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PERFORMANCE OF GROWING LAMBS FED FUNGS TREATED SUGARCANE BAGASSE

A. A. Mahrous; M.H. El-Shafie and T.M.M. Abdel-Khalek

Animal Production Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.

SUMMARY

The aim of this study was to evaluate changes in nutritive values of sugarcane bagasse when treated with fungus and to evaluate performance of growing lambs at partial replacement of CFM with treated sugarcane bagasse.

Nine local Ossimi rams were used to evaluate the effects of replacing 15 or 30% of concentrate feed mixture with biologically treated Sugarcane bagasse on nutrients digestibility and nutritive values in terms of total digestible nutrient (TDN) and digestible crude protein (DCP). Ruminal pH, NH_3-N and TVFA's were measured CP and ash contents were increased in biologically treated sugarcane bagasse while, NDF, ADF, cellulose and hemi-cellulose were reduced.

Control group recorded ($P<0.05$) the highest digestibility coefficients for all nutrients and nutritive values compared with 15% and 30% replacement groups. Control group had higher value of ammonia nitrogen and total volatile fatty acid in rumen liquor at 4 hrs after feeding. Acetic and Propionic acids were higher in control group than treated groups while butyric acid was higher in treated groups than control group. The maximum total fungi counts and microbial protein were observed in control group followed by 15 and 30% replaced ones, respectively. Serum urea, total protein, albumin, globulin, albumin/globulin ratio, GOT and GPT were not significantly changed.

Eighteen Rahmany lambs with average body weight 20.00±0.30 kg/head were distributed into three similar groups. Groups were fed, for 120 days, Animals were weighed monthly to determine total and daily gain and feed conversion. The highest total body weight gain, daily gain and lowest feed conversion efficiency were recorded for control group, while medium values were recorded with 15% replacement one. The highest feed cost per head per day and lowest relative economical efficiency were obtained with control group. Controverslly, the lowest feed cost per head per day and highest relative economical efficiency were obtained with 30 % replacement group. The most efficient economical efficiency synchronized with moderate growth rate was obtained with 15 % replacement.

INTRODCUTION

Most cultivated plants, grown with the purpose of production for commodities, yield considerable amounts of crop residues, which are not suitable for human consumption. Such residues usually contain high amounts of fibrous substances. In Egypt, more than 33 million tons of crop residues are produced annually. Sugarcane bagasse amount 3 million tons of these residues (Agriculture Economic and Statistics Institute, 2009).

Sugarcane bagasse is poor in nutritive value owing to its low protein content, high fiber content and low palatability. Biological treatments have been used to breakdown the linkage in cellulose and lignin targeting to increase the nutritive value of such crop residues (Gado *et al.,* 2006). Microbial treatment could be conducted by administration of microbial cells, microbial extracts or microbial enzymes such as cellulases. Microbial treatments improved the nutritive value of these lignocelluloses materials, as well as digestibility, palatability and DM content (Morrison, 1988).

This study was conducted to evaluate role of some biological treatments on improving nutritive value of sugarcane bagasse through modifying its chemical composition, cell wall constituents, digestibility, and the feed efficiency when fed to lambs.

MATERIALS AND METHODS

Microorganisms:

Strain of *Trichoderma viride* F-416 was obtained from Microbial Chemistry Department, National Research Center. Dokki, Cairo, Egypt.

Fungal treatments:

Three days old slant cultures of *Trichoderma viride* was crushed in flasks containing 20ml sterilized water. The fungal spores suspension was used as inoculums at 10% v/w to inoculate 500ml capacity flasks containing 25g of ground waste moistened at solid: liquid ratio of 1:2 with basal medium composed of, g/L, molasses, 25; urea, 2.0, potassium dihydrogen phosphate, 0.2 and magnesium sulfate, 0.3. The inoculated flasks were incubated at 30^{o}C for 7 days under static solid-state fermentation system.

The above prepared inoculants were employed to inoculate 500g of crop residues (sugarcane bagasse) under the studied moistened using the above basal medium at solid: liquid ratio of 1:2 at 10% v/w which introduced into 10L capacity flasks. The inoculated flasks were incubated under static condition for 7, 14 and 21 days at 30± 2^{o}C. At the end of incubation periods the flasks were oven dried at 70^{o}C and milled for chemical analysis.

