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The effect of partial replacement of barley by chemically treated crushed date seeds in diets on production, economical performance of sheep

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Abstract

The study was conducted in the fields of Barakat Aba Al-Fadl Al-Abbas from the Al-Abbas's (p) Holy Shrine and the current work aimed to study the effect of substituting different levels of chemically treated crushed date seeds instead of barley in the concentrated diet of local male Awassi lambs to know its impact on productive and economic performance. Using a completely randomized design, forty-two male Awassi lambs (average body weights 22.6 ± 0.8 kg) at the age of 4-5 months were used, for the period from 10/8/2022 to 17/10/2022 (63 days). Animals were randomly distributed into seven groups (6 animals/group) in separate cages and experimental treatments were provided. All animals were fed concentrated diets at 3 % of body weight and barley straw was the main source of roughage and was provided as ad libitum. The normal crushed date seeds were replaced by 25.50 % instead of barley and the same proportions for the crushed date seeds were soaked with acetic acid and citric acid in seven treatments. There were significant differences observed in the averages of daily weight gain, feed intake and efficiency of feed conversion. Non-significant differences appeared in the rumen fluid parameters of pH and volatile fatty acids, while the treatments T6 and T7 recorded the lowest significant values in urea nitrogen compared to the highest values in the treatment T1 control. Treatments T6 and T7 were significantly superior in the digestion of nutrients over all treatments. All treatments achieved replacing crushed date seeds by 25 and 50 %, normal and soaked with organic acids, instead of barley, the best economic efficiency compared with the treatment T1 control.

Keywords

Awassi lambs; average daily weight gain; crushed date seeds; feed intake; organic acids

Introduction

The lack of feed of all types due to the lack of pastures and the allocation of lands for cultivating concentrated and green fodder to be determined from animal husbandry, it is important to find other feed substitutes such as agricultural and industrial waste, whose energy content is low and protein date pits and its industries are unconventional and locally available feed for ruminants.

In recent years, the price of energy sources has increased dramatically with the increase in demand for feeding animals. The increases in feed prices encouraged nutritionists to search for cheaper high-energy feed ingredients.

Known for Iraq in its famous palm trees in the world, as the number of female palm trees reached 16.8 million and the average productivity of one palm tree is (60 kg/year), so the total production of dates in Iraq is more than one million tons. Therefore, the total production of date pits as waste is approximately 150000 tons (1). Ground date seeds are medium-grade protein fodder and an important source of energy, as they contain 7.0 to 8.0 % crude protein and 73 % TDN. When using date seeds at a level of 10 or 20 % in the concentrated diet, it did not lead to a significant decrease in the daily weight gain averages of lambs (2). Reported by several research the importance of utilizing date seeds as part of animal rations (3), macro and micronutrients (4), phenolic acids (5), substitute for flour in the baking industry (6), as well as Protein solubility, (7). As well as antibacterial against Gram-negative bacteria (*E. coli*) and Gram-positive (*S. aureus*) and fungi, (8-10). In addition, it was concluded that the extraction solvent plays an important role in determining the phenolic content and these contents are always higher in aqueous extracts than in alcoholic extracts (11, 12). The heightened public concern over the emergence of antibiotic-resistant strains prompted the exploitation of alternate growth promoters to antibiotics (13, 14). Among such alternatives, one striking preference includes acidifiers, especially in the swine and poultry sectors. The potential of acidifiers in the livestock feed industry has been known for decades for their preservative and nutritional qualities (15, 16). Organic acids, commonly employed for feed acidification from the natural constituent in several feedstuffs, are generated during metabolism in animals. Being known for their defensive effects against bacteria, fungus or mould, they have been applied as an in-feed prophylactic measure to counter such pathogens in the feed industry (17). Performance and health-promoting impacts have been elucidated for several organic acids, such as fumaric, formic, lactic and citric acids and their salts (18). Therefore, the current study aimed to soak the crushed date seeds in commercial organic acids (acetic acid and citric acid) and replace it by 25, 50 % with barley in concentrated diets to find out its effect on the productive and economic performance of local Awassi male lambs.

Materials and Methods

***Design of Experiment (Feeding Trial)*:** The experiment was conducted at the fields of Barakat Abu al-Fadl al-Abbas of the Abbasid holy shrine from 10/8/2022 to 17/10/2022 (63 days), The study was conducted according to the International Guidelines for research involving animals (Directive2010/63 /EU), according to the Islamic procedures. Approximate chemical analysis was done for all ingredients before mixing diets and after mixing, as well as for barley straw as the main roughages in the experiment as shown in Tables 1, 2.

