IMPROVING THE ENERGY VALUES OF RICE STRAW AND OIL PALM EMPTY FRUIT BUNCH IN RUMINANT FEEDING

SYED HUSSEIN S.A.[1]*, ALIMON A.R.[2], MOHAMAD NOOR I.[3], NURZILLAH M.[3] AND HARYANI H.[3]

[1] Department of Veterinary Services, Ministry of Agriculture and Agrobased Industries, Wisma Tani, Blok Podium, Lot 4G1, Presint 4, Putrajaya.
[2] Universiti Putra Malaysia, Serdang, Selangor, 43400 UPM Serdang, Malaysia,
[3] Institut Veterinar Malaysia, KM 13, Jalan Batu Pahat, Beg Berkunci 520, 86009 Kluang, Johor
* Corresponding author: shussein@dvs.gov.my

ABSTRACT. Rice straw and oil palm empty fruit bunch were treated with urea and commercial effective microorganisms to study their ability to breakdown fibres, improved in protein and energy values. In rice straw, the crude protein and crude fibre treated with urea and urea + effective microorganisms showed significant differences from the untreated control. The neutral detergent fibre and nitrogen free extract values in the rice straw treatment did not show significant differences. Metabolizable energy values decreased with the treatment groups compared to the control. The results of keeping the treated rice straw in anaerobic plastic bags up to 30 days showed no significant breakdown of fibre components in the control and urea treated groups. But there is a significant dropped in the neutral detergent fibre in urea + effective microorganisms treatment. In oil palm empty fruit bunch, there were no significant differences seen in the crude protein, crude fibre, acid detergent fibre, neutral detergent fibre, nitrogen free extract and metabolisable energy values. Storage showed decreased in energy values in all treated groups. The addition of urea and microbes showed improved protein level and in the reduction of the fibre components in rice straw only.

Keywords: rice straw, oil palm empty fruit bunch, urea, effective microorganisms, crude fibre, acid detergent fibre, neutral detergent fibre, metabolisable energy.

INTRODUCTION

Rice straw and oil palm empty fruit bunch are cheap natural agricultural by-products resources found in abundance in Malaysia. However, they are considered low quality animal feeds due to their low protein content and low energy values. Both sources have high fibre content. Rice straw contains about 34% crude fibre while oil palm empty fruit bunch contains 47% crude fibre. Fibre contains high energy but is not available to animals due to its highly indigestible nature. In monogastric animals, they are unable to digest fibres and non starch polysaccharides. The primary components of fiber are cellulose, hemicellulose, and lignin. On a chemical basis, cellulose is comprised of linear chains of glucose molecules linked together in a β1,4 link whereas in starch, it is an α1,4 link, (Limin). Only microbial enzymes can digest the β1,4 linked glucose in cellulose. Hemicellulose is also dependent on microbial enzymes for digestion because it has a complex structure of the sugar xylose that is also in β1,4 links. Hemicellulose and lignin have a strong negative influence on fibre digestion. In ruminant animals fibres are digested by microbes in the rumen through the process of fermentation. But the efficiency of digestibility of these fibres is low. Extensive researches have come out with the use of exogenous enzymes that can increase the bioavailability of energy and nutrients by hydrolyzing these materials (Costa *et al.,*2008). The use of beneficial microorganisms technology can be considered a natural technology and has no known adverse effects on plants, animals, humans, or environment (Higa and Wood, 2007). Beneficial microorganism is the termed use for a group of known and unknown microorganisms which interact and give positive results with plants/ livestock. Effective microorganisms consist of cultured mixture of microorganisms mainly lactic acid bacteria, photosynthetic bacteria, yeast and other microorganisms that exist naturally in the environment (Wikipedia, 2008).

Fibre if can be effectively degraded can be the answer for the future supply of energy in monogastric and ruminant animal production. The present situation sees rapid usage of effective or beneficial microorganisms in the animal industry (Agus, 2009 and Dahal, 2006). It includes waste treatment, odour control and feeding. The addition of effective microorganisms in rice straw was widely studied through the process of fermentation and enzymes. Rai *et al.* (1989), used the fungus coprinus fimetarius in the solid state fermentation observed in the improvement of rice straw. Agus *et al.* (1999), used commercial probiotic products that contains a mixture of microbial, fungi and enzymes on rice straw with the addition of urea. The results showed improved nutritive quality of rice straw. The ability of these beneficial microorganisms in transforming the nutritive value of oil palm empty fruit bunch needs to be evaluated also. The objectives of the trial are to evaluate and verify the effectiveness of using commercial available effective microbes in fibre degradation and energy improvement determined by *in-vitro* method on rice straw and oil palm empty fruit bunch.

