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Research Article
Effect of Feeding Urea Treated Palm Leaves on Milk Production, Composition and Animal Performance of Lactating Ardi Goats

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Abstract

Background and Objective: Saudi Arabia is one of the major date producing countries in the world. Consequently, huge quantity of date palm leaves are removed annually as agricultural waste and is a potential source of environmental problems due to its improper disposal. The aim of this study was to evaluate the effect of feeding Urea Treated Palm Leaves (UTPL) by substituting the regular feed on milk production, milk composition and animal performance. **Materials and Methods:** This study was conducted at Agricultural Research and Training Station, King Faisal University, Al-Ahsa, Saudi Arabia. Twenty Ardi goats in their 2nd and 3rd lactation stages were selected and randomly allotted to one of the four diets with five replicates. A total of four diet treatments were studied. Data were analyzed using SPSS package (SPSS 14.0 SPSS Inc. Inc., Chicago, IL, USA). **Results:** Dry matter intake of goats fed with 10 UTPL was significantly ($p<0.05$) low than the control and other diets. Milk Yield (MY) was significantly low for the control group than the other groups. Fat (%) of milk was significantly higher in goats fed with 20 and 30 UTPL diets than other groups. Milk protein percentage was significantly high in goats fed with 20 UTPL diet than the control and other diets. Goats fed with 30 and 10 UTPL diets contained significantly more lactose (%) than those fed with the control and 20 UTPL diets. The DM and OM digestibility of goats fed with 10 UTPL diet was significantly low compared to other diets. The CP digestibility was significantly ($p<0.05$) higher of goats fed with 20 and 30 UTPL diets than the control and 10 UTPL. Goats fed with control and 30 UTPL diet showed significantly ($p<0.05$) higher NDF, ADF digestibility and DCP than those fed with 20 and 10 UTPL diets. Goats fed with control, 20 and 30 UTPL diets were significantly ($p<0.05$) higher in NFE digestibility than those fed with 10 UTPL diet. Goats fed with 10 UTPL diet was significantly low in TDN than other dietary treatments. **Conclusion:** Urea treated palm leaves can be replaced up to 30% of alfalfa hay without affecting the animal health, milk composition, crude protein digestibility and overall performance.

Key words: Crude protein, digestibility, goats, milk production, urea treated date palm leaves

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Date palm trees provide old leaves as an agricultural waste that is sometimes used as a supplemental source of feed to the existing inadequate supplies of animal feeds[1]. According to an estimate, there are more than 23 million date palm trees in Saudi Arabia[2]. A date palm tree can produce 13.5-20 kg of dry leaves annually[3,4]. Based on this information, it is estimated that leaves 31-47 million tons of dry leaves are available per year. Unfortunately, major portion of the leaves is not used beneficially and is burned by the farmers which may cause environmental pollution. The crude protein content of date leaves is usually low ranging between 5-7% of DM[1,5]. In contrast, Ziaei and Hosseini[6] reported the crude protein content of palm leaves between 10.6-16.5% on dry weight basis. Bacha *et al.*[7] found that considerable variations in the chemical composition of date palm leaves during growing season that includes protein, fiber, NDF, ADF and ADL[5,6]. The variations in the chemical composition of date palm leaves depends on the stage of maturity (young leaves harvested green or senescent ones) or the part of the leaves used in animal feed (with or without the midrib or petiole). According to Kebede[8], the crop residues contain very low contents of Crude Protein (CP) and Metabolizable Energy (ME). If these residues are fed to animals as complete feed, then animals receive only sub-maintenance nutrient requirement[8]. Previously, many methods were developed to improve the nutritive values of crop residues thus enhancing their utilization in livestock feeding. Chopping, addition of ammonia or urea N[9], anaerobic in-silo fermentation, treatment with ammonium hydroxide[10] and supplementation with concentrates[11] or with good quality hay[9] are the most commonly used treatments of low quality crop residues due to easy handling and on economical grounds[12]. Therefore, the small farmers in the tropics and sub-tropics prefer urea treatment as it is the best adapted to their condition[13]. The National Research Council (NRC[14]) suggested that (30 g kg^{-1} DM) of urea can be added to low quality forages, while ARC[15] indicated that feeding 0.5 g urea kg^{-1} b.wt., is not toxic to animals. The ammonia ion swell and hydrolyses the cell wall carbohydrates and phenolic monomers[16]. As a result, an increase on the digestibilities of cell wall and dry matter and the protein content in the forage was observed by Oji *et al.*[17]. In order to obtain reliable and applicable results for treated date palm leaves, two factors namely the leaves delignification treatment and nutrient supplementation must be combined for animal performance. The aims of this study were to determine the effect of feeding urea treated palm leaves on milk production and its chemical composition as well as on the performance of Ardi goats under Al-Ahsa climatic conditions.