***Preparation of acid solutions*:** Lemon salt (citric acid) and Apple cider vinegar (acetic acid) were obtained from local markets. The cost of one kilogram of citric acid is 4000 Iraqi dinars and the cost of one litre of acetic acid is 600 Iraqi dinars, then date seeds were ground at a commercial Feed Mill. The dilution ratio of citric acid and acetic acid to Crushed Date Seeds (CDS) was adjusted, as well as the time required for date pits powder to be saturated with acids, without powder digestion occurring. Soaked a small amount of CDS (2 gm) in different proportions of citric and acetic acid concentrations at different times. The pH value of citric acid and acetic acid before dilution is found to be 1.7 and 2.7, respectively.

It was concluded that the best dilution ratio of citric acid for soaking CDS is to add 1 g of citric acid salt: 120 mL of distilled water and 1 mL of acetic acid: 40 mL of distilled water until the acidity value (pH) of the two acids reaches 3 by reading the pH meter. Soaking was done. 1000 kg of CDS was kept in separate plastic basins at room temperature of 25°C containing citric and acetic acid with equal acidity for four days at the end of the soaking period and dried the crushed date seeds until moisture reached 10 % and were put in bags until mixing in various concentrate diets as in Table 1. Also did the approximate chemical analysis for all ingredients concentrate diets and barley straw on DM % basis (Table 2).

Forty-Two Awassi male lambs (4-5 months old and with an average live weight of about 22.6 ± 0.8 kg) were distributed in a completely randomized design, lambs were housed in individual cages of (1×2 m) and the experiment was conducted for 63 days. All cages were provided with two cans to be utilized for concentrate and roughage diets

Table 1. Chemical Composition for Crushed Date Seeds Before soaked and After soaked In acids (on DM% basis)

Ingredients*	Before soaked	Soaked in acetic acid	Soaked in citric acid
DM	91.00	93.45	93.15
OM	98.00	95.00	94.00
Ash	1.06	2.16	2.46
CP	7.06	6.04	5.01
CF	10.45	7.45	6.45
EE	7.15	5.35	5.55
NFE	72 .28	74.0	74.53

*DM: Dry Matter, OM: Organic matter, CP: Crude Protein, CF: Crude Fibre, EE: Ether Extract, NFE: Nitrogen Free Extract. AOAC (24).

Table 2. Chemical composition of ingredients, concentrate diet and barley straw (on DM% basis)

Ingredients	Barley grain	Soybean meal	Yellow corn	Wheat bran	Conc. diets	Crushed date pits	Barley straw
DM% of fresh	92.18	92.88	90.34	91.03	91.91	91.00	94.41
OM	96.77	92.67	98.65	94.25	92.94	98.00	88.17
Ash	3.23	7.33	1.35	5.75	7.06	1.06	11.83
CP	10.49	44.07	8.91	10.95	13.83	7.06	2.25
CF	6.13	5.81	1.97	11.05	8.67	10.45	44.16
EE	3.28	1.63	4.40	4.03	2.37	7.15	2.08
NFE	76.87	41.16	83.37	68.22	68.08	72 .28	39.68
ME*(MJ/Kg DM)	13.34	11.86	14.20	12.67	12.36	11.50	6.77

*MAFF (1975):0.012×CP + 0.031×EE +0.005×CF +0.014×NFE

separately. Fresh water was freely available in front of the animals in each cage. Minerals and vitamin blocks were fixed among cages to enable animals to lick whenever they require. The animals were subjected to a preliminary period of 15 days for adaptation before the experiment was started. The total study period with digestibility trials was 88 days. The experiment utilized one concentrated diet and animals divided into seven treatments,6 male lambs/treatment. Animals fed on fattening concentrated rations Table 3. According to NRC (17), all groups of animals had prevention remedies against internal and external parasites. The treatments consisted of inclusion the following treatments:

Control: T1(Basal Concentrate diet; T2(25 % Crushed Date Seeds (CDS) +75 % barley; T3(50 % CDS +50 % barley; T4(25 % CDS soaked in acetic acid +75 % barley); T5(50 % CDS soaked in acetic acid +50 % barley); T6(25 % CDS soaked in citric acid +75 % barley); T7(50 % CDS soaked in citric acid+50 %barley). The provided concentrated feed mixture was 3 % of the live body weight. One hour before, refusals diets were gathered and re-weighed before the offering of the next day.

