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Effect of chemically and biologically treated rice straw on some productive characteristics of Iraqi buffalo (*Bubalus bubalis*) calves

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Abstract

This study was conducted to find out the effect of chemically treating rice straw with urea and biologically with the fungus *Trichoderma harzianum* on feeding Iraqi buffalo calves on the weight gain, feed intake, and feed conversion. The results showed that there were highly significant differences (P<0.01) between treatments in the amount of total feed intake, as T2 (7.713 kg) and T3 (7.428 g) were compared with T1 (6.461 kg), and in the amount of nutrients intake for roughage, where T3 was significantly superior (P<0.05) on T1 intake from daily roughage 2804.2, 2191.7 gm for T3 and T1, respectively, while T2 did not differ significantly from T1 and T3. The results showed significant differences in the intake of nutrients from roughage, where T3 and T2 were significantly (P<0.01) superior to T1 in crude protein, ether extract, ash, and metabolic energy, and the differences were significant (P<0.05) in favor of T2 and T3 in both dry matters. organic matter and nitrogen-free extract. The treatments had a highly significant effect on the intake of total roughage, and significantly (P<0.01) T3 and T1 in dry matter, organic matter, crude protein, nitrogen-free extract, and metabolic energy, while the treatments did not significantly effect crude fiber. The results also showed that treatment with urea and fungi led to a highly significant increase (P<0.01) in the weight gain (daily and total) and a high improvement in the feed conversion ratio for calves. We conclude that the chemical (Urea) and biological (*T. harzianum*) straw treatment led to an improvement in the nutritional value of the rice straw by raising the nitrogen content in it and improving the feed conversion ratio, knowing that the effect of the biological treatment was significantly better.

Keywords: *Trichoderma harzianum*, urea, weight gain, digestibility, feed intake

Introduction

Buffalo is of great importance in the field of livestock, especially river and swamp buffalo, for its main role in the production of milk and meat, and a working animal in some countries [1]. Buffalo is the best in converting low quality roughage into milk and meat [2]. Iraqi suffers from a shortage of green fodder and roughage in general, therefore unconventional feeds were used to feed ruminants, such as reeds and straw [3] . Due to the importance of rough feed in feeding ruminants, research attention has turned to improve its nutritional value by some nutritional supplements or physical treatments such as grinding, cooking and crushing [4] and chemical treatments such as adding NaOH, urea and other alkaline or organic solvents [5] and Biological treatments are by using microorganisms that analyze the bonds between lignin, cellulose and hemicellulose to analyze the plant cell wall and make better use of its components to obtain a high digestibility factor and high nutritive value for these feeds [6]. Rice straw treatment with fungi and enzyme improve digestibility [7] Livestock breeders suffer annually from a shortage of fodder and high prices of concentrated rations, which results in nutritional problems for animals and poor production. This study aimed to know the effect of treating rice straw with urea and fungus on feed consumption and the rate of feed conversion in calves, and increasing the intake of straw by improving its nutritional value in feeding Iraqi buffalo.

Materials and Methods

The study was conducted at the ruminant Research Station in Abu Ghraib / Directorate Agricultural Researches / Ministry of Agriculture, for the period from June 1, 2021, until August 27, 2021. Twelve calves were selected post-weaning, weighing 140-160 kg Individual feeding was conducted for 87 days of the experiment preceded by 14 days as an adaptation period.

The concentrate diet was introduced by 3% of body weight consisting of 67% barley, 10% yellow corn, 12% soybean meal, 8% cottonseed meal, 2% lime, and 1% salt. treatments then sampled for analysis. Chemical analysis of feed applied to found dry matter (DM), organic matter (OM), Ash, crude protein (CP), crude fiber (CF), ether extract (EE) [8]. (Table 1). The calves were weighed bi-weekly and the concentrate diet was adjusted based on weight. The roughages were offered *ad libitum*, The remained roughages and concentrate were collected daily in the morning pre- feeding for calculating the amount of daily feed intake. The animals were weighed every two weeks pre- morning feeding during the experiment period. All animals were provided clean water, and vaccines and kept under continuous veterinary supervision during all experimental. First group (control) the calves were fed on rice straw only, while, the second group (T1) on urea treated rice straw and the third group (T2) were fed on rice straw treated with *T. harzianum*.

