EFFECT OF DIETS CONTAINING SOME BIOLOGICALLY TREATED CROP RESIDUES ON PERFORMANCE OF GROWING SHEEP

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SUMMARY

The present study was done to investigate the best method to improve the nutritive values of some crop residues by biological treatments through two experimental trials. In the first trial bean and rice straws, corn stalks and sugarcane bagasse were treated with brown-rote fungi (*Trichoderma reesei* F-418) or white-rote fungi (*Phanerochaete chrysosporium*) for 3 incubation periods (7, 14 and 21 days). The tested treatments were followed through *in-vitro* DM and OM disappearance. In the second trial, twenty Barki lambs averaged 34 kg body weight, 9 months old were divided into 4 groups of 5 in each according to live weight for 90 days trial to study the growth performance through 4 rations, C (CFM + berseem hay), T1 (CFM + BS treated with *T. reesei*), T2 (CFM+ BS treated with *T. reesei* and *S. cerevisiae*) and T3 (CFM + untreated BS supplemented with probiotic). Also, nutrients digestibilities and nutritive values of the previous rations were studied using four Rahmany rams (4X4) latin square. Results exhibited that incubation of crop residues with *T. reesei* for 14 days decreased contents of CF, NDF and ADF by 33.7, 14.4 and 10.0% and increased CP by 294.4%, respectively. The corresponding values were 22.2, 10.2, 7.2 and 247.6% with *Ph. chrysosporium*. The data indicated that the highest IVDMD and IVOMD were noticed when bean straw was treated with *T. reesei* being 57.4 and 45.3%, respectively. Insignificant differences in final body weight, growth rate and feed conversion were detected among treatments. Average daily body gain did not significantly differ between T2 and control, but it was decreased with T1 and T3. Inclusion of BS treated either with *T. reesei* alone (T1) or *T. reesei* and *S. cerevisiae* (T2) in sheep rations improved digestibilities of CF, CP, NDF, ADF and cellulose and DCP. The combination between *T. reesei* and *S. cerevisiae* (T2) was more efficient in increasing digestibilities of CF, CP, NDF, ADF, hemicellulose, cellulose and ADL and DCP compared with *T. reesei* alone (T1). Supplementation of untreated BS ration with probiotic increased digestibilities of CF, CP and cellulose compared with control. It may be concluded that treatment of bean straw with *T. reesei* and *S. cerevisiae* for 14 days seemed to be more suitable for improving its nutritive value to be used in practical feeding.

Keywords: crop residues, biological treatments, chemical composition, in-vitro, digestibility, performance

INTRODUCTION

Shortage in animal feeds has been found to have a negative impact on animal production in Egypt. Therefore, more attention was given to crop residues and agroindustrial by-products that generate plentiful and inexpensive resources available around the year. Al-Asfour (2009) mentioned that only one third of 30 million tons of crop residues, resulted in Egypt annually, are used for ruminant feeding. While, the rest are used in another purposes or burned leading to environmental pollution and consequently health hazards (El-Tahan *et al.*, 2003)

These crop residues are poor in nutritive value when used for ruminants owing to their low protein content, high fiber content and hence low palatability. Biological treatments have been used to breakdown the linkage between cellulose and lignin and as a means to the nutritive value of such crop residues (Abdul Aziz *et al.*, 1997; El-Sayed *et al.*, 2001; El-Ashry *et al.*, 2002; Allam *et al.*, 2006 and Gado *et al.*, 2006).

Meanwhile, probiotics have been recently used in animal feeds for improving their performance. Many of the beneficial productive responses are related to probiotic effects on the microbial population in the digestive tract (Nahashon *et al.*, 1992). Probiotics regulate the microbial environment of the intestine, decrease digestive disturbances, inhibit pathogenic intestinal microorganisms and improve feed conversion efficiency and health (Windschitl, 1992). Several researchers observed that direct-fed microbial (probiotics) increased cellulolytic bacterial number in the rumen and stimulate the production of some fermentation end products (Martin and Nisbet, 1992).

The present study aimed to (1) investigate the ability of biological treatments to improve the chemical composition of some crop residues (bean and rice straws, corn stalks and sugarcane bagasse) and the suitable incubation period using brown-rote fungi (*Trichoderma reesei* F-418) or white-rote fungi (*Phanerochaete chrysosporium*) by *in-vitro* study. (2) Evaluate the effect of using the more suitable crop residues in sheep ration alone or supplemented with probiotic on digestibility and growth performance.

MATERIALS AND METHODS

This study was carried out in Animal Production Department, Faculty of Agriculture, Cairo University and Microbial Chemistry Department, National Research Center, Dokki, Giza, Egypt, during summer 2008.

The first experiment (laboratory study):

Crop residues preparation:

Four different agricultural by-products (bean and rice straws, corn stalks and sugarcane bagasse) were chopped to lengths of 1-3 cm.

Microorganisms:

Trichoderma reesei F-418, *Phanerochaete chrysosporium* were obtained from Microbial Chemistry Laboratory, National Research Center, Dokki, Cairo, Egypt. The cultures were maintained on Potato Dextrose Agar (PDA) medium.

Fungal treatment of crop residues:

Three days old slants cultures of *Trichoderma reesei* F-418 and *Phanerochaete chrysosporium* were crushed in flasks containing 20 ml of sterilized water. The fungal spores suspension were used as inoculums at 10% v/w to inoculate 500 ml capacity flasks containing 25 g of ground waste moistened at solid : liquid ratio of 1:2 with basal medium composed of sugarcane molasses; 25, urea; 2.0, potassium dihydrogen phosphate; 0.2 and magnesium sulfate; 0.3 (g/L). The inoculated flasks were incubated at 30 °C for 7 days under static solid-state fermentation system.

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

In-vitro dry matter and organic matter disappearance:

The *in-vitro* DM and OM disappearance for untreated and treated crop residues either with *T. reesei* or *Ph. chrysosporium* for 14 days were carried out according to Naga and El-Shazly (1963) modified by Norris *et al.* (1976).