Preparation of sugarcane bagasse:

Sugarcane bagasse was chopped into 3-5 cm length and divided into two piles (untreated and treated with fungi).

Large scale:

A heap of 150kg sugarcane bagasse was moistened with medium containing; 2.5% molasses, 0.2% urea, 0.1% ammonium sulphate, 1.0% super phosphate and 0.5% magnesium sulphate at solid: liquid (1:2). The fungal biomass was used at 10% w/w, mixed well in mineral medium container, spread and mixed well with sugarcane bagasse.

The heap of treated sugarcane bagasse was shuffled up and down at 48hrs intervals. The treated residue was exposed to sundry until moisture content started to be less than 10%, then packed and stored until used in the feeding trials.

Digestibility trials:

A digestibility trial was conducted using nine local Ossimi rams (3 animals each) averaged 55 kg weight and 3 years old. Animals were individually kept in metabolic cages for 30 days (21 days as a preliminary period followed by 7 days collection), to determine the digestibility coefficients and nutritive value of the following three tested rations.

R1: 60% CFM + 40% berseem hay (control)

R2: 45% CFM + 40% berseem hay + 15% treated sugarcane bagasse.

R3: 30% CFM + 40% berseem hay + 30% treated sugarcane bagasse.

The digestibility trials were conducted to evaluate the effects of replacing treated bagasse to concentrate at two rates on nutrients digestibility, nutritive value in terms of total digestible nutrient (TDN) and digestible crude protein (DCP). Ruminal pH, NH_3-N and TVFA’s were also determined.

The experimental rations were offered once daily at 9:30 am. Feces were collected before feeding at 8:30 am. Fresh feces weight was daily recorded. Samples represented 10% of total fresh feces weights were sprayed with solutions of 10% sulfuric acid and 10% formaldehyde and oven dried at 60°C for 48 hrs. Samples of dried feces were ground and stored for chemical analyses. Representative samples of experimental feeds and feces were analyzed for DM, OM, CP, ether extract (EE), and CF according to A.O.A.C. (1990). Nitrogen free extract was calculated by difference. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and ADL were determined in feeds and feces, according to Van Soest (1982). Hemicellulose was calculated as the difference between NDF and ADF, while cellulose was calculated as the difference between ADF and ADL. Rumen fluid samples were collected for all lambs at the end of digestion trial by using stomach tube. Samples were collected three times for three consecutive days before, 3 and 6 hrs post feeding. Samples were filtered through four layers of cheese cloth. Ruminal pH was immediately measured. Ruminal ammonia nitrogen concentrations were determined applying NH_3 micro diffusion technique according to Conway (1957). Total volatile fatty acids concentrations were determined as described by Warner (1964). Volatile fatty acids fractions were determined using HPLC (Column: Rezex organic, Dimensions: 300x7.8, Mobile phase: 1% Orthophosphoric, Flow rate: 0.8 Detector: UV and Wave length (220 nm). Potassium, sodium, magnesium and chloride were also determined in caecum fluid samples according to Bush *et al.*, (1979). Total fungal counts were determined according to Difco (1984) while microbial protein was measured by sodium tangistate methods according to Shultz and Shultz (1970). Blood samples were collected from the jugular vein and centrifuged for 20 min at 3000 rpm. The supernatant was frozen and stored at -20^{o}C for subsequent analysis. Plasma total protein was determined according to (Armstrong and Carr, 1964); albumin according to (Doumas *et al.*, 1971); GOT and GPT according to (Reitman and Frankel, 1957); creatinine according to (Folin, 1994) and urea according to (Siest *et al.*, 1981).

Feeding trial:

Eighteen Rahmany lambs with average body weight 20.00±0.30 kg were distributed into three similar groups. Animal groups were fed according to the same regime of digestibility trials for 120 days. All lambs were fed according to NRC (1985) allowances. Animals were weighed monthly to determine total gain, daily gain and feed conversion.

