EFFECT OF FEEDING RICE IMPURITIES WITH OR WITHOUT ACETIC ACID ON PRODUCTIVE PERFORMANCE OF AWASSI LAMBS

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ABSTRACT

The aim of this experiment was to study the effect of replacing treated and untreated rice impurities with urea, with or without acetic acid on the digestibility and performance of Awassi lambs. Twenty-four Awassi male lambs, aged 3-4 months with an initial weight 25.08 ± 0.64kg were divided into six treatments in a 2×3 factorial experiment/ Completely Randomized Design. Experiment period was 56 days, 14/3/2022 to 9/5/2022, preceded by 10 days as an adaptation period. Individual feeding was conducted. All animals fed on three levels of rice impurities treated with urea (0, 50,100%) without acetic acid (T1, T2, T3) and with 1% acetic acid (T4, T5, T6) respectively. The results showed a highly increase (P<0.01) of dry matter and organic matter intake for treatment T6. High increase (P<0.01) of dry matter digestibility (DMD), organic matter digestibility (OMD), digestibility of nutrients and total digestible nutrients (TDN) for treatments T5 and T6. Daily gain and total weight gain increased (P<0.05) for T6, 169.64 g/day and 9.5 kg respectively. In conclusion: Using of 100% rice impurities treated with urea and 1% acetic acid had a positive effect on lambs' performance with best digestibility.

Keywords: Organic acids, rice impurities, ruminants, daily gain, digestibility, feed efficiency.
***Part of Ph.D. Dissertation of the 1st author**

تأثير تغذية شوائب الرز مع وبدون حامض الأسيتيك في الأداء الإنتاجي للحملان العواسي

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المستخلص

هدفت هذه التجربة إلى دراسة تأثير استبدال شوائب الرز المعاملة وغير المعاملة باليوريا مع أو بدون حامض الخليك على معامل الهضم وأداء الحملان العواسي. تم تقسيم أربعة وعشرين من ذكور الحملان العواسية، أعمارهم بين 3–4 أشهر ووزن ابتدائي 25.08 ± 0.64 كغم، إلى ست معاملات في تجربة عاملية 2 × 3 / تصميم عشوائي كامل. استمرت التجربة لمدة 56 يومًا، من 2022/3/14 إلى 2022/5/9، وسبقتها 10 أيام فترة تمهيدية. تم تغذية جميع الحيوانات تغذية فردية على ثلاثة مستويات من شوائب الرز المعاملة باليوريا (0، 50،100٪) بدون حمض الخليك (T1، T2، T3) ومع 1٪ حامض الخليك (T4، T5، T6) على التوالي .أظهرت النتائج زيادة كبيرة (P <0.01) في تناول المادة الجافة والعضوية للمعاملة T6 ، وكذلك تفوقت المعاملتين T5و T6 معنويا (P<0.01) في معامل هضم المادة الجافة (DMD) والمادة العضوية (OMD) ومعامل هضم جميع العناصر الغذائية ومجموع العناصر الغذائية المهضومة الكلية (TDN)، وكذلك تفوقت المعاملة T6 (P <0.05) في الزيادة الوزنية اليومية والكلية، 169.64 غم / يوم و 9.5 كغم على التوالي. نستنتج إن استخدام 100٪ شوائب الرز المعاملة باليوريا مع 1٪ حامض ألخليك له تأثير إيجابي على أداء الحملان والأفضل في معامل الهضم.

الكلمات المفتاحية: الاحماض العضوية، شوائب الرز، المجترات، الزيادة الوزنية اليومية، معامل الهضم، كفاءة استهلاك العلف.
* البحث مستل من أطروحة الباحث الأول.