The second experiment (growth trial):

According to the results in first experiment, growth trial was carried out to test the effect of including bean straw treated by *T. reesei* for 14 days without or with *S. cerevisiae* compared with supplemented probiotic (Bacillozym) in rations for growing lambs.

Preparation of bean straw:

Bean straw was obtained from The Agriculture Experimental and Researches Station, Faculty of Agriculture, Cairo University and chopped at 1-3 cm using a chopper machine and divided into three piles (untreated, treated with fungi alone or treated with fungi and yeast).

Biological treatments of bean straw in large scale (under the farm conditions):

A heap of 150 kg of the tested chopped bean straw were moistened with medium containing: 2.5% molasses, 2.0% urea, 1.0% 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 bean straw.

Another heap of 150 kg of the tested chopped bean straw were moistened with previous medium at solid: liquid (1:2). The fungal biomass was used at 10% (w/w) and commercial dry active *Saccharomyces cerevisiae* (9×10^9 cell/g) was used at 0.1% (w/w), mixed well in mineral medium container, spread and mixed well with bean straw.

The two heaps of treated bean straw were shuffled up side down at intervals 48 h. The treated residue was exposed to sun dry until the moisture content reached less than 10%, then packed and stored until used in feeding trials.

Experimental animals:

Twenty Barki lambs averaged 34 kg body weight; 9 months old were divided into 4 groups of 5 each according to live weight for 90 days trial.

Tested rations:

All animal groups were offered 2.8% of their LBW concentrate feed mixture (Ghoniem, 1964), while roughages were offered *ad lib* as follows:-

C (control ration): berseem hay,

T1: bean straw treated with *T.reesei*,

T2: bean straw treated with *T.reesei* and *S. cerevisiae*

T3: bean straw supplemented with probiotic (3 g/h/d of Bacillozym) at the time of feeding.

The concentrate feed mixture (CFM) consists of 65% whole yellow corn, 15% wheat bran, 15% soybean meal, 1.2% premix, 0.8% common salt and 3% limestone.

The commercial probiotic (Bacillozym) used in this study was mixed manually with CFM daily. The ingredients in the probiotic pack (per 1 kg):- *Bacillus subtills* (0.75×10^{10} CFU), cellulase enzyme (15000 enzyme unit), protease enzyme (187500 enzyme unit), alfa- and ß- amylase enzymes (300000 and 15000 enzyme unit, respectively) and *S. cerevisiae* (200×10^{10} cell).

Feeding system:

The growing lambs were fed CFM and roughages twice daily and water was allowed freely all the time. Orts were collected just before offering the next day's feed. Lambs were weighed biweekly before morning feeding after 17 h fasting. The CFM was adjusted biweekly according to body weight changes.

Metabolism trials:

Four Rahmany rams were used to evaluate the experimental rations through metabolism trails (14 days for adaptation and 6 days for sampling collection) using (4X4) latin square design. The animals were individually fed in metabolic cages. During this trial the experimental rations were offered at 2% of LBW (70% CFM and 30% roughages). Drinking water was freely available.

Analytical methods:

Chemical composition of untreated and treated crop residues, experimental rations and feces were determined according to A.O.A.C. (1990). Meanwhile, fiber fractions were determined according to Van Soest and Wine (1967).

Statistical analysis:

All data in first and second trails were statistically analyzed by two-way and one-way Analysis of Variance (ANOVA), respectively. Data were statistically compared according to Duncan (1955). The Duncan's Multiple Range Test (DMRT) has been done at the 5% level of probability using The General Linear Models Procedure of SAS (1986).

RESULTS AND DISCUSSION

I- The first experiment:

1- Chemical composition of crop residues:

The results in Tables 1 and 2 showed that bean straw was the highest content of hemicelluloses and cellulose being 28.0 and 40.0%, respectively. Lignin contents were similar in all untreated crop residues. The bean straw and corn stalks have similar CP contents being 4.3 and 4.2 %, respectively. The same observation was found with sugarcane bagasse and rice straw being 1.6 and 1.6%, respectively.

Data indicated that biological treatments either with *T. reesei* or *Ph. chrysosporium* decreased the OM, CF, NDF, ADF, hemicellulose and cellulose and increased CP and ash contents in all the experimental crop residues. The improvement in the chemical composition of lignocellulosic residues may be a result of the action of enzymes secreted by fungus *i.e* cellulases, hemicellulases and lignolytic enzymes. These results are coincide with those obtained by Fadel (2001) who illustrated that these enzymes hydrolyse the biopolymer to fermentable sugars used as carbon source for fungal growth to produce biomas enriching the treated crop residues. Similar results were recorded by El-Ashry *et al.*, (2002), Kholif *et al.*, (2005) and Mahrous (2005).

The highest increase in CP content was achieved by treating bean straw with *T. reesei* being 14.9 and 15.1% after 14 and 21 days fermentation, respectively. This could be attributed to the high CP content in untreated bean straw (4.3%) that stimulates fungus to secrete enzymes such as cellulase and hemicellulase to produce fermentable sugars used for fungal growth. The high hemicellulose and cellulose contents in untreated bean straw compared to other residues stimulated also the fungal growth.

It was observed that crop residues treated with *T. reesei* were higher in ADL and lignin contents than those untreated or treated with *Ph. chrysosporium*. This could be attributed to lack of peroxidase enzyme that hydrolyzes lignin in *T. reesei*. Meantime, the increase in ADL may be due to the lignin like substances formed through the fermentation as suggested by Kerem *et al.*, (1992).These results also coincide with those obtained by Abedo *et al.*, (2005) who found that treatment with *T. reesei* increased the ADL content of sugar beet pulp. On the other hand, the peroxidase produced by *Ph. chrysosporium* was more effective in reduction of lignin by about 6.4 to 33.5% in treated crop residues.

