Journal of Novel Applied Sciences
Available online at www.jnasci.org
©2014 JNAS Journal-2014-3-9/978-983
ISSN 2322-5149 ©2014 JNAS

Study of chemical composition and nutritive value of treated sesame straw by using *in vitro* gas production method

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ABSTRACT: This aim of the present study was determine the chemical composition and nutritional value of sesame straw silage in response in urea, molasses and enzyme. The experiment arranged in a factorial design 2×2×2 on based a completely randomized design. After determination of dry matter and chemical composition, gas production test and their parameters investigated in treatments. Results showed that the addition of urea significant increased in pH, DM, CP, OM content and reduction EE, ADF and NDF content respectively. Addition of molasses caused a significant increased in DM content and reduction pH, EE, ADF and NDF content (p< 0/05). Addition of enzyme caused a significant reduction ADF and NDF content (p<0/05).Addition supplements urea, molasses and enzyme caused a significant different in DM and CP content and there was no significant effect on the chemical composition. Results from *in vitro* gas production method revealed that in all incubation times after adding urea amount of gas production decreased but with adding molasses it was increased and with adding enzyme expect in time 2 and 4 gas production value was increased. In conclusion, considering the changes in cell wall contents, hemicelluloses contents and degradability values in the present study, it can be suggested that the use of supplements urea and molasses can be used to make good sesame straw silage.

***Keywords*:** Sesame Straw, Gas production, Degradability.

INTRODUCTION

Sesame is an annual plant, broadleaf that cultivated after wheat in arid and semi-arid regions of Iran for its seed oil and extensively used for medicinal and feed purposes. Sesame Stover is the most abundance residual of sesame cultivation in Iran and traditionally used as a basal feed in ruminants (Danesh Mesgaran *et al*., 2009) Stovers are a major feed resource for ruminants in regions where fresh pasture is limited and seasonal. Because harvesting stover is seasonal, it could be ensiled to provide a continuous supply of feed for ruminants since ensiling preserves nutritive components by decreasing the pH through homofermentation of the major water soluble carbohydrates (WSC) to lactate. Stover fermentation is determined by its chemical composition and ensiling procedures, and ensiling additives such as enzymes or bacterial inoculants can accelerate fermentation (Nadeau *et al.,* 2000) Fibrous crop residues (wheat straw, rice straw, stovers and corncobs) are important feedstuffs for ruminants in south Asian region. However, these feedstuffs are characterized by high content of indigestible fiber due to increased lignification of cellulose. Fermentable energy and protein deficiencies in crop residues coupled with their low digestibility impaired the ruminal functions, intake and ruminant productivity (Sarwar *et al*., 2004) Urea treatment is also shown to increase the palatability, intake and extent and rate of digestion of straw (Tuen et al., 1991). Furthermore it improves the nutritive value of feed by increased bacterial synthesis in rumen and increase in cell wall digestion (Chermiti *et al*., 1994) By treating straw with urea or calcium hydroxide or by supplementing straw with protein, intake, degradability and milk yield can be enhanced, as compared to feeding with untreated straw alone (Wanapat *et al*., 2009). These beneficial effects of urea treatment have been translated into improved animal production, the voluntary feed intake and digestibility coefficients being significantly higher than untreated or urea-supplemented rations when fed to dairy cows (Prasad etal., 1998) Molasses is commonly used to provide readily available energy for lactic acid fermentation (Baytok and Aksu., 2005) Addition of molasses to silages increases the number of aerobic bacteria, including the lactic acid bacterium, therefor, the NDF and ADF degradation of silage increases (Bolsen et al.,1996). Enzymes such as cellulose and xylanase most of all have been considered because cellulose and lignin consist the indigestible part plant cell walls and this enzyme are able broken link lignocellulosic and thus put material more susceptible to microbial digestion rumen (Tang *et al*., 2008) Use of exogenous fibre-degrading enzymes may be a potential means of increasing the nutritive value of rice straw, as enzyme costs are expected to decline in the future with recent developments in fermentation technology and alternative enzyme production systems (Beauchemin *et al*., 2004). In one study, the use of cellulases improved the degradation characteristics of rice straw, and further improved the nutritional value of steam-treated rice straw (Liu and Ørskov, 2000).The objective of this study was to determine the nutritional value of sesame straw treated with urea, molasses and enzyme using in vitro gas production technique**.**