Table (1): The chemical composition of and concentrate diet and experiment treatments (% of dry matter)

Ingredients	Treatment diet			
	Concentrate	T1	T2	T3
DM	93.09	93.89	90.75	90.60
OM	92.59	92.86	89.98	89.68
CP	14.75	3.94	8.75	10.94
CF	11.30	32.28	26.56	25.60
NFE	62.19	52.93	53.24	52.32
EE	4.35	1.25	1.43	1.30
Ash	7.41	9.60	10.02	9.84
*ME	12.39	9.89	10.28	10.32

*Metabolic energy (MJ/kg DM) = 0.012 × crude protein + 0.031 × ether extract + 0.005 × crude fiber + 0.014 × nitrogen free extract[9]. **(**T1) rice straw, (T2), rice straw treated with urea , (T3),rice straw treated with *Trichoderma harzianum*.

Preparation of roughage (rice straw)

Straw treated with urea

The straw was treated with urea at 3% of the weight of the rice straw (3 kg urea + 100 liters of water+ 100kg straw). The straw was spread over a piece of nylon and then sprayed with the solution prepared in advance, and then it was agitation, covered, and weights were placed to prevent the loss of ammonia after the degradation of urea. It was incubated for 60 days after the end of the incubation period. The lid was lifted and stirred for drying and storage, with a sample taken for chemical analysis. [10].

Straw treated with fungus *T. harzianum*

The straw was put on a piece of nylon in a dark room after it was wet slightly with water to reach a moisture content of 60%, then sprayed rice straw with a solution containing the fungus and sports at a rate of 0.1% (1 kg/ton of straw). Then it was mixed and covered for two weeks at a temperature of 25-30 C˚, and after the incubation period ended, the lid was lifted and dried under the sun and stored in nylon bags until it was used in the experiment [11].

Statistical analysis:

The experimental data analyzed as a complete randomized design (CRD) were and compared the significant differences among the averages by Duncan multiple range tests [12] using the statistical program SAS [13] the statically model was as follows:

$Yij = \mu + Ti + eij$

As:

Yij = View value j Per transaction i
μ = The overall mean of the trait
ti = Treatment effect
eij = Random error that is normally distributed with a mean equal to zero and variance of its magnitude σ 2 e.

Results and Discussion

Feed intake

Table (2) shows that there are significant differences among treatments in daily feeds intake, as the third treatment increased significantly (P<0.05) and scored 2804.2 g compared with the control group of 2191.7 g, while the second treatment, which amounted to 2589.6 g and a highly significant (P<0.01) in total feed intake and reached to T2 and T3 7713.7 and 7428.4 compared with T1 6461.7 g DM/head/day respectively. The result of increase in the daily intake of roughage and the total intake may be due to the breakdown of the lignocellulosic bonds between the roughage rice straw particles as a result of the treatment with urea and fungus or may be attributed to the increase in the palatability of roughage as a result of the effect of chemical and biological treatment [14]. These results do not agree with [15 , 16].

Table (2): Effect of treating rice straw with urea and *T. harzianum* on Concentrate, Roughage, and total daily feed intake

Treatment	Concentrate intake, g DM/head/day	Roughage intake, g DM/head/day	Total intake g DM/head/day
T1	4270.0±200.22	2191.7±100.40 b	6461.7±223.14 b
T2	5124.2±348.41	2589.6±167.19 ab	7713.7±231.57 a
T3	4624.3±228.55	2804.2±133.52 a	7428.4±125.54 a
Significance	N.S	*	**

Different litters in the same column means significant differences; (P< 0.01)**. (P<0.05) *; NS, non-significant T1untreated rice straw, T2, urea treated rice straw T3, Trichoderma harzianum treated rice straw.

