive and energy value of the harvested green mass from sesame, *Sesamum indicum,* is presented in Table 1. We would like to mention that the dry matter of sesame whole plants contained 190 g/kg CP, 114 g/kg ash, 239g/kg CF, 296 g/kg ADF, 479 g/kg NDF, 72 g/kg ADL, 224 g/kg Cel, 183g/kg HC with 10.6 MJ/kg ME, 6.52 MJ/kg NEl. The content of acid detergent lignin in sesame fodder was higher than in fodders from control variants. The sesame green fodder, as compared with the traditional forage crop alfalfa, is characterized by a higher content of crude protein and lower content of minerals,

crude fibre, hemicellulose and cellulose. As compared with common oat green forage, the sesame forage stands out due to its higher concentration of crude protein and minerals, low level of crude fibre, hemicellulose and cellulose, which has a positive effect on relative feed value and energy concentration. The green corn forage is characterized by lower amount of crude protein, acid detergent fibre and minerals, but high amount of hemicellulose and cellulose, higher energy supply than sesame forage.

Little information is available about the chemical composition and nutritional value of *Sesamum indicum* whole plants. Mbaebie al. [18] mentioned *that* chemical composition of *Sesamum indicum* whole plants was 21.44% CP, 8.80% CF, 4.54% EE, 58.86% carbohydrates, 6.68% ash, 0.46% P, 2.41% Ca. Amorim et al. [4] compared the forage quality of green mass and remarked that sesame green forage contained 251.7g/kg DM, 11.77 % CP, 10.54 % EE, 56.24 % NDF, 15.35 % NFC, 36.99 % ADF, 3.14 % ADL, 33.85 % Cel, 19.25 % HC, 56.41 % TDN, 6.08 % ash, but corn green forage – 404.5 g/kg DM, 6.67 % CP, 1.65 % EE, 69.99 % NDF, 15.92 % NFC, 34.17 % ADF, 2.76 % ADL, 31.41 % Cel, 35.82 % HC, 45.90 % TDN, 5.75 % ash.

Table 1. The biochemical composition and the nutritive value of the harvested green mass of the studied species

Indices	*Sesamum indicum*	*Medicago sativa*	*Avena sativa*	*Zea mays*
Crude protein, g/kg DM	*190*	*182*	*95*	*84*
Minerals, g/kg DM	*114*	*138*	*65*	*52*
Crude fibre, g/kg DM	*239*	*352*	*356*	*248*
Acid detergent fibre, g/kg DM	*296*	*361*	*374*	*271*
Neutral detergent fibre, g/kg DM	*479*	*557*	*627*	*474*
Acid detergent lignin, g/kg DM	*72*	*43*	*46*	*48*
Cellulose, g/kg DM	*224*	*318*	*328*	*336*
Hemicellulose, g/kg DM	*183*	*196*	*258*	*223*
Digestible dry matter, g/kg DM	*658*	*608*	*598*	*678*
Relative feed value	*128*	*102*	*89*	*133*
Digestible energy, MJ/ kg	*12.91*	*11.96*	*12.00*	*13.28*
Metabolizable energy, MJ/ kg	*10.60*	*9.82*	*9.85*	*10.90*
Net energy for lactation, MJ/ kg	*6.52*	*5.83*	*5.88*	*6.91*

Source: Own calculation.