MATERIALS AND METHODS

Rice straw and oil palm empty fruit bunch were purchased and air dried to bring the moisture level to about 12%. They were shredded manually to increase the surface area for better microbe penetration. The experiment consisted of 2 groups, i.e. group 1 which consisted of rice straw and group 2 which consisted of oil palm empty fruit bunch. Each group underwent

3 treatments. Treatment 1 was the control group which consisted only the substrate. Treatment 2 consisted of the substrate with the addition of urea solution. Urea was given in solution form by dissolving 40 grams of urea in 1 litre of water. Urea solution was added to assist in chemical break-up of the fibres, inhibit mould growth and as a source of nitrogen for microbial proliferation. Addition of urea also increases the nutrition value of the feed as a source of nitrogen. Treatment 3 consisted of the substrate with the addition of urea and effective microorganisms. The effective microorganisms were prepared as instructed by the supplier. The floor area for each treatment was 3 meters long × 1.5 meters wide. In treatment 2, a layer of substrate was placed 7.62 cm high and urea solution was poured at the rate of 1 litre per square meter area. The procedure was repeated until a total of 7 layers high. In treatment 3, urea and effective microorganisms at the rate of 0.04 kg/layer were randomly spread. At 21 days, all treatment groups were filled into plastic bags. The purpose of this procedure was to further study the effects of storage in anaerobic conditions on further degradation of fibre materials. Initial samples were taken before the bags were sealed. After that, samples were taken at random at intervals of 10, 20, and 30. Samples were analysed by proximate analyses (AOAC, 1990) to determine the nutrient contents at the different storing intervals.

For metabolisable energy determination, the gas test method using rumen liquor as described by Menke *et al.* (1979) was carried out. Two cattle fitted with airtight rumen fistula were used as donor animals for the rumen liquor to be used in the *in vitro* energy determination. The donor cattle were fed twice daily consisting of 30–50% of a mixed concentrate. Air dry treatment sample (approximately 200 mg dry matter) incubated (39ºC) with rumen liquor for 24 hours, can be used for estimation of digestibility of organic matter and metabolisable energy content of straight and compound feeding stuffs. Each sample should be incubated in triplicate on at least two different days (with different batches of rumen liquor), yielding 6 parallel measurements. Samples were incubated *in vitro* with rumen fluid in calibrated glass syringes. In determining the metabolisable energy value, about 230 mg air dry weight of the sample were weighed in calibrated 100 ml glass syringes. The syringes were pre-warmed at 39°C before the injection of 30 ml rumen fluid-buffer mixture into each syringe followed by incubation in a specially modified oven at 39°C. Readings of gas production recorded at 24 h incubation time. The mean gas production from incubation was measured, and corrected for differences in sample weight and standard factors from measurements of standard feeding stuffs. The equation used to calculate metabolisable energy in sample treatments based on roughages is as follows:

$$\text{ME (MJ/kg)} = 2.20 + 0.136\ \text{Gb} + 0.0057\ \text{XP} + 0.00029\ \text{XL}^2$$

Where:

Gb, mean correction gas production in 24 hours of rumen liquor with sample treatment;
XP, Percentage of Crude Protein sample treatment
XL, Percentage of Crude Fat sample treatment

All data were analysed statistically using analysis of variance and Duncan New Multiple Range Test as described by Ott (1977).

RESULTS AND DISCUSSION

The results of the experiment after 21 days post treatment for rice straw (0 day) is shown in Table 1. Crude protein content of rice straw treated with urea and, urea and effective microorganisms showed significant difference from the control. It showed an average increase of 33% from the control. The higher values of protein in these treatments could be due to the addition of urea in the substrate and maybe due to the contribution of protein from the proliferation of organisms. However the contribution of protein from microorganisms was not noted to be significant. There is a significant reducing level in the crude fibre contents between the control and the treated groups. An average reduction of 10% in crude fibre content was observed in the treated groups. Thus the addition of urea and beneficial microbes seemed to have an effect in the breakdown of fibre materials in rice straw.

The acid detergent fibre value refers to the cell wall portions of the forage that are made up of cellulose and lignin. These values are important because they relate to the ability of an animal to digest the forage. As acid detergent fibre increases, the ability to digest or the digestibility of the forage decreases. Treating rice straw with urea and effective microorganisms decreased the acid detergent fibre component thus making it more digestible.

