Journal of Tropical Resources and Sustainable Science

journal homepage: jtrss.org

Effect of corn grain in a wet soya waste based total mixed ration silage on goat performance

Mohammad Mijanur Rahman[1,*], Mohd Shahmi Hakimi Bin Mazlishah[2], Wan Embong Wan Khadijah[3], Ramli Bin Abdullah[3]

[1]Faculty of Agro Based Industry, Universiti Malaysia Kelantan, Locked Bag No.100, 17600 Jeli, Kelantan, Malaysia.
[2]Glami Lemi Biotechnology Research Center, University of Malaya, 71650 Jelebu, Negeri Sembilan, Malaysia.
[3]Faculty of Bioresources and Food Industry, University Sultan Zainal Abidin, 22200 Besut, Terengganu, Malaysia.

Received 12 September 2018
Accepted 1 November 2018
Online 17 December 2018

Keywords:
Feed intake, goat, growth performance, soya waste, total mixed ration silage

⊠*Corresponding author:
Dr. Mohammad Mijanur Rahman,
Faculty of Agro Based Industry,
Universiti Malaysia Kelantan,
Locked Bag No.100, 17600 Jeli,
Kelantan, Malaysia
Email: mijanur.r@umk.edu.my

Abstract

The utilisation of wet soya waste as feed is low due to difficulties of storage and transportation, which needs to reach normal technical standard and comprehensive utilisation. The aim of this study was to investigate the effect of cracked corn grain as a source of moisture absorbent and energy in a wet soya waste based total mixed ration silage on goat performance. Ten growing goats were assigned to two feeding treatment groups for 84 days. Goats in Group 1 received Napier grass (*Pennisetum purpuerum*) ensiled with 30% soya waste (w/w) and 8% molasses (w/w) (T1) as control, and Group 2 received same grass ensiled with 30% soya waste (w/w) and 15% cracked corn grain (w/w) (T2). All goats received their respective silage *ad libitum* after 2 months of fermentation. The pH in T1 silage was 4.1, while pH in T2 silage was 4.0. Goats fed T2 diet showed higher intakes of dry matter, organic matter and metabolisable energy than those of goats fed T1 diet, while it was observed vice versa for neutral detergent fibre intake. However, there was no difference in average daily gain and feed conversion ratio between two treatment diets. Results of this study indicate that cracked corn grain, as a source of moisture absorbent and energy, can be used successfully in wet soya waste based total mixed ration silage for growing goats.

1. INTRODUCTION

Consumption of soya products has risen because of its beneficial effect in humans. The global production of soya bean (including soya products) has reached 284 million metric tons (Baize, 2013). There is a huge amount of industrially soya by-products are produced from soya bean which needs to be disposed of, including soya waste from the tofu and soya milk processing factories. Soya waste is characterised by high moisture and high crude protein (CP) contents, resulting in spoilage by mould and yeast development under aerobic condition, which creates an environmental nuisance.

Fresh wet soya waste can be used directly as ruminant feed due to high nutritive value. In previous study, feeding fresh soya waste to goat increased feed intake and daily weight gain (Rahman et al., 2015). Although some data are available on the use of wet soya waste in goats (Rahman et al., 2014, 2015), utilisation of this waste as animal feed is still limited due to difficulties of storage and transportation cost, which needs to reach normal technical standard and wide utilisation. Ensiling may be an option to utilise soya waste efficiently for long term and it can be ensiled with other feed ingredients or tropical forages down to 65-70% moisture. Ensiling is an easy method to improve the quality of diet, which results to increase feed intake and enhance dry matter (DM) digestion in the ruminants (Bureenok et al., 2012).

There is an issue about low DM silage using wet soya waste. Duru et al. (2018) observed that DM content of plantago silages significantly increased with 3% of molasses additives. Optimum DM of silage should be at least 30% as suggested by Collins and Owens (2003). Since soya waste and Napier grass contain fairly high moisture (Rahman et al., 2015), added molasses or grain to forage would increase the DM content of the silage (Bureenok et al., 2012) and these additives can help to prevent the cause of seepage and undesirable fermentation. Although molasses has various advantages during silage fermentation, sometimes it is difficult to get optimum DM content in silage due its viscosity and should be diluted with water to apply. On the other hand, adding corn grain to silage is not only increase the DM content of the silage but also increase the energy content of the silage which may offer to the animals as complete feed.

