Journal of Research in Ecology

An International Scientific Research Journal

ISSN No: Print: 2319 –1546; Online: 2319– 1554

Journal of Research in Ecology

Short Communication

Effect of *Trichoderma harzianum*, on chemical composition and *in vitro* digestibility of crop residues

Authors:
Al-Samaraee WH[1], Ahmed AA[1], Hussein HZ[1] and Alwaeli SN[2]

Institution:
1. Department of Animal Production, College of Agriculture, University of Baghdad, Iraq.

2. Office of Agriculture Research, Ministry of Agriculture, Iraq.

Corresponding author:
Al-Samaraee WH

ABSTRACT:

Effect of *Trichoderma harzianum* treatment on the chemical composition of crop residues and *in vitro* digestibility of dry matter and organic matter at two different concentration of *Trichoderma harzianum* (1g/L and 2g/L) at three different incubation periods (0, 20 and 30 days) were studied. The results showed different effects among treatments as follows: highly significant increase (P<0.01) in dry matter (DM) was recorded when treating the corn cobs with *T. harzianum* with a significant increase (P<0.01) in organic matter (OM), crude protein (CP) and *in vitro* digestibility of dry matter (DDM) and organic matter (DOM). The results showed the highest increase (P<0.01) in crude fibre when treating rice husks with *T. harzianum*. The concentration of fungi at 2g/L showed significant increase (P<0.01) in the amount of DM, OM and CP. The variation of the period of incubation on chemical composition showed the best significant increase (P<0.01) during the incubation period of 30 days with regard to dry matter, crude fibre and *in vitro* digestion of dry matter and organic matter. The results indicated that the interaction between the concentration of fungus and the incubation period showed a significant improvement (P<0.01) in the quantity of dry matter and its ratio of protein, while there was no significant effect in the quantity of organic matter, *in vitro* digestion of dry and organic matter was observed. The results of the interaction between the type of material and the concentration of fungus and incubation period was highly significant (P<0.01) in all attributes.

Keywords:
Trichoderma harzianum, Rice husks, *in vitro* digestion.

Article Citation:
Al-Samaraee WH, Ahmed AA, Hussein HZ and Alwaeli SN
Effect of *Trichoderma harzianum*, on chemical composition and *in vitro* digestibility of crop residues
Journal of Research in Ecology (2018) 6(2): 2235-2243

Dates:
Received: 30 May 2018 **Accepted:** 05 July 2018 **Published:** 29 Sep 2018

Web Address:
http://ecologyresearch.info/documents/EC0575.pdf

INTRODUCTION

Nutrition is the main factor in increasing production. The success of fattening depends largely on the availability, quality and cost of feed. Most of the raw materials are high in fiber content and low in protein content and energy (Ibrahim, 2002). The importance of fiber in stimulating the secretion of saliva will contribute to the process of fermentation in the rumen and 15-35% of the energy consumed turn into a net energy because of the incomplete digestion of fiber in the rumen and due to the low grazing areas and thus reducing the production of animals in Iraq (Saadi, 2009) To find alternatives and to get rid of these problems and to reduce costs, the use of biologically treated fodder is a best option (Al-Samraee, 2006; Hassan, 2009). Many researchers resorted to the use of different microorganisms (fungi and bacteria) to choose the best alternative to improve the value of cattle feed (Mohini and Mahesh, 2013; Al-Waeli, 2013). *T. harzianum* is a fungus that breaks the bond between the walls of the building cells of the plant enhancing the decomposition of the crop residues faster. The objective was to study the effect of microbial treatment using the fungi *Trichoderma harzianum* on some crop residues (corn cobs, rice husks, hay reed, reed, palm leaves and wheat bran).

MATERIALS AND METHODS

The research was conducted at the Faculty of Agriculture, University of Baghdad using six type of roughages (corn cops, rice hulls (subbase), hay reed, reed, frond and wheat bran). *Trichoderma harzianum* was used at the concentration of 1g/L and 2g/L and incubated at three intervals *viz*. 0, 20 and 30 days. Mushrooms were obtained from the Department of Plant Protection, Faculty of Agriculture of University of Baghdad, Iraq.