By increasing incubation time of crop residues, the CP and ash contents increased while the contents of OM, CF, NDF, ADF, hemicelluloses and cellulose decreased either with *T. reesei* or *Ph. chrysosporium*. El-Gamal (2006) found that CP and ash contents increased, while OM and CF contents of sugarcane bagasse, linseed straw, linseed and peanut hulls decreased with increasing of incubation time from 1 to 10 days with *T. reesei.*

The present results indicate that biological treatments either with *T. reesei* or *Ph. chrysosporium* for 14 or 21 days incubation periods improved chemical composition and fiber fraction of crop residues. While the incubation period for 21 days had little more effect than 14 days on improving chemical composition, 14 days incubation period may be recommended when we consider that there is one week differences.

Table (1): Effect of the biological treatment with *T. reesei F-418* and incubation period on chemical composition of different crop residues.

Item	*T. reesei F-418*															
	Bean straw				Sugarcane bagasse				Corn stalks				Rice straw			
	Untreated	Incubation period (days)			Untreated	Incubation period (days)			Untreated	Incubation period (days)			Untreated	Incubation period (days)		
		7	14	21		7	14	21		7	14	21		7	14	21
DM	94.2^{ab}	94.1	93.8^{abc}	92.3^{de}	95.0^{a}	94.1^{abc}	93.8^{abc}	93.1^{bcd}	93.6^{abcd}	92.6^{cde}	94.1^{abc}	94.4^{ab}	91.6^{e}	93.2^{bcd}	94.4^{ab}	94.6^{ab}
	±0.19	±0.1	±0.35	±0.91	±0.08	±0.46	±0.55	±0.45	±0.23	±0.64	±0.47	±0.25	±0.68	±0.17	±0.29	±0.49
OM	87.4^{bcd}	85.7	84.8^{efg}	83.9^{fgh}	90.6^{a}	87.8^{bc}	83.7^{fgh}	83.5^{gh}	88.4^{ab}	87.2^{bcde}	85.2^{defg}	84.9^{defg}	88.6^{ab}	85.2^{defg}	82.7^{gh}	81.9^{h}
	±0.40	±0.4	±0.21	±1.44	±1.36	±0.57	±0.21	±0.23	±0.69	±0.09	±0.58	±0.41	±1.44	±1.00	±0.72	±0.41
CP	4.3^{g}	8.9^{e}	14.9^{a}	15.1^{a}	1.6^{h}	6.3^{f}	10.9^{d}	11.1^{cd}	4.2^{g}	8.6^{e}	12.1^{bc}	12.6^{b}	1.6^{h}	4.9^{g}	8.3^{e}	9.3^{e}
	±0.10	±0.7	±0.64	±0.12	±0.16	±0.23	±0.86	±0.18	±0.24	±0.15	±0.18	±0.58	±0.13	±0.43	±0.35	±0.17
CF	42.6^{e}	38.1	35.2^{f}	32.3^{g}	49.9^{b}	35.1^{f}	22.2^{h}	21.6^{h}	51.4^{b}	47.3^{c}	36.1^{ef}	35.1^{f}	54.2^{a}	51.4^{b}	44.3^{d}	43.8^{d}
	±0.09	±0.2	±0.47	±0.35	±0.21	±0.35	±0.48	±0.17	±0.32	±0.78	±1.06	±0.71	±1.13	±1.80	±0.26	±0.19
EE	1.96^{a}	1.91	1.72^{b}	1.70^{b}	1.24^{c}	1.19^{c}	1.11^{c}	1.06^{c}	1.13^{c}	1.10^{c}	1.08^{c}	1.08^{c}	1.20^{c}	1.22^{c}	1.16^{c}	1.09^{c}
	±0.02	±0.0	±0.10	±0.17	±0.03	±0.03	±0.06	±0.01	±0.05	±0.03	±0.03	±0.02	±0.11	±0.05	±0.03	±0.02
Ash	12.6^{f}	14.3	15.2^{cde}	16.1^{bcd}	9.4^{g}	12.2^{f}	16.3^{bcd}	16.5^{abc}	11.6^{f}	12.8^{f}	14.8^{de}	15.1^{cde}	11.4^{f}	14.8^{de}	17.3^{ab}	18.1^{a}
	±0.34	±0.5	±0.24	±0.72	±0.44	±0.25	±0.54	±0.34	±0.28	±0.50	±0.51	±0.42	±1.01	±0.51	±0.31	±0.71
NFE	38.5^{c}	36.8	33.0^{f}	34.7^{e}	37.9^{c}	45.2^{b}	49.5^{a}	49.7^{a}	31.7^{fg}	30.2^{gh}	35.9^{de}	36.1^{de}	31.6^{fg}	27.7^{j}	28.9^{hi}	27.8^{j}
	±0.06	±0.2	±0.56	±0.18	±0.29	±0.28	±0.55	±0.30	±0.52	±0.47	±0.30	±0.54	±1.49	±0.64	±0.62	±0.56
Fiber fraction																
NDF	81.6^{a}	75.8	66.1^{f}	61.2^{gh}	73.1^{c}	68.4^{e}	62.4^{g}	59.9^{h}	75.9^{b}	71.1^{d}	65.8^{f}	61.4^{gh}	69.9^{de}	65.6^{f}	62.8^{g}	61.5^{gh}
	±0.08	±0.1	±0.53	±0.46	±0.47	±0.40	±0.85	±0.80	±0.77	±0.77	±0.47	±0.66	±0.81	±1.22	±0.48	±0.40
ADF	53.6^{a}	54.1	46.2^{g}	43.1^{h}	51.6^{bc}	49.9^{cd}	46.6^{fg}	45.8^{g}	52.8^{ab}	50.1^{cd}	48.1^{ef}	46.3^{g}	48.8^{de}	46.1^{g}	45.2^{g}	44.9^{g}
	±0.10	±0.4	±0.33	±0.58	±0.67	±0.57	±0.68	±0.12	±0.46	±0.81	±0.80	±0.92	±0.65	±0.74	±0.26	±0.20
ADL	13.6^{g}	15.9^{f}	18.5^{e}	19.1^{de}	20.2^{d}	22.5^{c}	25.3^{ab}	25.8^{a}	16.2^{f}	18.6^{e}	22.5^{c}	24.1^{b}	15.1^{f}	16.3^{f}	18.1^{e}	18.8^{e}
	±0.10	±0.1	±0.39	±0.59	±0.50	±0.39	±0.41	±0.08	±0.24	±0.45	±0.72	±0.36	±0.67	±0.60	±0.76	±0.32
Hemic	28.0^{a}	21.7	20.0^{def}	18.1^{ghi}	21.6^{bcd}	18.5^{fgh}	15.8^{j}	14.1^{k}	23.1^{b}	21.0^{cde}	17.7^{hi}	15.1^{jk}	21.1^{cde}	19.5^{efg}	17.6^{hi}	16.6^{ij}
	±0.33	±0.4	±0.36	±0.25	±0.04	±0.65	±0.17	±0.31	±0.86	±0.67	±0.69	±0.36	±0.98	±0.62	±0.45	±0.49
Cellulo	40.0^{a}	38.3	27.7^{fg}	24.0^{hi}	31.4^{de}	27.4^{fg}	21.3^{ij}	20.1^{j}	36.6^{bc}	31.5^{de}	25.6^{gh}	22.3^{ij}	33.7^{cd}	29.8^{ef}	27.1^{fgh}	26.1^{gh}
	±0.13	±0.8	±1.22	±3.02	±0.32	±0.29	±0.22	±0.48	±0.75	±0.29	±0.23	±0.98	±0.80	±0.92	±1.28	±0.67
Lignin	12.8^{defg}	13.6	14.2^{cde}	14.3^{cde}	11.8^{fg}	13.4^{cdef}	16.2^{b}	18.1^{a}	12.1^{fg}	13.6^{cdef}	14.6^{bcd}	14.8^{bc}	11.4^{g}	12.6^{efg}	14.5^{bcde}	15.1^{bc}
	±0.23	±0.2	±0.33	±0.27	±0.31	±0.42	±1.85	±0.16	±0.44	±0.18	±0.62	±0.33	±0.52	±0.23	±0.47	±0.07