The neutral detergent values in the rice straw treatment did not show significant differences. However, those treated with effective microorganisms showed an increase in value. Neutral detergent fibre value is the total cell wall which comprised of the acid detergent fibre fraction plus hemicellulose. Neutral detergent fibre value is important because it reflects the amount of forage the animal can consume. As neutral detergent fibre percent increases, the dry matter intake generally decreases.

The nitrogen-free extracts did not show any difference in all treatments. Metabolisable energy values decreased with the treatment groups compared to the control in rice straw. Even though the fibre contents showed positive results of breakdown, there was no increase in the energy value of rice straw.

Further storage of the materials for 10, 20 and 30 days was to study if there would be further breakdown of materials under anaerobic condition. The results of keeping the treated rice straw in anaerobic plastic bags up to 30 days showed no significant further breakdown of fibre components in the urea treated treatment. Howevere, there was a significant drop in the neutral detergent fibre in the urea + effective microorganisms treatment. The nitrogen-free extract values showed an increase in value up to 20 days' storage time. Contrarily, the metabolisable energy values showed no difference except in the urea + EM group which showed a significant drop at 30 days. The metabolisable energy values showed a decreasing trend with days of storage. A study by Mahizah *et al* .(2010) noted a significant reduction of acid detergent fibres and neutral detergent fibres when rice straw was incubated with fungus *Pleurotus sajor*-caju. The time of incubation of 30 days showed higher reduction in the fibre components when compared to 15 days incubation.

Table 2 shows the results for oil palm empty fruit bunch. The effects of adding urea and/or microorganisms in increasing the protein value was not shown in oil palm empty fruit bunch treatments. There were no significant differences seen in the crude fibre contents, acid detergent fibres, nitrogen free extract and metabolisable enegy values. Oil palm empty fruit bunch was not affected with treatment of urea and effective microorganisms. The effects of storage time under anaerobic conditions up to 30 days showed consistent results for the fibre compositions and nitrogen-free extract. But the metabolisable energy values seemed to be affected with storage time in the treated groups. The longer the storage time, the lower the metabolisable energy values in the treated groups. The addition of urea and microbes do not have a direct effect on the nutritive values of the oil palm empty bunch. Oil palm empty fruit bunch contains low nutritive values in all categories of nutrient as compared to rice straw. It contains higher values of crude fibre than rice straw. High values of both acid detergent fibres and neutral detergent fibres showed that oil palm empty fruit bunch is highly indigestible and the energy is not readily available to the animal.

The addition of urea and microbes showed a general trend in the reduction of the fibre components in rice straw only. The beneficial microorganisms found in the products seemed to act on specific substrates and in this case is rice straw. They did not show any effects on the fibres found in the oil palm empty fruit bunch. If this is the case then, a more specific microorganism need to be identified and propagated to act on oil palm empty fruit bunch. In addition, the level of microbes added may influence the impact on fibre degradation. Feeding trials could be used to assess whether these substrates after treating with effective microorganisms show beneficial effects in terms of growth and production. The presence of these beneficial microorganisms in the rumen might be an enhancing factor in increasing fibre utilisation by ruminants.

CONCLUSION

The treatment of urea and commercial effective microorganisms is effective in rice

Table 1. Nutritive contents of rice straw treated with urea and effective microorganisms.

