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EFFECT OF FEEDING SPENT ROUGHAGE PRODUCED FROM MUSHROOM CULTIVATION ON THE PERFORMANCE OF GOATS

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SUMMARY

Fifteen male Baladi goats (Av. BW.40kg and aged about 3 years) were divided into five similar groups (3 bucks each) in five digestibility trials to study the effect of feeding spent roughage on performance of goats. The spent roughages were obtained after harvesting Mushroom fungi *(Pleurotus Ostreatus)*. Goats assigned at random to receive one of the following rations: I. Rice straw (control); II. Spent wheat straw; III. Spent rice straw; IV. Spent sugar cane bagasse and V. Spent corn stalks. Roughages were fed at level of 1% of the live body weight of the bucks. Animals in all groups were fed concentrate mixture (about 600g/head/day) to cover the maintenance requirements according to NRC (1985). Spent roughages had higher content of CP and ash, but lower CF, EE and OM in the spent roughages compared with raw roughages. The CP digestibility increased ($P<0.05$) for rations 3, 4 and 5 compared with control. There were no significant differences in dry matter intake (DMI) and digestibilities of DM, OM, CF and EE. Digestible crude protein and nitrogen retention increased in all rations containing spent roughage ($P<0.01$), but there were no differences in TDN and SV values. Ruminal NH3-N concentrations were lower in groups 2 and 3, also VFA`s decreased in the control group than other groups ($P<0.01$). Higher red blood cell count ($P<0.01$) in groups 3, 4 and 5 was observed, also white blood cell count were higher in groups 2 and 5 ($P<0.05$) than the control. Blood haemoglobin increased for groups 2, 4 and 5 compared the other groups ($P<0.01$). Plasma protein and total lipid concentrations were higher in group 3 than those of other experimental groups. Animals in group 3 and 4 showed higher ($P<0.01$) blood plasma cholesterol than the control group.

Keywords: Goats, Mushroom fungi, spent roughages, rumen fermentation, nitrogen retention, blood constituents

INTRODUCTION

The shortage in animal feeds in Egypt necessitates that intense research efforts should be directed towards exploring the possibility of using new-non

conventional sources or agricultural by-products as animal feeds and improving the nutritive values (Shoukry *et al.*, 1985). There are about 12 million tons of plant by-products: rice straw, wheat straw, corn stalks and sugar cane bagasse (Hathout, 1984). The nutritive value of by-products could be improved by biological treatments. Fungi could utilize plant wastes materials. The spent produced as waste from Mushroom cultivation could be used as animal feed (Zadrazil, 1973). Wiedmeier *et al.* (1987) reported that DM digestibility increased when ruminants fed on ration treated by Aspergillus orizae culture, also they found that the addition of fungal cultures increased CP and hemicellulose digestibilities as well as the ruminal cellulytic bacteria and acetate : propionate ratios.

Gupta and Langar (1988) observed an increase in CP content from 3.25 to 8.33% after adding *Pleurotus Florida* fungi to wheat straw. Zadrazil (1980) found that treating different roughages by two species of *Pleurotus* fungi increased ash content. Shoukry *et al.* (1985) reported that CF content decreased while CP content increased in sugar cane bagasse when it is fermented with different fungi spices. Fungal fermentation increased the in vitro dry matter disappearance (IVDMD) of sugar cane bagasse from 21.5 to 52.9%. The improvement in IVDMD may be related to the decrease in CF content and its change in cell wall constituents (Van soest, 1967 and Van Horn *et al.*, 1979), the increase in CP content (Kempton and Leng, 1979) and higher ash content with fungal treatments (Shoukry, 1982).

The aim of the present study was to evaluate the effect of microbiological treatments on nutrient utilisation of rice straw, wheat straw, corn stalks and sugar can bagasse fed to goats.