Means followed by the same letter(s) within a row in each block are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

Table (2): Effect of the biological treatment with *Ph. chrysosporium* and incubation period on chemical composition of different crop residues.

Item	*Ph. Chrysosporium*															
	Bean straw				Sugarcane bagasse				Corn stalks				Rice straw			
	Untreated	Incubation period (days)			Untreated	Incubation period (days)			Untreated	Incubation period (days)			Untreated	Incubation period (days)		
		7	14	21		7	14	21		7	14	21		7	14	21
DM	94.2^{b}	93.2^{de}	92.1^{fg}	93.1^{de}	95.0^{a}	92.8^{def}	91.6^{g}	92.1^{fg}	93.6^{bcd}	93.1^{de}	92.5^{ef}	93.4^{cd}	91.6^{g}	92.8^{def}	94.1^{bc}	92.9^{def}
	±0.19	±0.37	±0.52	±0.41	±0.08	±0.19	±0.15	±0.06	±0.23	±0.08	±0.21	±0.08	±0.68	±0.22	±0.07	±0.25
OM	87.4^{abc}	86.8^{abc}	85.2^{bc}	84.1^{b}	90.6^{a}	89.3^{ab}	88.2^{abc}	87.9^{abc}	88.4^{abc}	87.9^{abc}	86.2^{abc}	85.9^{abc}	88.6^{abc}	86.3^{abc}	84.1^{b}	83.7^{b}
	±0.40	±0.48	±0.22	±0.15	±1.36	±0.12	±0.06	±0.14	±0.69	±0.21	±0.43	±0.15	±1.44	±0.49	±0.25	±0.21
CP	4.3^{f}	8.1^{d}	12.9^{a}	13.2^{a}	1.6^{g}	7.2^{e}	9.1^{c}	9.8^{c}	4.2^{f}	7.1^{e}	10.9^{b}	11.1^{b}	1.6^{g}	4.5^{f}	7.8^{de}	9.1^{c}
	±0.10	±0.29	±0.53	±0.15	±0.16	±0.02	±0.04	±0.08	±0.24	±0.08	±0.38	±0.08	±0.13	±0.15	±0.31	±0.02
CF	42.6^{e}	39.8^{g}	36.1^{j}	35.6^{j}	49.9^{c}	41.6^{f}	38.1^{h}	38.1^{h}	51.4^{b}	48.2^{d}	39.3^{g}	37.1^{i}	54.2^{a}	51.1^{b}	48.2^{d}	47.3^{d}
	±0.09	±0.37	±0.42	±0.20	±0.21	±0.11	±0.17	±0.07	±0.32	±0.03	±0.07	±0.17	±1.13	±0.22	±0.06	±0.07
EE	1.96^{a}	1.91^{ab}	1.88^{abc}	1.86^{abcd}	1.24^{bcde}	1.08^{e}	1.08^{e}	1.08^{e}	1.13^{e}	1.13^{e}	1.09^{e}	1.09^{e}	1.20^{cde}	1.20^{cde}	1.18^{de}	1.17^{de}
	±0.02	±0.04	±0.07	±0.04	±0.03	±0.03	±0.03	±0.01	±0.05	±0.02	±0.02	±0.01	±0.11	±0.03	±0.02	±0.01
Ash	12.6^{abc}	13.2^{abc}	14.8^{ab}	15.9^{ab}	9.4^{c}	10.7^{bc}	11.8^{abc}	12.1^{abc}	11.6^{abc}	12.1^{abc}	13.8^{abc}	14.1^{abc}	11.4^{abc}	13.7^{abc}	15.9^{ab}	16.3^{a}
	±0.34	±0.31	±0.12	±0.42	±0.44	±0.22	±0.13	±0.19	±0.28	±0.10	±0.26	±0.15	±1.01	±0.19	±0.17	±0.42
NFE	38.5^{a}	37.0^{ab}	34.3^{abc}	33.4^{abc}	37.9^{ab}	39.5^{a}	39.9^{a}	38.9^{a}	31.7^{abc}	31.5^{abc}	34.9^{abc}	36.6^{ab}	31.6^{abc}	29.5^{bc}	26.9^{c}	26.1^{c}
	±0.06	±0.19	±0.27	±0.12	±0.29	±2.04	±0.31	±0.03	±0.52	±0.10	±0.06	±0.10	±1.49	±0.08	±0.25	±0.06
								Fiber fraction								
NDF	81.6^{a}	76.1^{ab}	72.5^{ab}	70.3^{ab}	73.1^{ab}	69.9^{ab}	66.0^{ab}	64.2^{b}	75.9^{ab}	73.2^{ab}	67.4^{ab}	65.5^{ab}	69.9^{ab}	66.8^{ab}	64.0^{b}	63.2^{b}
	±0.08	±0.21	±0.15	±0.57	±0.47	±0.59	±0.09	±0.06	±0.77	±0.06	±0.06	±0.09	±0.81	±0.22	±0.18	±0.28
ADF	53.6^{a}	51.2^{ab}	50.2^{ab}	48.2^{ab}	51.6^{ab}	50.1^{ab}	48.3^{ab}	47.6^{ab}	52.8^{a}	51.8^{ab}	48.0^{ab}	47.2^{ab}	48.8^{ab}	47.2^{ab}	45.3^{b}	45.1^{b}
	±0.10	±0.54	±0.16	±0.39	±0.67	±0.33	±0.14	±0.23	±0.46	±0.34	±0.09	±0.41	±0.65	±0.15	±0.08	±0.09
ADL	13.6^{cdef}	13.5^{cdef}	12.9^{def}	11.4^{f}	20.2^{a}	19.9^{ab}	17.5^{abc}	16.3^{abcd}	16.2^{abcd}	16.0^{bcde}	12.4^{def}	11.8^{ef}	15.1^{cdef}	14.5^{cdef}	11.8^{ef}	11.4^{f}
	±0.10	±0.14	±0.17	±0.27	±0.50	±0.13	±0.14	±0.04	±0.24	±0.13	±0.15	±0.16	±0.67	±0.22	±0.12	±0.09
Hemicell	28.0^{a}	24.9^{ab}	22.3^{ab}	22.1^{ab}	21.6^{ab}	19.8^{ab}	17.7^{b}	16.6^{b}	23.1^{ab}	21.4^{ab}	19.4^{ab}	18.3^{b}	21.1^{ab}	19.6^{ab}	18.7^{ab}	18.1^{b}
	±0.33	±0.41	±0.14	±0.14	±0.04	±0.36	±0.13	±0.07	±0.86	±0.04	±0.31	±0.18	±0.98	±0.34	±0.06	±0.54
Cellulose	40.0^{a}	37.7^{a}	37.3^{a}	36.8^{a}	31.4^{a}	30.2^{a}	30.8^{a}	31.3^{a}	36.6^{a}	35.8^{a}	35.6^{a}	35.5^{a}	33.7^{a}	32.7^{a}	33.5^{a}	33.8^{a}
	±0.13	±0.32	±0.05	±0.47	±0.32	±0.06	±0.09	±0.16	±0.75	±0.03	±0.05	±0.06	±0.80	±0.24	±0.04	±0.25
Lignin	12.8^{a}	11.5^{abc}	9.2^{defg}	8.7^{fg}	11.8^{abc}	11.0^{abcd}	10.9^{abcde}	10.1^{cdef}	12.1^{ab}	10.4^{bcdef}	8.9^{fg}	8.1^{g}	11.4^{abc}	10.1^{cdef}	9.2^{defg}	9.1^{efg}
	±0.23	±0.26	±0.28	±0.09	±0.31	±0.03	±0.30	±0.04	±0.44	±0.10	±0.16	±0.09	±0.52	±0.05	±0.01	±0.05