Nutrient	Rice Straw*		
	Control (C)	(C)+urea	(C)+urea+EM
Crude protein			
0 day	5.20^{a,x} ±0.21	6.96^{b,x} ±0.42	6.92^{b,x} ±0.38
10 days	5.32^{a,x} ±0.29	6.44^{b,x} ±1.05	6.82^{c,x} ±0.50
20 days	5.06^{a,x} ±0.50	6.24^{a,x} ±0.81	5.88^{a,x} ±1.0
30 days	4.96^{a,x} ±0.22	6.44^{b,x} ±0.71	6.98^{b} ±0.44
Crude fibre			
0 day	37.64^{a,y} ±0.59	33.78^{b,x} ±0.71	33.68^{b,x} ±1.23
10 days	34.72^{a,x} ±1.89	32.86^{a,x} ±3.10	32.3^{a,x,y} ±0.46
20 days	33.46^{a,x} ±2.17	33.40^{a,x} ±1.77	30.06^{b,y} ±2.00
30 days	34.72^{a,x} ±2.01	33.00^{a,x} ±2.33	31.9^{a,x,y} ±0.64
Acid detergent fibre			
0 day	56.02^{a,x} ±2.41	54.16a^{b,x} ±0.67	51.70^{b,x} ±1.98
10 days	53.14^{a,y} ±2.23	55.08^{a,x} ±6.16	54.08^{a,x} ±0.99
20 days	56.80^{a,x} ±1.52	51.60^{a,x} ±6.55	51.34^{a,x} ±0.44
30 days	55.56^{a,x,y} ±1.20	54.48^{a,x} ±2.11	53.30^{a,x} ±1.20
Neutral detergent fibre			
0 day	74.36^{a,x} ±3.38	73.42^{a,x} ±0.94	76.62^{a,y} ±0.94
10 days	75.98^{a,x} ±1.19	73.28^{b,x} ±1.26	76.02^{a,x,y} ±1.80
20 days	73.04^{a,x} ±1.62	72.18^{a,x} ±2.36	67.88^{b,x,y} ±1.75
30 days	74.24^{a,x} ±0.98	72.94^{a,x} ±2.56	64.98^{b,x} ±13.52
Nitrogen-free extract			
0 day	40.00^{a,x} ±1.47	39.60^{a,x} ±0.90	39.70^{a,y} ±0.86
10 days	40.84^{a,x,y} ±1.15	40.98^{a,x,y} ±0.76	42.14$^{a,x\ y}$ ±0.90
20 days	43.36^{a,y} ±0.78	42.12^{a,y} ±1.08	43.98^{a,x} ±1.73
30 days	42.22^{a,x,y} ±2.92	41.20^{a,x,y} ±1.87	40.86$^{a,x\ y}$ ±1.01
Metabolisable energy, Kcal/kg			
0 day	4.84^{a,x} ±0.28	4.44a^{b,x} ±0.30	4.29^{b,x} ±0.15
10 days	4.42^{a,x} ±0.30	4.94^{a,x} ±1.58	4.06^{a,x,y} ±0.21
20 days	4.75^{a,x} ±0.22	4.59^{a,x} ±0.40	4.27^{a,x,y} ±0.20
30 days	4.64^{a,x} ±0.34	4.26^{b,x} ±0.22	3.91^{b,y} ±0.22

* a, b, c means with same superscript letter in same row are not significantly different at $P<0.05$

* x, y, z means with same superscript letter in same column are not significantly different at $P<0.05$

Table 2. Nutritive contents of oil palm empty fruit bunch treated with urea and effective microorganisms.

Nutrient	Oil Palm Empty Fruit Bunch*		
	Control(C)	(C)+urea	(C)+urea+EM
Crude protein			
0 day	$5.06^{a,x}$ ±0.41	$5.46^{a,x}$ ±0.64	$5.26^{a,x}$ ±0.50
10 days	$5.42^{a,x}$ ±0.66	$5.82^{a,x}$ ±0.36	$5.56^{a,x}$ ±0.88
20 days	$5.06^{a,x}$ ±0.32	$5.44^{a,x}$ ±0.49	$5.12^{a,x}$ ±0.41
30 days	$5.56^{a,x}$ ±0.49	$5.88^{a,x}$ ±0.08	$5.56^{a,x}$ ±0.29
Crude fibre			
0 day	$52.82^{a,x}$ ±0.89	$53.10^{a,x}$ ±1.44	$52.98^{a,x}$ ±0.89
10 days	$51.98^{a,x,y}$ ±1.47	$52.52^{a,x}$ ±1.45	$50.54^{a,x}$ ±3.60
20 days	$52.10^{a,x,y}$ ±1.47	$53.60^{a,x}$ ±1.47	$51.50^{a,x}$ ±0.97
30 days	$49.00^{a,y}$ ±1.23	$49.22^{a,y}$ ±1.01	$50.58^{a,x}$ ±0.44
Acid detergent fibre			
0 day	$67.92^{a,x}$ ±2.78	$70.56^{a,y}$ ±2.99	$67.16^{a,y}$ ±0.35
10 days	$70.66^{a,x}$ ±0.86	$69.08^{a,x,y}$ ±1.33	$68.88^{a,x,y}$ ±1.62
20 days	$67.80^{a,x}$ ±1.95	$67.72^{a,x,y}$ ±0.61	$67.74^{a,x,y}$ ±1.35
30 days	$65.54^{a,x}$ ±5.39	$65.82^{a,x}$ ±0.87	$67.18^{a,x,y}$ ±3.45
Neutral detergent fibre			
0 day	$85.66^{a,y}$ ±0.80	$85.74^{a,y}$ ±1.98	$87.88^{a,y}$ ±2.13
10 days	$85.48^{a,x,y}$ ±1.64	$87.58^{a,y}$ ±1.85	$87.74^{a,y}$ ±1.39
20 days	$81.94^{a,x}$ ±2.49	$82.64^{a,x}$ ±1.54	$81.62^{a,x}$ ±1.87
30 days	$84.86^{a,x,y}$ ±2.31	$86.22^{a,y}$ ±0.99	$86.32^{a,y}$ ±1.96
Nitrogen-free extract			
0 day	$33.60^{a,y}$ ±0.64	$34.28^{a,x}$ ±3.32	$35.52^{a,x}$±0.70
10 days	$34.58^{a,x,y}$ ±1.16	$33.38^{a,x}$ ±1.08	$35.92^{a,x}$±3.14
20 days	$36.94^{a,x}$ ±1.52	$34.44^{a,x}$ ±1.43	$35.76^{a,x}$±1.41
30 days	$36.56^{a,x,y}$ ±1.69	$36.68^{a,x}$ ±0.77	$35.92^{a,x}$±0.93
Metabolisable Energy, Kcal/kg			
0 day	$4.27^{a,x}$ ±0.33	$4.40^{a,x}$ ±0.22	$4.51^{a,x}$±0.21
10 days	$4.21^{a,x}$ ±0.30	$3.96^{a,y,z}$ ±0.25	$4.07^{a,y,x}$±0.21
20 days	$3.88^{a,x}$ ±0.13	$3.75^{a,y,z}$ ±0.12	$3.72^{a,y}$±0.28
30 days	$4.12^{a,x}$ ±0.15	$3.56^{b,z}$ ±0.21	$3.21^{c,z}$±0.21

