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Effect of biological Treatment of Barley Straw with Baker's Yeast (*Saccharomyces cerevisiae*) *on* some productive performance of growing lambs.

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ABSTRACT

This study was conducted at the farm of Ruminants Research Station, Office of Agricultural Research, Ministry of Agriculture, Abu Ghraib – Baghdad. The experiment continued for 56 days, in addition to 14 days as preliminary period from 11/10/2015 until 06/12/2016 to study the effect of treating barley straw with baker's yeast (*Saccharomyces cerevisiae*) on some productive performance of growing lambs. Ten Awassi lambs used in this experiment with average initial weight of 38±0.50 kg and age 8-9 months. Lambs divided randomly into two equal groups and kept in separate individual pens. Lambs fed individually on a unified concentrate diet (2.5% of body weight), while, roughages offered *ad libitum*. Each group fed on roughages (barley straw), as follows:

1. The first group fed untreated barley straw plus concentrate mixture and operated as control
2. The second group fed barley straw treated with baker's yeast (*Saccharomyces cerevisiae*) at rate 0.5% (5 kg / tones).

Animals weighed every two weeks before morning feeding. The digestibility experiment performed in the seventh week. Rumen liquor collected at fifth week of the experiment at three times (before feeding, after three and six hours from feeding). Results showed different effects among treatments. The yeast not significantly affected the feed intake, average daily gain (15 – 28 d), *in vivo* digestibility, and rumen fermentation (pH and NH_3-N). Moreover, there was significant decrease ($P < 0.05$) in daily weight gain during 29 - 42 d with baker's yeast compared with control (107.14 and 160.71g/d, respectively), while a significant increase ($P < 0.05$) found in daily weight gain in the (1 – 14 d and 43 – 56 d) with baker's yeast (103.57 and 178.57 g/d, respectively) compared with control (48.33 and 142.86 g/d, respectively). We conclude that treatment with baker's yeast not improved feed conversion ratio, feed intake, intake of different nutrients, weight gains, digestibility and rumen fermentation (pH and NH_3-N concentration).

INTRODUCTION

Raising sheep in Iraq are suffering a lot of obstacles and problems. One of the most important problems is feeding where down spaces pastures as well as low areas allocated for cultivation of green fodder, are not consistent with needs and requirements of animals. (Al-Saady, 2009). So, many researchers resort to use low quality forages that characterize with low nutritive value and contain high percentage of lignin to compensate this shortage (Mahesh and Mohini, 2013).

Many treatments were conducted to improve the nutritional value of low quality feeds including physical, chemical treatments (Al-Zubaidi, 2006, Hassan, 2004) and biological treatments (Hassan et al., 2007), which helps to break link between lignin and cellulose and increase cellulose for ease using by ruminant animals (Mahesh and Mohini, 2013).

Fungi used in biological treatments where research still going to know the best and qualified fungus to improve the nutritional value of forage and of these fungus the baker's yeast (*Saccharomyces cerevisiae*) tested in this study. It is of the kinds used to break link between lignin and cellulose (Nsereko et al., 2002). The baker's yeast is a rich source of protein, vitamin B composite, minerals and enzymes as well as important elements for immunity (Milewski and Sobiech, 2009). It works to improve the performance of ruminants by affecting rumen microorganisms (Inal et al., 2010).

Therefore, the purpose of this study was to know the effect of feeding barley straw treated with baker's yeast (*Saccharomyces cerevisiae*) on the performance of Awassi Lambs.

MATERIALS AND METHODS

This study was conducted in the farm of Ruminants Research Station, Office of Agricultural Research, Ministry of Agriculture, Abu Ghraib – Baghdad. The experiment continued for 56 days in addition to 14 days as preliminary period, from 11/10/2015 to 06/12/2015.

The purpose of the study was to investigate the effect of treating barley straw with baker's yeast (*Saccharomyces cerevisiae*) on some productive characteristics of growing lambs (feed intake, daily gain and feed conversion ratio) digestibility, and rumen characteristics (ruminal pH and ammonia–N concentration).