Means followed by the same letter(s) within a row in each block are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

2- In-vitro OM and DM disappearance:

The results concerning *In-Vitro* OM and DM disappearance of crop residues after 14 days incubation either with *T. reesei* or *Ph. chrysosporium* are presented in Table (3).

Regarding feedstuff source, bean straw was significantly higher in IVDMD being 49.7%. While, both bean and rice straw recorded the highest values of IVOMD being 41.1 and 41.2%, respectively. These results may be due to the high CP content of bean straw compared with other crop residues.

Regarding fungi species, treatment with *T. reesei* had the higher significant effect on IVDMD and IVOMD being 51.1 and 41.2%. These results may be due to the increase in CP content by 294.4% and the decrease in CF content by 33.7% when crop residues were treated with *T. reesei* for 14 days. While treated with *Ph. chrysosporium* increased CP by 247.6% and decreased CF by 22.2%.

Data in Table (3) indicated that the highest IVDMD and IVOMD were obtained with bean straw when treated with *T. reesei*.

II- The second experiment:

1- Chemical composition:

Data of the chemical composition of CFM, tested roughages and experimental rations are presented in Table (4). Results indicated that biological treatments of bean straw either with *T. reesei* (FBS) or *T. reesei* and *S. cerevisiae* (FYBS) decreased contents of OM, CF, EE, NFE, NDF, ADF, hemicellulose and cellulose, and increased ash, CP and ADL contents compared with the untreated bean straw. The chemical composition of berseem hay (H) showed lowest contents of ash, CF, NDF, ADF, ADL, cellulose and lignin, and highest contents of OM, EE and NFE compared with bean straw either untreated or biologically treated. The data showed that rations including biologically treated bean straw (T1 and T2) had the highest ash and CP, the lowest OM, CF, NDF and hemicellulose contents, and almost the same contents of ADF, ADL and cellulose compared with the control ration. This could be attributed to the effect of biological treatments on increasing CP and ash contents and decreasing CF content and its fractions of bean straw. These results are in agreement with those obtained by Mahrous (2005) and Allam *et al.* (2006) when sheep rations included either cotton stalks treated biologically with *T. viride* or *Cheatomium cellublyticum* or sugar beet pulp treated with *T. viride* and *S. cerevisiae.* On the other hand, ration of untreated bean straw (T3) had the lowest CP and the highest OM, NDF, ADF, ADL and cellulose contents.

Table (3): Effect of feedstuff source, treatment and the interaction between feedstuff source and biological treatment on *in-vitro* DM and OM disappearance.