Received:15 /5/2023, Accepted:20/9/2023, Published:December 2025

INTRODUCTION

Improving livestock by-product intake has become essential to increases the sustainability and face the global climate change. Iraq suffers from a severe shortage of green fodder or natural pasture because of tropical or semi tropical climate, and the availability of pasture areas or the land specified for growing green fodder aren't enough with the needs of animals. So, the concentrated feeds are very important to achieve livestock daily requirements (11), by this way, the cost of feeds increased up to 70-80% of total production cost (6). The demand on by-products reduces environmental pollution, and production costs. There are a lot of by-products that we used in animal feeds, like wheat bran, corn gluten, corn bran, corn grits, soybean husks, rice impurities, corn impurities. Most of by-products are low in crude protein and high content of lignocellulosic compounds, which have low digested in the rumen and low feed efficiency. The improvement of these by-products nutritional value by physical or chemical treatments (with urea) leads to have good quality feed ingredients, and the researchers conducted many biological and chemical treatments and urea treatment is the most used for its safety, simplified using, increasing by-products nitrogen content, and increase feed intake (28). However, the chemical treatments improvement leads to decrease lignin and release of cellulose and hemicellulose, and increase pH value of rumen liquor (2, 21) with negatively effects on the activity and effectiveness of the rumen microorganisms that animal needs as a source of microbial protein. Researchers also added organic acids to increase the utilization of the feed, Pearlin et al. (19) indicated that the organic acids improve the absorption of minerals, nutrients digestibility, stimulate and activate the immune system, protect true protein from degradation in the rumen, increase the feed efficiency, improve production and reproductive performance. Urea treatments lead to increase pH value of feeds, and acetic acid as a volatile fatty acid or week acid is found naturally in the rumen, so, it's assumed the added with feeds that treated with urea, leads to decrees the pH value of rumen fluid and providing a neutral environment and suitable for rumen microorganisms to live and reproductive. Rice impurities, as a by-product of rice production possible to use it instead of barley grain or wheat bran to achieve low-priced feed ingredients with a higher weight gain and sustainable development (3), and to improve feeding value, it's preferred to treated with urea. So, this study aimed to evaluate the effect of substitution treated and untreated rice impurities with urea, with or without acetic acid in productive performance and the digestibility of concentrated feeds of Awassi lambs.

MATERIALS AND METHODS

Chemical treatment and experimental feeds: Rice impurities (RI) were treated with urea by adding urea to prepare a solution of 3.3% nitrogen (7.17% urea as dry basis) at air temperature about 30 °C and a humidity 60% (adding 60L water per 100 kg dry matter rice impurities that is meaning added 50L water for 90% dry matter of impurities which equivalent 60% humidity) for 30 days of incubation period as Tawfeeq (27) as follows: Calculate the amount of urea required to achieve 3.3% nitrogen (7.17 kg urea/ 100 Kg DM of impurities); Calculate the amount of water required to achieve 60% of humidity as DM basis of impurities, then, dissolve urea with water to prepare urea solution, put the impurities on clean nylon and spray prepared urea solution with manual mixing of impurities until homogeneity, then wrapped tightly to ensure the ammonia gas that will liberate from the decomposed urea does not escape. After 30 days, open the nylon and mix for drying and volatilization of the remaining ammonia gases. After drying, it was sampled for chemical analysis (Table 1) as AOAC (5) and collected in bags until used. Six treatments of three levels of rice impurities treated with urea (0, 50,100%) without acetic acid (T1, T2, T3) and with 1% (w/w) acetic acid (T4, T5, T6) were used.

Table 1. Formulation and chemical composition of concentrated feeds, wheat straw, rice impurities on DM basis (%)

Ingredients	Without acetic acid			With 1% acetic acid			WS	NTRI	TRI
	T1	T2	T3	T4	T5	T6			
Barley (B)	46	46	46	46	46	46			
Rice impurities (RI)	40	40	40	40	40	40			
Soya bean meal (SBM)	12	12	12	12	12	12			
Minerals & Vitamins	2	2	2	2	2	2			
Dry matter (DM) %	89.62	89.58	89.17	89.24	89.58	89.94	93.46	90.74	89.09
Organic matter (OM) %	92.31	92.67	92.04	92.88	92.47	92.2	90.49	93.39	93.65
Crude protein (CP) %	16.68	18.71	19.17	16.44	18.54	19.86	2.3	15.25	24.15
Ether extract (EE) %	5.99	5.5	5.35	5.83	5.87	5.72	1.06	5.65	5.47
Crude fiber (CF) %	9.49	8.33	8.23	9.86	8.15	8.3	33.25	12.44	11.97
Nitrogen free extract (NFE)	60.15	60.13	59.29	60.75	59.91	58.32	53.88	60.05	52.06
Inorganic matter (ash) %	7.69	7.33	7.96	7.12	7.53	7.8	9.51	6.61	6.35
*Me (MJ/kg DM)	12.7	12.78	12.67	12.77	12.83	12.73	9.81	12.61	12.48
pH value	6.6	6.9	7.1	6.2	6.3	6.5	7.32	6.4	7.8