Table (1): The chemical composition of barley straw (T_1), treated barley straw (T_2) and concentrate diet (% of dry matter)

Contents (%)	T_1	T_2	Concentrate
DM	90.83	91.78	89.91
OM	76.37	74.63	82.19
CP	2.17	2.96	12.33
CF	64.47	63.59	13.31
EE	1.38	1.38	5.23
NEF	15.52	13.92	61.40
ASH	14.46	17.15	7.72
Cellulose	17.94	20.39	13.52
Hemicellulose	21.66	23.03	22.56
NDF	63.68	63.48	41.1
ADF	42.02	40.45	18.5
ADL	24.08	20.08	5.02
TDN	33.00	31.02	67.81

TDN (% of DM) = -17.2649+1.2120(%CP) + 0.8352 % NFE+2.4637% EE+0.4475 %CF

2.2 . Method of treating barley straw

Barley straw divided into two batches where humidity lifted to 70% by spraying water on barley and sections had treated as follows: -

The first batch did not treat and used as control group. The second section treated with 0.5% baker's yeast (5 kg/ton), where yeast sprayed on barley straw and mixed until yeast well distributed within barley straw.

After spraying ended, barley straw covered by a black polyethylene sheets to prevent air and sun light, left for two weeks and then polyethylene bags removed. Barley straw left to dry and then grinded for using and submitting to experimental animals.

Growth trial

Ten Awassi lambs used in this experiment had average initial weight 38 ± 0.50 kg and age 8-9 months. Lambs divided randomly into two equal groups (5 each) then kept in individual pens (1.25 × 1.25 m) and numbered according to transactions. All lambs fed individually on a unified concentrate mixture at 2.5 % of live body weight (LBW) while the roughage portion offered at ad libitum for animals of the two groups. The adaptation period amounted 14 days where fodder offered gradually. The roughages introduced separate from concentrate diets at 8:00 am. The concentrate diets provided at 12:00 pm to ensure consuming a larger amount of roughages.

The remained roughages and concentrate collected daily in the morning before start feeding for calculating the amount of daily feed intake. The animals weighed every two weeks before morning feeding and periodically at the beginning of the experiment to the end. Samples of concentrates and roughages collected for chemical analysis. Table 1 show the chemical

composition of untreated barley straw and concentrate mixture.

Digestion trials

Two in vivo digestibility trials were conducted on the animals of feeding trial (5 lambs each), to determine the digestibility and feeding values of the experimental ration. The trials performed during the seventh week of the feeding experiment for all animals. Feces were collected for 7 days at morning before provision of feed by using bags (locally made from flour bags containing small holes at the bottom) to collect feces, then weighed by electronic balance, samples took and put in small and clean plastic bags to save in the fridge. The process repeated on the second day, and so for a period of 7 days, samples kept in the refrigerator (freezed) until chemical analyses.

Chemical analysis of feed and feces applied to estimate dry matter (DM), organic matter (OM), ash, crude protein (CP), crude fiber (CF), ether extract (EE) (AOAC, 2005), neutral detergent fiber (NDF), acid detergent fiber (ADF), acid detergent lignin (ADL), (Goering and Van Soest, 1970), cellulose and hemicelluloses were calculated by subtraction.

Rumen Fermentation Characteristics

Rumen liquor samples collected from lambs during the fifth week of experiment. They were withdrawn at zero time (just before feeding), then at 3 h and 6 h post morning feeding to study rumen fermentation characteristics through the determination of ruminal pH and NH_3-N concentrations.

Samples were withdrawn from the same animals in all sampling time by using a smooth rubber stomach tube which connected to Hand Operated Siphon Pump (SI-60) and inserted into the rumen via the esophagus as described by Saeed, (2011). Rumen liquor was strained through four layers of cheesecloth to discard the solid unfermented particles and immediately measured for pH using portable digital pH meter (ph-80) after adjusting with standard pH buffer solutions (pH=7). After that, a retention of about 10 ml of rumen liquor was kept and 2-3 drops of toluene added to prevent fermentation. The samples stored at -20 °C until analysis. (Filípek and Dvořák, 2009).

Statistical analysis:

The experimental data analyzed applying a complete randomized design (CRD) and compared the moral differences between averages by Duncan test multi – border (Duncan, 1955) using statistical program SAS (SAS, 2012).

RESULTS AND DISCUSSION

1. Feed intake

Data in table 2 show that treatment with baker's yeast did not have any significant effect on the amount of intake either roughages or concentrate. These results agree with (Deraz and Ismail, 2001, Ibrahim, 2002, El-Menniawy, 2008) while not agree with Gado et al., (2007), Abdelhamid et al., (2009), Fayed et al., (2009) and Omer et al., (2012).

