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Effect of variety on nutritive value and anti-methanogenic potential of oat grain

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Summary. The objective of the study was to evaluate effect of variety on chemical composition, *in vitro* gas production, methane production, metabolisable energy (ME), in vitro organic matter digestibility (IVOMD) of oat grain. Variety had on chemical composition, in vitro gas production, methane production, ME, IVOMD of oat grain. Crude ash contents of oat varieties ranged from 2.25 to 3.25% with the highest values in TL 575 and Checorta and the lowest in Kahraman. Crude protein contents of oat varieties ranged from 9.30 to 12.65% with the highest values in TL 293 and the lowest in Arslanbey.

Ether extract contents of oat varieties ranged from 4.46 to 5.05% with the highest values in Arslanbey and the lowest in TL 258. NDF and ADF contents of oat varieties ranged from 33.21 to 45.57% and 14.10 to 17.31% respectively. NDF content of Variety of TL 258 was significantly higher than the others whereas ADF content of variety of Checorta was significantly higher than the others. Starch contents of oat grains ranged from 46.35 to 53.52% with the highest values in TL 80 and Kahraman and the lowest in Faikbey. Gas and methane production ranged from 49.70 to 58.01 ml, 7.72 to 10.18 ml. The gas production from TL 80, Arslanbey and Faikbey were significantly higher than the others whereas methane production from variety of TL 304 was significantly lower than the others. The percentage of CH_4 of oat grain ranged from 15.20 to 17.60%. ME and IVOMD of oat grains from different varieties ranged from 10.46 to 12.03 MJ (kg/DM) and 71.44 to 78.76% respectively with the highest values in TL 80 and the lowest in TL 258. Variety had a significant effect on chemical compositions, gas production, CH_4 production, ME and IVOMD of grain. There is considerable amount of variation among oat varieties in terms of chemical compositions, gas production, CH_4 production, ME and OMD of oat grain. The oat grains 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 TL 80 can be recommended for grain production since it has a high CP, ME and IVOMD.

Key words: chemical composition, digestibility, in vitro organic matter, methane production Oat, variety

INTRODUCTION

Recently oat (*Avena sativa*) has gained growing interest from researchers thanks to agronomic and nutritive values as well as the increase in the popularity of organic agriculture (1). Oat has been used not only for human but also livestock nutrition (2-5). When compared with other cereals, oat grain considerable different in terms of chemical composition and nutritive value (3) and has been known functional food due to beneficial effects on the health (6). Therefore, recently considerable effort has been diverted into agronomic researches, which resulted in considerable amount of new oat varieties with different agronomic characteristics (7-10).

Although the new oat varieties have been investigated in terms of the chemical composition, there is limited information on fermentability, gas production, methane production, ME and IVOMD of the new oat varieties. Recently *in vitro* gas production technique along with chemical composition have been used to evaluate the uninvestigated raw material to determine fermentability, gas production, methane production, ME and IVOMD (11-13). The aim of the current experiment was to evaluate effect of variety on chemical composition; i*n vitro* gas production, methane production, ME and IVOMD.

Materials and Methods

Collection of oat grain samples

Oat grain samples come from agronomic trial carried out in 2017-2018 in Kahramanmaras, Southern Turkey. Oat grain from 17 varieties was sown on in the first 15 day of November, 2017 and harvested at full grain maturity in the first 10 day of June, 2018. Grain samples were collected on randomly located experimental plots (8.3X1.2 m) with three replications. Oat grain samples were ground to pass through 1 mm sieve size and transferred into nylon bags for subsequent chemical analysis and *in vitro* gas production.

Chemical analysis of oat grain samples

Dry matter, crude ash, crude protein and ether extract of oat grain samples were analyzed using the method of AOAC (14). NDF and ADF contents of oat grain samples were analyzed with the method suggested by Van Soest (15). Starch content of oat grain sample was determined by the Ewers polarimetric method of EEC (16). All chemical analyses were carried out in triplicate.