MATERIALS AND METHODS

Experimental site: This study was carried at Agricultural Research and Training Station at King Faisal University, Al-Ahsa, Saudi Arabia to determine the effect of feeding urea treated palm leaves on animal performance, milk production and milk composition of Ardi goats.

Animals and dietary treatments: Twenty Ardi goats in their 2nd and 3rd lactation stage with an average weight of 48.3±1.24 kg were assigned randomly to one of the four diets. The treatments were replicated five times for each milking and digestibility trials. All the goats were inspected for health before the experiment to ensure that the trial animals are in good condition. Each goat was kept in a separate pen located under semi-shed house. The total period of each trial was 60 days. Water and mineral salt were available at all time. Chemical composition of Urea Treated Palm Leaves (UTPL) and experimental diets were determined before the trial. All four treatments were balanced to be isocaloric and isonitrogenous for all the goats according to the recommendations of NRC[14]. However, these diets were formulated to contain an average of 14% crude protein and 66% TDN. The ingredients and chemical composition of the experimental diets are presented in Table 1. Alfalfa hay was partially substituted by UTPL. Dietary treatments were T1: 0 UTPL (40% alfalfa hay+60% concentrate), T2: 10 UTPL (10% of alfalfa hay (diet 1) was substituted by UTPL in forage portion), T3: 20 UTPL (20% of alfalfa hay was substituted by UTPL in forage portion) and T4: 30 UTPL (30% of alfalfa hay was substituted by UTPL in forage portion). In order to ensure the uniformity of the control and dietary treatments, forages and concentrate feed were mixed thoroughly manually before feeding. All the diets were fed as a Total Mixed Ration (TMR) once a day at 9 am in the morning. The milk samples collected from the experimental animals were analyzed for fat, protein, lactose, total solids and solid non-fat concentration as per given schedule for the experiment in the previous study[18]. The amount of feed and orts were weighed daily to determine the feed intake and were composited weekly for further analysis. The amount of ration offered was scheduled in such a way in order to minimize the refusals to less than 2%. The weight of all the goats was recorded on biweekly basis before the feeding time throughout the trial to find out the difference between the initial and final weight for treatment evaluation.

Table 1: Ingredients and chemical composition of the experimental diets

	Inclusion of UTPL (%)			
Items	0	10	20	30
Ingredient (DM%)				
Alfalfa hay	40.00	30.00	20.00	10.00
Untreated palm leaves (UTPL)	0.00	10.00	20.00	30.00
Barley	43.04	38.36	37.26	38.36
Soybean	0.76	2.38	4.07	2.38
Wheat bran	12.50	15.60	15.03	15.60
Dicalcium phosphate	1.00	1.00	1.00	1.00
Limestone	2.00	1.97	1.95	1.97
Salt	0.60	0.59	0.59	0.59
Vitamins and minerals Premix[a]	0.10	0.10	0.10	0.10
Chemical composition (on dry weight basis)				
Dry Matter (DM)	88.89	89.50	90.10	90.78
Crude Protein (CP)	14.04	14.10	14.00	14.25
Total Digestible Nutrient (TDN)	66.89	66.23	66.00	66.83
Crude Fiber (CF)	16.65	16.51	16.30	15.63
NDF	46.78	45.93	44.30	40.44
ADF	28.51	27.32	26.00	24.26
Ether Extract (EE)	2.38	2.30	2.12	1.74
Ash	5.79	6.58	7.24	7.64
Calcium	1.59	1.30	1.23	1.22
Total phosphorus	0.60	0.62	0.63	0.57

Dry Matter Intake (DMI), nutrient intakes, Feed Conversion Ratio (FCR) and body weight gain were calculated to evaluate goat performance.