The amounts of feed concentrate were divided into two meals, a morning at 8:00 am and an evening at 3:00 pm and adjusted according to the change of body weight, barley straw was offered ad libitum. The animals are weighed weekly.

Feed intake: The amount of feed intake per day was calculated by subtracting the amount of residual feed from the offered feed for forage and concentrating on each animal, as in the following equation:

Feed intake (g) = offered feed - residual feed.

Body Weight and Weight Gains: Body weight was measured at the start of the experiment and thereafter every week until the end of the experiment. The total weight gain for each animal was calculated as in the following equation:

Total weight gain (kg) = final body weight-initial body weight.

***Efficiency of Feed Conversion*:** The efficiency of feed conversion was based on the dry matter of both forage and concentration consumed during a certain period that required an increase in body weight in the same period and according to the following equation:

Efficiency of Feed Conversion (kg feed/kg weight gain) = Amount of feed consumed / total weight gain.

***Digestibility of experimental diets*:** A digestibility trial was conducted to determine the digestibility coefficients of total diets. The ninth week was assigned for this trail using three males of the Awassi lambs. The offered quantities of both diets and those that remained were accurately recorded to estimate daily intake during the 10 days-collection period. Faeces were collected by using special handmade digestion sacs that ensured the separation of urine without sticking to their movement inside the individual pens housed as described by Saeed (19). Fresh faeces excreted by each lamb were weighed precisely and mixed thoroughly by hand and about 10 % were sampled daily and stored at -20 °C for the subsequent chemical analysis. Digestibility coefficients were estimated as a percentage of dividing the difference between the ingested quantity of ingredients and that excreted in faeces on the quantity ingested.

***Rumen liquor sampling*:** At the end of the last week of the feeding trial, samples were collected before the morning feeding at times 0 and after feeding concentrate rations for 3 - 6 hr, rumen liquor samples were taken. Rumen liquor samples were collected through a rubber stomach tube attached to an electric suction pump. Samples of rumen liquor were strained through two layers of cheesecloth. The pH value of the rumen liquor sample was directly determined using a pH meter. Strained rumen liquor (SRL)

Table 3. Chemical composition of concentrated Diets

Ingredients	**Concentrate diets (%)**						
Treatments	**1**	**2**	**3**	**4**	**5**	**6**	**7**
barley	40.0	30.0	20. 0	30.0	20.0	30.0	20.0
Yellow corn	13.0	13.0	13.0	13.0	13.0	13.0	13.0
Wheat bran	35.0	35.0	35.0	35.0	35.0	35.0	35.0
Soybean meal	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Normal (CDS)*	-	10.0	20.0	-	-	-	-
CDS soaked in acetic acid	-	-	-	10.0	20.0	-	-
CDS soaked in citric acid	-	-	-	-	-	10.0	20.0
Premix(1)	1.0	1.0	1.0	1.0	1.0	1.0	1.0
NaCl	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Chemical composition of Concentrate diet (%)							
Dry Matter (DM)	89.76	89.64	89.52	89.50	89.22	89.48	89.46
Organic Matter (OM)	93.78	93.90	94.02	93.70	93.52	93.50	93.22
Crude Fibre (CF)	6.95	7.36	7.77	6.65	6.35	6.55	6.15
Crude Protein (CP)	13.60	13.26	12.92	13.14	12.68	13.04	12.48
Ether Extract (EE)	3.45	3.66	3.87	3.76	3.97	3.68	3.91
Nitrogen Free Extract (NFE)	69.78	69.62	69.46	70.40	70.52	70.23	70.68
ME (MJ/Kg DM)(2)	12.81	12.61	12.41	12.61	12.41	12.61	12.41

*CDS: mean Crushed Date Seeds

(1) Mineral and vitamin premix (SPI-Saudi Arabia). on DM basis, the premix contained: 600000 IU/kg of vitamin A, 200000 IU/kg of vitamin D3, 200 mg/kg of vitamin K3, 100 mg/kg of vitamin B1, 100 mg/kg of vitamin B2, 10 mg/kg of vitamin B6, 2 mg/kg of vitamin B12, 1250 mg/kg of Nicotinic acid, 25000 mg/kg of Choline chloride, 16% of Ca, 4% of Mg, 2000 mg/kg of Fe, 500 mg/kg of Cu, 1000 mg/kg of Mn, 10 mg/kg of Co, 1000 mg/kg of Zn; 180 mg/kg of I in addition to antioxidant

