Jurnal Peternakan Sriwijaya **Vol. 6, No. 1, Juni 2017, pp.44-51**
ISSN 2303 – 1093

Effect of Maize Stover in Fermented Total Mixed Ration on Nutritive Value and Digestibility Quality *in Vitro*

R. Buddanoi[1], A. Abrar[2,*] & C. Wachirapakorn[1]

[1]Department of Animal Science, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand
[2]Department of Animal Science, Faculty of Agriculture, Sriwijaya University Palembang-Prabumulih Street Km.32 Indralaya-Ogan Ilir 30662 South Sumatera, Indonesia
*Corresponding Author: arfan_abrar@unsri.ac.id

ABSTRACT

The objective of this experiment was to investigate the effect of maize stover used as roughage source in fermented total mixed ration on nutritive value and digestibility quality by *in vitro* technique. The experimental compared between the feeds non-fermented total mixed ratio (TMR) group and fermented total mixed ratio (FTMR) group by fermentation 21 days, each group were ratio 60:40 and five replications. The results revealed that CF content of FTMR increased from 33.79% to 40.70% significantly different ($P<0.05$) and DM, CP, EE and ash were not significantly different between treatments ($P>0.05$). The digestibility quality were dry matter digestibility (%DMD) in FTMR higher than control group significantly different ($P<0.05$). Moreover total volatile fatty acids (VFAs) in FTMR increased from 15.00 to 39.50 mM higher than control group not significantly different ($P>0.05$) and N-NH3 concentrations were not significantly different ($P>0.05$). The gas production was recorded at 0, 6, 12, 18, and 24h of incubation. The cumulative gas production curve both of treatments was remarkable boost from 0h to 6h incubation of FTMR from 57.5 to 37 ml and then incubation time the cumulative gas production both of them were slowly decrease.

Key words: Digestibility quality, fermented Total Mixed Ration, maize stover, nutritive value, *in vitro*

INTRODUCTION

Maize stover is one of the most abundant crop straw resources in the world, and is usually utilized as an important forage source for ruminants (Tang *et al*., 2011). Further, these the major crop residue in locally of South Sumatra Indonesia because main agricultural products of Indonesia mostly are rice palm oil and cassava. Maize stovers as crop residue left in field after the grain harvest. There are many in locally and the trend of quantities may increase in the future (Office of Agricultural Economics. 2014). Previously, utilization of maize stover used as roughage source only in ruminant feeding for reduce the cost of production animals and enables efficient utilization of crop residue potentially useful feed resource (Walli *et al.*, 2012). However, characterised of maize stover by high fiber content low digestibility and this limits their nutritive value for ruminants (Fon *et al.*, 2012). Maize stover should be adjust of the quality by processing to increase nutritive value for animal requirement such as maize stover with urea an important feed for animals especially in the dry season . It was increase digestibility (Smith *et al*., 2002; Syomiti *et al*., 2011) and improved the chemical composition

of diet (Egbu, 2014). By using maize stover use as roughage source in TMR (Total Mixed Ration) could be increase nutritive value and and digestibility but them can not to store available for a long time (Bureenok *et al*., 2009; Rajamma, 2014). There are no information about research in chemical composition and digestibility of maize stover roughage source in FTMR (fermented total mixed ration). Therefore, in this study the effects of utilization maize stover roughage source in fermented total mixed ration on nutritive value and digestibility quality *in vitro*.

MATERIALS AND METHODS

Experimental Design and Treatment

The experimental design was a t-Test and the feeds has maize stover used as a roughage source and concentrate ratio (60:40). The feeds there are control group: non-fermented total mixed ratio (TMR) and 1 treatment group: fermented total mixed ratio (FTMR) by fermentation 21 days, each group has five replications, Concentrates were formulated to contain cassava by product, palm oil kernel cake, peel coffee, coconut kernel cake, premix mineral and molasses. Maize stover was collected from field after harvested of cereal grain at Indralaya, South Sumatra Province, Indonesia. Samples of maize stover chopped size 1 inch, Fermentation in plastic bag then vacuum and wrapped with tape. Samples has the evaluate of TMR and FTMR group, The fermentation period 21 days before used for chemical analysis and digestibility quality in vitro technique. The samples both of them sundried for 2 days and to grind through a fine grinder. The samples both of TMR and FTMR group were chemical analysis for dry matter (DM), crude protein (CP), crude fiber (CF), ether extract (EE) and Ash using the procedures of AOAC (1998). The chemical compositions of concentrate in experiment are shown in Table 1.