MATERIALS AND METHODS

The experiment was carried out at the Experimental Farm of the Department of Animal Production, Faculty of Agriculture, Kafr El-sheikh, Tanta University. Five digestibility trials were conducted to study the effect of biological treatments of poor quality roughages on goats performance. Fifteen male Baladi goats aged about three years with an average body weight 40 Kg, were divided into five similar groups (3 bucks each). The experimental rations were: I. Rice straw control, II. Spent wheat straw, III. Spent rice straw, IV. Spent sugar cane bagasse and V. Spent corn stalks. Roughages were fed at rate 1% of body weight. Animals were fed concentrate mixture to cover the maintenance requirements according to NRC (1985). Concentrate mixture composed of 35% undecorticated cotton seed cake, 23% yellow corn, 32% wheat bran, 4% rice bran, 3% molasses, 2% limestone and 1% common salt. Vitamin A, D3 and E premix was added daily to the concentrate mixture. Spent roughages were obtained after harvesting of Mushroom fungi (*Pleurotus Ostreatus).* Some supplements such as: rice bran, wheat bran, peat moss,

gypsum and balanced mixture of these supplements were added at rate of 5% to improve the nutritive value of substrates (roughages). The spent roughages were collected from the Experimental Farm of Agriculture Botany Department.

The bucks were housed in individual metal metabolism crates which permitted total collection and separation of feces and urine. Each digestibility trial consists of 15 days as a preliminary period followed by 7 days as a collection period. Animals were fed twice at 8.0 a.m. and 3 p.m. Fresh water was free choice offered. At the end of the collection period, composite feed, feces and urine samples were prepared and preserved to analysis according to A. O. A. C. (1984).

Rumen liquor samples were collected 3 hours after the morning feeding at the last day of collection period by using a stomach tube. Ruminal pH was determined directly by using Beckman pH meter, while 1 ml. of saturated mercuric chloride was added to the samples to inhibit the microbial activity. Samples after that filtered through filter paper NO. 40 and were stored in polyethylene bottles in freezer for later analysis. The concentrations of ammonia-N (NH3-N) were determined by using magnesium oxide distillation (A.O.A.C., 1984). Total volatile fatty acids (VFA`s) were determined applying steam distillation methods (Warner, 1964). Blood samples were collected from the left jugular vein in a clean dry heparinized plastic centrifuge tubes. Blood 3500 r.p.m. for 15 minutes to obtain plasma.

Blood haemoglobin (Hb) concentration was determined using calorimetric method described by Wany (1922) and total red blood cells (RBC`s) and total white blood cells (WBC`s) were counted using haemocytometer.

Plasma protein (PP) concentration was determined according to the method recommended by Gornall *et al.* (1949), total lipids (Zollner and Kirsch, 1962) and total cholesterol (Watson, 1960).

Data were statistically analysed as one-way analysis of variance using Statgraphic Statistical Graphics System Software (Statgraphics, Version 5.0, *Rockville, 1991).*

RESULTS AND DISCUSSION

Chemical composition of untreated and spent roughages are presented in Table 1. The CP and ash content increased but CF, EE and OM decreased in all spent roughages. The results were in agreement with findings of Langar *et al.* (1980); Mohsen, (1981); Shoukry *et al.* (1985) and Badr (1993).

Table 1. Chemical composition of the different roughages before and after spawning with Mushroom fungi *(Pleurotus Ostreatus)* and concentrate mixture

Items	Wheat straw		Rice straw		Sugar cane bagasse		Corn stalks		Concentrate mixture
	Raw	Spent	Raw	Spent	Raw	Spent	Raw	Spent	
DM %	91.50	91.75	91.04	92.44	92.48	92.28	91.86	86.59	90.07
Dry matter composition %									
OM	92.07	78.20	87.91	73.87	94.36	81.11	91.50	85.22	89.58
CP	2.65	9.81	2.39	8.36	1.58	9.78	4.65	8.99	13.42
CF	38.96	30.04	35.09	22.79	46.35	28.01	41.20	27.25	12.42
EE	1.12	0.68	1.04	0.85	2.13	0.72	1.15	0.70	2.99
Ash	7.93	21.80	12.08	26.13	5.64	18.89	8.50	14.78	10.42
NFE	49.34	37.67	49.40	41.87	44.30	42.60	44.50	48.28	60.75

Gupta and Langar (1988) observed an increase in CP content from 3.25 to 8.33% after treated wheat straw by *Pleurotus Florida* fungi. Furthermore, Shoukry *et al.* (1985) found that CP content increased and CF decreased in fermented sugar cane bagasse with different fungi species. In the present study the higher CP content in all spent roughages may be due to the materials used with roughages in the preparation of the media such as rice bran and wheat bran and incubation time. The decrease in CF and EE in spent roughages might be attributed to the effect of fungal growth and pasteurization and other chemical pretreatments which could affect crude fiber content of roughage and increase nutrient availability for rumen microflora Badr (1993). Ash content of all spent roughages increased as a result of the decrease in organic matter utilized by fungi (Zadrazil, 1980).