The noticed minor difference in feed intake may due to the large age of animals or because we have adopted in this study to treat barley straw with yeast instead of using it as additive to feed as used in previous studies which may have a role in declining animal palatability to some treated feeds.

Intake of nutrient

Table 2 shows that treatment with baker's yeast did not have any significant effect on the amount of dry matter (DM), organic matter (OM), ash, crude protein (CP), crude fiber (CF), ether extract (EE), cellulose, hemicelluloses, neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL). These results agree with Chandra et al., (1991), El-Ashry et al., (2002) and El-Menniawy, (2008), while did not agree with Viesturs et al., (1981), Yalchi and Hajieghrari, (2010), Yalchi and Hajieghrari, (2014) and Abdel-Azim et al., (2011).

These results not agree with Akinfemi et al., (2010), who reported a decrease in NDF, ADF and ADL, which can be an indication of the disintegration of the cell wall basic materials because of the extracellular enzymes secreted from fungus. While increase of digestion might have associated with disintegration of carbohydrates structure and increase the crude protein content of the cornhusk when treated with the White fungus mold. The decrease in crude fiber content may relate to use of

Table 2: Effect of treated barley straw with baker's yeast on feed Intake and its contents of growing lambs

Intake, Kg	Control	**baker's yeast** treated group	Signify
Roughages	34.02 ± 2.86	33.75 ± 2.13	NS
Concentration	57.63 ± 1.32	54.48 ± 2.83	NS
Total	91.65 ± 3.89	88.23 ± 4.48	NS
DM	30.90 ± 2.60	30.97 ± 1.96	NS
OM	29.55 ± 2.48	28.43 ± 1.80	NS
CP	1.29±0.11	1.22± 0.08	
CF	19.92 ± 1.67	19.69 ± 1.24	NS
EE	0.43 ± 0.04	0.43 ± 0.03	NS
Cellulose	6.11± 0.51	6.88± 0.43	NS
Hemicelluloses	7.37± 0.62	7.77 ± 0.49	NS
NDF	21.67 ± 1.82	21.42 ± 1.35	NS
ADF	14.30 ± 1.20	13.65 ± 0.86	NS
ADL	8.19± 0.69	8.77± 0.43	NS

NS = non-significant

carbohydrate by the fungus as an energy source for the growth of fungoid.

Daily gain and feed conversion ratio

Results presented in table 3 show that final body weight, total body weight gain and daily gain over the whole experimental period were not significantly affected by tested ration compare to those of control ration. While found significant decrease (P <0.05) in weight gain within 29 to 42 d with baker's yeast compared with control (107.14 and 160.71, respectively). Meanwhile, a significant increase (P <0.05) in daily gain weight (1 – 14 d and 43 – 56 d) (103.57 and 178.57 g, respectively) compared with control (48.33 and 142.86, respectively), These results do not agree with Deraz and Ismail, 2001, Ibrahim, 2002, Gado et al., 2007, Abdelhamid et al., 2009, Fayed et al., 2009, and Abdel-Azim et al., (2011). The cause of change in weights within experimental weeks goes back to the influence of yeast on improving anaerobic conditions within the animal's rumen then it works to improve function of microorganisms and increase its effectiveness in cracking the bonds that link lignin with structural carbohydrates, which increases the readiness of nutrients in the rumen.

***In vivo* Digestibility**

Result concerning digestion coefficients (Table 4) showed that treated barley straw with baker's yeast and inclusion of tested ration did not significantly affected all nutrients digestibility's compare to control ration. These results agree with Yalchi and Hajieghrari, (2014) and Okab et al., (2012) while not agree with Viesturs et al., (1981), Nsereko et al., (2002), El-Menniawy, (2008), Fayed et al., (2009), Yalchi and Hajieghrari, (2010), Abdel-Azim et al., (2011), Salman et al., (2011), Omer et al., (2012) and Abo-Donia et al., (2014). Furthermore, it not agree with Bhumibhomon et al., (1988), who suggested that improvement of digestion coefficient of both crude protein (CP) and crude fiber (CF) might due to enzymes produced by microbes (specially amylase and protease) which were involved indirectly in digestion of carbohydrate and protein. They suggested that increase in digestible crude protein may attributed to better digestibility of most nutrients

Table 3: Effect of treatment with baker's yeast on final weight, total gain, daily gain and feed conversion ratio.