Statistical analysis:

The data were statistically analyzed according to Snedecor and Cochran (1980) using SAS (1985). The differences among means were tested by Dancan's multiple range test (1955).

RESULTS AND DISCUSSION

Chemical composition:

Chemical composition of sugarcane bagasse, treated sugarcane bagasse, berseem hay and CFM are presented in Table (1). Treatment of sugarcane bagasse with *T. viride* resulted in deceasing ($P<0.05$) its contents of DM, OM and CF (93.00 to 90.30, 90.50 to 84.32 and 45.30 to 33.60%, respectively).

The CP and ash contents were increased in the biologically treated sugarcane bagasse (2.40 to 10.30 and 9.50 to 15.68%, respectively). These results are in agreement with those reported by Chawla and Kunda (1985) and El-Banna *et al.* (2010). Dahanda *et al.* (1994) found that crude protein content of spent straw increased from 3.42 to 8.19%.

Table (1): Chemical composition (%) of feedstuff used in the experiment.

Item	Untreated Sugarcane	Treated sugarcane	Berseem hay	CFM*
DM	93.00	90.30	89.00	91.20
OM	90.50	84.32	89.19	87.50
CP	2.40	10.30	13.05	16.10
CF	45.30	33.60	35.51	14.01
EE	1.24	1.05	1.94	4.29
Ash	9.50	15.68	10.81	12.5
NFE	41.56	39.37	38.69	53.10
NDF	73.20	60.20	74.01	39.0
ADF	61.50	53.60	55.50	23.0
ADL	31.60	16.30	8.73	6.30
Cellulose	29.90	37.30	46.77	16.7
Hemicellulose	11.70	16.60	18.51	16.0

* Concentrate feed mixture (CFM): Consisted of: 40% ground yellow corn, 20% undecorticated cotton seed meal, 5% soybean meal, 15% wheat bran, 12% rice bran, 5% cane molasses, 2% lime stone and 1% common salt.

Obviously, the increase of crude protein in straw treated with white rot fungi was due to capture of excess nitrogen by aerobic microbes and conversion of it to biological protein during solid-state fermentation (Mahrous *et al.*, 2009 and 2010). It is of interest to note that application of biological treatment resulted in OM decrease in sugarcane bagasse. These results are in agreement with El-Ashry *et al.* (2002); Mahrous *et al.*, (2005 and 2010)

On the other hand, biological treatment resulted in decreasing NDF and ADF in treated sugarcane bagasse (73.20 vs. 60.20; 61.5 vs. 53.6%;, respectively), while cellulose and hemicelluloses were increased (29.9 vs. 37.3 and 11.7 vs. 16.6%). These results agree with those obtained by Mahrous *et al.* (2010).

The improvement in chemical composition of lignocelluloses residues might result of action of enzymes secreted by fungus, i.e, cellulases, hemicululases and lignolytic enzymes. These results are coincide with those obtained by Mahrous *et al.*, (2005) who illustrated that these enzymes hydrolyze the biopolymer to fermentable sugars which used as carbon source for fungal growth to produce biomass that enrich the treated crop residues.

Table (2): The calculated chemical composition (%) of tested experimental rations, on DM basis.

Item	Rations		
	R1	R2	R3
DM	90.32	90.19	90.05
OM	88.18	87.70	87.22
CP	14.88	14.01	13.14
CF	22.61	25.55	28.49
EE	3.35	2.86	2.38
Ash	11.82	12.30	12.78
NFE	47.34	45.28	43.22
NDF	53.00	56.18	59.36
ADF	36.00	40.59	45.18
ADL	7.27	8.77	10.27
Cellulose	28.73	31.82	34.91
Hemi-cellulose	17.00	17.09	17.18

The calculated composition (Table 2) show slight differences in concentrations of some ingredients among the three rations R1, R2 and R3. Increased CF (22.6, 25.5 & 28.5%), decreased NFE (47.34, 45.28 & 43.22%), increased NDF (53.0, 56.18 & 59.36%), increased ADF (36, 40.6 & 45.2%), increased ADL (7.3, 8.8 & 10.3%) and increase cellulose (28.7, 31.8 & 34.9%), respectively.