MATERIALS AND METHODS

Straw samples were obtained from neyshabour region of Iran .samples chopped with cutting length about 2 to 4cm. the chopped straw then were mixed with the urea(%5), molasses(%10) and enzyme (2/4 g/kg DM) and ensiled in 5 Kg plastic baskets. The silages were opened after 45 day. At the end of the storage period, samples were exposed to free air, in shadow for 24 h for excess NH^3 to escape but 200 g of each sample was separated immediately for determination of pH. The residual samples were oven-dried at 55 ºC for 72 h. For determination of pH, 100 ml of deionized water was added to 100 g of each fresh sample, mixed and shaken for 2 min, juice obtained by compression and pH measured with a pH meter. Samples of 200 g oven-dried straw from each treatment were ground in a Wiley mill (1 mm screen) and used for subsequent chemical analysis. DM, total N (TN), CP, ash contents of samples were determined by standard methods (AOAC, 1995) Neutral detergent fiber (NDF) and acid detergent fiber (ADF) was analyzed according to (Van Soest *et al*., 1991)

In vitro gas production

Rumen fluid was obtained from two fistulated cattle fed twice daily with a diet containing alfalfa hay (60%) and concentrate (40%). 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. 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 one hour for the first 10 h of incubation. Gas production was measured as the volume of gas in the calibrated syringes and was recorded before incubation and 2, 4, 6, 8, 12, 24, 48, 72 and 96 h 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):

$Y = b\ (1-\ exp^{-ct})$

Where:

b = the potential gas production (ml), c = the gas production rate (ml/h), t = incubation time (h), y = gas production at time (t)

The OMD of silage was calculated using equation of Menke *et al.*

$OMD\ (\%) = 14.88 + 0.889GP + 0.45CP + XA$

Where:

GP = is 24 h net gas production (ml / 200 mg), CP = Crude protein (%), XA = Ash content (%)

ME (MJ/Kg DM) content of silage was calculated using equation of Menke *et al* as follows:

$ME\ (MJ/kg\ DM) = 2.20 + 0.136GP + 0.057CP + 0.0029CP^2$

Where:

GP = is 24 h net gas production (ml / 200 mg), CP = crude protein

Statistical Analyses: All 2×2×2 factorial design data from the experiment were analyzed by using the SAS (1998) GLM procedure according to the model:

$y = \mu + \alpha_i + \beta_j + \gamma_k + \alpha_i.\beta_j + \beta_j.\gamma_k + \alpha_i.\gamma_k + \alpha_i.\beta_j.\gamma_k + \varepsilon_{ijk}$ where Yijk: observation from steer μ: the overall mean; αi: effect urea (i = 1, 2), β_j: effect molasses (j = 1, 2), γ_k: the effect enzyme (k = 1, 2), $\alpha_i.\beta_j$: effect interaction urea and molasses, $\beta_j.\gamma_k$: effect interaction molasses and enzyme, $\alpha_i.\gamma_k$: effect interaction urea and enzyme, $\alpha_i.\beta_j.\gamma_k$: The effect of three additives and ε_{ijk}: residual effect. Results are presented as mean values with the standard error of the means. Differences among means with $P<0.05$ was accepted as representing statistical differences and tendencies of differences, respectively. The comparison among supplementation and trend of ratios responses were performed by orthogonal contrast using the GLM procedure.