The whole material was divided into 6 groups and the fungus was dissolved at a concentration of 1g/L and 2g/L respectively. It was sprayed on half of the roughages and incubated at three different periods (0, 20 and 30 days). At the end of each period, the material is extracted and dried and kept in plastic bottles and processed until further chemical analysis and then to estimate the amount of dry matter and organic matter, crud fiber and crude protein (AOAC, 2005) and *in vitro* digestion of dry and organic matter (Al-Samraee, 2006).

Statistical analysis

The experimental data was analyzed by using a Complete Randomized Design (CRD) and the averages were compared by Duncan test (Duncan, 1955) using statistical program SAS (SAS, 2012). Statistical analysis was done according to the following mathematical model:

$$Yijkl = \mu + Ai + Bj + Ck + AB(ij) + AC(ik) + BC(jk) + ABC(ijk) + eijkl$$

Table 1. The effect of *Trichoderma harzianum* in the chemical composition and *in vitro* digestion

S. No	Item	*Trichoderma harzianum* concentration		Significance
		1 g/L	2 g/L	
1	DM (%)	95.14 ± 0.44^{b}	95.83 ± 0.29^{a}	**
2	OM (%)	85.27 ± 0.82^{b}	85.95 ± 0.83^{a}	**
3	CP (%)	7.08 ± 0.59^{b}	8.37 ± 0.66^{a}	**
4	CF (%)	30.87 ± 1.91^{a}	28.35 ± 1.76^{b}	**
5	DDM (%)	51.55 ± 2.73^{b}	55.79 ± 2.69^{a}	**
6	DOM (%)	55.19 ± 2.60^{b}	59.63 ± 2.61^{a}	**

**=significant (P<0.01); Alphabets in the superscript refers significant difference between them

Table 2. Effect of fungus on chemical composition and laboratory metabolomics of processed feed

S. No	Item	Corn cobs	Rice husks	Reed hay	Reeds	Palm leaves	Wheat bran	Sign.
1	DM (%)	96.87±0.3^{a}	96.10±0.3^{cb}	94.13 ± 1.03^{D}	96.49 ± 0.53^{ab}	95.67±0.27^{c}	93.65± 0.63^{d}	**
2	OM (%)	87.58±1.65^{ab}	77.42 ± 0.65^{e}	86.20± 1.23^{D}	87.54 ± 0.54^{b}	87.17 ± 0.59^{c}	87.77±0.53^{a}	**
3	CP (%)	4.85± 0.55^{f}	8.16±0.22^{c}	8.87 ±0.30^{B}	5.13± 0.68^{e}	5.50 ± 0.91^{d}	13.84±0.78^{a}	**
4	CF (%)	20.74± 0.49^{e}	41.92 ± 0.67^{a}	33.80±1.04^{C}	30.51 ± 0.45^{d}	38.97 ± 1.82^{b}	11.71± 0.44^{f}	**
5	DDM (%)	40.88 ±1.27^{d}	40.78±1.20^{f}	60.07± 0.41^{B}	52.78 ± 2.15^{c}	38.38±2.31^{e}	76.23± 0.96^{a}	**
6	DOM (%)	44.57±1.31^{d}	43.00±2.03^{f}	63.46± 0.40^{B}	56.85 ±2.25^{c}	43.08±2.05^{e}	79.10 ±0.79^{a}	**

**=significant (p<0.01); Alphabets in the superscript refers significant difference between them

Table 3. The effect of different incubation periods on chemical composition and *in vitro* digestion of dry and organic matter

S. No	Item	Incubation period (days) 0	20	30	Sign.
1	DM (%)	94.42 ± 0.36^{c}	95.54 ± 0.27^{b}	96.49 ± 0.61^{a}	**
2	OM (%)	85.34 ± 1.10^{b}	86.27± 0.88^{a}	85.22 ± 1.05^{b}	**
3	CP (%)	5.45 ± 0.67^{c}	8.38 ± 0.75^{b}	9.34 ± 0.69^{a}	**
4	CF (%)	30.96 ± 2.38^{a}	29.63 ± 2.26^{b}	28.23 ± 2.16^{c}	**
5	DDM (%)	48.71 ± 3.48^{c}	54.55 ± 3.36^{b}	57.75 ± 2.96^{a}	**
6	DOM (%)	53.04 ± 3.39^{c}	58.07 ± 3.19^{b}	61.12 ± 2.90^{a}	**

