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Asian Journal of Animal and Veterinary Advances

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Asian Journal of Animal and Veterinary Advances 8 (6): 821-826, 2013
ISSN 1683-9919 / DOI: 10.3923/ajava.2013.821.826

Evaluation of Tomato and Cucumber Wastes as Alternative Feeds for Ruminants Using Gas Production Technique *in vitro*

[1]A.M. El-Waziry, [2]F. AlKoaik, [2,3]A.I. Khalil, [1]H. Metwally and [2]M.A. Al-Mahasneh

[1]Department of Animal Production, College of Food and Agriculture Sciences, King Saud University, P.O. Box 2460, Riyadh, 11451, Saudi Arabia

[2]Department of Agricultural Engineering, College of Food and Agriculture Sciences, King Saud University, P.O. Box 2460, Riyadh, 11451, Saudi Arabia

[3]Department of Environmental Studies, Institute of Graduate Studies and Research, University of Alexandria, Alexandria, Egypt

Corresponding Author: A.M. El-Waziry, Department of Animal Production, College of Food and Agriculture Sciences, King Saud University, P.O. Box 2460, Riyadh, 11451, Saudi Arabia

ABSTRACT

This study was conducted to evaluate of tomato wastes (fresh or silage), cucumber wastes (fresh or silage) as alternative feeds for ruminants using *in vitro* gas production technique. Rumen liquor was obtained from four Naimey sheep fed on barely and alfalfa hay (slaughter house). The mixtures of rumen fluid with buffer 1: 2 v/v, 30 mL were placed into each syringe, containing the samples. The incubation procedure was repeated three times. The gas production was recorded after 3, 6, 9, 12, 24, 48 and 72 h of incubation. Potential degradability (a+b) and gas production rate (c) were measured. Metabolizable Energy (ME), Net Energy (NE), Organic Matter Digestibility (OMD) and Microbial Protein (MP) were also estimated. Tomato silage had the highest crude protein followed by tomato fresh, cucumber fresh and cucumber silage. There were no significant differences ($p>0.05$) among forms of wastes in potential degradability (a+b) except cucumber silage had the lowest a+b. The OMD was highest in tomato fresh and lowest in cucumber silage. There were no significant differences between tomato fresh, tomato silage and cucumber fresh but the lowest value of ME recorded with cucumber silage. There were no significant differences ($p>0.05$) among four forms in NE except in cucumber silage. The present study suggest that tomato waste could be used in the fresh form as alternative feeds for ruminants followed by tomato silage, cucumber fresh and cucumber silage.

Key words: Tomato waste, cucumber waste, silage, gas production, alternative feeds, ruminant

INTRODUCTION

In Saudi Arabia, there is now big challenge concerning animal farmers, because a high price of animal feed and ground water is limited for forage cultivation. On the other hand, the increasing consumer demand for animal products, make us to search for other alternatives of feeds. In the Kingdom of Saudi Arabia there are usually significant amounts of by-products from food industry that have either limited or no value as human feed and it is a feasible solution to minimize the problem of feed shortage and can be used as feedstuffs for ruminant animals.

Agriculture by-products that can be used for animal feed as alternative feeds such as tomatoes and cucumbers produced from the greenhouses after harvested either in its fresh form or in the form of silage.

Peel and seeds mixture of tomato by-products called tomato pulp (Alicata *et al.*, 1988). Tomato by-products have high nutritional value particularly in crude protein (Bartocci *et al.*, 1980; NRC, 1984; Mikail, 1997; Soltan, 2002). FAO (1991) reported that tomato by-products from world production after processing are about 2-4 million ton year^{-1}. Fresh tomato waste contained high moisture content approximately 80-84% (El-Hassan, 1999). In fact, there are many type of vegetables by products such as cucumber, carrot, potato, cabbage and etc. can used as alternative feeds for ruminants. Therefore, the objective of the current study was conducted to evaluate tomato and cucumber wastes (fresh or silage) as alternative feeds for ruminants using gas production technique.

MATERIALS AND METHODS

Silage tomato and cucumber wastes procedure: Tomato and cucumber waste were collected from greenhouses after harvested the main yield of tomato and cucumber. Collected vegetable wastes were cleaned to remove any foreign substances and cut to 5-10 cm pieces and then mixed with 5% palm molasses (v/w). The mixtures of Tomato or cucumbers waste with palm molasses were placed in three liter plastic bucket by hand, firmly compressed, closed and strapped to prevent air ingress. Each group was prepared as three replicates and plastic bucket were left for fermentation at room temperature for 30 days. Samples of vegetable wastes silage were opened after fermentation and used for determining of pH, further analyses.