Determination of gas and methane production of oat grain samples

The *in vitro* experimental protocols were approved by the Animal Experimentation Ethics Committee of University of Kahramanmaras Sutcu Imam, Faculty of Agriculture (Protocol No: 2020/06-03). *In vitro* gas production technique (17) was employed to determine the gas production, methane production of oat grain. Three fistulated Awassi sheep were fed with alfalfa hay (800g) and barley (400g) to obtain rumen fluid for *in vitro* fermentation. The rumen fluid obtained from two fistulated Awassi sheep were transferred with thermo flask to laboratory, then filtered with four layered cheesecloth under flushing with CO_2. Approximately 200 mg oat grain samples were weighted into 100 ml of glass syringes in quadruplicate. Then 30 ml of the buffered rumen fluid (1:2 V/V) was added into glass syringes containing oat grain samples and transferred in water bath set at 39 °C for 24 h incubation. The same amount of the buffered rumen fluid was added into four glass syringes without substrate to obtain the blanks. The gas and CH_4 production of GP samples were measured after 24 h incubation. The percentages of CH_4 of total gas production of oat grain samples after 24 h incubation were determined using infrared methane analyzer (Sensor Europe GmbH, Erkrath, Germany) (18).

The methane productions of oat grain samples as ml were calculated as follows:

CH_4 production (ml) = Total gas production (ml) X Percentage of CH_4 (%)

The ME and IVOMD of oat grain samples were estimated with equations suggested by Menke and Steingass (19).

ME (MJ/kg DM) = 1.06 + 0.1570GP + 0.084CP + 0.220EE-0.081CA

IVOMD (%) = 28.49 + 0.7967GP + 0.325CP

GP: Gas production of 200 mg sample at 24 h incubation (ml)

CP: Crude protein (%)

EE: Ether extract (%)

CA: Crude ash (%)

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 grain samples. Differences ($P<0.05$) among the mean of oat grain varieties were determined with Tukey's multiple range tests

Results and Discussion

Effect of variety on the chemical composition of oat grain samples

The effect of variety on the chemical composition of oat grain is presented in Table 1. The variety had a significant effect on the chemical composition of oat grain.

Table 1. Effect of variety on chemical composition of oat grains.

Variety	DM	CA	CP	EE	NDF	ADF	Starch
Sebat	90.13^{efg}	2.83^{d}	10.33^{gh}	4.86^{bc}	39.10^{cdef}	15.37^{cdef}	49.23^{fgh}
Faikbey	89.99^{gh}	2.68^{f}	10.25hi	4.66^{def}	33.21i	15.82^{bcde}	46.35^{h}
Seydişehir	89.98^{gh}	2.84^{cd}	10.78^{ef}	4.62^{ef}	40.20^{bc}	14.10^{f}	48.98^{fg}
TL 80	90.16^{efg}	2.71^{ef}	12.47^{b}	4.74^{cd}	36.29^{fgh}	14.30^{f}	52.98^{ab}
Arslanbey	90.35^{cde}	3.04^{b}	9.30l	5.05^{a}	34.03hi	15.21^{ef}	51.66^{bcd}
TL 304	90.53^{bc}	2.94^{bc}	9.49k	4.71^{de}	36.18^{fgh}	16.75^{ab}	48.49^{g}
TL 575	89.49i	3.25^{a}	11.00^{d}	4.87^{b}	34.84ghi	14.80^{ef}	51.11^{cd}
Kırklar	90.47^{bcd}	2.82^{d}	11.57^{c}	4.57^{fg}	41.06^{bc}	15.28^{def}	48.44^{g}
Checorta	90.34^{cdef}	3.24^{a}	9.84^{j}	4.69^{de}	37.05^{efg}	17.31^{a}	48.51^{g}
TL 254	90.25^{def}	3.05^{b}	10.85^{e}	4.57^{fg}	39.83^{cde}	16.52^{abcd}	51.66^{bcd}
TL 256	89.42i	3.04^{b}	11.46^{c}	4.72^{de}	37.55^{defg}	16.94^{ab}	50.89^{cde}
Yeniçeri	90.12^{fg}	2.61^{f}	10.17i	4.69^{de}	40.05^{bc}	14.66^{ef}	50.37^{def}
Kahraman	89.99^{gh}	2.25^{g}	12.45^{b}	4.51^{g}	42.89^{ab}	15.39^{cdef}	53.52^{ab}
TL 255	89.88^{h}	2.85^{cd}	10.42f	4.67^{def}	41.28^{bc}	15.12^{ef}	50.77^{cdef}
TL 293	90.60^{b}	2.81^{de}	12.65^{a}	4.66^{def}	39.42^{cde}	15.31^{def}	52.57^{abc}
TL 374	91.30^{a}	2.94^{bc}	10.71^{f}	4.76^{bcd}	39.52^{cde}	15.91^{bcde}	50.58^{def}
TL 258	91.13^{a}	3.03^{b}	10.34^{gh}	4.46^{g}	45.57^{a}	16.65^{abc}	47.51^{gh}
SEM	0.062	0.030	0.036	0.031	0.784	0.348	0.494
Sig.	***	***	***	***	***	***	***