Intake of nutrient

Observed from Table 3 significantly increased (P<0.01) the total daily intake of all nutrients except crud fiber, It reached dry matter (DM) 7428.4, 7713.7and 6461.7 , organic matter (OM) 6796.4, 7074.6 and 5988.8, crude protein (CP) 988.85, 982.40 and 716.18, ether extract (EE) 237.61, 259.93 and 213.14 nitrogen-free extract (NFE) 4343.0, 4565.4 and3815.6 and ash 618.59, 639.18 and 526.81(g/day) respec-

tively with biological and chemical treatment Compared with the control group. While no significant effect of the treatments was observed on the intake of crude fiber (CF). The results in table 4 showed that significantly effects (P<0.05) of the daily nutrients roughage Intake DM2191.7 , 2589.6 and 2804.2 , OM 2035.2 2330.1 and 2528.2 , NFE 1160.0 , 1378.7 and 1467.1 g/d respectively ,While the treatments had a significant effect (P<0.01) on the CP 86.35 226.59 and 306.78 , EE 27.396, 37.031 and 36.454 , Ash 210.40 259.48 , and 275.93, ME 216.76, 266.21 and 289.39. The improvement of nutrient intake may be attributed to the effect of biological treatment with Trichoderma harzianum increased digestibility of processed rice straw compared to untreated straw. [17] reported that straw of urea-treated rice can improve feed intake, rumen environment, and nutrient digestion in cows. [26] reported that biological treatment of rice straw with fungi enhances the ability to digest nutrients, as they observed an increase in the intake and digestibility of DM and OM by more than 10% of cows consuming untreated straw. [15] observed that feeding calves on the straw with fungus-treated rice improved the consumption and digestion of nutrients, increased body weight, and economic efficiency. These results agree with the findings of [18] when feeding Fogera cows on straw of urea- and micro-organisms-treated rice. [19] also found an increase in the intake of nutrients and an improvement in both the digestion coefficient and the efficiency of feed conversion when feeding Farta sheep on rice straw chemically treated with urea.

Table (3): Effect of treating rice straw with urea and *T. harzianum* on the total daily intake of nutrients (g/day) ± Standard error

Treatments / Factors	T1 control	T2	T3	Significant
DM	b 6461.7 ± 223.14	a 7713.7 ± 216.69	a 7428.4 ± 125.54	**
OM	b 5988.8 ± 206.72	a 7074.6 ± 13.26	a 6796.4 ± 118.44	**
CP	b 716.18 ± 29.76	a 982.40 ± 40.24	a 988.85 ± 21.76	**
EE	b 213.14 ± 8.78	a 259.93 ± 13.26	ab 237.61 ± 8.43	*
CF	1189.98 ± 39.35	1266.82 ± 25.48	1240.41±16.26	N.S
NFE	b 3815.6 ± 134.92	a 4565.4 ± 152.25	a 4343.0 ± 86.10	**
Ash	b 526.81 ± 17.61	a 639.18 ± 15.37	a 618.59 ± 7.96	**
*ME	b 745.81± 26.63	a 901.09 ± 30.65	a 862.33 ± 17.24	**

Different litters in same column means significant differences; (P< 0.01)**. (P<0.05) *; NS, non-significant T1untreated rice straw , T2, urea treated rice straw T3 , Trichoderma harzianum treated rice straw, *Metabolic energy (MJ/kg DM) = 0.012 × crude protein + 0.031 × ether extract + 0.005 × crude fiber + 0.014 × nitrogen free extract [9] .

Table (4): Effect of treating rice straw with urea and *T. harzianum* on Intake of nutrients from daily roughage (g/day) ± Standard error

Treatments / Factors	T1 control	T2	T3	Significant
DM	b 2191.7 ± 100.40	ab 2589.6 ± 167.19	a 2804.2 ± 133.52	*
OM	b 2035.2 ± 93.23	ab 2330.1 ± 150.44	a 2528.2 ± 120.38	*
CP	c 86.35 ± 3.95	b 226.59 ± 14.62	a 306.78 ± 14.60	**
EE	b 27.396 ± 1.25	a 37.031 ± 2.39	a 36.454 ± 1.73	**
CF	707.47 ± 32.41	44.40 ± 687.79	34.18 ± 717.87	N.S
NFE	b 1160.0 ± 53.14	ab 1378.7 ± 89.01	a 1467.1 ± 69.86	*
Ash	b 210.40 ± 9.63	a 259.48±16.75	a 275.93 ± 13.13	**
*ME	b 216.76± 9.92	a 266.21± 17.18	a 289.39 ± 13.78	**

Different litters in same column means significant differences; (P< 0.01)**. (P<0.05) *; NS, non-significant T1untreated rice straw , T2, urea treated rice straw T3 , Trichoderma harzianum treated rice straw *Metabolic energy (MJ/kg DM) = 0.012 × crude protein + 0.031 × ether extract + 0.005 × crude fiber + 0.014 × nitrogen free extract [9].