Ensiled fodder, haylage, is an important component of livestock diets and can be an excellent source of nutrients particularly in the autumn - middle spring period, but also throughout the year. The haylage prepared from *Sesamum indicum* was distinguished by dark olive leaves and yellow stems with pleasant specific smell, the consistency was retained, in comparison with the initial plant green mass, without mould and mucus. The fermentation profile, the nutrient composition of the haylage prepared from sesame plants is shown in Table 2. The fermentation profile of prepared sesame haylage was pH =4.33, 7.8 g/kg free lactic acid, 2.8 g/kg free acetic acid, 26.7 g/kg fixed lactic acid, 3.9 g/kg fixed acetic acid, 0.2 g/kg fixed butyric acid. It was determined that the pH of the sesame haylage is lower than alfalfa haylage, but higher than in common oat haylage and corn silage. In sesame haylage, the concentration of total organic acids is lower, as compared with alfalfa haylage and corn silage. The acetic acid content in sesame haylage is low in comparison corn silage, but much higher than in common oat haylage. In sesame haylage, butyric acid was detected in fixed form, in very small quantity, at the same level as in corn silage. The concentrations of nutrients in the sesame haylage dry matter were: 161g/kg CP, 151g/kg ash, 212 g/kg CF, 285 g/kg ADF, 520 g/kg NDF, 70 g/kg ADL, 210g/kg Cel, 235 g/kg HC with nutritive and energy values 66.7% DMD, RFV= 120, 9.75-11.73 MJ/kg ME, 6.75 MJ/kg NEl. As compared with the green mass fodder in the *Sesamum indicum* haylage, a reduction in the crude protein content, cell wall fractions (NDF, ADF, ADL) was noticed, and an increase in the content of minerals and hemicellulose. The dry matter digestibility and energy concentration is higher in sesame haylage than in sesame green mass fodder. We would like to mention that sesame haylage is characterized by an optimal

content of crude protein, low content of crude fibre, cellulose and high content of acid detergent lignin and hemicellulose as compared with the control – corn silage. Sesame haylage had high concentration of crude protein, acid detergent lignin and minerals, reduced content of neutral detergent fibre than common oat haylage. It has been found that the concentration of crude protein, cell wall fractions (NDF, ADF, ADL), and minerals in sesame haylage is higher, but the relative feed value, metabolizable energy and net energy for lactation is lower than in corn silage.

Several studies have evaluated the quality indices of ensiled mass from *Sesamum indicum*. Medeiros et al. [19] reported that silage nutrient content from whole sesame (S*esamum indicum* L.) plants harvested in different phenological stages were 172-260.9 g/kg DM, 11.13-13.93 % CP, 2.01-7.62 % EE, 49.76-53.59 % NDF, 23.28-25.13 % NFC, 35.83-40.27% ADF, 12.68-13.41 % HC, 57.53-60.98 % TDN, 5.32-8.54 % ash. Amorim et al. [5] found that sesame silage is characterized by pH=4.07, 326.5g/kg DM, 10.13 % CP, 13.03 % EE, 62.74 % NDF, 9.61 % NFC, 37.44 % ADF, 2.55 % ADL, 34.89 % Cel, 25.30 % HC, 51.44 % TDN, 4.47 % ash and corn silage – pH=4.21, 429.4 g/kg DM, 5.92 % CP, 1.85 % EE, 73.26 % NDF, 13.64 % NFC, 34.95 % ADF, 2.68 % ADL, 32.27 % Cel, 38.31 % HC, 43.41 % TDN, 5.31% ash. Galeana et al. [12] reported that sesame silage is characterized by pH=5.22, 217.5g/kg DM, wilted silage is characterized by pH=4.91, 364.3g/kg, but 50% sesame +50% corn silage pH=3.96, 255.3g/kg.

Table 2. The fermentation profile, the nutrient composition of the ensiled fodder from the studied species