WS= Wheat straw, NTRI= Non treated rice impurities, TRI= Treated rice impurities with urea
*** Me = Metabolic energy (MJ/kg DM) = 0.012 × crude protein + 0.031 × ether extract + 0.005 × crude fiber + 0.014 × nitrogen free extract… (15). T1= NTRI without acetate; T2 = 50% TRI without acetate; T3 = 100% TRI without acetate; T4 = NTRI with acetate; T5 = 50% TRI with acetate; T6= 100% TRI with acetate**

Experimental animals and management

Twenty-four Awassi male lambs aged 3-4 months, and weighing 25.08 ± 0.64 kg were randomly distributed to six treatments in a 2×3 factorial experiment. They were T1 T2 T3 with three levels of rice impurities treated with urea (0, 50, 100%) instead of untreated rice impurities without acetic acid and T4 T5 T6 with three levels of rice impurities treated with urea (0, 50, 100%) instead of untreated rice impurities with 1% acetic acid (w/w) respectively. Individual feeding was conducted for 56 days of experiment preceded by 10 days as adaptation period. All animals were provided clean water, vaccines and kept continuous veterinary supervision, The concentrate was fed at 3% of body weight as a DM basis (11,12) and wheat straw was provided ad-libitum with remaining. Residual feeds were recorded to calculate daily intake and daily fecal were collected and weighted for five days to determine the digestibility of nutrients, there were weekly weighted for all replicates to monitor live weight changes.

Statistical analysis

All data were statistically analyzed using completely randomized design (CRD), factorial experiment 2 × 3, One-way ANOVA analysis was performed using statistical program (6) while Duncan's multiple range test was used to determine the significant differences (p<0.05) and (p<0.01) among treatments (8) using following formula:

Yijk = μ + Ai + + Bj + AB(ij) + eijk

RESULTS AND DISCUSSION

Feed intake and digestibility

The effect of feeding rice impurities treated and untreated with urea and acetic acid on daily feed intake (Table 2) shows that there is a high significant increase (P<0.01) of dry matter intake, organic matter, crude fiber, non-structural carbohydrate or nitrogen free extract, minerals, metabolizable energy and ether extract for all treatments of rise impurities treated with urea and acetic acid, and crude protein increased (P<0.05) for the same treatments compared without acetic acid. The reason may be to the chemical treatment with urea which leads to improve the nutritional value of the by-product by analyses glycosidic bound between lignin, cellulose and hemicellulose, increase nitrogen content, and prevent to increase pH value of rumen liquor. Sheikh et al. (26) and Tekliye et al. (30) referred to increase daily feed intake (P<0.01) for treated rice straw with urea compared with the control or untreated with urea. Adugna et al. (1) stated to no significant differences in the daily feed intake of treated millet straw with urea compared with the control or untreated treatment. The effect of treated and untreated rice impurities with urea and acetic acid on the nutrient's digestibility of concentrated feed (Table 3) showed that treated with urea improved the digestibility and adding 1% acetic acid for urea treatments increased the digestion of nutrients, and T5 was significantly increased (P<0.01) and superior to other treatments (T1, T2, T4, T6) of dry matter digestibility (DMD), soluble carbohydrates or nitrogen free extract (NFE), metabolizable energy (Me) and total digestible nutrients (TDN), the same results of organic matter digestibility (DOM), significantly increased (P<0.01) for T5 and superior to all treatments, as well as treatments of rice impurities treated with urea for T3 and T6 comparing to T1, T2, and T4. Crude protein digestibility significantly increased (P<0.05) for treatments T2 and T6 comparing to T1 and T4. The digestibility of ether extract (EE), crude fiber (CF) and inorganic matter (ash) were significantly superior (P<0.01) for T5 and T6 comparing to all other treatments. The superiority of treatments treated with urea and/or with acetic acid due to the degradation of the lignocellulosic bonds or glycosidic bounds between lignin, cellulose, and hemicellulose, as well as the breakdown of lignin itself by the base treatment of urea (27), and the liberation of lignin leads to liberate cellulose hemicellulose and increase the digestibility by microorganisms (28). The results agreed with Saeed and Abdel-Latif (23) who investigated the feasibility of treating wheat straw before feeding with a high level of urea 3% on feed intake and the digestibility of nutrients for local Arabi lambs, straw was treated with 10% molasses and was given with two levels of concentrated feed 150 and 300 g/head/day. The results showed that treatment with urea led to a significant improvement (P<0.05) in dry matter and crude protein digestibility (P< 0.05). Sheikh et al. (26) mentioned to a significant increase (P< 0.05) of nutrients digestibility (DM, CP, EE, acid detergent fiber (ADF) and cellulose) when treating rice hay with urea and molasses (2% urea and 5% molasses / 40 water) to feed male sheep Koredil, this will provide better rumen environment for microorganisms to growth and reproduction and produce microbial protein (4, 13). The researchers showed that the replacement of urea with 20% of true protein reduces cost of feeds and increases nitrogen content in low-quality roughage and increases the daily intake (10) and increasing rumen out flow rate which promotes dry matter intake (17, 24). Carvalhoa et al. (7) showed an increase in the digestibility of neutral detergent fiber (NDF) and acidic detergent fiber (ADF) when added 4.5% urea. So, increasing the digestibility of nutrients when treated rice impurities with urea and acetic acid indicates the preference of treated roughages with urea and acetic acid which reduces the disadvantages of treatment with urea (increasing pH of feeds) and neutralize rumen liquor pH and leads to an increase in the palatability of the feed, and reduces stress on the animal.

