Black Sea Journal of Agriculture
doi: 10.47115/bsagriculture.1419351

Open Access Journal
e-ISSN: 2618 – 6578

Research Article
Volume 7 - Special Issue: 429-433 / July 2024

EFFECT OF VARIETY ON THE POTENTIAL NUTRITIVE VALUE OF OAT HAYS

Bilal SELÇUK[1]*, Adem KAMALAK[2], Mustafa YILDIRIM[3]

[1]Ondokuz Mayıs University, Ladik Vocational School, Department of Plant and Animal production, 55760, Ladik, Samsun, Türkiye
[2]Kahramanmaraş Sütçü İmam University, Faculty of Agriculture, Department of Animal Science, 46100, Kahramanmaraş, Turkiye
[3]Kahramanmaraş Sütçü İmam University, Faculty of Agriculture, Department of Field Crops, 46100, Kahramanmaraş, Turkiye

Abstract: This study was conducted to determine the differences in the chemical composition, *in vitro* gas production (GP), methane production (CH_4), metabolizable energy (ME), and *in vitro* organic matter digestion (IVOMD) of oat hay varieties commonly used in ruminant feeding (Küçükyayla, Kahraman, Kırklar, ST-4, Yeniceri, Sebat, and Arslanbey). The oat hay varieties in the study were harvested during the flowering period in the 2019-2020 season in Kahramanmaras province. The *in vitro* findings of this study revealed significant differences among oat hay varieties in terms of their chemical composition, *in vitro* gas production, methane production, ME and IVOMD ($P<0.001$). The crude protein (CP) content of oat hays ranged from 7.61% to 9.57%, neutral detergent fiber (NDF) ranged from 64.46% to 72.96%, acid detergent fiber (ADF) ranged from 36.74% to 41.70%, crude ash (CA) ranged from 6.56% to 7.91%, metabolizable energy ranged from 6.96 to 7.98 MJ kg^{-1} DM, IVOMD ranged from 67.30% to 74.90%, and methane production rate ranged from 15.42% to 16.35%. The Yeniceri variety stood out with a NDF content of 64.46%, an ADF content of 36.74%, a ME of 7.98 MJ kg^{-1} DM, and an IVOMD of 74.90%. ST-4 had the highest *in vitro* gas production with 49.46 ml, while Sebat had the highest methane production rate with 15.42%. In conclusion, considering the chemical composition and fermentation parameters, the Yeniceri variety can be considered a potential source of forage, but further *in vivo* studies are needed to assess their effects on feed intake and animal production.

Keywords: Oat hay varieties, in vitro, Methane production, Metabolic energy

***Corresponding author:** Ondokuz Mayıs University, Ladik Vocational School, Department of Plant and Animal production, 55760, Ladik, Samsun, Türkiye
E mail: bllselcuk46@gmail.com (B. SELÇUK)
Bilal SELÇUK https://orcid.org/0000-0001-9136-5707
Adem KAMALAK https://orcid.org/0000-0003-0967-4821
Mustafa YILDIRIM https://orcid.org/0000-0001-9253-5173

Received: January 19, 2024
Accepted: July 10, 2024
Published: August 15, 2024
Cite as: Selçuk B, Kamalak A, Yıldırım M. 2024. Effect of variety on the potential nutritive value of oat hays. BSJ Agri, 7(4): 429-433.

1. Introduction

Oats are preferred as a feed ingredient in animal nutrition due to their high nutritional value, antioxidant content, and facilitative effect on digestion (Peterson et al., 2005; Naneli and Sakin, 2017). Oat grain is known as a functional food due to its distinct chemical composition, nutritional value, and beneficial effects on health compared to other cereals (Biel et al., 2014; Sterna et al., 2016). Consequently, significant efforts have been made in recent years in agronomic research, leading to the emergence of a substantial number of new oat varieties with different agronomic characteristics (Buerstmayr et al., 2007; Redaelli, 2008; Martínez et al., 2010).

The nutrient content of forages included in the rations of ruminant animals and their microbial digestion in the rumen, as well as the extent to which they are converted into metabolic energy, are of vital importance for ruminants (Ørskov and McDonald, 1979). Ruminants, due to their digestive systems, undergo ruminal fermentation of the consumed feed, resulting in the production of methane (CH_4), which is released into the environment. This emission leads to an energy loss of approximately 12-16% from the feed (Johnson and Johnson, 1995; IPCC, 2001). Therefore, low methane-producing feeds should be preferred in ruminant rations (López et al., 2010). Additionally, factors such as the timing of forage harvesting, maturity stage, and processing methods applied to these feeds, such as grinding, drying, wilting, etc., greatly affect their potential nutritional values and fermentation parameters (Doane et al., 1997; Sanderson et al., 1997; Filya et al., 2002).