Table 1. Chemical composition of concentrate used in the experiment.

Chemical composition	%
Ash	6
OM	94
DM	88
CP	16
CF	11
EE	0
Ca	0.46
P	0.21

In vitro Fermentation

Samples of 1.0 g of TMR and FTMR group were prepared bottles for each group, five replications. Ruminal fluid collected from animal was mixed with McDougall's buffer mixture by following the procedure of Tilley and Terry (1963) in a proportion 1:2 (200:400 mL) at temperature 39°C under continuous flushing with CO_2 and 25 mL of mixture solution were added 25ml into each bottle under CO_2 flushing, bottles were sealed with rubber stoppers and aluminum caps (under anaerobic conditions) and incubated at 39°C (24 hours) in water bath. During the incubation the bottles were gently mixed and each the bottles every 6 hours for gas production test and digestibility quality for dry matter digestibility (DMD), N-ammonia (N-NH_3) and total volatile fatty acids (VFAs). After 24

hours of fermentation the samples for centrifuged at 16,000 x g for 15 minutes and precipitate samples pour in the crucibles to dry at temperature 105°C for 2 nights and then weigh the samples and then can be calculated dry matter digestibility (DMD) and the supernatant was stored at -20°C before NH_3-N analysis and volatile fatty acids (VFAs) analysis.

Statistical Analysis

The experimental the effect of maize stover in fermented total mixed ration on nutritive value and digestibility quality *in vitro*. All data from the experiment were analysis design was a t-Test to using type Two-Sample Assuming Equal Variance (two-tail) by SPSS programmed software.

RESULTS AND DISCUSSION

Chemical composition of diets

The chemical composition of maize stover in TMR and FTMR are shown in Table 2. The FTMR diet contained 99.75% DM, 0.88% CP, 40.70% CF, 8.23% EE and 2.13% ash respectively. In this study the DM, CP, EE and ash each groups were not significantly difference ($p>0.05$) but found that the DM content decrease in FTMR group when compared with TMR group from 99.78% to 99.75% similar to that reported by Khejornsart *et al.* (2015), Wongnen *et al.* (2009), Chaiyasit *et al.* (2013) and Palapom *et al.* (2015).

Table 2. Effect maize stover in total mixed ration and fermented total mixed ration on chemical composition.

Chemical composition (%)	TMR (control)	FTMR (treatment)	P-value
Dry Matter (DM)	99.78±0.04	99.75±0.03	ns
Crude Protein (CP)	0.91±0.34	0.88±0.71	ns
Crude Fiber (CF)	33.79±5.81	40.70±2.89	*
Ether Extract (EE)	9.35±1.83	8.23±0.43	ns
Ash	1.92±0.19	2.13±0.23	ns

Note : TMR = non-fermented total mixed ratio group; FTMR = fermented total mixed ratio group; Mean ± standard deviation; ns = non-significant; *= $p<0.05$

The CP content decreased in FTMR group when compared with TMR group from 0.91% to 0.88% found by Wongnen *et al.* (2009) and Vasupen *et al.* (2006). Similarly to that fermentation time were decreased CP content could be due to loss crude protein during fermentation time (Bureenok *et al.*, 2009).

The EE content also decrease from 9.35% to 8.23% found by Vasupen *et al.* (2006) could be due to fermentation improved lipids in the diets (Tatsapong *et al.*, 2013) Moreover it found that ash in FTMR group was increased 1.92% to 2.13% but non-significant also found that by Wongnen *et al.* (2009) and Chaiyasit *et al.* (2013).

The CF content in FTMR group was increased 33.79% to 40.70% significant ($p<0.05$) with TMR group. Sirisan *et al.*

(2017) reported that CF content were related to digestibility.

