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EFFECT OF BIOLOGICAL TREATMENT ON CHEMICAL COMPOSITION AND *IN VITRO* DIGESTIBILITY OF SOME AGRICULTURAL BY-PRODUCTS

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ABSTRACT: ***This study was conducted to evaluate the effect of biological treatments on chemical composition, fiber fraction and in vitro digestibility of some low quality roughages i.e., wheat straw, rice straw, corn stalk and sugarcane bagasse. The experimental treatments were either 1 or 3 liters of ZAD compound added to 1000 litter water + 50 kg molasses and 20 kg urea for 1 ton of the feedstuff. The samples were treated with the ZAD compound and pressed in plastic bags (holding 1 kg) and closed for either one, two or four weeks. The results obtained reveal that CP content increased in all treated materials with all levels of ZAD. Values of CP were linearly increased as the time of ensiling increased. Biological treatment with ZAD caused a decrease in most fiber fraction especially with sugarcane bagasse; it improved IVDMD and IVOMD for all the tested roughages. The highest values were noticed with 3L ZAD for 4 wks ensiling time.***
Key words*: *Roughages, biological treatments, chemical composition, fiber fraction, in vitro digestibility

INTRODUCTION

The shortage in feedstuff in Egypt is one of the major constraints in the development of animal production. About 13.0 million tons of total digestible nutrients (TDN) are required per year, yet only 9.6 million tons are annually produced providing 75% of the livestock energy requirements (Abou-Akkada, 1984). During summer season, about 5.4 million tons TDN are required, yet only 3.7 million tons are annually produced presenting 64% of the energy requirements. Abou-Akknada (1984) More than ten years later (El-Shinnawy ,1998) estimated the production of crop residues (low quality roughages) to be approximately 15-22 million tons. Only 4-4.3 million tons out of this amount are used for feeding ruminants (Hathout and El-Nouby, 1998and Gado, 1997). These feeds are poor in protein, energy, minerals and vitamins. The ruminant productivity can be improved by enhancing the nutritive value of the poor quality crop residues (Devendra, 1985). Supplementing these roughages with microbial culture such as yeast and their effects on growth performance and feed utilization by livestock have been investigated by many nutritionists (El-Badawi *et al.,* 1998 and Metwally, 2001; El-Sheikh, 2007). Biological treatment is a new method for the improving the nutritive value of lignocelluloses materials which are the most abundant in

agricultural residues (El-Ashery *et al*., 2003). The present study was conducted in order to evaluate the effect of biological treatments on chemical composition, fiber fraction and *in vitro* digestibility of some low quality roughages i.e., wheat straw, rice straw, corn stalk and sugarcane bagasse.

MATERIALS AND METHODS

Control samples (untreated) of the tested roughages i.e., wheat straw, WS; rice straw, RS; corn stalks, CS and sugarcane bagasse, SC) were sun dried to about 90% DM. The experimental treatments were either 1 or 3 liters of ZAD compound added to 1000 litter water + 50 kg molasses and 20 kg urea for 1 ton of the feedstuff. The samples were treated with the ZAD compound and pressed in plastic bags (holding 1 kg) and closed for either one, two or four weeks. A biological material called ZAD was used in the present study. ZAD (patent on: 22155) is biotechnical product made from natural sources to elevated level of cellulase enzyme from anaerobic bacteria which convert the polysaccharide into monosaccharide by specific enzymes (cellulase, 8.2 u/gm; hemi-cellulase, 6.2 u/gm; amylase, 64.4 u/g and protease, 12.3 u/gm). It is produced in the Molecular Biology Lab, Animal Production Department, Ain-Shams University according to the procedure of Gado (1997).

The two stage technique of Tilley and Terry (1963) was used to study the *in vitro* dry matter (IVDMD) and organic matter (IVOMD) disappearances. Rumen Liquor was obtained from two fistulated rams kept on high quality hay. The fluid was strained through 4 layers of cheese cloth.

Samples of the untreated and treated roughages were ground and subjected in duplicate to proximate analysis according to A.O.A.C. (1990). Representative samples of the tested roughages, experimental rations and feces were analyzed for fiber fraction according to Van Soest (1969) to determine neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL). Data were statistically analyzed using SPSS (1999) analysis program version 11.5. The significant differences among individual means were analyzed by Duncan's multiple range test Duncan (1955).