RESULTS AND DISCUSSION

Chemical composition

The chemical composition of untreated and treated sesame straws are shown in Table 1. Results showed that the addition of urea significant increased in crud protein content. vadiveloo (2003) showed that the treatment Malaysian rice straw with 4% urea increased CP content from (6%) for the untreated to(9/3%) for treated rice straw. This was agreed with the finding of Danesh Mesgaran (2009) who reported crud protein content increased for urea treated sesame straw. Dry matter content sesame straw significant increased by urea and molasses. High DM content of silage treated with molasses may have resulted from the high DM content of molasses used which is Similar to the results (balakhial *et al*., 2008). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) decreased with each three additive. Researches indicated the addition of molasses to silage increases the number of aerobic bacteria including the lactic acid bacterium therefore, NDF and ADF degradation of silage increases (Bolsen et al., 1995). Enzyme are able broken link lignocellulosic these results were Correspondence with Zobell *et al (*2000).

pH

Generally treated sesame straw with urea increased significantly (p<0.05) pH content This was agreed with the finding of (Morgavi *et al*., 2002) who reported pH content increased for urea treated Forage maize and treated by molasses decreased significantly (p<0.05) pH content This was agreed with the finding of (Thomas, 1978) who reported pH content decreased Because addition molasses to silage due to production of lactic acid and low pH.

Table 1. Means chemical composition sesame straw with urea, molasses and enzyme

Treatment	DM	NDF	ADF	CP	EE	ASH	OM	pH
Control	42/89[d]	59/78	48/89	9/75[d]	3/63[a]	12/23	87/77	4/80
Control+ 10%molasses	47/76[a]	51/75	44/57	9/07[d]	2/42[b]	10/87	89/13	4/89
Control+ 5% urea	44/19[dc]	52/44	42/23	23/63[a]	2/36[b]	9/60	90/40	5/23
Control +enzyme	45/79[bc]	56/66	42/97	8/61[d]	3/43[a]	11/77	88/23	*4/89*
Control +5%urea+10% molasses	45/30[bc]	49/14	35/67	18/85[c]	1/72[d]	10/72	89/28	4/29
Control +enzyme +10% molasses	42/87[d]	48/88	43/60	9/98[d]	2/05[c]	11/69	88/30	4/38
Control +enzyme +5% urea	46/15[ab]	50/77	46/20	21/35[b]	2/28[bc]	10/61	89/38	5/18
Control +enzyme +5%urea +10%molasses	47/94[a]	49/92	40/70	23/52[a]	2/35[b]	10/64	89/35	4/29
U	**	**	**	**	**	**	**	**
M	**	**	**	ns	**	ns	ns	**
A	ns	**	**	ns	Ns	ns	ns	Ns
UM	ns	**	**	**	**	ns	ns	**
UA	**	ns	**	ns	**	ns	ns	Ns
MA	**	ns	Ns	**	**	ns	ns	Ns
UMA	**	ns	Ns	**	**	ns	ns	Ns
SEM	1/023	1/583	1/544	0/822	0/151	0/809	0/809	0/123

Columns having different superscript significantly (P<0.05) differ.DM: dry matter, NDF: natural detergent fiber, ADF: Acid detergent fiber, CP: Crude protein, OM: organic matter, EE: ether extract, U: effect urea, M: effect molasses, A: effect enzyme, UM: effect interaction urea and molasses, UA: effect interaction urea and enzyme, MA: effect interaction enzyme and molasses, UMA: The effect of three additive, SEM: stander error of means

In vitro gas production

Gasproduction volumes (ml/200mg DM) at different incubation times are shown in Table2.Gas production was decreased when sesame straw treated with urea due to The high protein content of the samples (Fernandez, 1998) but with adding molasses it was increased, this finding was similar to that found by Khodaparast *et al* (2011) and with adding enzyme expect in time 2 and 4 gas production value was increased. Researchers reported The Negative relationship showed between Rate and volume of gas produced with ADF and NDF content (hadi *et al.,* 2003). The insoluble but fermentable fraction (b) and gas production rate (c) were significantly (p<0.05) decreased with adding urea due to the high protein content of the samples. adding molasses were significantly (p<0.05) The insoluble but fermentable fraction (b) and gas production rate (c) increased Because of the Increase the rate and extent of fermentation and enzyme lead to insoluble but fermentable fraction (b) increased. Gofoon and khalifa (2007) reported The Negative correlated between Rate and volume of gas production and the insoluble but fermentable fraction (b) with NDF and ADF content