In vitro Digestibility Quality

The *in vitro* digestibilities of dry matter digestibility (DMD), total volatile fatty acids (VFAs) and N-ammonia (N-NH_3) are given in Table 3**.** In this study was found that the treatment FTMR group (62.80% DMD) lower than the control TMR group (70.79% DMD) decreased significantly ($p<0.05$) similarly reported that DMD in the control TMR group was lower when compared with FTMR group (Vasupen *et al*., 2006; Wongnen *et al*., 2009). Similarly Yuangklang *et al.* (2008) also reported that %DMD between FTMR and TRM group was different significantly. Palapom *et al.* (2015) explained that fermentation may be due to decreased dry matter digestibility. Sirisan *et al.* (2017) reported that CF content were related to digestibility. Addition in the present experiment total volatile fatty acids (VFAs) increased 15.00mM to 37.50mM non-significant each the treatments was no different on total VFAs but tend to be higher (Yuangklang *et al*., 2008) supported by Khejornsart *et al.* (2015) and Wongnen *et al.* (2009) stated that total VFAs in FTMR group highest than the non-fermented TMR group. This finding is similar to Palapom *et al.* (2015) that FTMR group was total VFAs and N-NH_3 higher TMR group. Concentration of N-ammonia in FTMR group higher than TMR group from 0.46mM to 0.58mM non-significant agreement with Khejornsart *et al.* (2015) and Wongnen *et al.* (2009). Similarly reported that concentration of N-NH_3 increased in FTMR group and each the treatments was no different on N-ammonia concentration (Yuangklang *et al*., 2008; Palapom *et al*., 2015).

Table 3. Effect of maize stover in total mixed ration and fermented total mixed ration on digestibility quality by *in vitro* technique.

Parameters	TMR (control)	FTMR (treatment)	P-value
DMD (%)	70.79±6.48	62.80±1.74	*
VFA (mM)	15.00±12.25	37.50±17.08	ns
N-NH (mM)	0.46±0.00	0.58±0.23	ns

Note : TMR = non-fermented total mixed ratio group; FTMR = fermented total mixed ratio group; Mean ± standard deviation; ns = non-significant; *= $p<0.05$

Cumulative Gas Production

The *in vitro* gas production technique during the incubation every 6 hours for gas production test (ml). In Figure 1 shown about cumulative gas production curves. The in vitro technique found that gas production both of them has a remarkable boost from 0 hour to 6 hour incubation time. At 6 hour found that gas production in FTMR has increased higher when compared to TMR group of 7.5 ml but then after 6 hour of incubation time gas production decreased in FTMR group gas production and at 24 hour gas production lower than TMR group at 2.45 ml attributed to FTMR has high crude fiber content were obstruct of activities microorganism decreased

cumulative gas production (Sallam *et al*., 2007; Roddoung *et al*., 2011) fermentation the diets were cumulative gas production lower then non fermented group and in FTMR has high crude fiber and ash were low digestibility (Tatsapong *et al*., 2013). Moreover was found that both of FTMR and TMR group no different of cumulative gas production could probably due to proportion of the total mixed ration was similar (Sallam *et al.*, 2007). The decreasing in cumulative gas production thought to be due to reduced substrates availability.

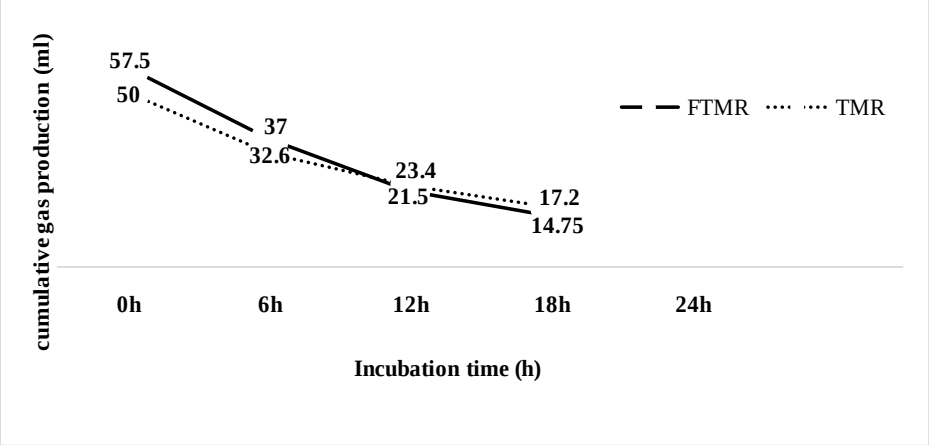

Figure 1. Effect of Maize stover in TMR and FTMR on cumulative gas production at different time of incubation.

CONCLUSION

Based on experimental data, FTMR is a conceivable method to improve the quality of TMR for long time storage, ensiling of maize stover in fermented total mixed ration improve the physical and quality of feed, both of TMR and FTMR were chemical composition consisted of DM, CP, EE and Ash no different and also found that low N-ammonia but FTMR tended to be increase total VFAs. It could be concluded that utilization crop residue maize stover as roughage source in fermented total mixed ration. Maize stover would be an alternative to feed of ruminant. However these findings should be applied further in *in vivo* experiment and in order to find efficiency of ruminant animals for the result more reliable.