Both corn grain and molasses have low concentrations of CP and minerals, but high concentrations of carbohydrates. Lanzas et al. (2007) suggested that the rate of degradation of sugars and starch in rumen from high moisture corn grain is approximately the same being 0.40 % h^{-1} and 0.35 % h^{-1}, respectively. On the other hand, soya

eISSN Number: 2462-2389© 2018

waste contains a moderate level of metabolisable energy (11.2 MJ/kg), high level of CP (21.9%) and adequate level of minerals (Rahman et al., 2014). Therefore, the mixtures of these ingredients could help to balance the diet for improvement of animal health and productivity.

Use of Napier grass (*Pennisetum purpureum*) for ruminants is gaining popularity in tropical and sub-tropical regions due to its high biomass yield, although this grass is considered low quality roughage (Ishii et al., 2005). The inclusion of wet soya waste to Napier grass may improve the quality of silage, because of its high content of nutritional value. However, there is little information about the feeding effect of wet soya waste ensiled with Napier grass and corn grain on animal performance. Therefore, the aim of this study was to (i) formulate rations using soya waste, Napier grass, corn grain and molasses, and (ii) investigate the feeding effect of wet soya waste based total mixed ration silage on goat performance.

2. MATERIALS AND METHODS

2.1. Location of study and silage materials

An experiment was conducted at a goat farm in Rumpun Asia Sdn. Bhd. (RASB), Selangor, Malaysia. Approval for the use of animal was made by the Institutional Animal Care and Use Committee of University of Malaya (Ref. No. ISB/11/08/2014/MMR-R). Before the start of the experiment, goats were dewormed with an anthelmentic drug. Soya waste was collected from tofu and soya milk processing factory by a local supplier. Napier grass was harvested at 45 days of regrowth defoliation from the experimental field of RASB goat farm. Napier grass was chopped at approximate 2–3 cm in length.

2.2. Silage preparation and feeding trial

Ten weaned male kids (Saanen × local) at 3 to 4 months of age with an average initial live weight (LW) of 14.6 ± 3.4 kg (mean ± standard deviation) were randomly divided into two treatment diets. The diets were: (i) Napier grass ensiled with 30% soya waste and 8% molasses (T1) as control, and (ii) Napier grass ensiled with 30% soya waste and 15% corn grain (T2). The silage materials used in this study contained ingredients and chemical compositions expressed in kilogram per 100 kilograms (fresh material basis) (Table 1). Mixed materials were kept in plastic containers anaerobically and stored in room temperature for 60 days. By calculation, the silage contained approximately 15.6 –17.4% of CP that meets the nutrients requirements for a goat of about 15 kg LW (NRC, 2007). After 60 days of silage fermentation, a feeding trial was conducted for 98 days, including 14 days for adaptation period to the treatment diets followed by 84 days for data collection. The goats were fed individually with free access of water. Each treatment had five goats and each goat was considered as replication.

2.3. Measurements

The pH of ensiled materials was measured using pH meter. Samples of 20 g from silage with six replicates were immersed in 100 ml of distilled water for about 30 minutes. After filtered, the supernatant was used for the determination of the pH. Feed intake was determined by subtracting the weights of refusal feed from the weights of offered feed on daily basis. Live weight of the animals was measured at the start and after a 14–day interval. Samples of the feed ingredients were obtained bi-weekly and then stored in the freezer. After the finish of the feeding trial, all samples were thawed, pooled, dried and stored in the freeze for subsequent chemical analysis. Feed conversion rate was computed as the amount of feed consumed divided by weight gain.

2.4. Chemical analysis

The ME values of the treatment diets were estimated as described by AFRC (1993). Dried samples were ground using grinding machine to pass a 1.0 mm sieve. Samples were used to determine ash and CP according to procedure of AOAC (1990). Organic matter (OM) was calculated by subtracting the ash content from the total dried sample (100%). Neutral detergent fiber (NDF) of samples was measured as reported by Van Soest et al. (1991).

2.5. Statistical analysis

Data were analysed by using Student's t-tests. A p-value of less than 0.05 was considered to be statistically significant.