* a, b, c means with same superscript letter in same row are not significantly different at $P<0.05$

* x, y, z means with same superscript letter in same column are not significantly different at $P<0.05$

straw but not in oil palm empty fruit bunch in breaking down the fibre components and increasing the protein values. But there is no improvement in energy values in all treated groups. The microorganisms found in the commercial products may contain bacteria and fungi that suit the breakdown of fibres in rice straw rather than oil palm empty fruit bunch. Post treatment of substrates under anaerobic storage did not indicate any improvement in the energy values.

REFERENCES

1. Agus A. (2009). Utilisation of effective microorganisms in livestock agriculture. Proceedings of the Malaysian Society of Animal Production, 30th Annual Conference, pp. 3-14.
2. Agus A., Bambang S. And Mundi W. (1999). In sacco degradability of dry matter, organic matter and crude fibre of fermented rice straw using different level of probiotics. Bulletin of Animal Science, Gadjah Mada University, ISSN 0126-4400, pp 85-91.
3. AOAC (2000). Official Methods Of Analysis, Association of Official Analytical Chemists, 17th edition, AOAC International, Geithersburg, MD.
4. Costa F.G.P., Goulat C.C., Figueiredo D.F., Oliveira C.F.S. and Silva I.H.V. (2008). Economic and environmental impact of using exogenous enzymes on poultry feeding. International Journal of Poultry Science **7**(4):311-314.
5. Dahal B.K. (2006). Effective microorganisms (EM) for animal production. http://www.cababstractplus.org.abstracts.
6. Higa T. and Wood M. (2007). Effective Microorganisms for Sustainable Community Development [Online]. [Accessed 8th August 2007]. Available from World Wide Web: http://www.scdworld.com.
7. http://en.wikipedia.org/wiki/effective_microorganism
8. Limin, K. Jr. The Role of Fiber in Ruminant Ration Formulation. http://ag.udel.edu/anfs/faculty/kung/articles/role_of_fiber_in_ruminant_ration.htm
9. Menke K.H., Raab l., Salewski A., Steingass H., Fritz D. and Schneider W. (1979). The estimation of digestibility and metabolisable energy content of ruminant feedstuffs from the gas production when they incubated with rumen liquor *in vitro. Journal of Agricultural Science (Camb.),* **92**, 217-222.
10. Mahizah M.Y., Yaakub H. and Alimon A.R. (2010). Solid state fermentation of rice straw using *Pleurotus sajor caju*. Proceedings 4th International Conference on Animal Nutrition, pp. 357-360.
11. Ott L. An Introduction To Statistcal Methods and Data Analysis. Duxbury Press, (1977).
12. Rai S.N., Walli T.K. and Gupta B.N. (1989). The chemical composition and nutritive value of rice straw after treatment with urea or Coprinus femetarius in a solid state fermentation. Anim. Feed Sci Tech. **26**:81-92.