Treatment of palm leaves with urea: Palm Leaves (PL) were obtained from a commercial farm in Al-Ahsa. Grass shear was used to separate the leaves from the coarse midrib manually and then cut into 3-5 cm length with a forage grinder. Four kilograms of urea (fertilizer grade) were dissolved in 100 L of water (at the rate of 40 g urea L^{-1} of water) and then 100 kg of shredded palm leaves were added to the mixture. A trash container was used to keep approximately 25 kg of UTPL and then compressed by feet to minimize the presence of air. After filling, the container was covered by a polyethylene sheet and then closed by the lid and sealed by tape to make it air tight and left to incubate for 21 days as recommended by Sundstol and Worth[12].

Sample collection and analysis: Samples of animal feed namely the alfalfa hay, untreated palm leaves were collected for ash, crude protein, crude fiber and ether extract, Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) determination according to the standard procedures[19,20]. While the total digestible nutrients were presented as calculated values.

Digestibility trial: After the end of the lactation trial, 12 goats were selected for digestion trial each batch receiving one of four treatments. Animals were fed at 8:00 am. During collection period, feed intake was monitored. Feed refusal, orts and fecal output were samples according to the experimental design for determining different feed parameters such as dry matter and various digestion coefficients, such as Organic Matter (OM), Crude Protein (CP), Ether Extract (EE), Crude Fiber (CF), Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF).

Statistical analysis: A completely randomized design was followed for the experiment consisting of four treatments with 5 animals in each treatment. The traits studied were milk production, milk composition and nutrients digestibility. Data were analyzed for treatment evaluation using SPSS package (SPSS 14.0 SPSS Inc. Inc., Chicago, IL, USA) according to a given model[21] and Duncan multiple range test[22].

RESULTS AND DISCUSSION

The chemical composition of all the diets with respect to protein, ash and total digestible nutrients were relatively close (Table 1). The TDN concentration of all the experimental diets was higher than the TDN requirement of goats at this weight according to NRC[14]. This indicates that the energy requirement of goats was fulfilled by the experimental diets. However, the contents of Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) decreased when the proportion of Urea Treated Palm Leaves (UTPL) was increased in the ration.

This finding is in agreement with the results of Aregawi *et al.*[23] who found that sesame straw treated with urea reduced NDF, ADF and cellulose contents of the straw. On the other hand, Madrid *et al.*[24] showed that urea effectively solubilized NDF and hemicelluloses without affecting the ther components of the cell wall. Also, the ash contents of experimental diets increased when the quantity of urea was increased for the treatment of date palm leaves. Similarly, Musimba[25] found that ash percent of wheat straw increased with urea treatment which may be due to the presence of other soluble nutrients like CP, Nitrogen Free Extract (NFE) and Ether Extract (EE) and soluble carbohydrates. In contrast to the present study, Aregawi *et al.*[23] showed that urea treatment did not affect the mineral composition of diets. However, in this study, the calculated TDN percentage of the dietary treatments was higher than the estimated TDN requirement of goats at this weight according to findings of NRC[14] which indicated that the energy requirement of goats was achieved.