As shown in Table 2. intake of both concentrate mixture and total feed intake (Kg/head/day) as well as roughage intake (%) slightly increased for all goats groups fed spent roughages compared to the control group, but these increases were insignificant, these results which might be due to Mushroom fungi improved palatability of spent roughages. Badr (1993) indicated that the nutritional quality of lignocellulosic by-products could increased by microbial treatment, also improved roughages palatability and dry matter intake by ruminants. On the other hand, DMI decreased with increasing level of spent roughage in the diets of ruminants (Langer *et al.*, 1982 and Badr 1993).

The present study showed that all rations containing spent roughage were higher ($P<0.01$) CP content than the control rations. The OM content decreased ($P<0.01$), while ash content increased ($P<0.01$) for rations 2,3 and 4 compared to the other rations. The CF content was lower ($P<0.01$) for ration 3 than the other rations, but the NFE content decreased ($P<0.01$) for rations 2, 3 and 4 compared to the control ration. The differences in the chemical composition of experimental rations which might be due to slightly differences in concentrate mixture and total feed intake as well as roughage percentage in

the rations. The chemical composition of spent roughages and concentrate mixture discussed previously with Table 1.

Table 2. Intake and chemical composition of total feed intake consuming by goats

Items	Rations					
	I	II	III	IV	V	SEM
Concentrate mixture, Kg	0.546	0.619	0.614	0.615	0.608	0.032
Roughage intake, Kg	0.146	0.199	0.198	0.218	0.219	0.036
Total feed intake, Kg	0.692	0.818	0.812	0.834	0.827	0.065
Roughage intake, %	21.15	23.77	23.84	25.82	26.22	2.650
Chemical composition (on DM basis)						
OM	87.67^{a}	85.48^{b}	84.46^{c}	86.07^{b}	87.14^{a}	0.269
CP	10.06 ^{b}	11.54 ^{a}	11.23 ^{a}	11.48 ^{a}	11.26 ^{a}	0.121
CF	18.84 ^{a}	18.16 ^{a}	16.42 ^{b}	17.95 ^{a}	17.79 ^{a}	0.365
EE	2.60	2.34	2.47	2.45	2.38	0.064
NFE	56.18 ^{a}	53.44 ^{c}	54.34 ^{bc}	54.20 ^{c}	55.63 ^{ab}	0.444
Ash	12.37 ^{c}	14.52 ^{b}	15.54 ^{a}	13.93 ^{b}	12.94 ^{c}	0.269

a, b,c Means within a raw with different superscripts are significantly different at ($P<0.01$)

Digestibility of CP significantly increased ($P<0.05$) in all rations containing spent roughages except ration 2 compared to the control group (Table 3). Higher CP digestibility may be due to higher CP content in spent roughage compared with raw roughage. Zadrazil (1975) reported that the biological treatment of straw as well as other fibrous roughage led to increase the CP content and digestibility when conditions for treatment were appropriate. The NFE in group 5 showed the lowest digestibility (79.13%) compared with control group (86.12%).