The aim of the current experiment was to evaluate effect of variety on chemical composition; *in vitro* gas production, methane production, ME and IVOMD.

2. Materials and Methods

The trial was conducted at the experimental field of the Faculty of Agriculture, Kahramanmaras Sutcu Imam University, during the 2019–2020 season. Seven oat genotypes (Kucukyayla, Kahraman, Kırklar, ST-4, Yeniceri, Sebat and Arslanbey) were used in the study. The experiment was set up in a randomized complete

block design with three replications. The plot size was 7 m long and 6 rows wide, with a spacing of 20 m between rows. The seeding rate was maintained at 500 seeds/m^2. Fertilization was applied at a rate of 12 kg/ha of pure nitrogen, half of which was applied as diammonium phosphate (DAP) fertilizer as top dressing, while the other half was applied as urea during the tillering stage. The oat varieties were harvested during the flowering period, and the remaining oat hay was brought to the laboratory for further analysis.

Dry matter, crude ash, crude protein and ether extract of oat hay samples were analyzed using the method of AOAC (1990). NDF and ADF contents of oat hay samples were analyzed with the method suggested by Van Soest (1991). All chemical analyses were carried out in triplicate.

The *in vitro* gas production technique was utilized to determine the gas production and methane production of oat hay. Rumen fluid was obtained from three sheep from a private abattoir in Kahramanmaras province and transferred to the laboratory in a thermos. The rumen fluid was then filtered through four layers of cheesecloth while being agitated with CO_2. Approximately 200 mg of oat hay samples were weighed into 100 ml glass syringes in triplicate. Subsequently, 30 ml of buffered rumen fluid (1:2 V/V) was added to the glass syringes containing oat hay samples and transferred to a water bath set at 39 °C for 24 hours of incubation. To obtain blanks, the same amount of buffered rumen fluid without substrate was added to four glass syringes (Menke et al., 1979). Gas and CH_4 production of the oat hay samples were measured after 24 hours of incubation. After the 24 hour incubation, the total gas production and the percentage of CH_4 in oat hay samples were determined using an infrared methane analyzer (Sensor Europe GmbH, Erkrath, Germany) (Goel et al., 2008).

The methane productions of oat hay samples as ml were calculated as follows in Equations 1-3:

$$CH4\ production\ (ml) = Total\ gas\ production\ (ml) * Percentage\ of\ CH4\ (\%) \quad (1)$$

The ME and IVOMD of oat hay samples were estimated with equations suggested by Menke and Steingass (1988).

$$ME\ \left(\frac{MJ}{kg}DM\right) = 1.06 + (0.1570 * GP) + (0.084 * CP) + (0.220 * EE) - (0.081 * CA) \quad (2)$$

$$IVOMD\ (\%) = 28.49 + (0.7967 * GP) + (0.325 * CP) \quad (3)$$

here, GP= gas production of 200 mg sample at 24 h incubation (ml), CP= crude protein (%), EE= ether extract (%), and CA= crude ash (%).

2.1. Statistical Analyses

One-way analysis of variance (ANOVA) was used to determine the effect of variety on chemical composition, *in vitro* gas production, methane production, ME and OMD of oat hay samples. Differences (P<0.05) among the mean of oat hay varieties were determined with Tukey's multiple range tests (Genç and Soysal, 2018).

3. Results

The effect of variety on the chemical composition of oat hay is presented in Table 1. Variety had a significant impact on the chemical composition of oat hay (P<0.05). The dry matter content of oat hay varieties ranged from 23.25% to 26.26%. The crude ash content of oat varieties ranged from 6.56% to 7.91%. The crude protein content of oat hay varieties ranged from 7.61% to 9.57%, with the highest values found in Kucukyayla, and Arslanbey variety, the lowest in Kırklar. Previous studies have reported crude protein contents of oat hay ranging from 4.2% to 9.2% (Sehu, 1998; Gursoy, 2023). The NDF (neutral detergent fiber) and ADF (acid detergent fiber) contents of oat varieties ranged from 64.46% to 72.96% and 36.74% to 41.70%, respectively.