RESUL21211TS AND DISCUSSION

Results in Table (1) indicated that DM content of wheat straw (WS) did not differ due to the biological treatment. The content of OM followed the same trend of DM. Value of CP was higher ($P<0.01$) for WS34 (12.99% vs. 3.57% for UTWS). Crude fiber contents decreased ($P<0.05$) from 45.85% in untreated to 41.95% in WS34. There was a decrease ($P<0.05$) in the NFE contents. Ash contents did not differ significantly among treatments ranging from 14.01 to 16.05%.

Values of DM of rice straw (Table 2) were not affected by ZAD treatment. Content of OM followed the same trend of DM. Values of CP were linearly increased as the time of ensiling increased. Crude protein increased ($P<0.01$)

due to the ZAD treatment. Also CF contents decreased (P<0.01) from 39.4% in untreated to 34.95% in RS34. There was also a decrease (P<0.05) in the NFE contents of treatments from 40.99% in UTRS to 36.08, 38.01, 32.19, 35.53, 38.22 and 34.08% for RS11, RS12, RS14, RS31, RS32 and RS34, respectively. Ash content ranged from 13.94 to 16.05%; difference was not significant.

Table 1: Chemical composition and *in vitro* digestibility of wheat straw as affected by biological treatments

Item	Treatments*							Sig.
	UTWS	WS11	WS12	WS14	WS31	WS32	WS34	
	------%------							
DM	91.91 ± 0.88	90.11 ± 1.00	91.21 ± 1.03	92.13 ± 1.13	90.25 ± 0.92	91.62 ± 0.76	91.88 ± 0.99	NS
OM	85.93 ± 1.12	84.70 ± 0.45	84.16 ± 1.00	84.01 ± 1.13	83.95 ± 0.52	84.22 ± 0.86	85.99 ± 1.45	NS
CP	3.57^{a} ± 0.29	5.81^{b} ± 0.66	8.98^{cd} ± 0.81	11.97^{e} ± 0.89	7.10^{bc} ± 0.37	9.35^{d} ± 0.59	12.99^{e} ± 0.56	0.01
EE	1.60 ± 0.21	1.67 ± 0.17	1.75 ± 0.27	1.88 ± 0.15	1.89 ± 0.11	1.95 ± 0.11	2.00 ± 0.07	NS
NFE	34.76^{d} ± 1.40	32.96^{cd} ± 0.64	29.42^{ab} ± 0.48	27.15^{a} ± 1.02	30.94^{bc} ± 0.81	29.61^{ab} ± 0.70	29.05^{ab} ± 1.19	0.05
Ash	14.07 ± 0.85	15.30 ± 1.12	15.84 ± 1.17	15.99 ± 0.70	16.05 ± 0.76	15.78 ± 0.61	14.01 ± 0.83	NS
CF	45.85^{b} ± 1.07	44.23^{ab} ± 1.08	44.01^{ab} ± 0.67	43.01^{ab} ± 0.51	44.02^{ab} ± 1.05	43.31^{ab} ± 1.00	41.95^{a} ± 0.78	0.05
NDF	68.83 ± 0.54	68.02 ± 0.54	67.91 ± 0.33	67.41 ± 0.25	67.91 ± 0.53	67.56 ± 0.50	66.88 ± 0.39	NS
ADF	49.09 ± 0.48	48.37 ± 0.48	48.27 ± 0.30	47.83 ± 0.23	48.28 ± 0.47	47.96 ± 0.45	47.35 ± 0.35	NS
ADL	12.19 ± 0.23	11.84 ± 0.23	11.79 ± 0.14	11.58 ± 0.11	11.80 ± 0.22	11.65 ± 0.21	11.36 ± 0.17	NS
IVDMD	33.05^{a} ± 1.07	35.22^{a} ± 0.96	40.15^{b} ± 0.93	51.15^{d} ± 1.11	38.92^{b} ± 0.86	48.11^{c} ± 0.48	64.15^{e} ± 0.68	0.01
IVOMD	25.35^{a} ± 1.15	28.41^{b} ± 0.61	34.25^{c} ± 0.86	44.58^{e} ± 0.87	29.48^{b} ± 0.32	38.68^{d} ± 0.40	55.89^{f} ± 0.70	0.01

***Treatments are: UTWS, untreated wheat straw; WS11 wheat straw treated with 1 liter of ZAD for 1 week (the first digit represents the ZAD level, 1 or 3 liter; the second digit represents weeks of treatment, 1, 2 or 4 weeks.**
[a,b,c,d] values having different superscripts within each raw differ.