Item		IVDMD (%)	IVOMD (%)
Feedstuff source effect			
BS		49.7 ^{a} ± 2.67	41.1 ^{a} ± 1.72
SB		44.0 ^{c} ± 0.66	30.7 ^{c} ± 1.36
CS		46. 8 ^{b} ± 2.48	35.6 ^{b} ± 1.61
RS		42.6 ^{c} ± 2.53	41.2 ^{a} ±1.15
Treatment effect			
Control		37.9 ^{c} ± 1.15	32.2 ^{c} ± 1.17
T. reesei F-418		51.1 ^{a} ± 1.39	41.2 ^{a} ± 1.28
Ph. chrysosporium		48.3 ^{b} ± 0.96	38.0 ^{b} ± 1.81
Interaction feedstuff source × treatment effect			
Control feedstuffs	BS	39.7 ^{gh} ± 1.46	34.5 ^{e} ± 0.59
	SB	42.0 ^{fg} ± 1.10	27.6 ^{f} ± 0.54
	CS	37.1 ^{h} ± 0.76	29.7 ^{f} ± 0.61
	RS	33.0 ^{i} ± 1.57	37.2 ^{cde} ± 0.43
T. reesei F-418	BS	57.4 ^{a} ± 0.82	45.3 ^{a} ± 0.36
	SB	45.4 ^{e} ± 0.91	35.7 ^{de} ± 1.26
	CS	52.8 ^{b} ± 0.50	39.3 ^{c} ± 1.68
	RS	48.9 ^{cd} ± 0.93	44.4 ^{ab} ± 1.03
Ph. chrysosporium	BS	51.9 ^{bc} ± 0.36	43.6 ^{ab} ± 1.17
	SB	44.7 ^{ef} ± 0.11	28.7 ^{f} ± 0.92
	CS	50.5 ^{bc} ± 0.80	37.8 ^{cd} ± 1.02
	RS	46.0 ^{de} ± 1.25	42.1 ^{b} ± 0.96

Means followed by the same letter(s) within a column in each block are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

BS: Bean straw, SB: Sugarcane bagasse, CS: Corn stalks, RS: Rice straw, Control: Untreated feedstuffs

Table (4): Chemical composition of the experimental concentrate feed mixture, roughages and experimental rations (DM basis).

Items	Chemical composition, (%)											
	OM	Ash	CF	EE	CP	NFE	NDF	ADF	Hemicel.	ADL	Cellul.	Lignin
CFM	94.5	5.6	4.2	4.2	15.7	70.4	24.7	6.1	18.6	1.8	4.3	1.0
H	88.1	11.9	30.6	3.8	11.8	41.9	61.3	34.8	26.5	13.1	21.7	10.3
BS	86.4	13.6	45.7	1.7	3.8	35.3	84.5	56.7	27.8	15.6	41.1	13.5
FBS	82.4	17.6	39.2	1.7	11.4	30.1	69.5	50.9	18.6	18.7	32.2	14.4
FYBS	81.1	18.9	36.4	1.2	13.0	30.5	67.8	49.5	18.3	19.0	30.5	15.0
Experimental rations												
Control*	93.1	6.9	10.0	4.1	14.8	64.2	32.7	12.3	20.4	4.3	8.0	3.0
T1	92.7	7.3	9.3	3.8	15.1	64.5	31.3	12.6	18.7	4.3	8.3	2.9
T2	92.4	7.6	9.2	3.7	15.3	64.2	31.4	12.8	18.6	4.5	8.3	3.1
T3	93.2	6.8	10.5	3.8	13.9	65.0	33.7	13.7	20.0	3.9	9.8	2.8

CFM: Concentrate feed mixture (65% whole yellow corn, 15% wheat bran, 15% soybean meal, 1.2% premix, 0.8% common salt and 3% limestone).
H: Berseem hay. BS: Bean straw. FBS: Bean straw treated with fungi (*T. reesei F-418*).
FYBS: Bean straw treated with fungi (*T. reesei F-418*) and yeast (*Saccharomyces cerevisiae*).
* Control ration (Concentrate feed mixture + Berseem hay).
T1: Concentrate feed mixture + bean straw treated with fungi (*T. reesei F-418*).
T2: Concentrate feed mixture + bean straw treated with fungi (*T. reesei F-418*) and yea[illegible] *[illegible]charomyces cerevisiae*).
T3: Concentrate feed mixture + untreated bean straw supplemented with probiotic (Ba[illegible]).

2- Digestion coefficients and nutritive values:

The results in Table (5) showed that the highest digestibilities of CF, CP, NDF, ADF, hemicellulose and cellulose were recorded for ration containing biologically treated bean straw with *T. reesei* plus *S. cerevisiae* (T2) followed by bean straw treated with *T. reesei* alone (T1) compared with control. While, inclusion of treated bean straw either with *T. reesei* alone (T1) or combined with *S. cerevisiae* (T2) decreased the digestibilities of DM and NFE, and did not significantly affect the digestibilities of OM and EE compared with control ration. The improvement in CP, CF and fiber fractions digestibilities related to the biological treatments may be due to satisfaction of the requirements of nitrogen for rumen microflora as single cell protein and the action of fungi on lignocellulose bonds in bean straw. These results coincided with those obtained by Mahrous (2005) and Al Asfour (2009) who found that sheep rations containing either cotton stalks or wheat straw treated with *Trichoderma sp*. increased the digestibilities of CP, CF, NDF, ADF, hemicellulose and cellulose.

Including bean straw supplemented with probiotic (T3) in sheep rations tended to increase the digestibilities of CP, CF and cellulose, and decrease the digestibilities of DM, OM and NFE, but had no effects on digestibilities of NDF, ADF, hemicellulose and ADL compared with control ration. The increase in CF and CP digestibilities was in agreement with the results obtained by Khattab *et al.* (2003). The improvement in nutrients digestibilities may be resulting from the increasing in the numbers of bacteria, especially cellulolytic bacteria and fungi in the rumen (Ali, 2005).