***In vitro* trial:** *In vitro* gas production technique was conducted according to Menke and Steingass (1988). Rumen liquor was obtained from four sheep fed on barley and alfalfa hay (slaughter house). Buffer solution was prepared according to Onodera and Henderson (1980) and placed in a shaker water bath at 39°C under continuous flushing with CO_2. Approximately 200 mg air dry of fresh or silages of tomato and cucumber waste samples were placed into syringe (100 mL, three syringes per sample). The mixture of rumen fluid with buffer 1: 2 v/v, 30 mL were placed into each syringe, containing the samples according to Blummel and Orskov (1993). The incubation procedure was repeated three times. The gas production was recorded after 3, 6, 9, 12, 24, 48 and 72 h of incubation. Cumulative gas production values was fitted to the potential equation, Gas (Y) = a+b (1-exp^{-ct}), where, a is the gas production from the immediately soluble fraction, b is the gas production from the insoluble fraction, a+b is potential degradability, c is the gas production rate constant for the insoluble fraction (b), t is incubation time, according to the model of Orskov and McDonald (1979).

Energy and microbial protein estimation: The energy values of fresh and silages of tomato and cucumber wastes were calculated from the amount of gas produced at 24 h of incubation with supplementary analysis of crude protein, ash, crud fibre and ether extract (Menke *et al.*, 1979; Menke and Steingass, 1988):

$$\text{ME (MJ kg}^{-1}\text{ DM)} = 2.2+0.136\text{GP}+0.057\text{CP}+0.0029\text{CF}$$

$$\text{OMD (\%)} = 14.88+0.889\text{ GP}+0.45\text{CP}+0.0651\text{XA}$$

where, ME is the metabolizable energy, OMD is organic matter digestibility, GP is 24 h net gas production (mL/200 mg DM), CP is crude protein (%DM), CF is crude fibre (%DM), XA is ash (%DM):

$$NE\ (Mcal/lb) = \frac{(2.2+(0.0272*Gas)+(0.057*CP)+(0.149*EE)}{14.64}$$

where, Gas is 24 h net gas production (mL g^{-1} DM), CP is crude protein (%DM); EE is Ether extract (%DM), then net energy unit converted to be MJ kg^{-1} DM.

Microbial Protein (MP) was calculated as g kg^{-1} OMD according to Czerkawski (1986).

pH measurement: Seventy mililiter of distilled water were added to 35 g of each sample (fresh or silage) in glass conical flask soaked at 4°C. The fresh and silage extracts were filtered through 2 layers of gauze and filter paper. The filtrate was stored at -20°C prior to chemical analysis (Shao *et al.*, 2007) as described by Li *et al.* (2012). pH values were measured using a digital pH-meter.

Chemical analysis: The fresh and silage samples of tomato and cucumber wastes were analyzed for Dry Matter (DM), Crude Protein (CP), Ether Extract (EE) and ash according to AOAC (1995). Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were determined according to Van Soest *et al.* (1991).

Statistical analysis: All data were analyzed using SPSS packet software was used (SPSS, 2002).

RESULTS AND DISCUSSION

The chemical composition, fiber fractions and pH of tomato and cucumber wastes in two forms fresh and silage are shown in Table 1. Tomato silage had the highest crude protein followed by tomato fresh, cucumber fresh and cucumber silage, the values were 16.69, 14.08, 13.57 and 9.83% for tomato silage, tomato fresh, cucumber fresh and cucumber silage, respectively. The increase of crude protein in tomato silage compared to tomato fresh probably due to the decrease in crude fiber, NFE, NDF and ADF (Table 1). The lower NDF and ADF in ensiled tomato waste was probably due to cell wall degradation by cellulolytic clostridia or acid hydrolysis (McDonald *et al.*, 1991; Baytok *et al.*, 2005). The decrease of crude protein in cucumber silage comparing with cucumber fresh may be due to some crude protein in cucumber silage was converted into ammonia during ensiling (Abarghoei *et al.*, 2011). The increase of crude fiber and cell walls of cucumber silage probably due to the increasing of lignin which protected the fiber degradation by cellulolytic