Table 2: The chemical composition and *in vitro* digestibility of rice straw as affected by the biological treatments

Item	Treatments*							Sig.
	UTRS	RS11	RS12	RS14	RS31	RS32	RS34	
	----------------------------------%----------------------------------							
DM	92.80 ± 0.48	90.35 ± 0.85	91.93 ± 0.77	92.08 ± 0.99	91.08 ± 0.59	91.94 ± 0.44	92.20 ± 0.44	NS
OM	85.70 ± 0.83	83.96 ± 0.75	84.65 ± 0.55	84.07 ± 0.61	84.65 ± 0.46	84.74 ± 0.55	86.06 ± 0.57	NS
CP	4.00^{a} ± 0.28	6.10^{b} ± 0.48	9.88^{c} ± 0.42	12.77^{d} ± 0.70	7.81^{b} ± 0.75	10.10^{c} ± 0.54	14.00^{d} ± 0.80	0.01
EE	1.31 ± 0.26	1.69 ± 0.17	1.90 ± 0.08	1.94 ± 0.11	1.58 ± 0.23	1.89 ± 0.12	2.31 ± 0.35	NS
NFE	40.99^{e} ± 0.54	38.22^{d} ± 0.38	35.53^{bc} ± 0.82	32.19^{a} ± 0.98	38.01^{d} ± 0.44	36.08^{c} ± 0.52	34.08^{b} ± 0.34	0.01
Ash	14.20 ± 0.52	16.04 ± 0.77	15.35 ± 0.94	15.91 ± 0.97	15.35 ± 0.97	15.26 ± 0.82	13.94 ± 0.42	NS
CF	39.40^{c} ± 0.39	37.95^{b} ± 0.55	37.34^{b} ± 0.53	37.17^{b} ± 0.58	37.25^{b} ± 0.25	36.67^{b} ± 0.68	34.95^{a} ± 0.04	0.01
NDF	65.60^{b} ± 0.20	64.88^{b} ± 0.28	64.57^{b} ± 0.26	64.49^{ab} ± 0.29	64.53^{ab} ± 0.13	64.24^{ab} ± 0.34	63.38^{a} ± 0.02	0.05
ADF	46.21^{b} ± 0.17	45.56^{b} ± 0.25	45.29^{b} ± 0.24	45.21^{b} ± 0.26	45.25^{b} ± 0.11	44.99^{ab} ± 0.30	44.22^{a} ± 0.02	0.05
ADL	10.81^{b} ± 0.08	10.50^{b} ± 0.12	10.37^{b} ± 0.11	10.34^{b} ± 0.12	10.35^{b} ± 0.05	10.23^{b} ± 0.14	9.86^{a} ± 0.01	0.05
IVDMD	25.68^{a} ± 0.85	28.45^{ab} ± 1.13	35.65^{c} ± 1.28	49.25^{e} ± 1.06	30.75^{b} ± 0.69	40.78^{d} ± 0.91	61.35^{f} ± 0.67	0.01
IVOMD	15.75^{a} ± 0.42	17.65^{a} ± 0.83	25.60^{c} ± 0.81	40.35^{e} ± 1.15	20.80^{b} ± 0.83	29.95^{d} ± 1.03	50.02^{f} ± 1.02	0.01

***Treatments are: UTRS, untreated rice straw; RS11 rice straw treated with 1 liter of ZAD for 1 week (the first digit represents the ZAD level, 1 or 3 liter; the second digit represents weeks of treatment, 1, 2 or 4weeks.**
^{a,b,c,d,e} values having different superscripts within each raw differ.

The chemical composition of corn stalk (CS) as affected by the biological treatment is presented in Table (3). Dry matter content of UTCS was ranging between 87.11 and 91.50%. Differences in DM contents among treatments were not significant. Data of OM decreased significantly as the treatment level increased and ensiling time increased. Content of OM was 93.50% for UTCS while that of treated corn stalk with ZAD (CS34) being 78.75%. Crude protein contents of UTCS, CS11, CS12, CS14, CS31, CS32, and CS34 were

4.50, 5.91, 9.83, 12.89, 7.01, 12.72 and 15.54, respectively. Differences were significant (P<0.01). There was a decrease (P<0.05) in the NFE contents due to ZAD treatment from 50.87% in UTCS to 48.48, 40.08, 38.06, 47.55, 40.89 and 35.02% for CS11, CS12, CS14, CS31, CS32 and CS34, respectively. Ether extract was almost equal in all treatments (ranging from 2.10 to 2.28%) except that of CS34 which had (P<0.05) the highest value (3.17%). CF contents decreased (P<0.01) from 36.5% in untreated to 24.99% in CS34; the other treatments were intermediates (28.02 – 34.25%). Ash content increased from 6.03% in the untreated to 21.25% in CS34; the other treatments ranged from 9.17 to 19.65%; difference was significant (P<0.01).