**=significant (P<0.01); Alphabets in the superscript refers significant difference between them

Table 6. Effect of overlap between the type of material and the concentration of fungus and incubation period of the treatment on the focus

S. No	Items	1g/L of *Trichoderma harzianum*			2g/L of *Trichoderma harzianum*			Significance
		0 (d)	20 (d)	30 (d)	0 (d)	20 (d)	30 (d)	
1	DM (%)	94.42±0.52^{B}	95.55±0.53^{B}	95.45±1.12^{b}	94.42±0.52^{b}	95.53±0.11^{B}	97.53±0.30^{A}	**
2	OM (%)	85.34±1.59	86.58±1.26	83.89±1.39	85.34±1.59	85.95±1.28	86.55±1.53	NS
3	CP (%)	5.45±0.96^{b}	7.73±1.06^{Ab}	8.05±0.94^{ab}	5.45±0.96^{b}	9.03±1.06^{a}	10.63±0.90^{A}	**
4	CF (%)	30.96±3.44	31.27±3.30	30.37±3.45	30.96±3.44	27.99±3.16	26.09±2.59	NS
5	DDM(%)	48.71±5.05	51.82±5.01	54.12±4.44	48.71±5.05	57.29±4.58	61.37±3.78	NS
6	DOM(%)	53.71±5.05	55.34±4.71	52.0±4.24	53.04±4.92	60.80±4.37	65.05±3.77	NS

**=significant (P<0.01); NS = non significant; Alphabets in the superscript refers significant difference between them

RESULTS AND DISCUSSION

Table 1 showed that the difference in the type of feed substrate affected the effect of the fungus with significant increase at P<0.01. Both the dry matter and organic matter was high at the concentration of 2g/L of *Trichoderma harzianum* with significant changes (P<0.01). Crude protein, DDM and DOM was also high at 2g/L concentration (8.37%, 55.79% and 59.63% respectively), whereas, the crude fibre was high at 1g/L concentration of *Trichoderma harzianum* (30.87%). This difference in the improvement in nutritional value may be due to the nature of the material used.

. The results of Table 2 showed that the difference in the type of feed substrate affected the effect of the fungus, where it obtained a significant increase (P <0.01) when using the corn cobs and reeds, where the

Table 4. The effect of the interaction between the type of substance and concentration of feed fungus treatment

S. No	Item	Types of roughages												Sign.
		Corn cob		Rice husks		Reed hay		Reeds		Palm leaves		Wheat bran		
		Conc. of *T. harzianum*		Conc. of *T. harzianum*		Conc. of *T. harzianum*		Conc. of *T. harzianum*		Conc. of *T. harzianum*		Conc. of *T. harzianum*		
		1g/L	2g/L	1g/L Conc.	2g/L Conc.	1g/L Conc.	2g/L Conc.	1g/L Conc.	2g/L Conc.	1g/L Conc.	2g/L Conc.	1g/L Conc.	2g/L Conc.	**
1	DM (%)	96.98± 0.40^{a}	96.76±0.50^{A}	95.71±0.15^{Abc}	96.49± 0.58^{a}	92.09 ±1.64^{D}	96.17 ±0.54^{Ab}	96.87 ±0.81^{a}	96.11 ±0.71^{ab}	95.64 ± 0.41^{abc}	95.70 ± .4^{abc}	93.56±0.91^{cd}	93.75±0.95^{cd}	**
2	OM (%)	88.40± 2.41^{A}	86.75± 2.44^{A}	77.46± 0.96^{B}	77.39± 0.96^{b}	84.63 ±2.02^{A}	87.76 ± 1.28^{a}	87.41 ± 0.65^{a}	87.66 ± 0.92^{a}	87.04 ± 0.77^{a}	87.29± 0.96^{A}	86.70 ±0.20^{a}	88.83±0.85^{a}	**
3	CP (%)	4.16± 0.43^{D}	5.54± 0.97^{Dc}	7.81± 0.12^{Bc}	8.50± 0.39^{b}	8.55 ± 0.32^{B}	9.19± 0.51^{B}	4.47± 0.71^{d}	5.79± 1.15^{dc}	4.35 ± 0.75^{D}	6.66± 1.59^{Dc}	13.15 ±0.87^{a}	14.53± 1.31^{a}	**
4	CF (%)	21.46± 0.41^{E}	20.03±0.83^{E}	43.46±1.00^{A}	40.38 ±0.14^{a}	34.36 ±0.34^{Bc}	33.24 ±2.13^{Bcd}	31.08 ± .40^{dc}	29.94 ± 0.77^{d}	42.69 ± 0.90^{a}	35.24 ± 2.87^{b}	12.14 ± 0.60^{f}	11.27±0.63^{f}	**
5	DDM (%)	39.14± 0.81^{De}	42.63±2.28^{D}	42.50±2.18^{F}	40.49±2.19^{g}	59.32 ±0.30^{b}	60.83 ± 0.65^{b}	48.80 ±1.02^{c}	56.76±3.60^{b}	35.39 ± 2.37^{E}	41.37 ±3.77^{De}	75.09 ± 0.91^{a}	77.37± 1.64^{a}	**
6	DOM (%)	42.58± 0.58^{D}	46.56±2.36^{D}	45.45±2.20^{E}	40.38±2.15^{f}	62.79 ±0.24^{B}	64.12 ±0.68^{B}	52.14 ± 0.61^{c}	61.56 ± 3.62^{b}	40.67 ± 2.33^{d}	45.49± 3.28^{D}	77.78 ± 0.47^{a}	80.41 ±1.36^{a}	**