(2) MAFF (1975)

samples were acidified with 0.1 N hydrochloric acid and concentrated orthophosphoric acid and stored by freezing for the determination of total volatile fatty acids (TVFA´s). The concentration of ammonia-N in rumen liquor was determined according to Conway (20). The concentration of total VFAs was determined in rumen liquor by the stream distillation method (21) using the Markham micro distillation apparatus.

***Economical evaluation*:** A simple economic evaluation was adapted as the difference between feed costs and the price of produced body weight gain (BWG). The price of body weight gain was calculated at the prevailing market price of 1 kg (ID). The cost of feeding was calculated, considering that the local price of one ton of Concentrate diets 531;491;451;485;445;485;445 thousand Iraqi Dinar/Ton and barley straw on DM basis were 300 thousand Iraqi Dinar/ton.

Statistical analysis

Data obtained during the experiment was statistically analysed using a completely randomized design model (CRD) procedure by SAS (22). Duncan's multiple range tests were used to determine the significance of differences between treatment means (23).

The mathematical equation is given below:

Yij= μ+Ti + eij

Yij: Observation value

μ: mean; Ti= Effect of treatment; and eij= standard error.

Results and Discussions

The results in Table 4 show the effect of substituting 25 and 50 % of normal crushed date seeds soaked with acetic and citric acid instead of barley in the experimental rations of Awassi lambs. T6 and T5 in the average total weight gain over all treatments, which amounted to 7.56, 7.30 and 7.09 kg/head, respectively and the T5 treatment did not differ significantly from the treatments T4, T3 and T2 and the latter in turn was significantly superior to the control treatment, which recorded 5.92 kg/head and the same trend was with the daily weight increase. From these results, it appears that soaking date pit powder with citric acid was better than soaking with acetic acid and both of them are better than regular un-soaked date pit powder. When replacing barley in concentrated diets and the same soaking treatments with citric acid, the lowest quantities were significant in the amount of concentrated and coarse fodder intake compared with regular date powder and the control treatment, as the amount of total fodder intake in the lambs of treatments T7, T6, T5 was 882.0, 928.0, 921.0 kg fodder/ head, respectively.

While the highest amount of feed intake was in the rest of all treatments, reaching 948.5, 1007.3, 1009.8 and 992.0 kg of feed/head in treatments T4, T3, T2 and control treatment ((T1), respectively. In the same table, whose statistical analysis indicates a decrease in the amount of total feed intake Significant ((P≤0.05), especially in the two treatments T7, T6, T5, which recorded rates of 882.0, 928.0, 921.0 gm of feed/head/day, respectively, while the rest of

Table 4. The effect of adding different levels of CDS on the productive performance of Awassi male lambs for 63 days (mean ± standard error)

	Treatments (1) Means ± SE							
items	**T1**	**T2**	**T3**	**T4**	**T5**	**T6**	**T7**	**Significantly**
Average initial weight. (kg)	23.4 ± 0.22	22.9 ± 0.23	22.4 ± 0.24	22.0 ± 0.24	21.7 ± 0.25	23.6 ± 0.21	23.9 ± 0.19	**NS**
Average final weight. (kg) at 63 days	29.3 ± 0.35^{c}	29.1 ± 0.36^{bc}	28.9 ± 0.39^{b}	28.9 ± 0.41^{b}	28.8 ± 0.46^{ab}	30.9 ± 0.41^{ab}	31.5 ± 0.37^{a}	*
Weight change (kg)	5.92 ± 0.15^{c}	6.24 ± 0.16^{bc}	6.51 ± 0.19^{b}	6.96 ± 0.24^{b}	7.09 ± 0.29^{ab}	7.30 ± 0.36^{ab}	7.56 ± 0.41^{a}	*
Average daily gain (g/day)	0.094 ± 0.02^{c}	0.099 ± 0.03^{bc}	0.103 ± 0.04^{b}	0.110 ± 0.05^{b}	0.113 ± 0.06^{ab}	0.116 ± 0.07^{ab}	0.120 ± 0.09^{a}	*
DM intake of concentrate g/d	684.5 ± 0.23^{a}	717.0 ± 0.25^{a}	718.2 ± 0.28^{a}	701.9 ± 0.33 ^{a}	687.0 ± 0.35^{a}	701.6 ± 0.32^{a}	643.9 ± 0.19^{b}	*
DM intake of barley Straw g/d	307.5 ± 0.11^{a}	292.8 ± 0.10^{a}	289.1 ± 0.09^{a}	246.6 ± 0.12^{b}	234.0 ± 0.15^{b}	226.4 ± 0.22^{b}	238.1 ± 0.16^{b}	*
Total feed Intake DM g/d	992.0 ± 0.65^{a}	1009.8 ± 0.69^{a}	1007.3 ± 0.74 ^{a}	948.5 ± 0.93^{a}	921.0 ± 0.97^{b}	928.0 ± 0.96^{b}	882.0 ± 0.53^{b}	*
Feed Conversion **Efficiency (FCE)**	10.55 ± 0.14^{a}	10.20 ± 0.12^{a}	9.78 ± 0.09^{a}	8.62 ± 0.07^{b}	8.15 ± 0.05^{b}	8.00 ± 0.05^{b}	7.35 ± 0.02^{b}	*