Table 3. Nutrient digestibilities (%) of different tested rations consumed by goats

Items	Rations					
	I	II	III	IV	V	SEM
DM	68.85	69.92	71.73	70.25	67.42	2.46
OM	69.62	73.19	75.56	72.42	71.27	3.00
CP	64.33 ^{b}	71.3 ^{ab}	73.29 ^{a}	72.89 ^{a}	75.89 ^{a}	2.35
CF	36.21	47.92	48.68	41.80	42.08	5.59
EE	87.13	83.95	88.44	86.88	83.12	1.80
NFE	86.12^{a}	81.62 ^{ab}	83.53 ^{ab}	81.78 ^{ab}	79.07 ^{b}	1.58

1. Rice straw +concentrate mixture 2. Spent wheat straw +concentrate mixture 3. Spent rice straw +concentrate mixture 4. Spent sugar cane bagasse +concentrate mixture 5. Spent corn stalks +concentrate mixture

a, b, Means within a raw with different superscripts are significantly different at ($P<0.05$)

Data presented in Table 4, showed higher digestible crude protein (DCP) in all rations containing spent roughage (8.21-8.36%) compared with the control ration (6.46%), this may be due to a higher protein CP content and digestibility in these rations. Fungal treatments were reported to increased CP digestibility (Gomez-Alarcon *et al.*, 1990 and Zadrazil, 1975). In the present study the differences among the experimental treatments were not significant (P>0.05) for TDN and SV. Values of TDN were nearly similar to the findings of Bakshi and Langar (1985). On the other hand, Ahuja *et al.* (1986) observed that the inclusion of spent wheat straw in the rations decreased the feeding value for these rations.

Table 4. Effect of Mushroom fungi treatments on the nutritive value for different experimental rations

Items	Rations					
	I	II	III	IV	V	SEM
DCP%	6.46[b]	8.27[a]	8.23[a]	8.36[a]	8.21[a]	0.21
TDN%	66.81	61.69	66.55	64.98	64.50	1.70
SV%	55.20	59.24	60.77	59.00	58.57	1.88

a, b, Means within a raw with different superscripts are significantly different at (P<0.05).

The data presented in Table 5, indicated that the average values of nitrogen balance (NB) were significantly higher (P<0.01) for groups fed rations containing spent roughage than the control group, the values were ranged from +5.26 to +6.82 g/day for treated groups being +2.96 g/day for the control group. These results were attributed to the higher nitrogen intake (P<0.05) and digestibility in these groups than in the control group. Data also indicated no significant differences (P>0.05) among the groups fed spent roughages.

Table 5. Average of nitrogen balance (g/day) and nitrogen retention (as % of total nitrogen intake) for bucks fed different rations

Items	Rations					
	I	II	III	IV	V	SEM
Av. Daily N. intake (g)	11.14[b]	15.12[a]	14.49[ab]	15.34[a]	14.92[a]	1.09
Av. Daily in feces (g)	3.99	4.24	3.85	4.13	3.67	0.40
Av. Daily in urine (g)	4.19[c]	4.53[bc]	3.82[c]	5.33[ab]	5.99[a]	0.35
Av. N. balance (g/day)	+2.96[c]	+6.35[ab]	+6.82[a]	+5.87[ab]	+5.26[ab]	1.17
Av. N. retention (as % of total N. intake)	25.24[b]	41.15[a]	46.01[a]	37.36[ab]	34.80[ab]	4.99

a, b, c, Means within a raw with different superscripts are significantly different at (P<0.05).

Generally, nitrogen balance values were positive for all experimental groups. Average nitrogen retention (as % of total N intake) was higher (P<0.01) in groups 2 and 3 (41.15 and 46.01%, respectively) compared to the control group (25.24%), but there were no significant differences among the groups fed spent roughages. The positive NB of the animals fed spent roughages were in agreement with findings of Langer *et al.* (1982) and Ahuja *et al.* (1986).

Data concerning ruminal fermentation are presented in Table 6. Values of ruminal pH were unaffected by Mushroom fungi treatments (P>0.05). However, lower values (P<0.01) of NH3-N concentrations were observed in groups 2 and 3 than the other groups (control or groups 4 and 5) this which may be due to the release of ammonia from the spent roughages in these groups were easier than spent wheat straw and rice straw or changes in rumen microbes activity for different spent roughages. Van Horn *et al.* (1979) and Badr (1993) reported that fungal treatments caused a reduction in ruminal NH3-N concentration. While, Arambel and Kent (1988) showed that the fungal treatments increased ruminal NH3-N. The main source of ruminal NH3-N is the degradation of dietary protein, hydrolysis of dietary non-protein nitrogen and recycled N via saliva or across the rumen wall (Badr, 1993).Total VFA`s concentrations in the rumen liquor of bucks were significantly higher (P<0.01) in all groups consumed spent roughages than the control group, the values were ranged from 5.80 to 6.94 mM/100 ml for bucks groups fed on spent roughages and 4.91 mM/100 ml for control group. In the present study higher VFA`s concentrations may be due to the little differences in the digestibility of OM or DM intake and higher protein digestibility among the experimental groups. Arambel and Kent (1988) reported that A.Orizae increased rumen ammonia and branched-chain VFA`s concentrations. Since A. Orizae promoted greater protein degradation and that branched-chain VFA`s are produced from protein degradation. Moreover, Huber *et al.* (1989) reported that the addition of yeast culture fungi to ruminant diets increased the concentrations of VFA`s formed to provide metabolizable energy and stimulate protein synthesis in the rumen.