**=significant ($P<0.01$); Alphabets in the superscript refers significant difference between them

Table 5. Effect of interaction between the type of material and the period of incubation during the treatment

S. No	Items	Types of roughages																		Sign.
		Corn cob			Rice husks			Reed hay			Reeds			Palm leaves			Wheat bran			
		Days			Days			Days			Days			Days			Days			
		0	20	30	0	20	30	0	20	30	0	20	30	0	20	30	0	20	30	
1	DM (%)	96.12± 0.11^{abc}	96.23 ±0.24^{Abc}	98.26 ± 0.0^{Ab}	95.50 ± 0.01^{C}	95.89 ±0.15^{bc}	96.91 ±0.82^{abc}	95.02 ± 0.01^{Cd}	94.65 ± 1.37^{cd}	92.72 ±2.96^{De}	94.51 ±0.18^{Cd}	96.39 ± 0.47^{abc}	98.57 ± 0.18^{a}	94.62 ± 0.01^{cd}	95.57 ± 0.06^{c}	96.83 ±0.01^{abc}	90.78 ± 0.02^{e}	94.53 ±0.15^{cd}	95.65 ± 0.01^{bc}	**
2	OM (%)	90.42±0.11^{ab}	92.26±0.88^{a}	80.05±0.65f	74.56±0.02^{g}	78.81± 0.53^{f}	78.91±0.47^{f}	90.26±0.03^{ab}	84.08± 0.22^{e}	84.25± 2.91^{e}	85.70± 0.06^{de}	87.03± 0.13 ^{cd}	89.87± 0.35^{ab}	84.94± 0.07^{de}	86.94± 0.08^{cd}	89.62± 0.29^{b}	86.19± 0.01^{cde}	88.49± 0.69^{bc}	88.62± 1.16^{bc}	**
3	CP (%)	2.79 ±0.01^{h}	5.32 ± 0.25^{g}	6.43 ± 0.95f^{g}	7.51 ± 0.01^{def}	8.15 ± 0.29^{cde}	8.83 ± 0.41^{cde}	7.58± 0.01^{Def}	9.31± 0.29^{bc}	9.27± 0.27^{Bc}	2.23± 0.01^{h}	6.21 ± 0.41^{fg}	6.95 ± 0.74^{efg}	2.21 ± 0.35	5.73 ± 0.67^{g}	8.58± 1.33^{cde}	10.42 ± 0.01$_{d}$	15.58 ± 0.42^{a}	15.53 ± 0.78^{a}	**
4	CF (%)	22.58±0.14^{f}	20.29± 0.65^{f}	19.37± 0.61^{f}	40.80±0.01^{Ab}	41.79± 0.88^{a}	43.17± 1.78^{a}	35.29± 0.01^{Cd}	36.08±0.99^{cd}	30.03± 1.96^{e}	32.32± 0.01^{de}	29.97± 0.4^{e}	29.26± 0.55^{e}	44.27± 0.01^{a}	37.73± 3.59^{bc}	34.90± 2.86^{cd}	10.53± 0.02^{g}	11.93± 1.10 ^{g}	12.66± 0.34^{g}	**
5	DDM (%)	36.59±0.04^{f}	41.26±0.57^{Ef}	44.80±2.46^{e}	43.70±2.18^{j}	43.80±2.20^{i}	43.13±1.75^{h}	58.79±0.02^{cd}	60.27±0.79^{cd}	61.17±0.52^{C}	45.61±0.01^{e}	55.12±2.98^{d}	57.61±3.90^{cd}	30.33±0^{g}	38.31±297^{f}	46.51± 2.48^{e}	72.23± 0.01^{b}	77.82± 0.86^{a}	78.65±1.11^{a}	**
6	DOM (%)	40.82±0^{ef}	44.45±0.51^{Cde}	48.44±2.97^{Cd}	32.28±0.01^{i}	33.28±0.01^{h}	34.28±0.01^{g}	62.2±0.06^{b}	63.43±0.43^{b}	64.72±0.71^{b}	50.31±0	59.42±3.4^{b}	60.83±4.75^{b}	35.54±0.01^{f}	43.28±2.67^{be}	50.41± 1.51^{a}	76.33± 0.01^{a}	79.75± 0.88^{a}	81.22±1.39^{a}	**