Organic Matter Digestibility and Metabolizable Energy

The Organic matter digestibility and metabolizable energy and in vitro organic matter digestibility in dry matter (IVDOMD) increased significantly (p<0.05) with addition urea. Lower NDF and lignin content in plants increased OMD (Filya, 2004). Increased organic matter digestibility and reduced cell wall lead to with increase metabolizable energy. Metabolizable energy Treated sesame straw with molasses increased significantly (p<0.05) the results were Correspondence Khodaparast *et al* (2011). Metabolizable energy and in vitro organic matter digestibility in dry matter (IVDOMD) increased significantly (p<0.05) with addition enzyme Due to the breakdown of cell walls by Exogenous enzymes .These results were Correspondence with (Xing and Chen. 2009)

CONCLUSION

This result concluded that the addition of three additives improved the quality of sesame straw silage, chemical composition, *in vitro* organic matter digestibility, metabolic energy and fermentation activities. Also suggested that the use of supplements urea and molasses can be used to make good sesame straw silage.

Table 2. means gas production volume (ml/ 200 mg DM) treatment containing sesame straw silage with urea, molasses and enzyme

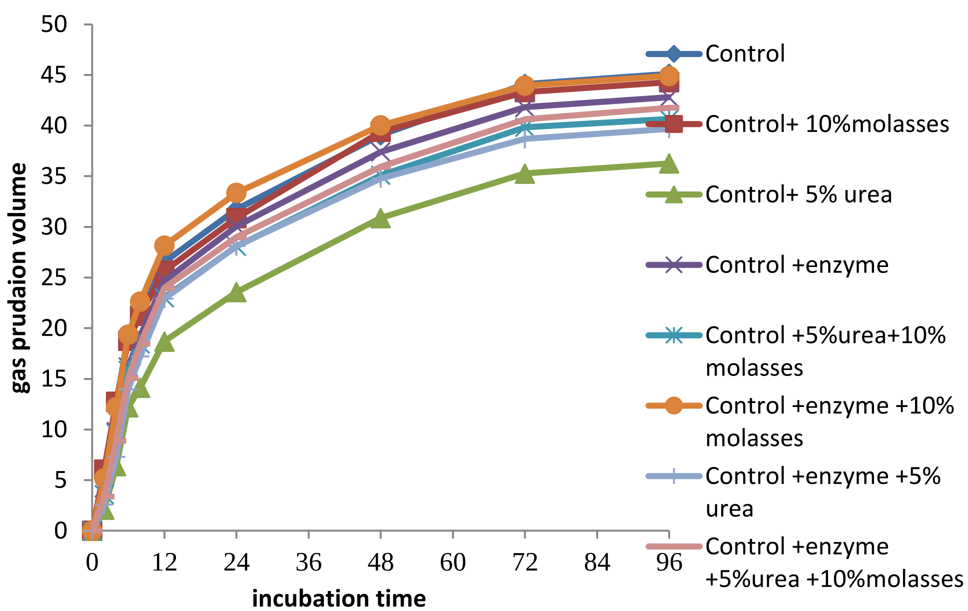
Treatment	2	4	6	8	12	24	48	72	96
Control	5/37^{b}	12/37^{a}	19/37^{a}	21/97^{ab}	26/53^{b}	31/74^{b}	39/07^{a}	44/11^{a}	45/11^{a}
Control+ 10%molasses	6/04^{a}	12/75^{a}	18/79^{b}	21/25^{b}	25/66^{bc}	30/89^{bc}	39/39^{a}	43/31^{a}	44/29^{a}
Control+ 5% urea	2/11^{f}	6/38^{d}	12/19^{e}	14/14^{e}	18/69^{f}	23/57^{f}	30/88^{d}	35/27^{e}	36/27^{e}
Control +enzyme	4/24^{c}	9/80^{b}	16/17^{c}	19/27^{c}	24/67^{dc}	30/06^{dc}	37/41^{b}	41/82^{b}	42/80^{b}
Control +5%urea+10% molasses	3/59^{d}	9/63^{b}	15/84^{c}	18/45^{c}	23/02^{e}	28/08^{e}	35/10^{c}	39/84^{dc}	40/65^{dc}
Control +enzyme +10% molasses	5/20^{b}	12/20^{a}	19/36^{a}	22/62^{a}	28/15^{a}	33/36^{a}	40/03^{a}	43/94^{a}	44/91^{a}
Control +enzyme +5% urea	2/60^{e}	7/31^{d}	13/97^{d}	17/23^{d}	22/91^{e}	28/12^{e}	34/78^{c}	38/68^{d}	39/68^{d}
Control +enzyme +5%urea +10%molasses	3/39^{d}	8/90^{c}	15/70^{c}	18/45^{c}	23/96de	28/98de	35/94^{c}	40/63^{bc}	41/76^{bc}
U	**	**	**	**	**	**	**	**	**
M	**	**	**	*	**	**	**	**	**
A	**	**	ns	ns	**	**	**	Ns	**
UM	ns	**	**	**	**	**	**	**	**
UA	**	**	**	**	**	**	**	**	**
MA	ns	ns	**	ns	ns	ns	ns	Ns	Ns
UMA	**	**	**	**	**	**	**	**	**
SEM	0/245	0/300	0/306	0/550	0/714	0/728	0/680	0/861	0/794