Effect of experimental diets on milk yield and composition: Data showed that the initial body weight, final body weight and total body weight gain were not significantly different ($p>0.05$) among the treatments. This suggests that the experimental diets provided adequate nutrient requirements to goats for maintenance and overall production. Also, feeding urea treated palm leaves to lactating goats did not show any detrimental effect on the health and growth performance of animals. However, dry matter intake of goats fed with 10 UTPL diet was significantly ($p<0.05$) less when compared to control and other experimental diets but the difference was not significant among these groups. The high intake of dry matter (DMI) by goats fed with 20 and 30 UTPL diets may be due to the effect of urea treatment on palm leaves which induced partial cleavages between lignin and structural carbohydrates. Also this phenomenon might have exposed the hemicellulose and cellulose to rumen fermentation by microbes thus increasing the fiber digestibility and enhanced the feed intake. These results were in agreement with the finding of Gunun *et al.*[26] who reported that steers fed with urea treated rice straw showed significantly higher dry matter intake compared to those fed with untreated rice straw. They attributed the higher dry matter intake to the high moisture contents of urea treated rice straw than the untreated rice straw indicating that urea treated straw was more palatable. In this study, urea was added at the rate of 40 g kg^{-1} palm leaves, therefore the results of DMI did not agree with those of Paengkoum *et al.*[27], who found that intake of oil palm fronds increased with increasing the quantity of urea up to 30 g kg^{-1} oil palm frond and thereafter decreased with increasing the level of urea. However, Mesfin and Ktaw[28] stated that the dry matter intake was higher in cows fed with hay based diet compared to those fed with diet prepared from urea treated wheat straw. Furthermore, these cows consumed more dry matter than those fed with diet constituted by mixing with untreated wheat straw. The difference in Feed Conversion Ratio (FCR) was not significantly ($p>0.05$) different between control and other experimental diets. The results of the present study indicated that addition of UTPL upto a 30% of total forage did not adversely affect the intake and digestibility of nutrients. Milk Yield (MY) ranging from 1.21-1.42 kg day^{-1} with the control group was significantly ($p<0.05$) low as compared to other groups. Goats fed with 30 UTPL produced significantly higher MY than goats fed with 20 UTPL diet but the difference in MY was not significant with those fed with 10 UTPL. Higher MY of goats fed with 30 UTPL may be attributed to the availability of ammonia from the breakdown of urea. Because urea might have been consumed by the rumen microbes to synthesize microbial protein and increased the fiber digestibility thus providing energy to goats required for milk production. Givens *et al.*[29] observed that reduction in NDF and hemicelluloses might be due to the dissolution of hemicelluloses fraction by urea and its subsequent removal from the cell wall constituents. Consequently, this increased the amount of cell wall solubility which might have elevated the concentration of fermentable sugars in the rumen. The results agree with the finding of Abu Hassan *et al.*[30] who showed that lactating cows fed with 30% oil palm frond silage produced more milk than those fed with 50% without any adverse effect on animal health and milk production. In contrast to these results, Mesfin and Ktaw[28] found that cows fed with hay based diet produced more milk compared to those fed with diet constituted by mixing with urea treated wheat straw. Milk fat ranging from 3.31-3.58% with goats fed on 20 UTPL diet was significantly ($p<0.05$) higher as compared to other groups. On the other hand, fat contents of milk from goats fed with 30 UTPL diet was significantly higher than the control and 10 UTPL diets. However, the difference in fat percent was not significant between 10 UTPL and the control diet. The results of milk fat percent in this study indicate that feeding UTPL did not show any negative effect on the synthesis of acetate. Thus, the experimental goats were capable of producing an adequate amounts of acetate required for fat synthesis in the mammary gland. In contrast to this study, Mesfin and Ktaw[28] reported that cows fed with hay based diet produced milk with higher fat content than cows fed with urea treated and untreated wheat straw. There was no significant difference in milk fat

Table 2: Dry matter intake, live body weight and daily milk production and composition of Ardi lactating goats fed diets supplemented with Urea Treated Palm Leaves (UTPL)