Indices	*Sesamum indicum*	*Medicago sativa*	*Avena sativa*	*Zea mays*
pH index	*4.33*	*4.65*	*4.10*	*3.77*
Content of organic acids, g/kg DM	*41.4*	*56.2*	*44.7*	*48.6*
Free acetic acid, g/kg DM	*2.8*	*2.2*	*2.5*	*5.1*
Free butyric acid, g/kg DM	*0*	*0*	*0*	*0*
Free lactic acid, g/kg DM	*7.8*	*10.3*	*10.7*	*17.0*
Fixed acetic acid, g/kg DM	*3.9*	*4.4*	*3.4*	*5.2*
Fixed butyric acid, g/kg DM	*0.2*	*0*	*0*	*0.2*
Fixed lactic acid, g/kg DM	*26.7*	*39.2*	*38.1*	*21.1*
Total acetic acid, g/kg DM	*6.7*	*6.6*	*5.9*	*10.3*
Total butyric acid, g/kg DM	*0.2*	*0*	*0*	*0.2*
Total lactic acid, g/kg DM	*34.5*	*49.5*	*38.8*	*38.1*
Acetic acid, % of organic acids	*16.18*	*11.75*	*13.20*	*21.19*
Butyric acid, % of organic acids	*0.48*	*0*	*0*	*0.41*
Lactic acid, % of organic acids	*83.34*	*85.25*	*86.80*	*78.40*
Crude protein, g/kg DM	*161*	*169*	*102*	*80*
Crude fibre, g/kg DM	*212*	*297*	*393*	*245*
Minerals, g/kg DM	*151*	*107*	*78*	*59*
Acid detergent fibre, g/kg DM	*285*	*321*	*413*	*258*
Neutral detergent fibre, g/kg DM	*520*	*481*	*699*	*469*
Acid detergent lignin, g/kg DM	*70*	*55*	*40*	*37*
Cellulose, g/kg DM	*215*	*266*	*373*	*221*
Hemicellulose, g/kg DM	*235*	*160*	*281*	*211*
Digestible dry matter, g/kg DM	*667*	*639*	*567*	*688*
Relative feed value	*120*	*122*	*76*	*136*
Digestible energy, MJ/ kg DM	*13.07*	*12.46*	*11.28*	*13.45*
Metabolizable energy, MJ/ kg DM	*10.73*	*10.23*	*9.26*	*11.04*
Net energy for lactation, MJ/ kg	*6.75*	*6.34*	*5.29*	*7.06*

Source: Own calculation.

Crop residues are important feed resources for livestock. The availability of these feeds depends on type of agroecosystem, cropping patterns and intensity, type and concentration of animal species, and prevailing animal production systems. The quality indices of residual *Sesamum indicum* biomass after seed harvesting are presented in Table 3. We would like to mention that sesame plant residues are characterized by high content of crude protein and minerals and lower – of structural carbohydrates, as compared with common oat plant residues, which had a positive effect on

the digestibility, nutritional value and energy supply of the feed.

Several publications have documented the chemical composition and nutritional value of *Sesamum indicum* crop residues. Mesgaran et al. [20] found that sesame stover forage contained 96.4% OM, 6.7% CP, 75.7% NDF, 46.2% ADF, 54.48% OMD and 7.8MJ/kg ME.

Yaşar et al. [27] identified in sesame stalks monosaccharide carbohydrate: 0.60% rhamnose, 18.97% xylose, 1.49 % arabinose, 1.11% arabinose, 45.70% glucose, 1.87% mannose and 23.64% Klason lignin.

Table 3. The biochemical composition and the nutritive value of the crop residues

Indices	*Sesamum indicum*	*Avena sativa*
Crude protein, g/kg DM	104	62
Crude fibre, g/kg DM	411	467
Minerals, g/kg DM	110	82
Acid detergent fibre, g/kg DM	446	499
Neutral detergent fibre, g/kg DM	621	800
Acid detergent lignin, g/kg DM	83	56
Cellulose, g/kg DM	363	443
Hemicellulose, g/kg DM	176	301
Digestible dry matter, g/kg DM	542	500
Relative feed value	81	58
Digestible energy, MJ/ kg	10.84	10.09
Metabolizable energy, MJ/ kg	8.90	8.28
Net energy for lactation, MJ/ kg	4.91	4.30

Source: Own calculation.