Table 2. Effect of rice impurities on daily feed intake (g/day) ± Standard error

Tret.	DM	OM	CP	EE	CF	Ash	NFE	Me*
T1	72.61±0.39 d	77.2±0.06 d	92.47±0.59 b	92.49±0.88 b	45.42±1.46 c	36.51±2.46 b	79.32±0.56 d	81.05±0.08 c
T2	75.73±1.36 c	78.95±1.17 cd	95.54±0.46 a	92.74±0.9 b	53.41±1.5 b	37.25±3.54 b	79.67±1.55 cd	82.28±0.76 c
T3	81.27±0.24 ab	83.52±0.34 b	94.56±0.75 ab	88.68±0.39 c	66.11±0.71 a	55.06±0.34 a	83.76±0.03 b	85.13±0.27 b
T4	77.49±0.34 c	80.74±0.16 c	92.81±1.51 b	90.89±0.8 b	55.37±0.19 b	38.72±2.32 b	84.04±0.36 b	83.88±0.21 b
T5	83.08±0.87 a	85.51±0.71 a	95.07±0.66 ab	96.94±0.16 a	65.59±2.69 a	54.81±2.77 a	87±0.36 a	88.03±0.46 a
T6	80.17±0.53 b	82.89±0.39 b	95.62±0.65 a	97.14±0.26 a	64.89±0.81 a	49.28±2.25 a	82.04±1.1 bc	85.21±0.48 b
Sign.	**	**	*	**	**	**	**	**

Different litters in same column means significant differences; ** Significant differences at level 0.01; * Significant differences at level 0.05 Me*=MJ/ day; T1= NTRI without acetate; T2 = 50% TRI without acetate; T3 = 100% TRI without acetate; T4 = NTRI with acetate; T5 = 50% TRI with acetate; T6= 100% TRI with acetate

Table 3. Effect of rice impurities on digestibility of dry matter, nutrients and metabolizable energy (%) ± Standard error