Table 3: The chemical composition and *in vitro* digestibility of corn stalk as affected by biological treatments

Item	Treatments*							Sig.
	UTCS	CS11	CS12	CS14	CS31	CS32	CS34	
	------------------------------%---------------------------------							
DM	91.50 ± 0.85	89.05 ± 1.22	90.63 ± 0.82	90.78 ± 0.73	87.11 ± 1.83	90.64 ± 1.21	90.98 ± 1.02	NS
OM	93.97^{e} ± 0.95	90.74^{d} ± 0.62	86.15^{c} ± 0.56	80.47^{a} ± 0.52	87.82^{c} ± 0.74	82.97^{b} ± 1.03	78.75^{a} ± 0.38	0.05
CP	4.50^{a} ± 0.40	5.91^{ab} ± 0.55	9.83^{c} ± 0.59	12.89^{d} ± 1.19	7.01^{b} ± 0.54	12.72^{d} ± 0.74	15.54^{e} ± 0.33	0.01
EE	2.10^{a} ± 0.10	2.19^{a} ± 0.10	2.23^{a} ± 0.07	2.23^{a} ± 0.36	2.21^{a} ± 0.15	2.28^{a} ± 0.36	3.17^{b} ± 0.11	0.05
NFE	50.87^{c} ± 1.15	48.48^{c} ± 0.78	40.08^{b} ± 1.48	38.06^{ab} ± 1.05	47.55^{c} ± 0.80	40.89^{b} ± 0.82	35.02^{a} ± 1.08	0.01
Ash	6.03^{a} ± 0.42	9.17^{b} ± 0.38	13.85^{cd} ± 0.29	19.65^{d} ± 0.40	12.18^{c} ± 0.68	16.09^{d} ± 0.98	21.25^{e} ± 1.42	0.01
CF	36.50^{e} ± 0.51	34.25^{e} ± 0.79	30.01^{cd} ± 0.69	27.20^{ab} ± 0.98	31.05^{d} ± 0.60	28.02^{bc} ± 0.62	24.99^{a} ± 1.04	0.01
NDF	64.15^{c} ± 0.26	63.03^{c} ± 0.39	60.91^{b} ± 0.34	59.50^{a} ± 0.49	61.43^{b} ± 0.30	59.91^{a} ± 0.31	58.40^{a} ± 0.52	0.05
ADF	44.92^{c} ± 0.23	43.91^{c} ± 0.35	42.01^{b} ± 0.31	40.76^{a} ± 0.44	42.48^{b} ± 0.27	41.12^{a} ± 0.28	39.77^{a} ± 0.46	0.05
ADL	10.19^{c} ± 0.11	9.72^{c} ± 0.17	8.81^{b} ± 0.15	8.21^{a} ± 0.21	9.03^{b} ± 0.13	8.39^{a} ± 0.13	7.74^{a} ± 0.22	0.05
IVDMD	31.56^{a} ± 0.80	33.18^{a} ± 0.86	38.72^{b} ± 0.85	50.08^{d} ± 0.50	36.78^{b} ± 0.59	43.25^{c} ± 1.41	62.16^{e} ± 0.66	0.01
IVOMD	27.88^{a} ± 0.93	29.75^{a} ± 0.77	36.15^{c} ± 0.60	48.55^{e} ± 0.83	33.95^{b} ± 0.62	41.70^{d} ± 0.58	60.18^{f} ± 0.61	0.01

***Treatments are: UTCS, untreated corn strlk; CS11 corn stalk treated with 1 liter of ZAD for 1 week (the first digit represents the ZAD level, 1 or 3 liter; the second digit represents weeks of treatment, 1, 2 or 4 weeks.**

^{a,b,c,d,e} values having different superscripts within each raw differ.