ACKNOWLEDGMENTS

The authors would like to acknowledge advisor Dr. Arfan Abrar for discussions the report and support during the exchange program cooperative education in agriculture. The authors would also like to thank the staff at the Department of Animal Science, Faculty of Agriculture Sriwijaya University, Indonesia for every service it rendered in facilitating this research. The authors would like to acknowledge Department of Animal Science, Faculty of Agriculture Khon Kaen University and International Relations Division Affairs of Khon Kaen University, Thailand for communication and providing financial support the research.

REFERENCES

Abdulrazak, S. A., R. W. Muinga, W. Thorpe, & E. R. Ørskov. 1997. Supplementation with *Gliricidia sepium* and *Leucaena leucocephala* on voluntary food intake, digestibility, rumen fermentation and live weight of crossbred steers offered Zea mays stover. *Livest. Prod. Sci.* 49: 53-62.

Alemu, T., P. Chairatanayuth, P. Vijchulata, & S. Tudsri. 2005. The potential of urea treated Maize stover for growth performance of weaned crossbred calves. *Kasetsart J. (Nat. Sci.).* 39: 638-646.

Alltech. 2017. Dairy Health – IFM. http://www.alltech.com/animal-nutrition/dairy/ifm. Accessed 14 Feb. 2017.

AOAC. 1998. Official Methods of Analysis. The Association of Official Analytical Chemistry, Washington, D.C. USA.

Aredo, T.A. & N.K.R. Musimba. 2003. Study on the chemical composition, intake and digestibility of Maize stover, Tef Straw and Haricot bean Haulms in Adami Tulu District, Ethiopia. *Kasetsart Journal*. 37: 401-407.

Bureenok, S., C. Yuangklang, K. Vasupen, S. Wongsuthavas, K. Sisaath, & Y. Kawamoto. 2009. Application of fermented juice of epiphytic lactic acid bacteria as a starter culture in fermented total mixed ratio (FTMR). *Khon Kaen Agriculture Journal*. 37: 245-254.

Chaiyasit, S., S. Toomperch, P. Boonsaen, & S. Sawanon. 2013. Study on ruminal digestibility of leucaena as a source of fiber in total mixed ration using nylon bag technique. *Agricultural Sci. J.* 44(1): 259-262.

Chupthong, N., C. Phatsara, & S. Yammuenart. 2014. Nutritional value and ruminal degradability of Total Mixed Ration containing Maize cob and Husk treated with ruminal cellulolytic bacteria from mountainous cattle. *Thai Journal of Animal Science.* 1(1): 1-10.

Egbu, C.F. 2014. Effect of feeding urea treated maize stover and *Centrosema pubescens* on grazing n' dama calves. Department of Animal Science Faculty of Agriculture University of Nigeria (NSUKKA).

Fon, F.N. & I.V. Nsahlai. 2012. The *in vitro* fermentation of maize stover as affected by faecal bacteria obtained from ungulates. *South African Journal of Animal Science*. 42(5): 478-482.

Khejornsart, P., W. Meenongyai, & T. Juntanam. 2015. A comparative study of rice straw and sorghum in fermented total mixed ration on intake, nutrients digestibility, and rumen fermentation of lamb. *Khon Kaen Agriculture Journal*. 43(1): 240-230.

Li, H. Y., L. Xu, W. J. Liu, M. Q. Fang, & N. Wang. 2014. Assessment of the nutritive value of whole corn stover and its morphological fractions. *Asian-Australasian journal of animal sciences*. 27(2): 194-200.

Office of Agricultural Economics. 2014. Analysis of agricultural potential in Thailand compared to ASEAN members study case: Indonesia. www.oae.go.th. Accessed 30 Jan. 2017.

Paladpom, A., & S. Sawanon. 2015. Effect of total mixed ratio silage from soybean milk by-product on milk production, composition and production cost in dairy cow. In proceeding of 53rd Kasetsart University annual conference of Animal and Veterinary Medicine.

Prachyalak, P., P. Sornprasitti, & V. Wanasitchaiwat. 2001. The utilization of pineapple leaves or rice straw in total mixed ration for fattening cattle. Animal Nutrition Research Section, Animal Nutrition Division. *Research Project*. 42: 269-281.