Table 1: Chemical composition (% of DM basis), fiber fractions and pH of tomato and cucumber wastes

	Tomato waste		Cucumber waste	
Item	Fresh	Silage	Fresh	Silage
Ash	24.89	25.65	47.43	50.34
Organic matter	75.11	74.35	52.57	49.66
Crude protein	14.08	16.69	13.57	9.83
Ether extract	1.53	2.16	1.38	1.46
Crude fiber	17.33	16.93	12.45	12.26
NFE	42.17	38.57	25.17	26.11
Fiber fractions				
NDF	34.08	32.26	36.81	41.76
ADF	28.37	27.28	35.28	40.06
pH	5.59±0.01	4.27±0.03	8.56±0.01	7.69±0.12

NDF: Neutral detergent fiber, ADF: Acid detergent fiber, NFE: Nitrogen free extract

Table 2: Cumulative gas produced (mL/200 mg DM) at different incubation times of tomato and cucumber wastes (Mean±SD)

	Incubation times (h)*						
Item	3	6	9	12	24	48	72
Tomato waste							
Fresh	6.17±0.41	11.33±0.82	19.00±1.26	21.17±0.75	24.5±0.84	28.67±0.82	32.67±1.21
Silage	3.50±1.38	7.50±1.64	11.50±2.74	15.17±2.79	21.83±2.86	24.83±2.04	32.00±2.28
Cucumber waste							
Fresh	4.17±0.75	6.33±0.52	11.00±0.89	14.00±1.26	20.17±1.17	27.00±2.76	31.83±1.33
Silage	2.00±0.00	5.33±0.82	9.00±0.00	10.33±1.21	17.17±2.93	25.00±1.67	28.17±2.56

*Rumen liquor was collected from four animals three times

Table 3: Parameters of gas production produced from tomato and cucumber wastes during 72 h iucubation (Mean±SD)

Items	a+b (mL)	c (mL h^{-1})
Tomato waste		
Fresh	31.30±0.94[a]	0.09±0.01[a]
Silage	33.04±4.24[a]	0.05±0.03[ab]
Cucumber waste		
Fresh	32.96±1.91[a]	0.04±0.01[bc]
Silage	29.91±3.70[b]	0.04±0.02[c]

Cumulative gas production data were fitted to the model of Orskov and McDonald (1979), Gas (Y) = a+b (1-exp^{-ct}), where, a: The gas production from the immediately soluble fraction, b: The gas production from the insoluble fraction, a+b: Potential degradability, c: The gas production rate constant for the insoluble fraction (b), t: Incubation time, [a,b,c]: Means within a column bearing different superscripts differ (p<0.05)

clostridia in ensiling (Abarghoei *et al.*, 2011). pH values decreased in silage form in both of tomato and cucumber wastes (Table 1). Ensiling of either tomato or cucumber wastes caused decrease the pH due to the lactic acid and volatile fatty acids produced (McDonald *et al.*, 1991; Abarghoei *et al.*, 2011).

Table 2 shows the cumulative gas produced at different incubation times of tomato and cucumber wastes. The values of gas production extent at 72 h were 32.67, 32.00, 31.83 and 28.17 mL for tomato fresh, tomato silage, cucumber fresh and cucumber silage, respectively. There were no significant differences (p>0.05) among forms of wastes in potential degradability (a+b) except cucumber silage had the lowest a+b (Table 3). The values were 31.30, 33.04, 32.96 and 29.91 mL for tomato fresh, tomato silage, cucumber fresh and cucumber silage, respectively. The gas production rate (c) of wastes in four forms is presented in Table 3. The highest value was recorded with tomato fresh followed by tomato silage, cucumber fresh and cucumber silage and the values were 0.09, 0.05, 0.04 and 0.04 mL h^{-1}, for tomato fresh, tomato silage, cucumber fresh and cucumber silage, respectively. The lowest value of potential degradability (a+b) and gas production rate (c) of cucumber silage might be due to the high content of ash, crude fiber and cell walls and its low content of crude protein. There was no significant difference (p>0.05) between tomato fresh and tomato silage in a+b and c and the tomato of two forms (silage and fresh) better than cucumber (silage and fresh). Gas production technique has been widely used to assess the nutritive value of feedstuff, the types of wastes (vegetables, fruits or crops) and tropical plants (El-Waziry *et al.*, 2005, 2007; El-Waziry, 2007; Razligi *et al.*, 2011; Getachew *et al.*, 1998).