Results indicated that biological treatments of bean straw (T1 and T2) increased the digestibilities of OM, CF, CP, NDF, ADF and cellulose compared with bean straw supplemented with probiotic (T3). While, no significant difference was observed in DMD, EED and NFED among the previous treatments.

Data indicated that rations containing bean straw (T1, T2 and T3) were lower in TDN than control. The decrease in NFE digestibility by rams fed these rations may be the reason. DCP was higher in T1 and T2, and lower in T3 compared with control and these results compatible with CP contents in these rations.

3- Growth performance:

No significant differences were detected between treatments in final body weight (FBW) and growth rate (Table 6). Also, total gain and average daily gain (ADG) did not differ significantly between control group and lambs fed ration containing bean straw treated with *T. reesei* and *S. cerevisiae* (T2), but was lower in T1 and T3. These results may be due to the highest intake of DM, TDN and CP and DM digestibility by lambs fed

Table (5): Digestion coefficients and nutritive values of the experimental rations (DM basis).

Item	Experimental rations			
	C	T1	T2	T3
Apparent digestibility, %				
DM	70.6 [a] ± 1.05	65.1 [b] ± 1.45	66.9 [b] ± 0.50	65.7 [b] ± 0.69
OM	78.1 [a] ± 0.59	76.1 [ab] ± 0.79	77.2 [ab] ± 0.62	75.5 [b] ± 0.55
CF	50.0 [d] ± 0.82	60.0 [b] ± 1.42	63.9 [a] ± 1.25	56.2 [c] ± 0.92
EE	79.2 ± 0.51	79.5 ± 0.65	79.2 ± 0.71	78.4 ± 0.79
CP	63.3 [d] ± 0.41	74.5 [b] ± 0.81	77.4 [a] ± 0.18	69.6 [c] ± 0.40
NFE	86.9 [a] ± 0.99	80.3 [b] ± 1.83	80.2 [b] ± 1.24	81.8 [b] ± 0.82
Fiber fractions:				
NDF	60.7 [c] ± 1.36	64.4 [b] ± 0.66	68.4 [a] ± 0.83	59.2 [c] ± 0.66
ADF	41.4 [bc] ± 0.20	43.5 [b] ± 1.12	48.9 [a] ± 1.38	38.7 [c] ± 0.54
Hemicellulose	67.9 [b] ± 0.90	69.9 [b] ± 0.34	73.4 [a] ± 0.81	69.1 [b] ± 1.40
ADL	21.6 [a] ± 1.27	16.0 [b] ± 1.69	17.1 [ab] ± 1.57	20.1 [ab] ± 0.92
Cellulose	39.1 [d] ± 0.16	56.0 [b] ± 0.49	61.9 [a] ± 0.48	52.5 [c] ± 0.58
Nutritive value, %				
DCP	9.2 [c] ± 0.07	10.7 [b] ± 0.11	11.5 [a] ± 0.02	8.5 [d] ± 0.03
TDN	76.3 [a] ± 0.56	72.5 [b] ± 0.72	73.1 [b] ± 0.53	72.8 [b] ± 0.55

Means followed by the same letter(s) within a row in each block are not significantly different (*P* = 0.05) according to Duncan's multiple range test.

C: Control ration (Concentrate feed mixture + Berseem hay), T1: Concentrate feed mixture + bean straw treated with fungi (*T. reesei F-418*), T2: Concentrate feed mixture + bean straw treated with fungi (*T. reesei F-418*) and yeast (*Saccharomyces cerevisiae*), T3: Concentrate feed mixture + untreated bean straw supplemented with probiotic (Bacillozym).

Table (6): Effect of the experimental rations on growth performance of sheep.

Item	Experimental rations							
	C		T1		T2		T3	
Initial live body weight (I.B.W), kg	34.2	±1.62	34.2	±3.44	34.4	±1.99	34.6	±2.25
Final live body weight (F.B.W), kg	54.2	±1.34	49.1	±3.45	52.5	±2.27	49.7	±2.36
Total gain, kg	20.0^{a}	±0.96	14.9^{b}	±1.30	18.1^{ab}	±0.84	15.1^{b}	±0.91
Daily gain[1], g	222.2^{a}	±10.7	165.6^{b}	±14.42	201.1^{ab}	±9.36	167.8^{b}	±10.2
Growth rate[2], %	58.5	±5.05	43.6	±7.36	52.6	±3.46	43.6	±4.13
Feed intake/day								
Concentrate (DMI), g	1216.0^{b}	±0.00	1115.0^{d}	±0.00	1250.0^{a}	±0.00	1141.0^{c}	±0.00
Roughage (DMI), g	338.0^{a}	±0.00	191.0^{d}	±0.00	230.0^{b}	±0.00	202.0^{c}	±0.00
Total DMI, g	1554.0^{a}	±0.00	1306.0^{d}	±0.00	1480.0^{b}	±0.00	1343.0^{c}	±0.00
TDN,g	1185.9^{a}	±0.32	946.7^{d}	±0.76	1081.9^{b}	±0.33	978.2^{c}	±0.49
TDN,g/kg $w^{0.75}$	69.4^{a}	±0.00	58.8^{b}	±0.00	64.3^{ab}	±0.00	59.7^{b}	±0.00
CP, g	230.6^{a}	±0.24	196.7^{c}	±0.55	226.1^{b}	±0.24	186.7^{d}	±0.36
CP, g/kg $w^{0.75}$	13.5^{a}	±0.00	12.2^{ab}	±0.00	13.4^{a}	±0.00	11.4^{b}	±0.00
Feed conversion, g/g								
DMI / daily gain	7.0	±1.61	7.9	±3.80	7.4	±2.32	8.0	±2.77
TDN intake / daily gain	5.3	±0.31	5.7	±0.79	5.4	±0.48	5.8	±0.53

Means followed by the same letter(s) within a row in each block are not significantly different ($P = 0.05$) according to Duncan's multiple range test.

[1] Daily gain: total gain,g / 90 days.