Tret	DM	OM	CP	EE	CF	Ash	NFE	Me	TDN
T1	72.61±0.39 d	77.2±0.06 d	92.47±0.59 b	92.49±0.88 b	45.42±1.46 c	36.51±2.46 b	79.32±0.56 d	81.05±0.08 c	76.74±0.06 c
T2	75.73±1.36 c	78.95±1.17 cd	95.54±0.46 a	92.74±0.9 b	53.41±1.5 b	37.25±3.54 b	79.67±1.55 cd	82.28±0.76 c	78.68±1.43 c
T3	81.27±0.24 ab	83.52±0.34 b	94.56±0.75 ab	88.68±0.39 c	66.11±0.71 a	55.06±0.34 a	83.76±0.03 b	85.13±0.27 b	81.69±0.15 b
T4	77.49±0.34 c	80.74±0.16 c	92.81±1.51 b	90.89±0.8 b	55.37±0.19 b	38.72±2.32 b	84.04±0.36 b	83.88±0.21 b	80.81±0.6 b
T5	83.08±0.87 a	85.51±0.71 a	95.07±0.66 ab	96.94±0.16 a	65.59±2.69 a	54.81±2.77 a	87±0.36 a	88.03±0.46 a	85.19±0.31 a
T6	80.17±0.53 b	82.89±0.39 b	95.62±0.65 a	97.14±0.26 a	64.89±0.81 a	49.28±2.25 a	82.04±1.1 bc	85.21±0.48 b	82.18±0.42 b
Sign.	**	**	*	**	**	**	**	**	**

Different litters in same column means significant differences; * Significant differences at level 0.05; ** Significant differences at level 0.01; TDN= Total digestible nutrients; T1= NTRI without acetate; T2 = 50% TRI without acetate; T3 = 100% TRI without acetate; T4 = NTRI with acetate; T5 = 50% TRI with acetate; T6= 100% TRI with acetate

Growth performance and feed efficiency

The effect of rice impurities on daily gain (g/day) and total weight gain (Kg) showed significantly increases of treatment T6 in daily gain and total weight gain ($P < 0.05$) comparing to T1 (Table 4), while daily gain and final weight didn't affect by treatments. It may be due to the chemical treatment with urea and acetic acid which work to protect food protein from rumen degradation and increase true protein reaching to the abomasum and intestine, as well as an increase nitrogen content of the by-product, or because of the availability of suitable rumen environment for the microorganisms. The efficiency of feed true protein in the abomasum 100% compared to the efficiency of microbial protein 80% (18) to providing the necessary amino acids for maintenance and production, and 20% of microbial protein undigested and excreted as nucleic acids. Khorasani et al. (14) indicated to the effect of treating canola meal with 3% (w/w) acetic acid on protein degradation inside the rumen of Holstein cows, rumen fermentations, and post-rumen digestion, the treatment of acetic acid reduces the degradation of protein 28.6% inside the rumen, and increase the dietary true protein reaching abomasum for maintenance and production, as well as an increase in crude protein intake, which led to increase the quantities of protein into the rumen. Studies indicated that there was a significant increase in the daily gains and final weights and total weight gains for lambs fed at levels high levels of concentrated feed (16) because of the high level of dietary protein enhances protein availability and thus increases the absorption and utilization of amino acids, which leads to improved and increase growth performance (22, 29) and feeding level related to growth performance in ruminants (20). Weekly gain referred to linear superiority to the rice impurities with urea and 1% acetic acid (figure 1). The effect of treated and untreated rice impurities with urea and 1%(w/w) acetic acid on feed efficiency (Table 5) indicated to insignificant improvement for concentrated feed efficiency, total feed efficiency, metabolizable energy/ daily gain and crude protein intake/ daily gain of treated rice impurities with urea and 1% acetic acid. The same improvement for metabolizable energy intake/ crude protein intake and decreased in treatment T6 compared to the other treatments, as well as an improvement in treatment T3 compared to treatments T1 and T2, T4 and T5. All results indicated to an improvement in the feed efficiency, and this is consistent with table (4) of daily and total weight gain, and treatments T3 and T6 were the highest daily and total weight gain with low proportion of feed intake, that led to high feed efficiency. Wang et al. (31) stated to decrease feed efficiency when decreased the level of feed protein intake and low nutrients digestibility and decreased the daily gain of goats. The same results for Estrada-Angulo et al. (9) who indicated to the superiority of high level and medium level of dietary protein for sheep growth with better feed efficiency, in contrasted to the low level of protein, and sheep fed at a high level of protein had the greatest feed efficiency to achieve the best growth performance.