(1) T1: Basal diet (Control barley 40% without CDS) ؛T2:30% barley +10% Normal CDS؛T3: 20% barley +20% Normal CDS ؛T4: 30% barley +10% CDS soaked in acetic acid, T5: 20% barley +20% CDS soaked in acetic acid; T6: 30% barley +10% CDS soaked in citric acid; T7: 20% barley +20% CDS soaked in citric acid

NS: Non-Significant

* Means within the same row with different superscripts are significantly different (P < 0.05).

the treatments were the highest significant, as they reached 948.5, 1007.3, 1009.8, 992.0 for the treatments T4, T3 T2 and control treatment (T1), respectively. This, in turn, was reflected naturally in the rates of feed conversion efficiency, as the best rates were recorded in the treatments of substituting powder of date pits soaked with acids against the powder of regular date pits and the comparison treatment, as the values reached 7.35, 8.00, 8.15, 8.62 kg feed/kg weight gain for treatments T6, T7, T4 and T5 versus values 9.78, 10.20 and 10.55 kg feed/kg weight gain for treatments T1, T2 and T3, respectively. Perhaps the reason for this is that soaking with citric acid has improved the digestion coefficient of feed inside the rumen by increasing the acidity of the rumen environment, which provided a suitable environment to increase the numbers of beneficial bacteria and thus destroy the largest amount of fibre, the high amount of energy represented, the increase in the availability of other nutrients and their high absorption. This was reflected in the consumption of the least amount of feed intake to satisfy their needs of the animal requirements to appear in the form of a higher weight gain with the least amount of feed intake, i.e. the lowest value in the efficiency of feed conversion. Organic acids appear to have several functions including lowering gastric pH, increasing gastric retention time for food, stimulating pancreatic secretions, influencing the shape of the mucosa and acting as a substrate for intermediate metabolic processes, all of which lead to improved digestion and absorption (15).

As for Table 5, its statistical analysis indicates that there are no significant differences in the measurement of rumen fluid parameters in terms of pH and volatile fatty acids, despite the presence of an arithmetic decrease in the pH values recorded by the treatments of crushed date seeds soaked with organic acids, while significant differences appeared (P≤0.05 in Average values of ammonia nitrogen at the three times 0, 3 and 6/h, as the treatments T7 and T6 recorded the lowest rates and amounted to 36.5 and 38.8 mg/dL respectively, while the highest values were recorded by the control treatment as it amounted to 53.87 and the latter did not differ significantly with the rest of all treatments.

Regarding the digestion experiment, Table 6 shows that there are significant differences (P≤0.05) in the rates of the digestion coefficient of all nutrients and favour of the treatments containing powdered date seeds soaked with organic acids, as it reached the highest rate in the rates of dry matter digestion in treatments T7, T6, T5 which recorded 53.7, 50.8, 48.6 %, respectively, while the lowest rates were recorded in the rest of the treatments and the same trend was with the digestion of nutrients: crude protein, crude fibre, ether extract, nitrogen-free extract, in addition to the total digested nutrients.