3. RESULTS AND DISCUSSION

The composition of silages was presented in Table 1. Dry matter (30.8 vs 22.0%) and OM (95.3 vs 88.6%) contents were higher in T2 silage than T1 silage, respectively. However, the CP and NDF contents were higher in T1 silage than T2 silage. The pH in T1 silage was 4.1, while pH in T2 silage was 4.0. Silage treated with corn grain was characterised by higher DM content (29.1-30.8%), while the DM content of silage treated without corn grain was lower (22.0%). Ensiling Napier grass and soya waste with dried corn grain increased its DM content about 37%, when compared with silage treated without corn grain (Table 1). Suitable DM content (30.8%) for T2 silage diet was achieved by addition of 15% corn grain, because adding grain to forage increases the DM content of the silage as well as make it a complete feed for animals (Yitbarek and Tamir, 2014). In general, adding grain does not improve fermentation because starch (the main carbohydrate in grain) is not readily fermented in the silo. In another experiment, Yokota et al. (1998) reported that addition of 15% rice bran to Napier grass silage increased DM of silage and decreased the volume of spoilage. Molasses has been proven to be an effective silage additive and it can be added up to 10% w/w to provide fast

eISSN Number: 2462-2389

fermentable carbohydrate for the ensilage of tropical herbages (Yitbarek and Tamir, 2014). For this reason, 8% molasses was added to the forage at ensiling for T1 silage diet and this diet was considered as a complete feed for animals though energy level was slightly lower.

Differences in nutrient content among treatment diets that had been arisen from uncontrolled factors could be introduced by different amount of molasses (8%) or corn grain (15%) effects during ensiling (Table 1). Addition of 8% molasses (fresh matter) in this experiment resulted in good quality silage with pH 4.1, may be due to the supplement of higher soluble carbohydrates with molasses (Davies et al., 1997). The pH of T2 silage was low enough (4.0) even though molasses was not added. This result might be attributed due to high moisture corn grain with wet soya waste. Some researchers reported that rumen degradation of starch from high moisture corn grain is 86.8% (Firkins et al., 2008) and 76.3% (Owens and Soderlund, 2006).

Table 1: Proportion of used feed ingredients and their chemical composition

Ingredient	Diet	
	T1	T2
Ingredient composition (kg/100 kg of diet, fresh basis)		
Molasses	8	0
Soya waste	30	30
Corn	0	15
Napier grass	62	55
Chemical composition (%, dry matter)		
Dry matter	22.0	30.8
Organic matter	88.6	95.3
Crude protein	17.4	15.6
Neutral detergent fibre	58.6	38.4
ME^{δ} (MJ/kg dry matter)	9.1	10.4
pH	4.1	4.0

T1: Napier grass ensiled with 8% molasses and 30% soya waste; T2: Napier grass ensiled with 30% soya waste and 15% corn. ME^{δ}: metabolizable energy (estimated value); MJ: mega joule.

Nutrient intakes and weight gain in goats fed treatment diets are presented in Table 2. The goats fed T2 silage had higher intakes of DM and OM ($P<0.05$) than those of goats fed T1 silage. This finding might be contributed due to the higher contents of DM and OM in the T2 silage that can improve DM intake in ruminants as suggested by Mustafa et al. (2008). Goats fed both treatment diets represented in similar CP intake. However, goats fed T1 silage showed higher NDF intake than T2 silage. Although dietary NDF content has been related negatively to feed intake (Mertens, 2009), it seems unlikely that it contributed to differences in DM intake that occurred between treatment diets. In this experiment, the DM intake ranged from 3.4–3.9% of LW which was almost similar to be 3.1–3.7% of LW as reported by Ashok and Wadhwani (1992). Nutrient intake is one of the important factors that significantly improve the animal performance (Kawas et al., 1999).

Table 2: Intakes of dry matter, nutrients and metabolisable energy for weaned goats fed silage based diets.

Traits	Diet (mean ± SD)	
	T1	T2
Daily intake, g		
Total dry matter	638±60.3[b]	733±33.6[a]
Total organic matter	565±53.4[b]	699±32.0[a]
Total crude protein	111±10.5	114±5.2
Total neutral detergent fibre	374±35.4[a]	282±12.9[b]
Total ME^{δ} intake (MJ/d)	5.8±0.5[b]	7.6±0.4[a]

SD: standard deviation; T1: Napier grass ensiled with 8% molasses and 30% soya waste; T2: Napier grass ensiled with 30% soya waste and 15% corn; ME^{δ}: metabolisable energy (estimated value); MJ: mega joule; [a,b]Means in the same row with different superscripts differed significantly ($P<0.05$).