Characteristics	Control	**baker's yeast**	Signify
Initial weight (kg)	38.53 ± 4.34	37.97 ± 7.74	NS
Final weight (kg)	46.96 ± 2.40	46.74 ± 7.36	NS
Daily gain weight (gm)	156.61 ±13.25	150.54 ± 9.51	NS
Weight gain (gm/d)			
1 – 14 d	48.33± 1.67 b	103.57 ± 1.93 a	*
15 – 28 d	250.00 ± 9.71	238.10 ± 7.99	NS
29 42 d	160.71 ± 10.31 a	107.14 ± 8.66 b	*
43 56 d	142.86 ± 7.55 b	178.57 ± 8.62 a	*
Total gain weight	8.43 ± 0.16	8.78 ± 0.72	NS
Feed conversion ratio	10.87 ± 1.30	10.04 ± 1.12	NS

*** = significant (*P* <0.05), NS = non-**significant

Table 4: Effect of treatment with baker's yeast on digestibility

Digestibility %	Control	**baker's yeast** treated group	Signify.
DM	56.38 ± 3.84	57.24 ± 2.30	NS
OM	60.49 ± 3.21	62.30 ± 0.91	NS
CP	64.74 ± 1.05	65.62 ± 0.79	
CF	68.28 ± 2.47	55.26 ± 2.97	NS
EE	69.82 ± 0.44	70.64 ± 0.10	NS
Cellulose	72.68 ± 6.41	78.50 ± 2.95	NS
Hemicelluloses	70.09 ± 2.47	71.36 ± 4.75	NS
NDF	60.55 ± 3.02	62.87 ± 2.61	NS
ADF	61.78 ± 3.60	68.21 ± 1.38	NS
ADL	62.59± 0.20	59.50± 1.51	NS

NS = non-significant

due to this treatment or the increase in fermentation capacity of rumen (Hungate, 1975).

Rumen fermentation

Table 5 shows that treatment with baker's yeast did not have any significant effect on rumen fermentation (pH and NH_3–N concentration) at all collection times. These results do not agree with El-Sayed et al., (2002), Saleh, (2004), Ding et al., (2008), El-Menniawy, (2008), Abdel-Azim et al., (2011) and Abo-Donia et al., (2014). The results of total counts of microorganisms agree with El-Sayed et al., (2002), Saleh, (2004), Ding et al., (2008), El-Menniawy, (2008), Abdel-Azim et al., (2011) and Abo-Donia et al., (2014).

The addition of fungus can work to stabilize the pH of rumen in the first place by encouraging the growth of bacteria consumed lactic, which is responsible for the reduction of concentration of lactate in the rumen (Williams et al., 1991), but as we have seen in our study no effect found on pH.

These results not agree with Stella et al., (2007) where fungi maintained a stabilized ruminal pH and consequently a higher cellulolytic activity in rumen. It is noteworthy that all research done on yeast, add yeast to feed and no search use yeast in treating roughages to improve nutritional value.

1.

Table 5: Effect of treatment with baker's yeast on Rumen fermentation

Treatments	0	3h	6h
Ph			
Control	6.35 ± 0.05	6.45 ± 0.15	6.35 ± 0.05
baker's yeast	5.65 ± 0.25	6.10 ± 0.20	5.65 ± 0.25
Significantly	NS	NS	NS
NH_3-N mg / dcl			
Control	31.52 ± 3.50	31.52 ± 3.50	24.52 ± 3.51
baker's yeast	35.02 ± 7.00	35.02 ± 7.00	24.52 ± 3.51
Significance	NS	NS	NS

NS = non-significant,

CONCLUSIONS

1. The treatment with baker's yeast improve feed conversion ratio.
2. The treatment with baker's yeast did not have any positive effects on productive characteristics (feed intake, intake of nutrients, *in vivo* digestibility, and rumen fermentation (ruminal pH and ammonia–N concentration).

REFERENCES

Abdel-Azim, S. N., Ahmed, M. A., Abo-Donia, F. and Soliman, H. (2011). Evaluation of fungal treatment of some agricultural residues. Egyptian Journal of Sheep and Goat Sciences, 6.