**=significant ($P<0.01$); Alphabets in the superscript refers significant difference between them

Table 7. The interaction between the fungus concentration and the incubation period on the chemical composition and the laboratory digestion coefficient of dry and organic matter

Items	Types of roughages																	
	Corn cob						Rice husks						Reed hay					
	1g/L Conc.			2g/L Conc.			1g/L Conc.			2g/L Conc.			1g/L Conc.			2g/L Conc.		
	Days			Days			Days			Days			Days			Days		
	0	20	30	0	20	30	0	20	30	0	20	30	0	20	30	0	20	30
DM (%)	96.12 ±0.19^{cde}	96.62 ±0.10^{cde}	98.20 ±0.10^{cde}	96.12±0.19^{cde}	95.85±0.18^{Cdef}	98.32 ±0.12^{Ab}	95.50 ±0.01^{Cdef}	96.11 ±0.1^{cde}	95.51 ±0.25^{Cdef}	95.50±0.01^{bc}	95.66 ±0.14^{cdef}	98.32±0.12^{ab}	95.02±0.02^{defg}	93.65±3.05^{g}	87.60 ±0.02^{i}	95.02 ±0.02^{defg}	95.66 ±0.04^{cdef}	97.84±0.04^{ab}
OM (%)	90.42 ±0.19^{bc}	93.75 ±0.13^{a}	81.03 ±0.21^{n}	90.42±0.19^{bc}	90.77±0.44^{B}	79.08 ±0.75^{p}	74.56 ±0.04^{r}	79.72 ±0.02^{o}	78.10 ±0.1^{q}	74.56±0.04^{r}	77.90 ±0.1^{q}	79.72±0.09^{o}	90.26±0.05^{bc}	84.41±0.08^{l}	79.22 ±0.02^{op}	90.26 ±0.05^{bc}	83.75 ±0.26^{m}	89.29±0.04^{ef}
CP (%)	2.79±0.02^{r}	4.90±0.08^{p}	4.78±0.1^{pq}	2.79±0.02^{r}	5.74±0.07^{o}	8.08±0.14^{k}	7.51±0.01^{l}	7.77±0.04^{l}	8.15±0.15^{K}	7.51±0.01^{l}	8.50±0.50^{j}	9.51±0.30^{h}	7.58±0.031^{l}	8.81±0.01^{i}	9.26±0.05^{h}	7.58±0.03^{l}	9.81±0.01^{g}	10.18±0.03^{f}
CF (%)	22.58 ±0.25^{t}	21.41 ±0.21^{u}	20.41 ±0.21^{v}	22.58±0.25^{T}	19.18±0.17^{W}	18.32 ±0.02	40.80 ±0.01^{e}	43.32 ±0.02^{d}	46.26 ±0.05	40.80±0.01^{e}	40.26 ±0.05^{f}	40.09±0.01^{fg}	35.29±0.02^{i}	34.37±0.07^{j}	33.43 ±0.03^{K}	35.29 ±0.02^{i}	37.78 ±0.08^{h}	26.64±0.04^{s}
DDM (%)	36.59 ±0.07^{m}	40.28 ±0.06^{i}	40.55 ±0.25^{i}	36.59±0.07^{m}	42.24±0.02^{k}	49.05 ±0.24^{i}	37.28 ±0.03^{j}	38.28 ±0.04^{j}	39.28 ±0.05^{j}	20.28±0.07^{k}	21.28 ±0.07^{k}	22.28±0.07^{k}	58.79±0.04^{g}	58.91±0.01^{g}	60.28 ±0.03^{fg}	58.79 ±0.04^{fg}	61.63 ±0.03^{ef}	62.06±0.05^{e}
DOM (%)	40.82 ±0.01^{u}	43.62 ±0.41^{s}	0.31±0.31^{t}	40.82±0.01^{u}	45.29±0.04^{r}	53.58 ±0.03^{m}	52.28 ±0.07^{o}	52.30 ±0.08^{o}	52.31 ±0.09	52.94±0.09^{n}	52.55 ±0.06^{n}	53.30±0.09^{n}	62.23±0.11^{l}	62.66±0.03^{k}	63.49 ±0.01^{j}	62.23 ±0.01^{j}	64.21 ±0.01^{i}	65.94±0.04^{g}