Growth Performance

Table (5) shows significantly increased (P<0.01), daily gain g/d and total gain kg T2 and T2 compared to T1 and recorded 764.36, 686.78, and 479.88 g/day, respectively, and in the same context the rates, where T3 and T2 outperformed T1 and reached 66.50, 59.75 and 41.75 kg, respectively. The results also indicate that there are non-significant differences between the averages of treatments in the initial weight (213.25, 216.50, 210.75) kg and the final weight (255.00, 276.25, 277.25) kg for calves of T1, T2, and T3, respectively. The moral improvement in the weight increases in the third treatment during the different weeks may be due to the action of the fungus on breaking the bonds linking lignin with cellulose and hemicellulose, which increases the availability of nutrients in the rumen and thus increases the utilization of them by microorganisms and improves the nutritional value of straw and improves Feed conversion efficiency [11]. The result of the biological treatment agrees with a previous result [20], which found an improvement in the daily and total gain and attributed this to the result of the positive effect of the biological treatment of rice straw with *T. harzianum* on the efficiency of microorganisms and the digestion of organic matter. The reason is due to the action of the cellulase enzyme secreted from this fungus used in the treatment, which led to the decomposition of

the plant cell wall of the straw using the carbon contained in glucose as a source of energy, which affected the ability and increases the number of microorganisms in the animal's rumen, which led to an increase in the efficiency of food conversion and an improvement in the laboratories. However, the role of this biological agent is not limited to the analysis of the organic matter, as it has been found to have antagonistic activity against many plant pathogens [21, 22].

The digestion of organic compounds resulting from the activity of microorganisms in the rumen, and this is in agreement with [23]. The same applies to the second treatment, as urea has a positive effect on the activity of microorganisms inside the rumen and is considered an easy source for digestion and release in the animal's rumen, thus benefiting from straw and its components of protein and energy, and this effect was positively reflected on the daily and total gain [24, 25]. The result of chemical treatment did not agree with [11], who noticed that there was no significant effect of chemical treatment on the daily and total gain when feeding cow calves on urea-treated rice straw compared with the control group for 75 days of feeding. and did not agree with [26], who noted that there was no significant effect on the daily and total gain when feeding cow calves on urea treated wheat straw compared with the control group for 120 days. The results of the Feed conversion efficiency in Table (5) indicate a highly significant decrease ($P<0.01$) for the biological treatment T3 9.77 and the chemical treatment T2 11.26 over the control treatment T1 13.49. The result of the biological treatment agreed with [15] who noticed a significant decrease in Feed conversion efficiency. The diet of calves fed on rice straw of the Biology plants with the fungus (*Phanerochaete chrysoporium*). The increase in the amount of nutrients consumed from concentrated feed and processed straw as a result of chemical and biological treatment led to an improvement in the rumen environment and an increase in the content of digested nutrients, thus leading to a significant improvement in the Feed conversion efficiency [27, 28].

Table (5): Effect of treating rice straw with urea and *T. harzianum* on daily gain (g/day), final and total weight gain (kg), and Feed conversion efficiency ± Standard error

treatments	Initial weight (kg)	Final weight (kg)	Daily gain (g / day)	Total gain (kg)	Feed conversion efficiency
T1	213.25±10.40	255.00±11.52	479.88±15.11 b	41.75±1.31 b	±0. 46a 13.49
T2	216.50±14.97	276.25±12.82	686.78±28.30 a	a 59.75 ±2.46	11.26 ±0.37 b
T3	210.75±6.30	277.25±8.01	764.36±33.34 a	66.50±2.90 a	9.77 ±0.47 c

Significant	N.S	N.S	*	*	*

Different litters in the same column means significant differences; (P< 0.01)**. (P<0.05) *; NS, non-significant T1untreated rice straw , T2, urea treated rice straw T3 , *Trichoderma harzianum* treated rice straw

The results of our study indicate that the percentage of nutrient intake increased after chemically treating rice straw with urea and biology with the fungus Trichoderma harzianum compared with untreated rice straw.

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