Table 6. Average values of pH, NH3-N and total VFA`s in rumen liquor for bucks fed the different experimental rations

Items	Rations					
	I	II	III	IV	V	SEM
pH	6.63	7.07	6.55	6.33	6.56	0.13
NH3-N (mg/100 ml.)	19.6[a]	14.9 [b]	13.5 [b]	22.5 [a]	21.3 [a]	1.03
VFA`s (mM/100 ml)	4.91 c	6.82 [a]	6.94 [a]	5.80 [b]	6.74 [a]	0.16

a, b, c, Means within a raw with different superscripts are significantly different at (P<0.05)

As shown in Table 7. Bucks fed on ration 3 showed significantly higher (P<0.01) blood haemoglobin, plasma protein, total lipids and cholesterol concentrations than those fed either treated or untreated rations. However, the control group showed the lowest values. Furthermore, RBC`s counts significantly increased (P<0.01) from 6.55×106/mm3 for control group to 10.25×106/mm3 for group 5. While WBC`s counts significantly increased (P<0.05) from 5.92×103/mm3 for group 3 to 8.32×103/mm3 for control group. On the other hand, bucks fed other rations (2, 4 and 5), their blood parameters showed intermediate values between group 3 and group 1 (control). The highest concentrations of blood components in group 3 were associated with the high protein digestibility and retention. The addition of yeast culture to the diets of ruminants was reported to increased the quantities of VFA`s formed to provide metabolizable energy and stimulate protein and lipids synthesis in the rumen in order to improve the supply of amino acids and other nutrients to blood stream (Huber *et al.*, 1989 and Yousef *et al.*, 1996).

Table 7. Average values of some blood constituents in goats fed the different rations

Items	Rations					
	I	II	III	IV	V	SEM
RBCs N×106/mm^3	6.55^{c}	8.07^{bc}	9.48^{b}	9.43^{b}	10.25^{a}	0.54
WBCs N×103/mm^3	8.32^{a}	6.93^{ab}	5.92^{b}	6.83^{ab}	7.46^{a}	0.47
Haemoglobin g%	11.04^{c}	13.05^{b}	14.78^{a}	11.82^{bc}	13.00^{b}	0.52
Plasma protein g%	7.55^{b}	8.54^{ab}	9.22^{a}	8.00^{ab}	7.72^{b}	0.42
Total lipids mg %	700.0^{c}	885.5^{b}	951.5^{a}	848.5^{b}	818.2^{bc}	42.9
Cholestrol mg %	114.5 d	122.2^{c}d	146.5^{a}	136.9^{ab}	132.1^{bc}	3.52

a, b, c,d, Means within a raw with different superscripts are significantly different at (P<0.05)

As described by Rowlands (1980) dietary protein can affect on the concentrations of blood protein and other contents, therefore, low concentrations of protein and other constituents in blood of animal is more likely to indicate protein deficiency in the ration as appeared in the control ration (low CP content). Generally, the results of blood parameters in the present study were within the normal range as described by Reece (1991).

The present study indicated that spent of each wheat straw, rice straw, corn stalks and sugar cane bagasse produced as waste after harvesting of Mushroom fungi (*Pleurotus Ostreatus)* could be used in goats feeding.