Table 4. Effect of rice impurities on daily gain (g/day), final and total weight gain (kg) ± Standard error

Treat.	Initial weight (kg)	Final weight (kg)	Daily gain (gm/day)	Total gain (kg)
T1	24.75±1.7 a	31.5±2.10 a	120.54±8.54 b	6.75±0.47 b
T2	24.75±2.05 a	32±2.04 a	129.46±18.40 ab	7.25±1.03 ab
T3	25.25±1.1 a	33.75±0.75 a	151.79±11.52 ab	8.5±0.64 ab
T4	24.75±2.09 a	32.25±1.93 a	133.93±17.09 ab	7.5±0.95 ab
T5	25.5±1.04 a	32.75±1.1 a	129.46±4.46 ab	7.25±0.25 ab
T6	25.5±0.95 a	35±1.68 a	169.64±21.25 a	9.5±1.19 a
Sign.	NS	NS	*	*

Different litters in same column means significant differences; NS= non-significant differences; * Significant differences at level 0.05; T1= NTRI without acetate; T2 = 50% TRI without acetate; T3 = 100% TRI without acetate; T4 = NTRI with acetate; T5 = 50% TRI with acetate; T6= 100% TRI with acetate

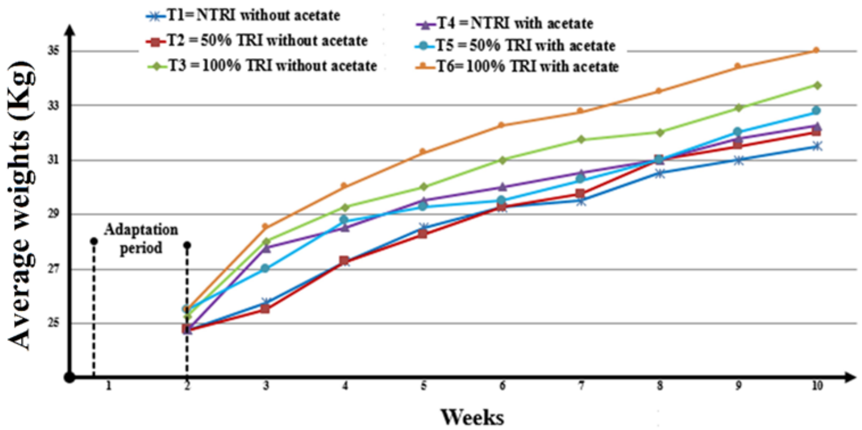

Figure 1. Average weekly weights of lambs (Kg)

Table 5. Effect of rice impurities on feed efficiency ± Standard error

Treat.	Concentrated feed intake/ daily gain	Total feed intake/ daily gain (gm/day)	Metabolic energy intake (KJ/day) / daily gain (gm/day)	Protein intake/ daily gain	Energy intake (KJ/day) / Crude protein (gm/day)
T1	7.18±0.40 a	8.86±0.43 a	0.11±0.005 a	1.24±0.06 a	0.087±0.0009 a
T2	7.16±1.38 a	8.77±1.60 a	0.11±0.01 a	1.38±0.26 a	0.078±0.0007 b
T3	6.23±0.64 a	7.59±0.75 a	0.09±0.009 a	1.23±0.12 a	0.075±0.0002 c
T4	7.01±0.91 a	8.65±1.12 a	0.11±0.01 a	1.19±0.15 a	0.088±0.0007 a
T5	6.94±0.42 a	8.55±0.46 a	0.1±0.005 a	1.32±0.07 a	0.079±0.0004 b
T6	5.81±0.52 a	7.11±0.68 a	0.09±0.008 a	1.18±0.1 a	0.073±0.0004 d
Sign.	NS	NS	NS	NS	**

Different litters in same column means significant differences; NS= non-significant differences; ** Significant differences at level 0.01; T1= NTRI without acetate; T2 = 50% TRI without acetate; T3 = 100% TRI without acetate; T4 = NTRI with acetate; T5 = 50% TRI with acetate; T6= 100% TRI with acetate

Contributions of Authors: All authors read and commented on draft versions, and agreed to the published version of the manuscript, and there are no conflicts of interest.

Acknowledgements

The authors are grateful to College of Agricultural Engineering Sciences, University of Baghdad, and College of Agriculture, University of Wasit, and the workers in the laboratories of higher studies for their valuable material support and assistance during the experimental period.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

DECLARATION OF FUND

The authors declare that they have not received a fund.

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