Rajamma, K., D.S. Kumar, E.R. Rao, & D.N. Nath. 2014. Effect of feeding total mixed rations supplemented with or without exogenous fibrolytic enzymes on rumen degradation kinetics in buffalo

bulls. *International Journal of Veterinary Science.* 3(4): 236-239.

Roddoung, S., C. Wattanachant, & W. Ngampongsai. 2011. Evaluation on digestible organic matter and metabolisable energy of total mixed ration (TMR) containing oil palm frond silage as a source of roughage using *in vitro* gas production technique. *Khon Kaen Agriculture Journal*. 39: 251-260.

Sirisan, V., V. Pattarajinda, & S. Duanyai. 2017. Usage of the fermented sugarcane bagasse in total mixed ration (TMR) diet on dairy cattle performance. *Khon Kaen Agriculture Journal.* 43(1): 770-774.

Smith, T. 2002. On-farm Treatment of Straws and Stovers with Urea. Field Evaluation of Animal Feed Supplementation Packages. University of Reading United Kingdom. 15-22.

Soulinthone, S., & P. Khejornsart. 2015 Effect of sugarcane pith and straw in fermented total mixed ration on intake digestibility of and microorganism of lamb. *Khon Kaen Agriculture Journal*. 43(1): 1-7.

Syomiti, M., M. Wanyoike, R. G. Wahome, & J.K.N. Kuria. 2011. The status of maize stover utilization as feed for livestock in Kiambu and Thika districts of Kenya: Constraints and opportunities. *Animal Science Journal*. 8: 9-13.

Tang, S.X., F.W. Li, J. Gan, M. Wang, C.S. Zhou, Z.H. Sun, & Z.L. Tan. 2011. Effects of sown season and maturity stage on *in vitro* fermentation and *in sacco* degradation characteristics of new variety maize stover. *Asian-Australasian Journal of Animal Sciences*. 24(6): 781-790.

Tatsapong, P., P.C. Khwamsul, & T. Kamonsurachte. 2013. Effect of roughage sources in total mixed ration on fermentation kinetics by using *in vitro* gas technique. *Agricultural Sci. J*. 44(1): 243-246.

Tilley, J.M.A. & R.A. Terry, 1963. A two stage technique metabolism by epithelial cells isolated from for the *in vitro* digestion of forages. J. Br. Grassland different areas of the ewe rumen. *J. Anim. Sci*. 80(18): 104-111.

Vasupen, K., C. Yuangklang, C. Sarnklong, & S. Wongsuthavas. 2006. Effects of total mixed ration and fermented total mixed ration on voluntary feed intake, digestion nutrients digestibility, and milk production in lactating dairy cows. In proceeding of 44th Kasetsart University annual conference of Animal and Veterinary Medicine.

Walli, T.K., M.R. Garg, & H.P.S. Makkar. 2012. Crop Residue Based Densified Total Mixed Ration - A User-Friendly Approach to Utilise Food Crop by-Products for Ruminant Production. FAO Animal Production and Health. 172.

Wongnen, C., C. Wachirapakorn, C. Patipan, D. Panpong, K. Kongweha, N. Namsaen, P. Gunun, & C. Yuangklang. 2009. Effects of Fermented Total Mixed Ration and Cracked Cottonseed on Milk Yield and Milk Composition in Dairy Cows. *Asian-Aust. J. Anim. Sci*. 22(12): 1625-1632.

Woyengo, T.A., C.K. Gachuiri, R.G. Wahome, & P.N. Mbugua. 2004. Effect of protein supplementation and urea treatment on utilization of maize stover by Red Maasai sheep. *South African Journal of Animal Science*. 34(1): 23-30.

Yotharin, C., C. Wachirapakorn, C. Yuangklang, N. Suphrap, & C. Wongnen. 2013. Effect of Amino Acids Supplementation in Total Mixed Ration Used Cassava Pulp on Feed Intake, Digestibility, Milk Yield and Milk Composition in Lactating Dairy Cows. *J. Mahanakorn Vet. Med*. 8(2): 53-69.

Yuangklang, C., K. Vasupen, S. Wongsutthavas, S. Wittayakun, P. Panyakaew, & K. Kongweha. 2008. Effect of roughage sources on voluntary feed intake, nutrient digestion and rumen fermentation in dairy cows. In proceeding of 46th Kasetsart University

annual conference of Animal and Veterinary Medicine.