Continued….

Items	Types of roughages																		Sign.
	Reeds						Palm leaves						Wheat bran						
	1g/L Conc.			2g/L Conc.			1g/L Conc.			2g/L Conc.			1g/L Conc.			2g/L Conc.			
	Days			Days			Days			Days			Days			Days			
	0	20	30	0	20	30	0	20	30	0	20	30	0	20	30	0	20	30	
DM (%)	94.51 0.31±^{efg}	97.21± 0.02^{abc}	98.89± 0.01^{a}	94.51± 0.01^{Efg}	95.58± 0.03^{cdef}	98.26± 0.05^{ab}	94.62± 0.02^{efg}	95.47± 0.01^{cdef}	96.85± 0.02^{bc}	94.67± 0.02^{Efg}	95.67± 0.01^{cdef}	96.82± 0.02^{bc}	90.78± 0.03^{h}	94.26± 0.04^{fg}	95.64± 0.03^{Cdef}	90.78± 0.03^{h}	94.79± 0.01^{Efg}	95.67± 0.01^{Cdef}	**
OM (%)	85.70± 0.10^{J}	87.26± 0.04^{g}	89.26± 0.06^{ef}	85.70± 0.10^{J}	86.81± 0.01^{m}	90.49± 0.02^{bc}	84.94± 0.01^{k}	87.07± 0.03^{gh}	89.13± 0.03^{f}	84.94± 0.01^{K}	86.81± 0.01^{Gh}	90.12± 0.01^{cd}	86.19± 0.02^{ij}	87.30± 0.02^{g}	86.62± 0.02^{hi}	86.19± 0.02^{Ij}	89.69± 0.03^{Ed}	90.62± 0.02^{Bc}	**
CP(%)	2.23± 0.03^{s}	5.51±0. 01^{o}	5.67±0. 01^{S}	2.23± 0.03^{S}	6.92± 0. 01^{h}	8.23± 0.03^{jk}	2.21± 0.01^{s}	4.57± 0.02^{q}	6.27± 0.03^{n}	2.21± 0.01^{S}	6.90± 0.01^{h}	10.89± 0.01^{e}	10.42± 0.02^{f}	14.85± 0.04^{c}	14.18± 0.03^{d}	10.42± 0.02^{f}	16.31± 0.02^{B}	16.88± 0.02^{A}	**
CF (%)	32.32± 0.02^{i}	30.73± 0.01^{n}	30.21± 0.01^{O}	32.32± 0.02^{I}	29.21± 0.01^{q}	28.31± 0.01^{r}	44.27± 0.01^{b}	43.95± 0.01^{c}	39.86± 0.01^{g}	44.27± 0.01^{b}	31.51± 0.01^{m}	29.94± 0.04^{P}	10.53± 0.03^{b}	13.83± 0.03^{y}	12.07± 0.06^{a}	10.53± 0.03^{B}	10.03± 0.03^{C}	13.26± 0.05^{Z}	**
DDM (%)	45.61± 0.01^{J}	49.95± 0.03^{Hi}	50.85± 0.01 H	45.61± 0.01^{j}	60.29± 0.01^{fg}	64.37± 0.01^{d}	30.33± 0.01^{o}	33.63± 3.00^{n}	42.21± 0.01^{k}	30.33± 0.01^{O}	42.99± 0.01^{K}	50.80± 0.02^{h}	72.23± 0.03^{C}	76.33± 0.03^{B}	76.73± 0.03^{B}	72.23± 0.03^{C}	79.32± 0.01^{A}	80.58± 0.03^{A}	**
DOM (%)	50.31± 0.01^{P}	53.54± 0.02^{o}	52.59± 0.01^{M}	50.31± 0.01^{P}	65.31± 0.01^{h}	69.06± 0.04^{f}	35.54± 0.01^{w}	38.65± 0.01^{v}	47.81± 0.01^{Q}	35.54± 0.01^{W}	47.81± 0.01^{w}	53.02± 0.01^{n}	76.33± 0.03^{e}	78.22± 0.02^{D}	78.81± 0.02^{c}	76.33± 0.03^{e}	81.28± 0.03^{e}	83.63± 0.03^{a}	**