The effect of variety on gas production, methane production, metabolizable energy (ME) and *in vitro* organic matter digestibility (IVOMD) of oat hay is shown in Table 2. Variety had a significant impact on methane production, ME, and IVOMD of oat hay. Gas production and methane production ranged from 50.17 to 58.73 ml and 7.98 to 9.37 ml, respectively. The percentage of CH_4 in oat hay ranged from 15.42% to 16.35%. ME and IVOMD of oat hay from different varieties ranged from 6.96 to 8.42 MJ (kg/DM) and 67.30% to 74.87%, respectively, with the highest values observed in Yeniceri and the lowest in ST-4.

4. Discussion

Gas production in feeds occurs as a result of the reaction between fermentable carbohydrates and buffer solutions, leading to the production of volatile fatty acids (Wolin, 1960). It has been reported that an increase in ruminal gas production may be associated with an increase in fermentable carbohydrate content (Sampath et al., 1995). The *in vitro* gas production values in the study indicate that the Yeniceri and Kucukyayla varieties fermented well compared to other varieties. In a study conducted by Lopez et al. (2010), feed ingredients were classified based on their anti-methanogenic properties. Feed ingredients with percentages ranging from 11% to 14% were classified as low, 6% to 11% as moderate, and 0% to 6% as high anti-methanogenic character. The findings of the current study revealed that oat hay varieties did not exhibit any anti-methanogenic effect according to the classification by Lopez et al. (2010).

It has been reported that if the crude protein (CP) content of feed ingredients is below 8%, the enzymatic activities of microorganisms in the rumen may be limited, resulting in an inadequate supply of ammonia in the rumen (Norton, 2012; Cappellozza et al., 2013).

Table 1. Effect of variety on gas, methane, metabolic energy and *in vitro* organic matter digestibility of oat hay

Variety	DM (%)	CA (%)	CP (%)	EE (%)	NDF (%)	ADF (%)
Küçükyayla	24.89^{ab}	6.56	9.57^{c}	3.06^{a}	66.76^{ab}	37.33^{ab}
Kahraman	25.87^{ab}	6.56	8.64^{abc}	3.14^{a}	69.37^{bc}	40.20^{bc}
Kırklar	24.97^{ab}	7.33	7.61^{a}	3.53^{ab}	72.96^{c}	41.70^{c}
ST-4	25.08^{ab}	7.91	8.02^{ab}	3.46^{ab}	68.70^{bc}	39.13^{abc}
Yeniçeri	23.25^{a}	6.86	8.82^{bc}	4.90^{bc}	64.46^{a}	36.74^{a}
Sebat	23.76^{ab}	7.72	8.73^{bc}	5.73^{c}	70.41^{cd}	38.06^{ab}
Arslanbey	26.46^{b}	7.56	9.52^{c}	3.08^{a}	66.85^{ab}	37.09^{a}
SEM	0.88	1.34	0.30	0.42	0.98	0.87
Sig.	0.036	0.901	<0.001	<0.001	<0.001	<0.001

ab: Column means with common superscripts do not differ (P<0.05), SEM= standard error mean, DM= dry matter (%), CA= crude ash (%), CP= crude protein (%), EE= ether extract (%), ADF= acid detergent fiber (%), NDF= neutral detergent fiber (%), P<0.05.

Table 2. Effect of variety on gas, methane, metabolisable energy and *in vitro* organic matter digestibility of oat hay

Variety	GP (ml)	CH_4 (ml)	CH_4 (%)	ME (MJ/kg)	IVOMD (%)
Küçükyayla	58.40^{c}	9.09^{bc}	15.55	7.97^{bc}	74.87^{c}
Kahraman	52.93^{ab}	8.65^{abc}	16.35	7.31^{ab}	69.66^{ab}
Kırklar	56.90^{bc}	9.10^{bc}	15.99	7.78^{bc}	72.96^{bc}
ST-4	49.46^{a}	7.99^{a}	16.15	6.96^{a}	67.30^{a}
Yeniçeri	58.73^{c}	9.37^{c}	15.95	8.42^{c}	74.90^{c}
Sebat	53.13^{ab}	8.20^{ab}	15.42	7.98^{c}	70.70^{abc}
Arslanbey	50.17^{a}	7.98^{a}	15.55	7.04^{a}	68.55^{ab}
SEM	0.88	1.34	0.30	0.42	0.98
Sig.	<0.001	0.002	0.304	<0.001	<0.001

ab: column means with common superscripts do not differ (P<0.05), SEM= standard error mean, GP= gas production (ml), CH_4= methane production (ml), CH_4= methane production (%), ME= metabolic energy (MJ/kg DM), IVOMD= *in vitro* organic matter digestibility (%), P<0.05.