Malekkhahi et al. [17] found that sesame residual components including more than 40% leaves, capsules and stems contained 963 g/kg DM, 88.3% OM, 9.4% CP, 36.1% NDF, 29.1% ADF,11.3 MJ/kg ME, but in low leaves sesame plant residues there was 964g/kg DM, 88.4% OM, 5.9% CP, 55.4% NDF, 36.00% ADF, 8.44 MJ/kg ME, respectively. Aregawi et al. [6] reported that sesame stover forage is characterized by 6.61-7.32 % ash, 4.14-4.69 % CP, 64.0-66.0 % ADF, 69.8-71.1 % NDF and 38.5-41.7 % IVOMD. Hamed & Elimam [13] studied the biochemical composition of plant residues of various crops and remarked that sesame straw contained 965.7 g/kg DM, 1.57% EE, 4.52% CP, 40.01% CF, 7.84% ash, 46.05 % NFE, 67.50 % NDF; sorghum stover – 975.3 g/kg DM, 2.7% EE, 5.72% CP, 30.44% CF, 11.13% ash, 51.44% NFE, 73.00% NDF; millet straw – 968.7 g/kg DM, 0.50% EE, 5.21% CP, 39.99% CF, 10.80% ash, 43.50% NFE, 79.00% NDF. Malekkhahi & Mesgaran [16] reported that the nutritive value of sesame stover was 882.5g/kg DM, 3.6% ash, 6.7% CP, 75.75% NDF, 46.20 % ADF, 575.8g/kg IVND. Bonos et al. [8] mentioned that the chemical composition of sesame seed hulls was: 11.6% CP, 94.9% OM, 13.84% EE 17.63% CF, 12.70% ADF, 17.07% NDF, 16.4 MJ/kg ME. Kumar et al. [14] remarked that sesame stover contained 22.80% of cellulose, 37.76% of hemicellulose, and 7.35% of lignin. Desta et al. [11] found that the nutrient content in fresh sesame residue was 34.55 g /kg TN, 9.6 g /kg S, 5.2 g/kg P, 23 mg/kg Zn, 130.23 mg/kg Fe, 17–6.2 mg/kg Cu and 10.67mg/kg B. Abdullahi et al. [1] mentioned that chemical composition of sesame chaff was: 942 g/kg DM, 89% OM, 13.65% CP, 83.62% NDF, 48.00% ADF, 38.32 % HC. Adeola et al. [2] remarked that after harvest of sesame, residues contained 89.8 % OM, 8.20 % EE, 9.30 % CP, 56.41 % NDF, 52.68 % ADF, 17.53 % NFE, 5.10 % ash. Bagudu [7] reported that sesame seed capsule contained 935.7 g/kg DM dry matter, 75.41% carbohydrate, 3.59 % EE, 4.32% CP, 12.01% CF and 4.77% ash.

CONCLUSIONS

The *Sesamum indicum* plants develop well under the climatic conditions of Moldova.

The productivity of studied ecotype of sesame, *Sesamum indicum* achieved 55.9 t/ha green mass or 12.3 t/ha dry matter, 2.34 t/ha crude protein, 196.8 GJ/ha metabolizable energy and 80.2 GJ/ha net energy for lactation.

The prepared haylage from *Sesamum indicum* plants is characterized by high concentration of crude protein (161 g/kg DM) and hemicellulose (235 g/kg DM), low content of crude fibre (212 g/kg DM) and cellulose (215 g/kg DM) as compared with the traditional fodder – corn silage.

As compared with *Medicago sativa* haylage, the haylage from *Sesamum indicum* plants had similar concentration of crude protein, low crude fibre, high level of digestible dry matter and energy supply.

Sesame haylage had high concentration of crude protein, metabolizable energy and net energy for lactation than common oat haylage.

The sesame plant residues after harvesting the seeds are characterized by high content of crude protein and minerals and lower concentration of structural carbohydrates, as compared with common oat plant residues, which had a positive effect on the digestibility, nutritional value and energy supply of the feed.

The green mass, prepared haylage and collected plant residues of studied ecotype of sesame, *Sesamum indicum* have optimal feed value and can be used as alternative forages for livestock, of partial replacement of traditional fodder crops, in the conditions of climatic change and aridification.

Thus, in order to reduce the negative influence of climatic change (insufficient precipitation and uneven distribution during the vegetation period, drought and heat, soil salinization, etc.) on the formation of the fodder base, widening the spectrum of fodder crops used in feeding farm animals to ensure the well-being and manifestation of the productive potential of farm animals, it is necessary to continue and deepen scientific investigations in the field of the average cost of fodder production per hectare, the proportion in which these fodders can be included in rations for different species and categories of farm animals, the level of milk production or average weight gain that can be ensured by rations with the participation of the non-traditional fodder crops *Sesamum indicum*.

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