Digestibility coefficients and nutritive value:

Data in Table (3) showed the effect of partial substitution of concentrate feed mixture (CFM) by biologically treated sugarcane bagasse on digestion coefficients and nutritive values of the experimental rations. Apparent digestibility of DM, OM, CP, CF, EE, NFE NDF, ADF, ADL, cellulose and hemicellulose were decreased by increasing sugarcane bagasse level in the rations.

Table (3): Effect of biological treatment and replacement rate on digestibility coefficients and nutritive values of rations tested.

Item	Rations			±SE
	R1	R2	R3	
Digestibility coefficients (%):				
DM	61.46[a]	58.54[b]	53.97[c]	±1.33
OM	66.07[a]	63.11[b]	59.81[c]	±0.16
CP	64.70[a]	60.05[b]	50.28[c]	±1.40
CF	63.10[a]	55.50[b]	51.59[c]	±0.96
EE	65.27[a]	62.63[b]	60.00[c]	±0.69
NFE	79.19[a]	74.13[b]	64.12[c]	±1.86
Cell wall constituents (%):				
NDF	68.8[a]	63.0[b]	59.40[c]	±0.45
ADF	48.8[a]	41.3[b]	38.94[c]	±0.38
ADL	21.2[a]	18.8[b]	15.25[c]	±0.70
Cellulose	58.7[a]	52.0[b]	48.74[c]	±0.18
Hemi-cellulose	65.6[a]	62.5[b]	57.9[c]	±0.47
Nutritive value (%):				
TDN	58.29[a]	55.03[b]	50.86[c]	±1.20
DCP	8.90[a]	7.21[b]	6.07[c]	±0.23

[a b] means in the same raw for each parameter with different superscripts are significantly different (P<0.05).

These results may be due to increasing the CF content in the rations due to replacement with sugarcane bagasse. These results agree with El-Ashry *et al.* (2002) who reported that biological treatments with different fungal strain decreased cell wall constituents of different crop residues.

The nutritive values (TDN and DCP) for R1, R2 and R3 were, 58.29, 55.03 and 50.86 for TDN and 8.90, 7.21 and 6.07% for DCP, respectively. The better digestibility coefficients recorded with rams fed control ration was of significantly ($P<0.05$) higher for TDN and DCP as compared to R2 and R3. These result due to the decreased digestibility of most nutrients in rations 3. This finding agree with the results of Mahrous *et al*. (2010).

Replacement of treated pagass to concentrate did not succeed to maintain digestibility values attained by the normal control diet. Moreover, Nutritive values were reduced also either as TDN or DCP.

Rumen liquor parameters:

Ruminal pH values were not significantly affected by the dietary rations, while concentration of ruminal metabolites (NH3-N and volatile fatty acids) were significantly ($P<0.05$) varied among the three experimental rations 4 hrs after feeding (Table 4).

Similar results was reported by El-Ashry *et al.* (2002) on goats and Mohamed (2005) on sheep fed 30% or 40% fungal treated Sugar beet bulp. On the other hand, ruminal NH_3-N concentration was obviously higher ($P<0.01$) after 4 hrs. of feeding in R1 (26.24mg/100ml) compared to R2 (20.40mg/100ml) and R3 (18.30 mg/100ml). Such results might be attributed to the high energy content of R1 and consequently fast down of the fermentation process in rumen, especially with the fibre complexity in sugarcane bagasse. This result seems in harmony with the estimated degradability kinetics of CP.

Table (4): Effect of biological treatments on rumen parameters and volatile fatty acids fractions (sampling time was 4 hrs post feeding).

Item	Rations			±SE
	R1	R2	R3	
pH	6.53	6.50	6.50	±1.33
NH_3-N (mg/100ml)	26.24[a]	20.40[b]	18.30[c]	±0.16
TVFA's (meq./100ml)	15.45[a]	13.40[b]	11.01[c]	±1.40

[a b] means in the same raw for each parameter with different superscripts are significantly different ($P<0.05$).