It appears from these results that soaking the date stone powder with organic acids has led to an increase in the digestion of nutrients in the diet and thus an increase in its digestive value, especially the crushed date seeds with their essential fatty acids and the quality of protein after soaking, which reflected positively on the productive characteristics related to growth and efficiency of Feed conversion in all treatments of the experiment. About the economic aspect, Table 7 shows the emergence of significant differences in economic efficiency between all experimental treatments compared with the control treatment (without replacing date stone powder instead of barley by 25 and 50 %). Transactions T2, T3, T4, T5, T6 and T7 recorded the following ratios 3.30, 4.82, 9.79 9.56, 12.53 and 15.89, respectively, against 1 for the control treatment and this means that the return of one dinar may be added upward from three times until it reaches 15 Almost double and these results are promising because of the cheapness of the by-product date kernels compared to the exorbitant cost of barley grains, which led to an increase in economic returns in the diets used in the experiment and we recommend using other organic acids for secondary waste and replacing them with expensive concentrated grains in sheep diets without having negative effects on performance production.

Table 5. Effect of partial substitution of barley by Crushed Date Seeds (CDS) in Awassi lambs' rations on rumen liquor parameters

Items	Treatments Means ±SE								
	T1	T2	T3	T4	T5	T6	T7	± SE (1)	Significant
pH (%)									
0	7.35	7.05	6.85	6.20	6.01	5.95	5.70	0.26	**NS**
3	6.65	6.25	6.10	5.90	5.81	5.75	5.55	0.06	**NS**
6	6.65	6.20	6.25	5.85	5.80	5.71	5.48	0.06	**NS**
Mean	6.88	6.50	6.40	5.98	5.87	5.80	5.57	0.16	
NH3-N (mg/ld.)									
0	49.2^{b}	56.2^{a}	46.0^{b}	45.2^{b}	43.0^{bc}	40.1^{c}	38.5^{c}	2.12	*
3	61.8^{a}	46.4^{b}	43.6^{b}	42.3^{b}	41.2^{bc}	38.3^{c}	35.7^{c}	3.08	*
6	50.6^{a}	45.4^{ab}	43.2^{b}	42.1^{b}	41.0^{bc}	38.1^{cd}	35.4^{d}	6.66	*
Mean	53.87	49.33	44.27	43.2	41.7	38.8	36.5	2.29	
TVFA´s (mmol/L)									
0	13.4	13.4	14.0	15.2	16.5	15.8	17.9	0.87	**NS**
3	16.0	15.5	14.1	15.4	17.8	16.2	19.3	1.67	**NS**
6	18.7	18.4	15.9	15.7	18.0	16.7	19.8	2.23	**NS**
Mean	16.03	15.77	14.67	15.4	17.4	16.2	19.0	0.94	

1) T1: Basal diet (Control barley 40% without CDS) ؛T2:30% barley +10% Normal CDS؛T3: 20% barley +20% Normal CDS ؛T4: 30% barley +10% CDS soaked in acetic acid, T5: 20% barley +20% CDS soaked in acetic acid; T6: 30% barley +10% CDS soaked in citric acid; T7: 20% barley +20% CDS soaked in citric acid

NS: Non-Significant

* Means within the same row with different superscripts are significantly different (P < 0.05).

Table 6. Effect of partial substitution of barley by Crushed Date Seeds (CDS) in Awassi lambs' rations in TDN% (mean ± standard error)

Treatments[(1)]	DMD%	OMD%	CPD%	CFD%	EED%	NFED%	TDN%
T1	41.3^{b} ± 1.43	52.1^{b} ± 0.51	51.2^{b} ± 0.83	35.8^{b} ± 2.79	38.3^{c} ± 1.51	52.7^{b} ± 0.92	82.9^{b} ± 1.92
T2	42.1^{b} ± 1.20	53. 8^{b} ± 0.54	52.3^{b} ± 2.38	37. 5^{b} ± 0.92	40.3^{c} ± 1.58	54.0^{b} ± 1.41	84.3^{b} ± 0.62
T3	42.8^{b} ± 0.21	54.3^{b} ± 0.71	54.1^{b} ± 0.36	39.4^{b} ± 0.52	42.0^{b} ± 1.52	55.9^{b} ± 0.65	85. 5^{b} ± 1.84
T4	45.7^{ab} ± 0.54	57. 4^{ab} ± 0.84	58. 6^{ab} ± 0.83	41. 9^{ab} ± 0.84	44.8^{b} ± 1.39	59.6^{ab} ± 0.93	88.7^{ab} ± 0.67
T5	48. 6^{a} ± 0.72	58. 7^{a} ± 0.88	61.3^{a} ± 1.78	42.1^{a} ± 0.81	46. 3^{ab} ± 2.28	62.8^{a} ± 0.24	90.6^{a} ± 0.23
T6	50.8^{a}	61.2^{a}	59.7^{a}	42.8^{a}	49.2^{a}	62.7^{a}	90.4^{a}
T7	53.7^{a}	63.8^{a}	62.5^{a}	44.6^{a}	54.1^{a}	66.3^{a}	94.5^{a}
SEM	0.80	0.86	1.15	1.01	1.40	0.89	0.84
Significant	*	*	*	*	*	*	*