With the exception of the Kırklar variety, the CP levels of oat hay varieties in the study can be considered sufficient for the proper functioning of microbial activity in the rumen. The difference in CP contents of oat varieties between the two experiments is possibly associated with differences in climatic conditions, fertilization, and soil type of the growing site (Sehu, 1998; Gursoy, 2023).

In rations, it is desired to have low acid detergent fiber (ADF) levels as it is difficult to digest in the rumen (Van Soest, 2018). An increase in ADF levels in the ration has been reported to result in a feeling of fullness in ruminants, leading to a decrease in feed intake and consequently a decrease in the utilization of energy and protein from the feed (Yavuz, 2005). Therefore, it is recommended to have ADF levels in ruminant rations between 21% and 30% (Balthrop, 2011). The ADF contents of oat hay varieties in the study were found to be higher than the desired optimal level.

The metabolizable energy (ME) values of oat hays obtained in the current experiment are consistent with the values indicated by NRC (2007). Furthermore, an increase in the cell wall content in feeds has been reported to result in a decrease in ME and organic matter digestibility (OMD) values (Sagocak, 2011).

5. Conclusion

Variety had a significant effect on chemical compositions, gas production, CH_4 production, ME and IVOMD of hay. There is considerable amount of variation among oat varieties in terms of chemical compositions, gas production, CH_4 production, ME and IVOMD of oat hay. The oat hays from different varieties had provided new raw materials with a range of nutritional characteristics and will provide not only energy and protein but also fiber for ruminant animals. Based on the chemical composition and fermentation parameters, variety Yeniceri can be recommended for hay production since it has a high CP, ME and IVOMD. However, *in vivo* studies are needed to determine the effects of oat hay varieties on feed intake and growth performance on ruminant animals.

Author Contributions

The percentage of the author(s) contributions is presented below. All authors reviewed and approved the final version of the manuscript.

	B.S.	A.K.	M.Y.
C	35	35	30
D	100		
S		100	
DCP			100
DAI	35	30	35
L	35	35	30
W	35	30	35
CR	35	35	30
SR	35	30	35
PM	35	35	30
FA	35	30	35

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The authors declared that there is no conflict of interest.

Ethical Consideration

Ethics committee approval was not required for this study because of there was no study on animals or humans.

Acknowledgments

This article was presented as an oral presentation at the VII. International Congress on Domestic Animal Breeding, Genetics and Husbandry - 2023 (ICABGEH-23) Krakow, POLAND, September 18 - 20, 2023.

References

AOAC. 1990. Official method of analysis, 15th ed. Association of Official Analytical Chemists, Washington, US, pp: 66-88.

Balthrop J, Brand B, Cowie RA, Danier J, de Boever JL, de Jonge LH, Piotrowski C. 2011. Quality assurance for animal feed analysis laboratories (No. 14). FAO, pp: 152.

Biel W, Jacyno E, Kawecka M. 2014. Chemical composition of hulled, dehulled and naked oat grains. S Afr J Anim Sci, 44(2): 189-197.

Buerstmayr H, Krenn N, Stephan U, Grausgruber H, Zechner E. 2007. Agronomic performance and quality of oat (Avena sativa L.) genotypes of worldwide origin produced under Central European growing conditions. Field Crops Res, 101: 341-351.8.

Cappellozza BI, Bohnert DW, Schauer CS, Falck SJ, Vanzant ES, Harmon DL, Cooke RF. 2013. Daily and alternate day supplementation of urea or soybean meal to ruminants consuming low-quality cool-season forage: II. Effects on ruminal fermentation. Livestock Sci, 155(2-3): 214-222.

Doane PH, Schofield P, Pell AN. 1997. Neutral detergent fiber disappearance and gas and volatile fatty acid production during the in vitro fermentation of six forages. J Anim Sci, 75(12): 3342-3352.

Filya I, Karabulut A, Canbolat O, Degirmencioglu T, Kalkan H. 2002. Bursa bolgesinde yetistirilen yem hammaddelerinin besleme degeri ve hayvansal organizmada optimum degerlendirme kosullarının in vivo ve in vitro yontemlerle saptanması uzerinde arastırmalar. UU Ziraat Fak Bil Aras Inc Ser, 25: 1-16.

Genç S, Soysal Mİ. 2018. Parametric and nonparametric post hoc tests. BSJ Eng Sci, 1(1): 18-27.

Goel G, Makkar HP, Becker K. 2008. Effects of Sesbania sesban and Carduus pycnocephalus leaves and Fenugreek (Trigonella foenum-graecum L.) seeds and their extracts on partitioning of nutrients from roughage-and concentrate-based feeds to methane. Anim Feed Sci Technol, 147(1-3): 72-89.