Meanwhile, Chikunya *et al.* (1996) reported that ruminal NH_3-N was decreased with increasing the proportion level of SBP in rations of sheep. However, TVFA's concentration was slightly decreased with increasing sugar cane bagasse (25% and 50%)compared to the control (4 hrs after feeding).

The mean TVFA's concentrations were found to be 15.45, 13.40 and 11.01 meq/100ml for R1, R2 and R3, respectively.

It is worthy to notice that the balance between NH_3-N and TVFA's concentrations was reflected on the pH values of the rumen liquor. Accordingly, the fungi effect might be related to the more utilization of the dietary energy and positive fermentation in the rumen.

Blood parameters:

Data in Table (5) showed the effect of the partial substitution of concentrate feed mixture by biologically treated sugarcane bagasse on some blood parameters of the experimental animals.

Adding biological treated sugarcane bagass did not cause significant changes in blood serum levels of urea, total protein, albumin, globulin, albumin/globulin ratio, GOT and GPT.

Adding biological treated sugarcane bagasse also did not cause significant changes in blood serum urea concentration. The blood serum total protein and its fractions were within the normal levels. GOT ranged from 20.36 to 20.52 µ/ml and GPT from 33.59 to 33.71 µ/ml, which are within normal ranges too and are in harmony with those reported by Fouad *et al.* (1998) and Deraz and Ismail (2001).

There were no adverse effects on animal health as a result of including biologically treated sugarcane bagasse in animal rations during the digestibility trial. The values were within the normal physiological range (Rowland, 1980).

Live body weight gain and feed conversion:

Data in Table (6) show that the highest body weight gain and best (lowest) feed conversion efficiency was recorded for the control group, while medium values were recorded for R2 and the poorest for R3. The reduction accompanied adding fungal treated bagass express the relative decrease of the nutritive value of the diets included treated bagsse.

Table (5): Effect of tested rations on blood parameters of experimental animals.

Item	Rations			±SE
	R1	R2	R3	
Urea (mg/100ml)	25.20	24.85	24.79	±0.52
Total protein (gm/100ml)	7.32	7.40	7.35	±0.67
Albumin (gm/100ml)	3.90	3.84	3.78	±0.04
Globulin (gm/100ml)	3.60	3.56	3.57	±0.11
A/G ratio	1.08	1.07	1.05	±0.12
GOT (U/L)	20.46	20.52	20.40	±0.52
GPT (U/L)	33.67	33.71	33.59	±0.82

These results agree with the finding of El-Marakby (2003) who mentioned that lambs fed 25% CFM + spawning wheat straw *ad lib*. had significantly ($P<0.05$) lower daily live body weight gain than those fed control or 50% CFM + spawning wheat straw *ad lib*..

On the other hand, Gado *et al.* (2006) found that ensiling sugarcane bagasse with cellulose based enzyme mixtures improved silage fermentation and animal performance. Baraghit *et al.* (2009) reported that enzyme mixture from different commercial sources increased dry matter intake and digestibility of DM by sheep fed biological treated sugarcane bagasse.

Data of economic efficiency (Table 6) showed that control group had the highest feed cost to produce one kilogram daily weight gain and the feed cost decreased by increasing replacement rate with sugarcane bagasse content on the ration .

The highest feed cost per head per day was recorded with R1 (2.00 L.E/h/d) which was accompanied with the poorest (least) relative economical efficiency though animals in this group attained the highest rate of gain.

Table (6): Effect of tested rations on feed intake and feed conversion efficiency for experimental animals.

Item	Rations		
	R1	R2	R3
No. of animals	6	6	6
Experimental period (days)	120	120	120
Initial weight (kg)	20.30	20.10	20.20
Final weight (kg)	42.40	38.90	34.80
Total gain (kg)	22.10	18.80	14.60
Average daily gain (ADG) (g)	184.1	156.6	121.6
DMI (g/d)	1558	1350	1106
Concentrate feed mixture, g/d	934.8	607.5	331.8
Berseem hay, g/d	623.2	540	442.4
Sugarcane bagasse, g/d	-	202.5	331.8
Feed conversion efficiency (g DM/g gain)	8.46	8.62	9.09
Economical evaluation:			
Feed cost, LE/h/d	2.00	1.44	0.95
Total feed cost L.E.	240.0	172.80	114
Total price of gain L.E	596.7	507.6	394.2
Economic Efficiency (cost/gain)	148.6	193.8	245.8

[a b] means in the same raw for each parameter with different superscripts are significantly different ($P<0.05$).