(1) T1: Basal diet (Control barley 40% without CDS) ؛T2:30% barley +10% Normal CDS؛T3: 20% barley +20% Normal CDS ؛T4: 30% barley +10% CDS soaked in acetic acid, T5: 20% barley +20% CDS soaked in acetic acid; T6: 30% barley +10% CDS soaked in citric acid; T7: 20% barley +20% CDS soaked in citric acid.

* Means within the same column with different superscripts are significantly different (P < 0.05).

Table 7. Economic efficiency for lambs fed the experimental diets

Traits	Treatments Means ±SE						
	T1	T2	T3	T4	T5	T6	T7
Weight gain (kg/head/63days)	5.92	6.24	6.51	6.96	7.09	7.30	7.56
DMI (kg/head/63days)							
Roughage	307.5	292.8	289.1	246.6	240.0	226.4	238.1
Concentrate mixture	684.5	717.0	718.2	701.9	699.7	701.6	643.9
Total DMI	992.0	1009.8	1007.3	948.5	939.7	928.0	882.0
Feed conversion efficiency (Kg DM/kg gain)	10.55	10.20	9.78	8.62	8.35	8.00	7.35
Roughage cost (ID)	5.812	5.534	5.464	4.661	4.536	4.278	4.500
Concentrate cost (ID)	22.90	22.178	21.945	19.978	20.991	19.669	18.051
Total feed cost (ID)	28.71	27.71	27.41	24.54	25.53	23.95	22.55
Fixed costs/head (ID)	5.45	5.45	5.45	5.45	5.45	5.45	5.45
Total cost (ID)	34.16	33.16	32.86	29.99	30.98	29.40	28.00
Selling income (ID)*	71.04	74.88	78.12	83.52	85.08	87.60	90.72
Net income (ID)**	36.88	41.72	45.26	53.53	54.10	58.20	62.72
Economic efficiency***	107.9	125.8	137.7	178.5	174.6	197.9	224.0
Relative economic efficiency	**100**	**116.6**	**127.6**	**165.4**	**161.8**	**183.4**	**207.6**

SE = Standard error, NS not significant, means in the same row with different letters significantly (P ≤ 0.05) differ.

The price of 1kg DM feed for T1, T2, T3, T4, T5, T6, T7: 531,491,485,445,485,445 thousand ID/Ton respectively and barley straw were 300 thousand ID/Ton.

Total feed cost = Price of 1kg DM feed x Total dry matter consumed.

Feed cost/kg gain = Total feed cost / Total body weight gain.

Price of 1kg live body weight = at the time of the experiment.

*1Kg live weight 6 thousand Iraqi Dinar

**Net income= Selling price – Total cost

*** Economic efficiency= Net income ÷ Total cost

Conclusion

We conclude from the results of the current study that there are positive effects on powdered date seeds soaked with acetic and citric acid and their replacement instead of barley by 25 and 50 % in the concentrated diet, which was reflected in the high rates of weight gain and a decrease in the amount of total feed intake with a significant improvement in the efficiency of feed conversion compared to the control diet. The return of one dinar rises directly with the increase in the percentage of substituting powdered date seeds soaked with citric acid, followed by soaked with acetic acid, then powdered regular date seeds, in exchange for the lowest value in the return of one dinar in the control treatment (without replacing crushed date seeds). These are promising results for the future to benefit from Secondary residue date seeds in sheep diet.

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Authors' contributions

HH carried out the work schedule research, and field experiment measuring effects on powdered date seeds soaked with acetic and citric acid. HH carried out the correlation, results and discussion.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

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