Table 3: Average daily gain and feed conversion ratio (FCR) for weaned goats fed silage based diets.

Traits	Diet (Mean ± SD)	
	T1	T2
Live weight, kg		
Initial	14.4±3.9	14.8±3.2
Final	23.4±5.2	23.1±3.6
Daily gain, g	107.1±20.1	98.8±8.5
FCR	6.4±1.6	7.6±0.7

SD: standard deviation; T1: Napier grass ensiled with 8% molasses and 30% soya waste; T2: Napier grass ensiled with 30% soya waste and 15% corn.

There were no significant differences in initial and final LWs of goats between treatment diets (Table 3). Similarly, daily LW gain and feed conversion ratio have not differed between treatment diets. This could possibly explain the better quality of silage, which was resulted from the inclusion of either molasses or corn grain in this study. Inclusion of molasses or corn grain helped to reduce the fibre content of the silage and increased energy content, which might be contributed to partial hydrolysis of hemicellulose in the silage (Kung and Muck, 1997). This result justified the addition of high level of molasses and corn grain in Napier grass ensiled with soya waste to improve the animal performance.

The ME intake should be about 7.0 MJ/d to fulfil the requirement of a 15.0 kg LW of goat with grow rate of 100 g/d (National Research Council, 1981). In this experiment, only those goats received T2 diet showed a sufficient in ME intake to achieve their potential growth. Although goats fed T1 diet showed a deficit in ME intake (5.8 MJ/day), the average daily gain of goats fed T1 diet was similar with those goats fed T2 diet, implying that molasses may play a role to enrich the silage quality of T1 diet during fermentation. Thus, further studies are required

eISSN Number: 2462-2389

on measurements of volatile fatty acids, ammonia-N, non-fiber carbohydrate, lignin and fat contents of silages to better characterise the silage and to better justify the results achieved. Rahman et al. (2015) reported that average daily gain of post-weaning goats was 73 g those fed Napier grass supplemented with soya waste (2.0% of LW/d).

The amount of soya waste used in this experiment was constant in both treatments, whereas the other feeds were used in different proportions. Although it is hard to sort out the causes of the results, the present results suggest that unpalatable by-products i.e. soya waste, might be added into silage since their odours and flavours were changed through fermentation (Xu et al., 2007). In this regard, ensiled soya waste could be utilised as an inexpensive feed ingredient, while decreasing the environmental impact of waste disposal in the soya bean processing factory. Livestock farmers may use the large quantities of soya waste from the manufacturers when it is cheap and available. Thus, it will create a mutually beneficial relationship between farmers, and tofu manufacturer and soya milk producers.

4. CONCLUSION

In this study, the CP content of soya waste was high enough to be a valuable protein supplement to Napier grass silage. Addition (w/w) of high level of molasses (8%) or corn grain (15%) with wet soya waste (30%) is a promising method of preserving Napier grass to enhance the performance of post-weaning goats. Thus, there is a possibility that a mutually beneficial relationship could be formed between farmers, and tofu manufacturer and soya milk producers.

ACKNOWLEDGEMENT

This study was supported by IPPP Research Grant (BK006-2015) of University of Malaya.

REFERENCES

AFRC (1993). Energy and Protein Requirements of Ruminants. Agricultural and Food Research Council. Wallingford, UK: CAB International.

AOAC (1990). *Official Methods of Analysis* (15th ed.). Virginia, USA: Association of Official Analytical Chemists, Inc.

Ashok, M.P., Wadhwani, K.N. (1992). Feed-lot performance of Marwari kids on rations with varying proportion of concentrate and roughages. Recent Advances in Goat Production. In: Proceedings of the International Conference on Goats (pp. 835-838). New Delhi, India.

Baize, J. (2013). Global market outlook for soybeans, soymeal and corn. Retrieved from https://ussec.org/wp-content/uploads/2015/10/2013-01-30-USSEC-IPE-luncheon-Market-Outlook-John-Baize.pdf

Bureenok, S., Yuangklang, C., Yasupen, K., Schonewille, J.T., Kawamoto, Y. (2012). The effects of additives in Napier grass silages on chemical composition, feed intake, nutrient digestibility and rumen fermentation. Asian-Australasian Journal of Animal Sciences, 25, 1248–1254.