Meanwhile, the lowest feed cost per head per day was recorded with R3 (0.95 L.E./h/d) while it attained the best (largest) relative economical efficiency though animals attained the least rate of gain. R2 (1.44 L.E.h/d) group show the medium cost, relative efficiency and rate of gain.

These results are in agreement with the result obtained by Abdel-Aziz (2002) who observed that replacing 40 % of concentrate feed mixture with biologically treated rice straw reduce the cost of feeding by 28%.El-Shafie *et al.* (2007) found that replacing 50 % of protein in concentrate feed mixture with fungus treated wheat straw increased economical efficiency by 19 %.

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CONCOLUSION

Sugarcane bagasse can positively treated with fungi, *Trichoderma viride* to increase crude protein content and degradation of crude fiber content. Use of treated sugarcane bagasse to partially replace concentrate, up to 50%, could in spite that digestibility coefficients and growth performance werereduced. feeding cost to a level make process more profit Meanwhile, no adverse effects on animal health accompanied this replacement.

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الاداء الانتاجى للاغنام المغذاه على مصاصة القصب المعاملة بيولوجيا

احمد عبد الرحمن محروس ، محمد حسن الشافعى و طارق محمد محمد عبد الخالق

معهد بحوث الانتاج الحيوانى – الدقى – الجيزة – مصر.

أجريت هذه الدراسة بهدف دراسة اثر استبدال جزء من العلف المركز بمصاصة القصب المعامله بيولوجيا بفطر *Trichoderma viride* على التحليل الكيماوى ومعاملات الهضم و القيمة الغذائية والكفاءة التحويلية ومعدل النمو للاغنام. تضمنت الدراسة تجربتان، الأولى تجربة هضم استخدم فيها 9 كباش أوسيمى وزعت على ثلاث مجموعات بالتساوى. المجموعه الأولى (كنترول) تم تغذيتها على دريس برسيم و علف مركز و الثانية تم إستبدال 25% من العلف المركز بمصاصة القصب المعامل و الثالثة تم إستبدال 50% من العلف المركز بمصاصة القصب المعامل. معاملة مصاصة القصب بالفطر أدت إلى زيادة محتواها من البروتين من 2.40% إلى 10.30% كما انخفضت المادة الجافة، الالياف الخام، NDF، ADF، ADL، الهيميسليلوز و السليلوز.

معاملات هضم كل من الالياف الخام، NDF، ADF، ADL، الهيميسليلوز و السليلوز كانت أعلى فى مجموعة المقارنة عن مجموعات المصاصة المعاملة وكذلك معامل هضم البروتين الخام و قياسات سائل الكرش كانت اعلى فى مجموعة الكنترول عن المجموعتين الثانية والثالثة. أما التجربة الثانية فكانت للنمو واستخدم فيها 18 حولي رحماني عمر اربع شهور بمتوسط وزن ابتدائي 20±0.3 كجم حيث تم توزيعهم على ثلاث مجموعات و تم تغذيتهم بنفس نظام التغذية فى التجربة الأولى. كان معدل الزيادة اليومية فى الوزن 184.1جم، 156.6جم و 121.6جم للمجموعات الاولى، الثانية والثالثة على التوالي. فى حين كان معدل التحويل الغذائي 8.46 ، 8.62 و 9.09 كجم مادة جافة/ كجم زيادة وزنية للمجموعات الاولى، الثانية و الثالثة على التوالي.

مما سبق يتضح ان المعاملات البيولوجية لها القدرة على زيادة المحتوى البروتينى لمخلف مصاصة القصب مع تحسين القيمة الغذائية له وزيادة كمية الماكول منه مما قد يؤدى الى تقليل تكاليف التغذية باستبدال جزء من المصاصة المعاملة محل جزء من العلف المركز فى علائق الاغنام دون اى تاثير سلبى على صحة الحيوان.