proportion of DM and OM was 96.87, 96.49% and 87.58, 87.54% respectively. While using the rice husks, a highly significant increase (P<0.01) in CF was 41.92% recorded. Also, a highly significant increase (P<0.01) in OM, CP, DDM and DOM was noticed when using wheat bran (87.77, 13.84, 76.23 and 79.10% respectively). This difference in the improvement may be due to the nutritional value of the raw materials. Table 3 showed that when incubation periods differed, there was a significant increase (P<0.01) in DM, CP, DDM and DOM was 96.49, 9.34, 57.75 and 61.12% respectively at 30 days incubation while the incubation period of 20 days was significantly better in increasing the proportion of OM (86.27%).

Results show in Table 4 indicate the effect of the overlap between the type of feedstuff and the concentration of fungus. Higher DDM and DOM was recorded in the wheat bran at the concentration of the fungi at 2g/L with a significant difference (P<0.01), whereas, crude fiber was high at 1g/L concentration of *T. harzianum* while using rice husks. The results of Table 4 indicate a significant increase in organic matter, crude protein ratio and laboratory digestibility ration of dry and organic matter, when the mixture between the wheat and the concentration of the fungi was 2g/L.

. Results in Table 5 showed the effect of interaction between the type of feed material and the period of incubation. With regard to dry matter, at the 30 days incubation period, reeds showed significant increase (98.57%), whereas, the organic matter had a significant increase (92.26) at 20 days of incubation using corn cobs. Higher crude protein was recorded (15.58%), while using wheat bran at 20 days of incubation with significant changes (P<0.01). Similarly, for DDM and DOM higher values were recorded for wheat bran at all the three incubation periods.

A significant increase of dry matter, crude protein, DDM and DOM was recorded at 2g/L of *T. harzianum* at 30 days of incubation with significant differences (P<0.01), whereas, a slightly higher organic matter (86.58) was noticed in 20 days of incubation using 1 g/L of *T. harzianum* followed by 2g/L (86.55) at 30 days of incubation.

The results of Table 7 indicated that the effect of triple interference between the type of feed material and incubation period and the concentration of fungi had a significant effect (P<0.01). Dry matter was high at 1 g/L concentration of *T. harzianum* at 30 days incubation using reeds (98.8%) followed by 2g/L concentration of *T. harzianum* at 30 days of incubation using corn cobs and reeds (98.20%). Similarly, organic matter was high at 20 days incubation using *T. harzianum* at 1g/L and corn cobs (93.75%). Lower organic matter was recorded while using rice husks. Also, the best increase in the proportion of crude protein at the treatment of wheat bran at the concentration of 2g/L at the lap period of 20 and 30 days were recorded. The mixture of wheat bran at 2g/L concentration during 30-days incubation period affected significantly. Crude fibre was high while using rice husks and palm leaves at 1g/L concentration of *T. harzianum* (46.26% and 44.2% respectively), whereas, crude fibre was lower when wheat bran was used at both the concentrations of *T. harzianum*. DDM was high while using wheat bran and reed hay at both the concentration of *T. harzianum* when compared with all other treatments. Similarly, DOM was also high in wheat bran at both the concentration of *T. harzianum* at all the incubation periods which was followed by read hay and rice husks.