$^{a\,b\,c}$ *Column means with common superscripts do not differ ($P>0.05$. **SEM**: standard error mean. DM – Dry matter (%), CA- Crude Ash (% of DM), CP – Crude protein (% of DM), EE – Ether extract ((% of DM), ADF – Acid detergent fiber (% of DM), NDF – Neutral detergent fiber (% of DM), *** $P<0.001$.*

Dry matter contents of oat varieties ranged from 89.42 to 91.30%, which is consistent with findings of Biel et al. (20). Crude ash contents of oat varieties ranged from 2.25 to 3.25% with the highest values in TL 575 and Checorta and the lowest in Kahraman.

Crude protein contents of oat varieties ranged from 9.30 to 12.65% with the highest values in TL 293 and the lowest in Arslanbey. This result obtained in the current experiment is consistent with finding of Biel et al. (20) who found that CP contents of five oat varieties ranged from 9.94 to 10.92%. On the other hand, Naneli and Sakin (21) found that CP contents of 15 oat varieties ranged from 12.28 to 13.03%. In the current experiment only three varieties (Kahraman, TL 293 and TL 80) fell in the range found by Naneli and Sakin (21). The difference in CP contents of oat varieties between two experiments is possibly associated with differences in climatic condition, fertilization and soil type of growing site. Naneli and Sakin (21) indicated that the growing site had a significant effect on the CP content of oat varieties.

Ether extract contents of oat varieties ranged from 4.46 to 5.05% with the highest values in Arslanbey and the lowest in TL 258. This result is in agreement with findings of Biel et al (20) and Sahin et al. (22) found that ether extract ranged from 5.2 to 6.3% and 4.1 to 7.0% respectively.

NDF and ADF contents of oat varieties ranged from 33.21 to 45.57% and 14.10 to 17.31% respectively. NDF content of variety of TL 258 was significantly higher than the others whereas ADF content of variety of Checorta was significantly higher than the others.

NDF and ADF contents of oat varieties obtained in the current experiment were consistent with findings of Sahin et al (22) who found that NDF and ADF contents of 29 oat varieties ranged from 32.4 to 48.3% and 10.2 to 20.3% respectively.

Starch contents of oat grains ranged from 46.35 to 53.52% with the highest values in TL 80 and Kahraman and the lowest in Faikbey. Starch contents of oat varieties obtained in the current experiment were consistent with finding of Sterna et al (6) but higher than that reported by Morgan and Campling (23). The differences between two experiment is possibly associated with differences in growing conditions and variety.

Effect of variety on gas production, methane production, metabolisable energy and in vitro **organic matter digestibility of oat grain**

Effect of variety on gas, methane, ME and IVOMD of oat grain was given in Table 2. Variety significant effect on the gas production, methane production, ME and IVOMD of oat grain

Gas and methane production ranged from 49.70 to 58.01 ml, 7.72 to 10.18 ml respectively. The gas production from TL 80, Arslanbey and Faikbey were significantly higher than the others whereas methane production from variety of TL 304 was significantly lower than the others

The percentage of CH_4 of oat grains ranged from 15.20 to 17.60%. This range is higher than 14% which is threshold for the feedstuffs. Lopez et al (24) suggested that feedstuffs with lower percentage than this threshold might have an anti-methanogenic potential and deserves to be tested in *in-vivo* experiment. However as can be seen Table 2, oat grains from all varieties is not likely to have an anti-methanogenic potential.