Results of chemical composition of sugarcane bagasse as affected by the biological treatment are presented in Table (4). Data indicated that DM of SC significantly (P<0.05) decreased from 92.01% for UTSC to 85.66% in SC34. The other treatments had intermediate values from 87.76 to 91.9%. Data of OM followed the same pattern being higher for UTSC (97.5%) and lower for SC34 (87.85%); the other treatments fall in between (ranging from 89.01 to 94.54%). Results of CP of SC indicated that ZAD treatment lead to a significant (P<0.01) increase from 1.6 in the untreated to 14.05% in SC34. Protein content linearly increased with time of ensiling being 4.98, 5.99 and 7.10% in SC11, SC12 and SC14; the corresponding values were 6.01, 8.00 and 14.05% for SC31, SC32 and SC34, respectively. There was a decrease (P<0.01) in the NFE contents due to ZAD treatment from 44.16% in UTSC to 37.64% in SC32 and 38.74% in SC34. The other treatments ranged from 40.38 to 44.6%. Ether extract increased (P<0.01) from 1.7 in the untreated SC to 3.78% in SC34. The trend was linear with the ensiling time. Contents of CF decreased (P<0.01) from 50.04% in untreated to 31.28% in SC34; the other treatments were intermediates (40.53 – 46.81%). The pattern was also linear with the ensiling time. Ash content increased from 2.50% in the untreated to 12.15% in CS34; the other treatments ranged from 5.46 to 10.99%; difference was significant (P<0.01).

It was obvious from the data presented herein that the main effect was on the CP content which was significantly increased in all treated materials with all levels of ZAD. Values of CP were linearly increased as the time of ensiling increased. The effects were due mainly to nitrogen content of the added urea (about 20 kg/ton) and nitrogen content of the growing bacteria in the silage of the tested roughages. It may be explained on the basis that bacterial growth (the increase in single cell protein) was on the expense of NFE as an energy source which significantly decreased in an opposite trend of CP. Zadrazil (1975) and Abdul-Aziz *et al*. (1994a and 1997) found that the biological treatment of straw and other fibrous roughages results usually in a marked increases their CP content when the treatment condition was appropriate. Also, Dhanda *et al*. (1994) fermented wheat straw with white rot fungi sp. and noticed that CP content of the straw increased from 3.42 to 6.81 %. Khorshed (2000) reported that biological treatments significantly (P<0.01) decreased DM, OM, CF and NFE contents and significantly (P<0.01) increased the content of ash, CP and EE for some crop residues (wheat straw, rice straw, cotton stalks, date palm residues).

The decline of CF value in the tested roughages could be a result of the enzymes secreted by the growing bacteria. Henderson *et al*. (1977) and El-Ashry *et al*. (2003) reported that cellulose contents of the silages were significantly reduced due to the biological treatments at the higher rate of enzymes. More recently, Mahrous and Abou Ammou (2005) showed that microbial treatments for rice straw increased CP contents significantly and decreased DM, CF and NFE.

Table 4: The chemical composition and *in vitro* digestibility of Sugarcane bagasse as affected by biological treatments