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تأثير تغذية المخلفات الناتجة من زراعة عيش الغراب علي مستوي أداء الماعز

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إستخدم في هذه الدراسة ١٥ من ذكور الماعز البلدي (الجديان) متوسط وزنها ٤٠كجم و متوسط عمرها ٣ سنوات وذلك لأجراء خمسة تجارب هضم لدراسة تأثير إستخدام مخلفات زراعة عيش الغراب على كل من القيمة الغذائية و معاملات هضم المركبات الغذائية المختلفة لهذه المخلفات كما تم تقدير بعض قياسات سائل الكرش و الدم وميزان الأزوت. حيث استخدمت هذه المخلفات بعد تنمية الفطر عليها وحصاده في تغذية ذكور الماعز البلدي. قسمت الماعز عشوائيا إلى خمسة مجموعات متساوية (٣ جديان بكل مجموعة) و تم تغذية كل مجموعة على إحدى العلائق الآتية:

١- قش الأرز (مجموعة المقارنة) ٢- تبن قمح معامل بالفطر

٣- قش أرز معامل بالفطر ٤- مصاصة قصب معاملة بالفطر

٥- حطب ذرة معامل بالفطر

جميع الحيوانات كانت تغذى على المادة المائئة بنسبة ١ %من وزنها وتكمل بقية احتياجاتها الحافظة بمخلوط العلف المركز وأظهرت الدراسة النتائج الآتية:

١-معاملة مواد العلف الخشنة الفقيرة بفطر عيش الغراب أدت إلى زيادة محتواها من البروتين الخام و الرماد ولكنها قللت محتواها من كل من الألياف الخام و المستخلص الأثيري و المادة العضوية مقارنة بتلك المخلفات الغير معاملة بالفطر.

٢- إزداد معامل هضم البروتين الخام معنويا (عند مستوى ١٪) في معظم العلائق المحتوية على المخلفات المعاملة بالفطر مقارنة بالعليقة الكنترول. بينما لم تلاحظ أي اختلافات معنوية بالنسبة لكل من المادة الجافة المأكولة ومعاملات هضم كل من المادة الجافة والمادة العضوية والألياف الخام والمستخلص الأثيري.

٣- إزداد البروتين الخام المهضوم والأزوت المحتجز معنويا (عند مستوى ١٪) بالنسبة لكل المجموعات المغذاة على المخلفات المعاملة بالفطر ولكن لم تلاحظ أي فروق معنوية بالنسبة لكل من مجموع المركبات الغذائية المهضومة ومعادل النشا بين المجموعات المختلفة.

٤- لم يلاحظ أي فروق معنوية بين المعاملات المختلفة في درجة حموضة سائل الكرش بينما انخفض تركيز نيتروجين الأمونيا معنويا (عند مستوى١٪) في المجموعتين الثانية والثالثة. وكذلك ارتفع تركيز الأحماض الدهنية الطيارة الكلية معنويا في كل المجموعات المغذاة علي المخلفات المعاملة بالفطر مقارنة بالكنترول.

٥- أوضحت قياسات الدم أن تركيز بروتين البلازما و الليبيدات الكلية ازداد معنويا (عند مستوى ١٪) بالنسبة للمجموعة الثالثة وكذلك ازداد تركيز الكولسترول معنويا في المجموعتين الرابعة والخامسة مقارنة بالكنترول. كما ازداد تركيز الهيموجلوبين معنويا بالنسبة للمجموعات رقم2,4,5 مقارنة ببقية المجموعات.ازداد عدد كرات الدم الحمراء معنويا (عند مستوي ١٪) في المجموعات رقم ٣ ، ٤ ، ٥ وكذلك ازداد عدد كرات الدم البيضاء معنويا (عند مستوى ٥٪) بالنسبة للمجموعتين الثانية والخامسة مقارنة بالكنترول.

واستنتج من البحث أنة يمكن استخدام مخلفات زراعة عيش الغراب بنجاح في تغذية الماعز نظرا لأن المعاملة بالفطر تغير من طبيعة هذه المخلفات وتحسن قيمتها الغذائية وبصفة خاصة البروتين الخام المهضوم والأزوت المحتجز كما تقلل من محتوي هذه المخلفات من الألياف الخام الصعبة الهضم وأيضا تحسن هضمها.