Collins, M., Owens, V.N. (2003). Preservation of forage as hay and silage. In: Barnes RF, et al., editors. Forages: An Introduction to Grassland Agriculture. 6th Ed. Vol. 1. Iowa State Press; Ames, IA, USA: pp. 443–471.

Davies, D.R., Merry, R.J., Williams, A.P., Bakewell, E.L., Lemans, D.K., Tweed, J.K.S. (1997). Proteolysis during ensilage of forages varying in soluble sugar content. Journal of Dairy Science, 81, 444–453.

Duru, A.A., Sarihan, E.O., Bulduk, I. (2018). Determination of ensiling possibilities of Plantago lanceolata L. International Journal of Agriculture, Forestry and Life Science, 2, 36–43.

Firkins, J.L., Oldick, B.S., Pantoja, J., Reveneau, C., Gilligan, L.E., Carver, L. (2008). Efficacy of liquid feeds varying in concentration and composition of fat, nonprotein nitrogen, and nonfiber carbohydrates for lactating cows. Journal of Dairy Science, 91, 1969–984.

Ishii, Y., Mukhtar, M., Idota, S., Fukuyama, K. (2005). Rotational grazing system for beef cows on dwarf napiergrass pasture oversown with Italian ryegrass for 2 years after establishment. Grassland Science, 51, 223–234.

Kawas, J.R., Schacht, W.H., Shelton, J.M., Olivares, E., Lu, C.D. (1999). Effects of grain supplementation on the intake and digestibility of range diets consumed by goats. Small Ruminant Research, 34, 49–56.

Kung, Jr. L., Muck, R.E. (1997). Effects of Silage Additives on Ensiling. In: Proceedings from the Silage: Field to Feedbunk North American Conference (pp. 187-199). Hershey, NRAES-99.

Lanzas, C., Sniffen, C.J., Seo, S., Todeschi, L.O., Fox, D.G. (2007). A revesed CNCPS feed carbohydrate fractionation sheme for formulating rations for ruminants. Animal Feed Science and Technology, 136, 167–190.

Mertens, D.R. (2009). Impact of NDF content and digestibility on dairy cow performance. Advances in Dairy Technology, 21, 191–201.

Mustafa, M.I., Chadwick, J.P., Akhtar, P., Ali, S., Lateef, M., Sultan, J.I. (2008). The effect of concentrate and silage based finishing diets on the growth performance and carcass characteristics of Suffolk cross and Scottish Blackface lambs. Turkish Journal of Veterinary and Animal Sciences, 32, 191–197.

National Research Council (1981). Nutrient Requirements of Goats: Angora, Dairy, and Meat Goats in Temperate and Tropical Countries. Washington DC, USA: The National Academies Press.

NRC (2007). Nutrient requirements of small ruminants. National Research Council, National Academy of Sciences, Washington, DC

Owens, F., Soderlund, S. (2006). Ruminal and postruminal Starch digestion by cattle. In: Proc. of Cattle Grain Processing Symposium, Stillwater, OK. Oklahoma State University, Stillwater, pp. 116–128.

Rahman, M.M., Rahman, M.R., Nakagawa, T., Abdullah, R.B., Wan Khadijah, W.E., Akashi, R. (2015). Effects of wet soya waste supplementation on intake, growth and reproduction of goats fed Napier grass. Animal Feed Science and Technology, 199, 104–112.

Rahman, M.M., Abdullah, R.B., Wan Khadijah, W.E., Nakagawa, T., Akashi, R. (2014). Feed intake and growth performance of goats supplemented with soy waste. *Pesquisa Agropecuária Brasileira*, 49, 554–558.

Van Soest, P.J., Robertson, J.B., Lewis, B.A. (1991). Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. Journal of Dairy Science, 74, 3583–3597.

Xu, C., Cai, Y., Moriya, N., Ogawa, M. (2007). Nutritive value for ruminants of green tea grounds as a replacement of brewers' grain in totally mixed ration silage. Animal Feed Science and Technology, 138, 228–238.

Yitbarek, M.B., B. Tamir. (2014). Silage additives: Review. Open Journal of Applied Sciences, 4, 258–274.

Yokota, H., Y. Fujii, M. Ohshima. (1998). Nutritional quality of Napier grass (Pennisetum purpueum Schum.) silage supplemented with molasses and rice bran by goats. Asian-Australasian Journal of Animal Sciences, 11, 697–701.

eISSN Number: 2462-2389