Item	Treatments*							Sig.
	UTSC	SC11	SC12	SC14	SC31	SC32	SC34	
	---------------------------------%---------------------------------							
DM	92.01^{b} ± 1.23	91.90^{b} ± 0.63	90.10^{ab} ± 0.50	87.76^{ab} ± 0.68	90.43^{ab} ± 0.85	91.20^{b} ± 3.72	85.66^{a} ± 0.81	0.05
OM	97.50^{e} ± 0.32	94.54^{d} ± 0.51	92.35^{c} ± 0.89	90.01^{b} ± 0.62	92.45^{c} ± 0.50	89.01^{ab} ± 0.60	87.85^{a} ± 0.22	0.01
CP	1.60^{a} ± 0.20	4.98^{b} ± 0.33	5.99^{bc} ± 0.44	7.10^{cd} ± 0.16	6.01^{bc} ± 0.51	8.00^{d} ± 0.25	14.05^{e} ± 0.62	0.01
EE	1.70^{a} ± 0.21	2.00^{ab} ± 0.25	2.70^{bc} ± 0.20	3.37^{cd} ± 0.45	2.31^{ab} ± 0.34	2.84^{bc} ± 0.30	3.78^{d} ± 0.18	0.01
NFE	44.16^{d} ± 0.53	40.75^{c} ± 0.70	41.67^{c} ± 0.41	44.61^{d} ± 0.34	40.38^{bc} ± 0.92	37.64^{a} ± 0.79	38.74^{ab} ± 0.41	0.01
Ash	2.50^{a} ± 0.35	5.46^{b} ± 0.34	7.65^{c} ± 0.78	9.99^{d} ± 0.43	7.55^{c} ± 0.69	10.99^{de} ± 0.68	12.15^{e} ± 0.28	0.01
CF	50.04^{f} ± 1.12	46.81^{e} ± 0.77	41.99^{cd} ± 0.62	34.93^{b} ± 0.59	43.75^{d} ± 0.81	40.53^{c} ± 0.61	31.28^{a} ± 0.60	0.01
NDF	70.92^{c} ± 0.56	69.31^{c} ± 0.39	66.90^{b} ± 0.31	63.37^{a} ± 0.30	67.78^{b} ± 0.40	66.17^{b} ± 0.31	61.54^{a} ± 0.30	0.01
ADF	50.97^{c} ± 0.50	49.52^{c} ± 0.35	47.37^{b} ± 0.28	44.21^{a} ± 0.26	48.16^{b} ± 0.36	46.72^{b} ± 0.27	42.58^{a} ± 0.27	0.01
ADL	13.08^{c} ± 0.24	12.39^{c} ± 0.16	11.36^{b} ± 0.13	9.86^{a} ± 0.13	11.74^{b} ± 0.17	11.05^{b} ± 0.13	9.08^{a} ± 0.13	0.01
IVDMD	13.95^{a} ± 1.00	15.60^{a} ± 1.09	23.43^{c} ± 0.97	39.51^{e} ± 0.71	18.65^{b} ± 0.74	28.05^{d} ± 0.51	48.85^{f} ± 0.95	0.01
IVOMD	14.15^{a} ± 0.96	16.35^{a} ± 0.73	24.15^{c} ± 0.83	38.42^{e} ± 0.97	19.27^{b} ± 0.43	27.88^{d} ± 0.84	46.95^{f} ± 0.69	0.01

***Treatments are: UTSC, untreated sugar cane bagasse; SC11 sugar cane bagasse treated with 1 liter of ZAD for 1 week (the first digit represents the ZAD level, 1 or 3 liter; the second digit represents weeks of treatment, 1, 2 or 4 weeks.**
^{a,b,c,d,e} values having different superscripts within each raw differ.

Cereal straw is composed primarily of cellulose and hemicellulose, which could form part of the feed as roughage for ruminants. Unfortunately, its low digestibility and protein contents, poor palatability and bulkiness, discourages its use as the sole source of feed. Straw, the major roughage of

ruminants, contains very little protein and mineral and very high amount of lignin and silica. The lignin component creates the barrier to efficient utilization, conversion or degradation of the polysaccharides in lignocelluloses to useful products. Lignocelluloses residues are not high value feeds, they are classified as low quality roughage, i.e. high in fiber, low in protein, vitamins and minerals and high lignifications make them less utilization than the green fodder. Physical, chemical and microbiological treatments of the cellulosic materials have been tried for improving the nutrient availability from such materials to the animals (Lyo and Antai, 1988; Singh *et al*., 1993; McHan, 1986 and Hunt *et al*., 1992).

Table (1) revealed that biological treatments with ZAD had no significant effect on cell wall constituents (fiber fraction) of wheat straw. ZAD treatment led to a very slight decrease in the entire fiber fraction (NDF, ADF and ADL). Table (2) represents the effect of biological treatments on cell wall constituents of rice straw. It was found that biological treatments decreased ($P<0.05$) NDF from 65.60% in untreated to 64.88, 64.57, 64.49, 64.53, 64.24 and 63.38 in RS11, RS12, RS14, RS31, RS32, and RS34, respectively. The least NDF content was recorded with RS34. There were significant decrease in ADF content From 46.21 in untreated to 45.56, 45.29, 45.21, 45.25, 44.99 and 44.22 in RS11, RS12, RS14, RS31, RS32 and RS34, respectively. Values of ADL followed the same pattern being high for untreated RS and decreased linearly as the level of ZAD and time of ensiling incubation increased.

Data in Table (3) revealed that biological treatment with ZAD led to a significant ($P<0.05$) decrease in all fiber fractions of corn stalk. Biological treatment linearly decreased NDF from (64.15) in untreated to 63.03, 60.91, 59.50, 61.43, 59.91 and 58.40% in CS11, CS12, CS14, CS31, CS32 and CS34, respectively. There was significant decline in ADF from 44.92 in untreated CS to 43.91, 42.01, 40.76, 42.48, 41.12 and 39.77% in treatment CS11, CS12, CS14, CS31, CS32 and CS34, respectively. The values of ADL decreased linearly as the level of ZAD increased and time of ensiling increased.