A study showed that biological treatments with fungi such as *T. harzianum* has led to a high quantity of dry matter and extract of ether and ash and its ratio of crude protein while decreasing the amount of organic matter and raw fiber and change the composition of the chemical result of the treatment of fungi *T. reesei,* in terms of increasing the raw protein and reducing the raw fiber content that may be behind the improvement of digestion and nutritional value (Salman *et al*., 2011).

This improvement can also be attributed to the digestion of raw fiber as a result of biological parameters to the enzyme activity of fungi that can be responsible for the gradual degradation of cellulose to glucose (Gado *et al*., 2007; Abdel-Azim *et al.,* 2011), that the innate treatment of the rabbit led to an increase in the content of the crude protein and the results were not consistent with what was found by Abo-Donia *et al*. (2005). The low fiber content may be related to the utilization of carbohydrates as a source of energy for fungal growth. It has been shown that the biological treatment has led to a decrease in the contents of the organic matter and the raw fiber while the high content of crude protein and ash compared with the non-processed feed (Zewil, 2010).

CONCLUSION

The difference in the concentration of the fungi had an effect on the treatments, as the use of 2g/L was better than 1 g/L in improving the chemical composition. When the incubation period was increased, significant changes were noticed.

REFERENCES

Abdel-Azim SN, Ahmed MA, Abo-Donia F and Soliman H. 2011. Evaluation of fungal treatment of some agricultural residues. *Egyptian Journal of Sheep and Goat Sciences*, 6(2): 1-13.

Abo-Donia F, Sobhy H, El-Gamal K and Mikhail W. 2005. Evaluation of applying the sold-state fermentation technique to upgrade chemical and sugar cane bagasse. *Egyption Journal of Nutrition and Feeds*, 8: 603-617.

Al-Samraee WHA. 2006. Use of chemical and microbial treatment in improving the value of palm date and barley straw. Ph.D Thesis Faculty of Agriculture University of Baghdad.

Al-Waeli SN. 2013. Effect of treated barley straw by *Trichoderma harzianum* fungi and Iraqi probiotic on performance of awassi lambs. M.Sc Thesis. College of Agriculture-University of Baghdad.

AOAC (Association of Official Analytical Chemists). 2005. Official methods of analysis. 18th ed. AOAC International, Gaithersburg, Maryland, USA.

Duncan DB. 1955. Multiple range and multiple F-Test. *Biometrics*, 11, 1-5.

Gado HM, Metwally HM, El-Basiony A, Soliman HS and Galil EA. 2007. Effect of biological treatment on sugarcane bagasse digestibility and performance of baldi goats. *Egyptian Journal of Nutrition and Feeds*, 10(2): 535-551.

Hassan SA. 2009. Effect of some medicinal plants supplementation on daily intake, live weight gain and carcass characteristics of awassi lambs. Egyptian *Journal of Nutrition and Feeds*, 12(1): 65-73.

Ibrahim MY. 2002. Nutritional studies on biological treatment of agriculture by-products on ruminants. M.Sc Thesis, faculty of agriculture, Zagazig University, Zagazig city, Egypt, 109 p.

Mohini M and Mahesh M. 2013. Biological treatment of crop residues for ruminant feeding: a review. *African Journal of Biotechnology*, 12,4221-4231

Salman FM, Salama R, Khattab A, Soliman S and El -Nomeary Y. 2011. Chemical, biological and biochemical treatments to improve the nutritive values of sugarcane bagasse (SCB): 1-Chemical composition, scanning electron microscopy, *in vitro* evaluation, nutrients digestibility and nitrogen utilization of untreated or treated Scb. *Life Science Journal-Acta*, Zhengzhou University overseas ed. 8(4): 351-363.

Saadi YMO. 2009. Effect of probiotic addition and substituting reed silage for alfalfa hay in the ration on awassi lambs performance. College of Agriculture/ University of Baghdad.

Zewil MGM. 2010. Upgrading of nutritive value for some agricultural residues through the biological treatments for animal feeding. Diss. Ph.D Thesis, faculty agriculture, Cairo. Al-azhar University.