Abdelhamid, A., Bassuny, S., Abd El-Aziz, A. and Ibrahim, M. Y. S. A. (2009). The production of microbial protein from some agricultural wastes and its utilization in ruminant feeding, II-digestibility study PhD thesis, Institute of Environmental Studies and Research, Egypt. URL: http:// en. engormix. Com./ MA-sheep/ articles/ evaluation-biological-treatments-agricultural_, 1360.

Abo-Donia, F. M., Abdel-Azim, S. N., Elghandour, M. M., Salem, A. Z., Buendía, G. and Soliman, N. (2014). Feed intake, nutrient digestibility and ruminal fermentation activities in sheep-fed peanut hulls treated with Trichoderma viride or urea. Trop. Anim. Health Prod., 46, 221-228.

Akinfemi, A., Adu, O. and Doherty, F. (2010). Conversion of sorghum stover into animal feed with white-rot fungi: Pleurotus ostreatus and Pleurotus pulmonarius. Afr. J. Biotechnol., 9.

Al-Saady, Y. M. O. (2009). Effect of Probiotic Addition and Substituting Reed Silage for Alfalfa Hay in the Ration on Awassi Lambs Performance. Mr Thesis, College of Agriculture / University of Baghdad.

Al-Zubaidi, K. A. (2006). The effect of using different levels of urea with yellow corn cops treated with mollas in the performance of Awassi lambs. Master Thesis. Technical College / Musayyib, body of technical education, the college Iraq.

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

Bhumibhomon, O., Chaiyapoland, K. and Sirisansaneeyakul, S. (1988). Studies on chemical and environmental changes during composting. Proc. Of Eighth Inter. Conf. 1-5 August. Hong Kong.

Chandra, S., Reddy, M. and Reddy, G. (1991). Effect of fungal treatment of paddy straw on nutrient utilization in complete diets for sheep. Indian J. Anim. Sci., 61, 1330-1334.

Deraz, T. and Ismail, H. (2001). Cotton stalks treated with white-rot fungus for feeding sheep. Egypt J. Nutrition Feeds, 4, 423-34.

Ding, J., Zhou, Z., Ren, L. and Meng, Q. (2008). Effect of monensin and live yeast supplementation on growth performance,

nutrient digestibility, carcass characteristics and ruminal fermentation parameters in lambs fed steam-flaked corn-based diets. Asian Australas. J. Anim. Sci., 21, 547.

Duncan, D. B. (1955). Multiple range and multiple F tests. Biometrics, 11, 1-42.

El-Ashry, A., Kholif, M., El-Almay, H., Fadel, M., El-Sayed, H. and Kholif, A. (2002). Effect of biological treatment on chemical composition and in vivo nutrients Digestibility of poor quality roughages. Egyption J. Nutr. Feed, 4, 435-436.

El-Menniawy, A. (2008). Studies on biological treatments in animal nutrition. Ph.D. Thesis., Fac. Agriculture, Al-Azhar University. Egypt. 482

El-Sayed, H., El-Ashry, M., Metwally, H., Fadel, M. and Khorshed, M. (2002). Effect of chemical and biological treatments of some crop-residues on their nutritive value: 3- Digestion coefficient, rumen and blood serum parameters of Goats. Egyptian Journal of Nutrition and Feeds, 1, 55-66.

Fayed, A. M., El-Ashry, M. and Aziz, H. A. (2009). Effect of feeding olive tree pruning by-products on sheep performance in Sinai. World Journal of Agricultural Sciences, 5, 436-445.

Filípek, J. and Dvořák, R. (2009). Determination of the volatile fatty acid content in the rumen liquid: comparison of gas chromatography and capillary isotachophoresis. Acta Vet. Brno, 78, 627-633.

Gado, H., Metwally, H., El-Basiony, A., Soliman, H. and Galil, E. A. (2007). Effect of biological treatments on sugarcane bagasse digestibility and performance of Baldi goats. Egypt. J. Nutr. Feeds, 10, 535-551.

Goering, H. K. and Van Soest, P. J. (1970). Forage fiber analyses (apparatus, reagents, procedures, and some applications). ARS/ USDA Handbook No. 379.

Hassan, A. a. A. (2004). use of some chemical treatments to improve the nutritive value of the palm date fronds. PhD thesis. College of Agriculture - University of Baghdad, Iraq.