The effect of biological treatments on fiber fraction of sugarcane bagasse is presented in Table (4). In is obvious that all fiber fraction decreased significantly ($P<0.01$) due to the ZAD treatment. Biological treatments decreased ($P<0.05$) NDF content from 70.92% in untreated SC to 69.31, 66.90, 63.37, 67.78, 66.17 and 61.54% in SC11, SC12, SC14, SC31, SC32, and SC34, respectively. The strongest effect on NDF was reported with SC34 while the lease effect was reported for SC11. The same pattern was obtained with ADF and ADL. Values of ADF decreased from 50.97 in UTSC to 49.52, 47.37, 44.21, 48.16, 46.72 and 42.58 for treatment SC11, SC12, SC14, SC31, SC32, and SC34, respectively.

Generally, the biological treatment with ZAD caused a decrease in most fiber fraction especially with sugarcane bagasse. This may have been due mainly to the effect of cellulase and hemicellulase enzymes on the linkage between lignin and cellulose and hemicellulose. Mahrous and Abou Ammou

(2005) showed that biological treatments for rice straw significantly decreased NDF, ADF, ADL, and cellulose contents. Rai and Mudgal (1984) hydrolyzed cellulose in wheat straw by a commercial cellulase product and reported that although the hydrolysis of hemi-cellulose and lignin was variable, NDF and ADF decreased (P<0.01) while cell contents (the soluble fractions) increased (P<0.01) with enzymatic treatments. Royse *et al*. (1991) reported a decrease in NDF and ADF in wheat straw when fermented with *P. seyttr- cqu*. In addition, incubated rice straw with *P. ostreatus* decreased hemicellulose contents, while the changes in cellulose content were small. Abdul-Aziz *et al*. (1994b) fermented rice straw, bean straw and sugarcane bagasse with *P. ostreatusthe* and reported that NDF and hemicellulose decreased by 14.85% and 65.59%, receptively. Gado (1997) observed that the degradation of various fiber fractions increased during the ensilage period with the increasing level of cellulase with the rice straw or bagasse. He noticed that the effect of ensiling was greater on NDF indicating greater influence on hemi-cellulose breakdown as an effect of the enzyme. Residues sugars increased with the increasing (P<0.01) levels of celluloses in rice straw and bagasse silages with greater impact on bagasse. Khorshed (2000) found that NDF, cellulose and ADF contents of some crop residues (wheat straw, rice straw, cotton stalks, date palm residues) decreased (P<0.05) with all biological treatments.

The effect of ZAD treatments on IVDMD and IVOMD of untreated and treated wheat straw are present in Table (1). The biological treatments improved (P<0.01) IVDMD from 33.05 in untreated wheat straw to 35.22, 40.15, 51.15, 38.92, 48.11 and 64.15 for WSll, WS12, WS14, WS31, WS32 and WS34, respectively. The highest value of IVDMD was reported for wheat straw that was treated with 3 litters of ZAD for four weeks. The improvement in IVDMD due to biological treatment in comparison with the untreated was 6.05% for WS11 but and reached 94.39% in WS34. Results of IVOMD followed the same pattern of IVDMD. It was increased (P<0.01) from 25.35 in untreated to 28.41, 34.25, 44.58, 29.48, 38.68 and 55.89 for WS11, WS12, WS14, WS31, WS32 and WS34, respectively. The improvement of WS11 was 12.07% and reached 120.4% for WS34.

The effect of ZAD treatments on IVDMD and IVOMD of untreated and treated rice straw are present in Table (2). The biological treatments improved (P<0.01) IVDMD from 25.68 in untreated rice straw to 28.45, 35.65, 49.25, 30.75, 40.78 and 61.35% for RSll, RS12, RS14, RS31, RS32 and RS34, respectively. The highest value of IVDMD was reported for rice straw that was treated with 3 litters of ZAD for four weeks. The improvement in IVDMD due to biological treatment in comparison with the untreated was 10.78% for RS11 and reached 138.9% in RS34. Results of IVOMD followed the same pattern of IVDMD. It was increased (P<0.01) from 15.75 in untreated to 17.65, 25.60, 40.35, 20.80, 29.95 and 50.02% for RS11, RS12, RS14, RS31, RS32 and

RS34, respectively. The improvement of RS11 was 12.06% and reached 217.6% for RS34.