The amount of methane (ml) of oat grains obtained in the current experiment was higher than those reported by the Lee et al. (25) who found that the methane production was 6.87 ml/0.2 g DM. The differences between two experiment is possibly associated with differences in variety used the experiment. The methane production is closely associated with

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

Variety	GP (ml)	CH4 (ml)	CH4 (%)	ME	IVOMD
Sebat	51.63^{efgh}	8.99^{bc}	17.42^{a}	10.87^{efg}	72.98^{efgh}
Faikbey	54.81^{bc}	9.31^{abc}	17.00^{ab}	11.33^{bcd}	75.49^{bcd}
Seydişehir	52.95^{cde}	8.84^{bc}	16.70^{ab}	11.06^{cde}	74.18^{cde}
TL 80	58.01^{a}	10.18^{a}	17.55^{a}	12.03^{a}	78.76^{a}
Arslanbey	56.65^{ab}	9.77^{ab}	17.25^{a}	11.60^{b}	76.64^{b}
TL 304	50.74^{efgh}	7.72^{d}	15.20^{b}	10.62^{fgh}	72.00^{fgh}
TL 575	52.08^{defgh}	8.63^{cd}	16.57^{ab}	10.97^{def}	73.56^{defg}
Kırklar	50.45^{fgh}	8.41^{cd}	16.67^{ab}	10.72^{efgh}	72.44^{efgh}
Checorta	50.31^{fgh}	8.47^{cd}	16.85^{ab}	10.55^{gh}	71.77^{gh}
TL 254	52.74^{cdef}	9.19^{abc}	17.42^{a}	11.01^{def}	74.04^{cde}
TL 256	52.39^{cdefg}	9.22^{abc}	17.60^{a}	11.04^{cde}	73.96^{cdef}
Yeniçeri	53.06^{cde}	8.79^{bc}	16.57^{ab}	11.06^{cde}	74.07^{cde}
Kahraman	54.16^{cd}	9.18^{abc}	16.95^{ab}	11.42^{bc}	75.69^{bc}
TL 255	53.05^{cde}	9.08^{bc}	17.12^{a}	11.06^{cde}	74.14^{cde}
TL 293	50.29^{fgh}	8.85^{bc}	17.60^{a}	10.82^{efgh}	72.67^{efgh}
TL 374	50.21^{gh}	8.42^{cd}	16.77^{ab}	10.65^{fgh}	71.97^{gh}
TL 258	49.70^{h}	8.59^{cd}	17.30^{a}	10.46^{h}	71.44^{h}
SEM	0.682	0.292	0.514	0.107	0.544
Sig.	***	***	***	***	***

[a b c] *Column means with common superscripts do not differ (P>0.05.* ***SEM****: standard error mean.* GP: Gas production (ml), CH_4 – Methane emission (ml), CH_4 – Methane emission (%), ME – Metabolisable energy (MJ / kg DM), IVOMD – İn vitro organic matter digestibility (%) *** P<0.001.

variety differences. As can be seen from Table 2 the variety had a significant effect on methane production.

ME and IVOMD of oat grains from different varieties ranged from 10.46 to 12.03 MJ (kg /DM) and 71.44 to 78.76% respectively with the highest values in TL 80 and the lowest in TL 258. ME values of oat grains obtained in the current experiment is consistent with the value indicated by NRC (26).

Conclusion

Variety had a significant effect on chemical compositions, gas production, CH_4 production, ME and IVOMD of grain. There is considerable amount of variation among oat varieties in terms of chemical compositions, gas production, CH_4 production, ME and IVOMD of oat grain. The oat grains 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 TL 80 can be recommended for grain production since it has a high CP, ME and IVOMD. However before large implication the grain yield of oat grain should be tested.

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