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In vitro evaluation of the nutritional value of sunflower disc florets for ruminants

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Abstract

The aim of present study was to estimating nutritional value of fresh or dried sunflower disc florets (SFDF) using in vitro gas production technique. Three fistulated native bulls fed experimental rations twice daily for 15 days, and ruminal fluid was collected for using in *in vitro* fermentation. Gas production of *in vitro* fermentation was measured as the volume of gas in the calibrated syringes and was recorded before incubation 2, 4, 6, 8, 12, 24, 48, 72 and 96 hours after incubation. Total gas values were corrected for blank incubation which contained only rumen fluid. The fresh SDFD has significantly more fermentation potential when compared with dried SDFD. All of gas production fractions (soluble, insoluble, and potential gas production value) are greater for fresh SFDF in comparison with dried SFDF. Also, all of energy indices include organic matter digestibility (OMD), metabolizable energy (ME), short chain fatty acids (SCFA), and net energy for lactation (NE_L) are significantly greater for fresh SFDF. It can be concluded that fresh sunflower disc floret (as a sunflower seed by-product) can be used in ruminant nutrition. However, drying of this feedstuff can decrease its nutritional value.

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Introduction

Sunflower wastes have potential for supplementation in ruminant diet. In this regard, Mafakher *et al.* (2010) had reported that sunflower waste silage can be used as combined feedstuff with corn silage (1:1 ratio) to improve nutritional value of ration. In their investigation, 12.87% rude protein (CP) was reported for sunflower silage. The nutritional value of sunflower silage for ruminant is equals to 80% of corn and 80-90 % of corn silage (McGuffey and Schingoethe, 1980).

Sunflower hulls are somewhat poor quality roughage with high fibre content and a low digestibility (DM digestibility 18). Consequently, limited amounts of sunflower hulls should be introduced in diets (Dinusson *et al.* 1973) and constitute less than 50 % of the total roughage (Sharma et al., 1988). They are well consumed when finely ground and included in pelleted feeds (Dinusson *et al.* 1973).

In growing cattle, Sunflower hulls may be included at up to 20 % dietary level to increase the total fibre content in the diets of dairy heifers or to provide roughage in high-grain rations for growing or finishing beef cattle (Lardy and Anderson, 2009). In dairy heifers, Sunflower hulls included at 10 to 40 % decreased nutrient (DM, CP, ADF) digestibility. At 27 % dietary level, the average daily gain was 1360 g/d and the feed efficiency was higher than for the control diet (+21 %). A higher level of sunflower hulls in the diet (50 %) was detrimental to DM intake and growth (Park et al., 1982). In Growing steers, Unground sunflower hulls introduced at 5 or 10 % as roughage in the diet of fattening steers (374 kg) resulted in lower daily gains and DM intake (1240 *vs* 1500 g/d and 0.766 kg/d *vs* 0.840 kg/d respectively). However, using sunflower hulls could be cost-effective at this inclusion rate (Pritchard and Robbins, 1990). In Sheep, In growing lambs, untreated or alkali-treated (NaOH, KOH or NH_4OH) sunflower hulls included at 25 % level (replacing the same amount of alfalfa hay) had no effect on DM intake (1.1 to 1.5 kg/d), DM digestibility (63-66%) and daily weight loss (-0.11 kg/d) (Sharma *et al.* 1988).

Since, the nutritional value of "sunflower disc florets" for ruminant is unclear. So the aim of present study was to estimating nutritional value of fresh or dried sunflower disc florets using in vitro gas production technique.

Materials and methods

The samples of sunflower disc florets were collected after completely harvesting. Seed-removed disc florets were divided for two treatments include drying and ensiling. All of samples were broken to 3-5 cm segments. The drying treatment was conducted under without sunshine. The nutritional analysis is described below:

Chemical analysis of samples

Dry matter (DM) was determined by drying the samples at 105°C overnight and ash by igniting the samples in a muffle furnace at 550°C for 6 h. Nitrogen (N) content was measured by the Kjeldahl method (AOAC, 1990) . Crude protein was calculated as N X 6.25. Acid detergent fibre (ADF) content and neutral detergent fibre (NDF) content of leaves were determined using the method described by Van Soest et al., (1991). All of chemical analyses were carried out in triplicate.

Statistical analysis

Data on apparent gas production parameters were subjected to one-way analysis of variance using the analysis of variation model ANOVA using SAS (2000). The comparison of means was evaluated by unpaired t-test. All values were shown as standard error of difference between means (SEM).

In vitro gas production

Rumen fluids was obtained from four fistulated cattle (cross bred bulls), fed twice daily with a diet containing alfalfa and concentrate. The samples were incubated in the rumen fluid in calibrated glass syringes following the procedures of Menke and Steingass (1988) as follows. 0.200 g dry weight of the sample was weighed in triplicate into calibrated glass syringes of 100 ml in the absence. The syringes were pre-warmed at 39°C before injecting 30 ml rumen

fluid-buffer mixture into each syringe followed by incubation in a water bath at 39°C. The syringes were gently shaken 30 min after the start of incubation and every hour for the first 10 h of incubation. The gas production was measured as the volume of gas in the calibrated syringes and was recorded before incubation 2, 4, 6, 8, 12, 24, 48, 72 and 96 hours after incubation. Total gas values were corrected for blank incubation which contained only rumen fluid. Cumulative gas production data were fitted to the model of Ørskov and McDonald (1979).