Result of IVDMD and IVOMD of untreated and treated corn stalk are present in Table (3). The biological treatments improved (P<0.01) IVDMD from 31.56 UTCS to 33.18, 38.72, 50.08, 36.78, 43.25 and 62.16 for CS11, CS12, CS14, CS31, CS32 and CS34, respectively. The highest value of IVDMD was reported for the treated corn stalk with 3L ZAD for 4 wks. The value of improvement was 5.13% for CS11 while the highest was found with CS34 (96.95%). The values of IVOMD were 27.88, 29.75, 36.15, 48.55, 33.95, 41.70 and 60.18 for CS11, CS12, CS14, CS31, CS32 and CS34 respectively; differences were significant (P<0.01). The value of improvement ranged from 6.71% for CS11 to 115.9% for CS34.

Data in Table (4) revealed that biological treatments improved (P<0.01) IVDMD from 13.95 in UTSC to 15.60, 23.43, 39.51, 18.65, 28.08 and 48.85 for SC11, SC12, SC14, SC32 and SC34, respectively. The improvement in IVDMD was 11.82% for SC11 and 250.2% for SC34. Values of IVOMD increased (P<0.05) from 14.15 in untreated to 16.35, 24.15, 38.42, 19.27, 27.88 and 46.95, for SC11, SC12, SC14, SC31, SC32 and SC34, respectively. The improvement reached 231.8% SC34 as a result of ZAD treatments (3L/4wk).

In general, the best improvement of *in vitro* digestibility was seen when all tested roughages was treated with 3L ZAD for 4wks ensiling time. Ibrahim and Pearce (1980) noticed that the *in vitro* digestibility of barley straw and bagasse increased when it was biologically treated with some species of white rot fungi at 14-25°C for 21 days. Streeter *et al*. (1982) and Des Chard (1983) showed that the IVDMD of *Pleuntus* grown paddy wheat straw was much higher than of ordinary straw. Eduardo *et al*. (1986) observed that the increase in IVDMD would arise almost exclusively from the release of water-soluble substances produced during decay with *Phanerochaete Chrusosporium*. Abdul-Aziz *et al*. (1997) reported increases by 42.13%, 31.45% and 114.6% for IVDMD, IVOMD and IVCFD, respectively when they treated rice straw by *P. ostreatus*.

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تأثير المعاملات الحيوية على التحليل الكيماوي ومعاملات الهضم المعملية لبعض المخلفات الزراعية

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الملخص العربي

أجريت هذه الدراسة بهدف تقييم تأثير المعاملات الحيوية على التحليل الكيماوي ومعاملات الهضم المعملية لبعض مواد العلف الخشنة المتاحة بمصر. المخلفات التي تم دراستها هي تبن القمح – قش الآرز – حطب الذرة ومصاصة القصب. تم تجفيف المخلفات حتى نسبة مادة جافة حوالي ٩٠%. كانت المعاملة الحيوية عبارة عن مركب (زاد) وهو عبارة عن مركب مخلوط إنزيمات محللة لجدر الخلايا بنسبة لتر واحد أو ثلاثة لترات محضنة لمدة ١و ٢ أو ٤ أسابيع في أكياس من البلاستيك مع بيئة مكونة من ٥٠كجم مولاس + ٢٠كجم يوريا مذابة في ١٠٠٠لتر من الماء لكل طن واحد من الخامات تحت الدراسة. تم تحليل المخلفات المعاملة وغير المعاملة كيماويا كما تم تقدير معاملات الهضم معمليا. أشارت أهم نتائج الدراسة إلى ارتفاع المحتوى البروتيني في جميع المعاملات نتيجة المعاملة البيولوجية. كانت الزيادة خطية للمحتوى البروتيني مع فترات التحضين مع المعاملة. أدت المعاملة الحيوية بمركب الزاد إلى انخفاض معظم مكونات الألياف الخام مع جميع المخلفات المدروسة خاصة مصاصة القصب. أدت المعاملة إلى تحسن معاملات هضم المادة الجافة والعضوية معمليا لجميع المخلفات تحت الدراسة وكانت أعلى القيم عند المعاملة ب٣لتر لمدة ٤أسابيع.