[2] Growth rate: total gain, kg / I.B.W., kg.

control ration followed by those fed T2. Total intake of DM, TDN and CP were found to be decreased with inclusion of bean straw either biologically treated (T1 and T2) or supplemented with probiotic (T3) compared with control. This could be attributed to the decrease in DMD and TDN in these rations. Abd-Allah (2007) showed that partial substitution of berseem hay by 10% corn cobs treated with *T. reesei* and *S. cerevisiae* did not affect FBW, ADG and DMI compared with control. While, lambs fed corn stover residue treated with *T. harizianum* and *S. cerevisiae* recorded higher ADG and almost the same FBW and DMI compared with those fed control ration (Abd El-Wahed, 2007).

It was indicated that combination of *T. reesei* with *S. cerevisiae* in biological treatments (T2) increased total gain, daily gain and total intakes of DM, TDN and CP compared with *T. reesei* alone (T1) or probiotic supplementation (T3). This result may be due to the highest DMD, OMD, DCP and TDN values with T2 compared with T1 and T3.

The feed conversion as DMI or TDN intake/daily gain did not differ significantly between treatments, but control group recorded the best values followed by T2. The same results were obtained by Abedo *et al.* (2005) and Allam *et al.* (2006).

CONCLUSION

Biological treatments with *T. reesei* was more effective in improving chemical composition and fiber fractions of some crop residues than *Ph. chrysosporium.* Combination between *T. reesei* and *S. cerevisiae* in biological treatments of bean straw could be successfully used to improve chemical composition, digestibility and growth performance compared with *T. reesei* alone or probiotic supplementation.

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تأثير استخدام بعض المخلفات الزراعية المعاملة بيولوجياً على أداء النمو في الأغنام

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[2] قسم الكيمياء الميكروبية- المركز القومي للبحوث- الدقي- الجيزة- مصر.

أجريت هذه الدراسة بهدف تحسين القيمة الغذائية لبعض المخلفات الزراعية باستخدام المعاملة البيولوجية. و قد أجرى البحث على مرحلتين هما:-

المرحلة الأولى: تم دراسة المعاملات البيولوجية لبعض المخلفات الزراعية (تبن الفول، قش الأرز، حطب الذرة و مصاصة القصب) باستخدام فطر العفن الأبيض (*Ph. chrysosporium*) أو العفن البني (*T. reesei*) مع التحضين لمدة ٧، ١٤ و ٢١ يوم لتحديد نوع الفطر ومدة التحضين الملائمة لتحسين التركيب الكيمياني و خواص الألياف لهذه المخلفات ، ثم اختيار أفضل معاملة من خلال تقدير معامل الهضم المعملي لكل من المادة الجافة (IVDMD) و المادة العضوية (IVOMD) للمواد تحت الدراسة. المرحلة الثانية: تم استخدام ٢٠ حمل برقى متوسط أوزانهم ٣٤ كجم عمر ٩ شهور لمدة ٩٠ يوم لدراسة أداء النمو عند التغذية على ٤ معاملات هي: المقارنة C (العلف المركز + دريس البرسيم)، T1 (العلف المركز + تبن الفول المعامل بفطر *T. reesei*)، T2 (العلف المركز + تبن الفول المعامل بفطر *T. reesei* والخميرة *S. cerevisiae*) و T3 (العلف المركز + تبن الفول الغير معامل + منشط حيوي).و كذلك تم دراسة معامل الهضم و القيمة الغذائية للعلائق السابقة باستخدام كباش رحماني بطريقة (٤ x ٤) مربع لاتيني. ومن نتائج المرحلة الأولى أدى تحضين المخلفات الزراعية لمدة ١٤ يوما إلى انخفاض في نسب الألياف الخام (CF)، الألياف الغير ذائبة في محلول الغسيل المتعادل (NDF) والحامضي (ADF) و زيادة نسبة البروتين الخام (CP) بنسب ٣٣,٧، ١٤,٤، ١٠,٠ و٢٩٤,٤% على التوالي عند المعاملة بـ *T. reesei* وكانت النسب ٢٢,٢، ١٠,٢، ٧,٢ و ٢٤٧,٦%، على نفس الترتيب عند المعاملة بـ *Ph. chrysosporium* . وكانت أعلى قيمة لمعامل الهضم المعملى للمادة الجافة (IVDMD) والمادة العضوية (IVOMD) عند معاملة تبن الفول بـ *T. reesei* ٥٧,٤ و٤٥,٣%، على التوالي بعد التحضين لمدة ١٤ يوما. ومن نتائج المرحلة الثانية يتضح أنه لا توجد فروق معنوية بين المعاملات في الوزن النهائي للجسم، معدل النمو و معدل التحويل الغذائي. متوسط الزيادة اليومية في الوزن لم تختلف معنويا بين T2 و الكنترول و لكنها انخفضت مع T1 و T3 . استخدام تبن الفول المعامل بيولوجيا سواء بفطر *T. reesei* فقط (T1) أو بفطر *T. reesei* والخميرة *S. cerevisiae* (T2) في علائق الأغنام أدى إلى تحسين معاملات هضم كل من الألياف الخام، البروتين الخام، الألياف غير الذائبة في محلول الغسيل المتعادل والسليلوز والقيمة الغذائية كالبروتين الخام المهضوم. المعاملة البيولوجية باستخدام فطر *T. reesei* والخميرة *S. cerevisiae* (T2) كانت أكثر كفاءة في زيادة معامل هضم كل من الألياف الخام، البروتين الخام، الألياف غير الذائبة في محلول الغسيل المتعادل والحامضى، الهيمسليلوز، السليلوز واللجنين غير الذائب في محلول الغسيل الحامضى والبروتين الخام المهضوم مقارنة بالمعاملة بفطر *T. reesei* فقط (T1) . إضافة المنشط الحيوي أدى إلى زيادة معامل هضم الألياف الخام، البروتين الخام والسليلوز مقارنة بالكنترول.

من النتائج السابقة يمكن استنتاج أن معاملة تبن الفول لمدة ١٤ يوما بفطر *T. reesei* والخميرة *S. cerevisiae* هي الأنسب لتحسين القيمة الغذائية والاستفادة منها في التغذية التطبيقية مقارنة بغيره من المخلفات الزراعية التي تم دراستها.