$y = a + b (1-exp-ct)$

Whereas:

a = the gas production from the immediately soluble fraction (ml)

b = the gas production from the insoluble fraction (ml)

c = the gas production rate constant for the insoluble fraction (b)

t = incubation time (h)

y = gas produced at time 't'

The OMD (organic matter digestibility) of forages was calculated using equations of Abash et al. (2005) as follows:

$DOM\ \% = 0.9042 \times GP + 0.0492 \times CP + 0.0387 \times CA + 16.49$

Whereas:

GP is 24 h net gas production (ml / 200 mg),

CP = Crude protein (%)

CA = Ash content (%)

ME (MJ/kg DM) content of forages (disc florets) was calculated using equations of Ismail Abash et al., (2005) as follows:

$ME\ (MJ/kg\ DM) = 0.136 \times GP + 0.0057 \times CP + 0.000286 \times EE^2 + 2.20$

$NEL\ (MJ/kg\ DM) = 0.096 \times GP + 0.0038 \times CP + 0.000173 \times EE2 + 0.54$

Whereas:

GP is 24 h net gas production (ml/200 mg),

CP = Crude protein (%)

EE = Ether Extract (%)

For determination of metabolizable energy (ME), net energy for lactation (NEL) and digestibility of organic matter (DOM) in in vitro conditions, Menke and Steingass (1988) equation was applied for gas production volume from a milligram of sample and turned it for 200 mg sample to 24h.

Results and discussion

The chemical composition of SFDF is presented in Table 1. The gas volume of fresh SFDF is greater in all of incubation hours (table 2). So, the fresh SDFD has significantly more fermentation potential when compared with dried SDFD.

Table 1. Chemical composition of sunflower disc floret (SFDF) (% percent).

Composition (%)	Dry matter (DM)	Crude protein (CP)	Ether extract (EE)	Ash	Acid detergent fibre (ADF)	Neutral detergent fibre (NDF)
SFDF (*fresh*)	41	10.76	2.50	10	0.4	20
SFDF (*dried*)	89	8.35	4.90	11	1.4	23.2

All of gas production fractions (soluble, insoluble, and potential gas production value) are greater for fresh SFDF in comparison with dried SFDF (Table 2). Also, all of energy indices include OMD, ME, SCFA, and NEL are significantly greater for fresh SFDF (Table 2).

In present study, based on tables 1, 2 and 3, the fresh SFDF has significantly better nutritional value for ruminant in comparison with dried SFDF.

Anandan *et al.,* (2002) had investigated on sunflower heads based complete feeds by in vitro analysis. In their study, incorporation of sunflower heads as a sole roughage resulted in higher digestibility values. They had suggests that sunflower heads can be a satisfactorily substitute for conventional roughages in

complete diets for ruminant. A published study on sunflower straw (Anonymous, 2013) shows lower OMD (34.72%) and CP (5.72%), greater NDF (65.19%), when compared with present results (OMD: 59.89-73.42, CP: 8.35-10.76%, NDF: 20-23.2%)(Table1 and 3). These results indicated that SFDF has better feedstuff in comparison with sunflower straw (Anonymous, 2013). In other hand, present results in agreement with Anandan *et al.,* (2002), indicate that sunflower disc florets can be incorporate in formulated diets for ruminant.

Table 2. The gas production for sunflower disc florets (SFDF) (ml/200 mg DM).

Incubation times (h)	**2**	**4**	**6**	**8**	**12**	**24**	**48**	**72**	**96**
SFDF (*fresh*)	12.36a	26.76 a	36.46 a	44.13 a	54.15 a	64.45 a	67.92 a	69.80 a	71.25 a
SFDF (*dried*)	8.30b	19.90 b	25.23 b	30.09 b	35.89 b	50.89 b	55.49 b	57.36 b	55.47 b
P value	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
SEM	0.26	0.13	0.18	0.22	0.21	0.21	0.21	0.24	0.17

SEM: standard error of the mean, Different letters (a or b) in each row shows significant difference between means.

Table 3. The estimated parameters from the gas production and energy indices for sunflower disc florets (SFDF).

Substrate	Estimated Parameters							
	a	b	a + b	C	OMD	ME	SCFA	NEL
SFDF (fresh)	3.90 a	73.24 a	77.20 a	0.132 a	73.42 a	11.72 a	1.43 a	7.05 a
SFDF (dried)	1.10 b	56.23 b	57.40 b	0.08 b	59.89 b	9.59 b	1.12 b	5.50 b
P value	0.001	0.001	0.001	0.001	0.0001	0.0001	0.0001	0.0001
SEM	0.21	0.26	0.34	0.003	0.21	0.03	0.004	0.019

a= the gas production from the immediately soluble fraction (ml)

b=the gas production from the insoluble fraction (ml)

c = the gas production rate constant for the insoluble fraction (t)

a+b: Potential gas production,

ME: Metabolizable energy, (MJ/kg DM),

OMD: Organic matter digestibility (%), SCFA: short chain fatty acids,

NEL: Net Energy Lactation (MJ/kg DM),

SEM: standard error of the mean. Different letters (a or b) in each row shows significant difference between means.

Albeit, SFDF has lower nutritional value than for sunflower silage (Mafakher, 2010), but it can be used after processing and treatments such as silage for better nutritional results. Further studies with silage, heat treatments and etc. are suggested for optimizing nutritional values of SFDF. It can be concluded that, fresh sunflower disc floret as a sunflower seed by-product can be used in ruminant nutrition. However, drying of this feedstuff can decrease its nutritional value.

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