Gursoy E. 2023. Samanların besin degeri ve sindirilebilirligini artırma yontemleri. Kadirli Uyg Bil Fak Derg, 3(1): 160-169.

IPCC. 2001. Climate Change 2001: The Scientific Basis. Contribution of Working Group Ito the Third Assessment Report of the Intergovernmental Panel on Climate Change.

Johnson KA, Johnson DE. 1995. Methane emissions from cattle. J Anim Sci, 73(8): 2483-2492.

López S, Makkar HP, Soliva CR. 2010. Screening Plants and Plant Products for Methane Inhibitors. In: Vercoe, P., Makkar, H., Schlink, A. (eds) In vitro screening of plant resources for extra-nutritional attributes in ruminants: nuclear and related methodologies. Springer, Dordrecht, the Netherlands, pp: 191-231. https://doi.org/10.1007/978-90-481-3297-3_10

Martínez MF, Arelovich HM, Wehrhahne LN. 2010. Grain yield, nutrient content and lipid profile of oat genotypes grown in a semiarid environment. Field Crops Res, 116(1-2): 92-100.

Menke KH, Raab L, Salewski A, Steingass H, Fritz D, Schneider W. 1979. The estimation of the digestibility and metabolizable energy content of ruminant feedingstuffs from the gas production when they are incubated with rumen liquor in vitro. J Agri Sci (Camb), 93: 217-222.

Menke KH, Steingass H. 1988. Estimation of the energetic feed value obtained from chemical analysis and in vitro gas production using rumen fluid. Anim Res Dev, 28: 7-55.

Naneli I, Sakin MA. 2017. Bazı yulaf çeşitlerinin (Avena Sativa L.) farklı lokasyonlarda verim ve kalite parametrelerinin belirlenmesi. Tarla Bitkileri Merkez Aras Enst Derg, 26: 37-45. https://doi.org/10.21566/tarbitderg.359057.

Norton BW. 2012. The nutritive value of tree legumes. URL: http://www.fao.org/ag/AGP/AGPC/doc/Pubicat/Guttshel/x5556e0j.htm (Accesed date, November 07, 2022).

NRC. 2007. National Research Council: Nutrient requirements of small ruminants.

Ørskov ER, McDonald I. 1979. The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. J Agri Sci, 92(2): 499-503.

Peterson DM, Wesenberg DM, Burrup DE, Erickson CA. 2005. Relationships among agronomic traits and grain composition in oat genotypes grown in different environments. Crop Sci, 45: 1249-1255.

Redaelli R, Lagana P, Rizza F, Nicosia OLD, Cattivelli L. 2008. Genetic progress of oats in Italy. Euphytica, 164: 679-687.

Sagocak AT. 2011. Determination of potential nutritive value of leaves Arbutus adrachne. MSc Thesis, Kahramanmaras Sutcu Imam University, Institute of Science, Kahramanmaraş, Türkiye, pp: 63.

Sampath KT, Wood CD, Prasad CS. 1995. Effect of urea and by products on the in vitro fermentation of untreated and urea treated finger millet (Eleusine coracana) straw. J Sci Food Agri, 67(3): 323-328.

Sanderson R, Lister, SJ, Sargeant, A, Dhanoa MS. 1997. Effect of

particle size on in vitro fermentation of silages differing in dry matter content. In Proceedings of the British Society of Animal Science Vol. 1997, Cambridge University Press, Cambridge, UK, pp: 197-197.

Sehu A, Yalçin S, Önol AG. Koçak D. 1998. Prediction of dry matter intake and live weight gain in lambs by some characteristics of roughages. Turkish J Vet Anim Sci, 22(6): 475-484.

Sterna V, Zute S, Brunava L. 2016. Oat grain composition and its nutrition benefice. Agri Agricultural Sci Proc, 8: 252-256.

Van Soest PJ. 2018. Nutritional ecology of the ruminant. Cornell University Press, New York, US, pp: 488.

Van Soest PV, Robertson JB, Lewis, BA. 1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. J Dairy Sci, 74(10): 3583-3597.

Wolin MJ. 1960. A theoretical rumen fermentation balance. J Dairy Sci, 43(10): 1452-1459.

Yavuz M. 2005. Bazı ruminant yemlerinin nispi yem degeri ve in vitro sindirim degerlerinin belirlenmesi. J Agri Fac Gaziosmanpasa Univ, 22(1): 97-101.