Columns having different superscript significantly (P<0.05) differ. U: effect urea, M: effect molasses, A: effect enzyme, UM: effect interaction urea and molasses, UA: effect interaction urea and enzyme, MA: effect interaction enzyme and molasses, UMA: The effect of three additive, SEM: stander error of means

Table 3. The parameters of the gas production, in viro organic matter digestibility (IVOMD %) and metabolic energy (ME MJ/kg DM)

Treatment	b	c	OMD	DOMD	ME
Control	42/42[a]	0/0817[a]	48/27[dc]	42/36[d]	7/33
Control+ 10%molasses	41/92[ab]	0/0802[a]	47/13[de]	42/00[d]	7/14
Control+ 5% urea	35/09[f]	0/0569[c]	47/05[de]	43/53[d]	8/34
Control +enzyme	40/91[bc]	0/0712[b]	46/24[e]	40/79[e]	6/98
Control +5%urea+10% molasses	38/70[de]	0/0711[b]	49/00[bc]	43/75[c]	8/10
Control +enzyme +10% molasses	42/67[a]	0/0860[a]	49/78[b]	43/95[c]	7/58
Control +enzyme +5% urea	38/27[e]	0/0662[b]	50/14[b]	44/82[b]	8/53
Control +enzyme +5%urea +10%molasses	39/80[dc]	0/0693[b]	51/88[a]	46/26[a]	9/05
U	**	**	**	**	**
M	**	**	**	**	**
A	**	**	Ns	**	**
UM	**	ns	Ns	ns	Ns
UA	**	**	**	**	**
MA	ns	ns	**	**	**
UMA	**	**	**	**	Ns
SEM	0/817	0/0033	0/707	0/476	0/127

Columns having different superscript significantly (P<0.05) differ. U: effect urea, M: effect molasses, A: effect enzyme, UM: effect interaction urea and molasses, UA: effect interaction urea and enzyme, MA: effect interaction enzyme and molasses, UMA: The effect of three additive SEM: stander error of means, a+b: potential gas production(ml), c: gas production rate during incubation(ml/h), IVOMD: in vitro organic Matter Digestibility(%), IVDOMD: in vitro organic Matter Digestibility in dry matter (%), ME: Metabolic energy (MJ/kgDM)



Gas production (ml/200mg DM) treatments studied in incubation different times

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