The predicted metabolizable energy (ME, MJ kg^{-1} DM), net energy (NE, MJ kg^{-1} DM), organic matter digestibility (OMD%) from gas production and microbial protein (MP, g kg^{-1} OMD) are presented in Table 4. The OMD was highest in tomato fresh and lowest in cucumber silage. The

Table 4: Predicted of metabolizable energy (ME), net energy (NE), organic matter digestibility (OMD) and microbial protein (MP*) in vitro* from tomato and cucumber wastes during 72 h incubation (Mean±SD)

Items	ME (MJ kg^{-1} DM)	NE (MJ kg^{-1} DM)	OMD (%)	MP g kg^{-1} OMD*
Tomato waste				
Fresh	6.21 ± 0.28^{a}	4.56 ± 0.15^{a}	43.94 ± 2.38^{a}	53.00 ± 2.87^{a}
Silage	5.76 ± 0.61^{a}	4.23 ± 0.23^{a}	39.81 ± 5.11^{bd}	$48.03\pm6.16b^{c}$
Cucumber waste				
Fresh	5.69 ± 0.23^{ab}	4.00 ± 0.17^{a}	40.05 ± 1.87^{ad}	48.31 ± 2.25^{ac}
Silage	2.86 ± 0.35^{b}	2.01 ± 0.40^{b}	34.14 ± 4.32^{c}	41.18 ± 5.21^{d}

$^{a-d}$: Means within a column bearing different superscripts differ ($p<0.05$), *Calculated according to Czerkawski (1986)

values were 43.94, 40.05, 39.81 and 34.14% for tomato fresh, cucumber fresh, tomato silage and cucumber silage, respectively (Table 4) and there was no significant difference between tomato fresh and cucumber fresh. The predicted ME which calculated from gas production at 24 h incubation were 6.21, 5.76, 5.69 and 2.86 MJ kg^{-1} DM for tomato fresh, tomato silage, cucumber fresh and cucumber silage, respectively. There were no significant differences between tomato fresh, tomato silage and cucumber fresh but the lowest value of ME recorded with cucumber silage. The same manner was found in OMD and MP (Table 4). There were no significant differences among four forms in NE except in cucumber silage (Table 4). ME and OMD in tomato fresh is agreement with the results of Rashwan (2010) which used artichoke by-products silage and hay.

CONCLUSION

The results of this study seems that tomato wastes in both forms fresh or silage better than that of cucumber fresh or silage in chemical composition, cumulative gas production *in vitro* , potential degradability, gas production rate, ME, OMD and MP. There was no significant difference between tomato fresh and silage, Therefore the present study suggest that tomato waste could be used in the fresh form as alternative feeds for ruminants followed by tomato silage, cucumber fresh and cucumber silage.

ACKNOWLEDGMENT

The Authors extend their appreciation to the Deanship of Scientific Research at King Saud University for funding the work through the research group project No. RGP-VPP-134.

REFERENCES

AOAC, 1995. Official Methods of Analysis. 16th Edn., Association of Official Analytical Chemists, Washington, DC., USA.

Abarghoei, M., Y. Rouzbehan and D. Alipour, 2011. Nutritive value and silage characteristics of whole and partly stoned olive cakes treated with molasses. J. Agric. Sci. Technol., 13: 709-716.

Alicata, M.L., A. Bonanno, P. Giococone, G. leto and N. Battaglia, 1988. Use of tomato skin and seeds in the feeding of meat rabbits. Rivista Coniglicotura, 25: 23-31.

Bartocci, S., V. Pace and M. Verna, 1980. Chemical composition and nutritive value of a by-product of the tomato concentrate industry. Annali dell'Istituto Sperimentale Zootecnia, 13: 99-107.

Baytok, E., T. Aksu, M.A. Karsli and H. Muruz, 2005. The effects of formic acid, molasses and inoculant as silage additives on corn silage composition and ruminal fermentation characteristics in sheep. Turk. J. Vet. Anim. Sci., 29: 469-474.