Hassan, S. a. A., Alsamraee, W. H. and Hashim, A. J. (2007). Use of microbial treatment in improving the nutritional value of chopped barley straw. Iraqi Journal of Agricultural Sciences 38 (1): , 43-58.

Hungate, R. (1975). The rumen microbial ecosystem. Ann. Rev. Ecol. Syst., 6, 39.

Ibrahim, Y. (2002). Nutritional studies on biological treatment of agricultural by products on ruminants. M.S.Thesis, Fac. Agriculture Zagazig University. Egypt.

Inal, F., Gürbüz, E., Coşkun, B., Alataş, M. S., Çitil, Ö. B., Polat, E. S., Şeker, E. and Özcan, C. (2010). The effects of live yeast culture (Saccharomyces cerevisiae) on rumen fermentation and nutrient degradability in yearling lambs. Kafkas Univ Vet Fak Derg, 16, 799-804.

Mahesh, M. and Mohini, M. (2013). Biological treatment of crop residues for ruminant feeding: A review. Afr. J. Biotechnol., 12, 4221-4231.

Milewski, S. and Sobiech, P. (2009). Effect of dietary supplementation with Saccharomyces cerevisiae dried yeast on milk yield, blood biochemical and haematological indices in ewes. Bull Vet Inst Pulawy, 53, 753-758.

Nsereko, V., Beauchemin, K., Morgavi, D., Rode, L., Furtado, A., Mcallister, T., Iwaasa, A., Yang, W. and Wang, Y. (2002). Effect of a fibrolytic enzyme preparation from Trichoderma longibrachiatum on the rumen microbial population of dairy cows. Can. J. Microbiol., 48, 14-20.

Okab, A. B., Ayoub, M. A., Samara, E. M., Abdoun, K. A., Al-Haidary, A. A., Koriem, A. A. and Hassan, A. A. (2012). Improvement of growth and nitrogen utilization in sheep using sugar beet pulp treated with Trichoderma reesei or urea. Trop. Anim. Health Prod., 44, 1623-1629.

Omer, H., Ali, F. and Gad, S. M. (2012). Replacement of clover hay by biologically

treated corn stalks in growing sheep rations. J. Agric. Sci., 4, 257.

Saeed, A. (2011). Effect of level and degradability of dietary protein fed without bakers yeast (saccharomyces cerevisiae) on Turkish Awassi lamb's performance. Ph.D. Thesis, College of Agriculture, University of Baghdad. Iraq.

Saleh, H. (2004). Effect of supplementing fenugreek seeds as galactagogue on performance of lactating ewes. Egyptian J. Nutr. and Feeds, 7, 155-165.

Salman, F. M., 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 EDITION, 8, 351-363.

Sas (2012). Statistical Analysis System, User's Guide. Statistical. Version 9.1th ed. SAS. Inst. Inc. Cary. N.C. USA.

Stella, A., Paratte, R., Valnegri, L., Cigalino, G., Soncini, G., Chevaux, E., Dell'orto, V. and Savoini, G. (2007). Effect of administration of live Saccharomyces cerevisiae on milk production, milk composition, blood metabolites, and faecal flora in early lactating dairy goats. Small Rumin. Res., 67, 7-13.

Viesturs, U., Apsite, A., Laukevics, J., Ose, V., Bekers, M. and Tengerdy, R. (Year) Published. Solid-state fermentation of wheat straw with Chaetomium cellulolyticum and Trichoderma lignorum. Biotechnol. Bioeng. Symp.; (United States), 1981.

Williams, P., Tait, C., Innes, G. and Newbold, C. (1991). Effects of the inclusion of yeast culture (Saccharomyces cerevisiae plus growth medium) in the diet of dairy cows on milk yield and forage degradation and fermentation patterns in the rumen of steers. J. Anim. Sci., 69, 3016-3026.

Yalchi, T. and Hajieghrari, B. (2010). Effect of Trichoderma spp. inoculation on the chemical composition and in vitro digestibility of wheat straw. Afr. J. Biotechnol., 9, 4132-4137.

Yalchi, T. and Hajieghrari, B. (2014). Effect of fungal treatment on chemical composition and in vitro ruminal digestibility of some agricultural residues. Afr. J. Biotechnol., 10, 19707-19713.