Blummel, M. and E.R. Orskov, 1993. Comparison of *in vitro* gas production and nylon bag degradability of roughages in predicting feed intake in cattle. Anim. Feed Sci. Technol., 40: 109-119.

Czerkawski, J.W., 1986. An Introduction to Rumen Studies. Pergamon Press, Oxford, UK., pp: 236.

El-Hassan, M.A., 1999. Effect of some agricultural industrial by-products on the performance of boroiler chicks. Ph.D. Thesis, Faculty of Agriculture, Zagazig University, Egypt

El-Waziry, A.M., 2007. Nutritive value assessment of ensiling or mixing *Acacia* and *Atriplex* using *in vitro* gas production technique. Res. J. Agric. Biol. Sci., 3: 605-614.

El-Waziry, A.M., M.E.A. Nasser and S.M.A. Sallam, 2005. Processing methods of soybean meal. 1-effect of roasting and tannic acid treated soybean meal on gas production and rumen fermentation *in vitro*. J. Applied Sci., 1: 313-320.

El-Waziry, A.M., M.E.A. Nasser, S.M.A. Sallam, A.L. Abdallah and I.C.S. Bueno, 2007. Processing methods of soybean meal, 2. Effect of autoclaving and Qucbraho tannin treated soybean meal on gas production and rumen fermentation *in vitro*. J. Applied Sci., 3: 17-24.

FAO, 1991. Production Year Book. Vol. 44, Food and Agricultural Organization of the United Nations, Rome italy.

Getachew, G., M. Blummel, H.P.S. Makkar and K. Becker, 1998. *in vitro* gas measuring techniques for assessment of nutritional quality of feeds: A review. Anim. Feed Sci. Technol., 72: 261-281.

Li, Y., C. Yu, W. Zhu and T. Shao, 2012. Effect of complex lactic acid bacteria on silage quality and *in vitro* dry matter digestibility of corn straw. J. Anim. Vet. Adv., 11: 1395-1399.

McDonald, P., A.R. Henderson and S.J.E. Heron, 1991. The Biochemistry of Silage. 2nd Edn., Chalcombe Publications, Marlow, Bucks, UK., ISBN: 0-948617-22-5, Pages: 340.

Menke, K.H. and H. Steingass, 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.

Menke, K.H., L. Raab, A. Salewski, H. Steingass, D. Fritz and W. Schneider, 1979. The estimation of the digestibility and metabolizable energy content of ruminant feeding stuffs from the gas production when they are incubated with rumen liquor *in vitro*. J. Agric. Sci., 93: 217-222.

Mikail, R.S., 1997. Food manufacturing by-products and kitchen residuals in rabbit nutrition. M.Sc. Thesis, Cairo University.

NRC, 1984. Nutrient Requirements of Beef Cattle. 6th Edn., National Academy of Sciences, Washington, DC., USA.

Onodera, R. and C. Henderson, 1980. Growth factors of bacterial origin for the culture of the rumen oligotrich protozoon, *Entodinium caudatum*. J. Applied Bacteriol., 48: 125-134.

Orskov, E.R. and I. McDonald, 1979. The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. J. Agric. Sci., 92: 499-503.

Rashwan, K.M.A., 2010. Nutritive value assessment of artichoke by-products hay and silage *in vitro*. M.Sc. Thesis, Alexandria University, Egypt.

Razligi, S.N., R.S. Doust-Nobar, N.M. Sis, A. Fartash, M. Salamatazar and H. Aminipour, 2011. Estimation of net energy and degradability kinetics of treated whole safflower seed by *in vitro* gas production and nylon bag methods. Ann. Biol. Res., 2: 295-300.

SPSS, 2002. SPSS for Windows Advanced Statistics. Release 11.5, SPSS Inc., Chicago, Illinois.

Shao, T., L. Zhang, M. Shimojo and Y. Masuda, 2007. Fermentation quality of Italian ryegrass (*Lolium multiflorum* Lam.) silages treated with encapsulated-glucose, glucose, sorbic acid and pre-fermented juices. Asian-Aust. J. Anim. Sci., 20: 1699-1704.

Soltan, M.A., 2002. Using of tomato and potato by-products as non-conventional ingredients in *Nile tilapia* diets. Ann. Agric. Sci. Moshtohor, 40: 2081-2096.

Van Soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods for dietary fiber, neutral detergent fiber and nonstarch polysaccharides in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597.