	Inclusion of UTPL (%)			
Item	0	10	20	30
Initial body weight (kg)	48.96±0.96	49.18±2.58	46.06±2.04	49.04±4.01
Final body weight (kg)	55.40±0.79	55.70±2.43	53.60±2.32	57.10±3.40
Total body weight gain (kg)	6.44±0.46	6.52±0.24	7.54±0.83	8.06±0.62
Milk production (kg day^{-1})	1.21±0.02^{c}	1.39±0.01^{ab}	1.37±0.02^{b}	1.42±0.02^{a}
DMI (kg day^{-1})	1.22±0.02^{a}	1.14±0.02^{b}	1.20±0.01^{a}	1.24±0.01^{a}
MY/DMI (Feed conversion ratio)	0.98±0.02	0.98±0.02	1.05±0.03	1.02±0.02
Fat (%)	3.31±0.02^{c}	3.32±0.02^{c}	3.58±0.01^{a}	3.48±0.01^{b}
Fat yield (g day^{-1})	42.07±0.55^{c}	46.41±0.54^{b}	49.30±0.59^{a}	49.41±0.56^{a}
Protein (%)	2.51±0.01^{c}	2.54±0.01^{c}	2.86±0.02^{a}	2.63±0.01^{b}
Protein yield (g day^{-1})	31.92±0.41^{d}	35.47±0.39^{c}	39.68±0.59^{a}	37.51±0.46^{b}
Lactose (%)	4.26±0.02^{b}	4.32±0.02^{a}	4.26±0.02^{b}	4.34±0.02^{a}
Lactose yield (g day^{-1})	54.32±0.72^{c}	60.64±0.73^{ab}	58.59±0.70^{b}	61.82±0.76^{a}
Total solids (%)	12.33±0.09	12.21±0.08	12.20±0.07	12.27±0.05
Solid not fat (%)	6.37±0.18	6.95±0.15	6.87±0.24	6.56±0.21

$^{a-d}$Means within a row with different superscripts are significantly different at p<0.05

contents of cows fed with urea treated and untreated wheat straws. But the fat percent was higher in their study as compared to the values obtained in the present study. Above all, the milk fat percentage in the current study was comparable with the range reported by Strzalkowska *et al.*[31] who found similar milk fat percentage of goats in the first stage of lactation. Goats fed with 30 and 20 UTPL diets did not show any significant difference in milk fat (g day^{-1}) but it was significantly (p<0.05) higher than those fed with the control and 10 UTPL diets. Goats fed with 10 UTPL showed significantly higher fat contents compared to those fed with the control diet. The milk protein percentage was significantly higher of goats fed with 20 UTPL than the control and other dietary treatments. The reduction in protein percentage of goats fed with the control and dietary treatments may be due to inadequate supply of amino acids to ruminal microbes for synthesizing the microbial protein. The values of protein percentages observed in the current study for all the dietary treatments were comparable and fall in the range reported by Strzalkowska *et al.*[31] and Al-Suwaiegh[18]. Goats fed with 20 UTPL diet showed significantly higher protein yield (g day^{-1}) between the control and other dietary treatments. While the protein contents of milk from goats fed with 30 UTPL were significantly higher than those fed with the control and 10 UTPL diets. The lactose percentage of milk of goats fed with 30 and 10 UTPL diets was significantly more compared to those fed with the control and 20 UTPL diets but the difference in lactose contents between these two groups was not significant. The result of this study did not agree with the finding of Mesfin and Ktaw[28] who reported that milk lactose was relatively higher in cows fed with hay based diet compared to those fed with urea treated wheat straw. The lactose percent observed in the present study were comparable with other studies[32]. This comparative finding could be attributed to the ability of amylolytic bacteria to produce propionate in the rumen required for lactose production. However, Kifaro *et al.*[33] showed that decreasing trend in lactose percent of milk may be associated with the infection of mammary glands. The normal percent of lactose obtained in the study indicated that animal diet constituted by mixing urea treated palm leaves proved useful for animal consumption. The effect of the control and experimental diets on total solids and non-fat solids were not significantly different (p>0.05). In the case of total solids, the values obtained in the current study were higher than those reported by Suranindyah and Astuti[34] but were similar to those reported by Strzalkowska *et al.*[31]. Although, several factors are responsible for the differences in milk composition of herbivore milk, yet the diet was considered as the most significant factor as reported by Min *et al.*[35].

Effect of experimental diets on nutrients digestibility: The mean values of DM and OM digestibility were 70.81 and 72.23, respectively (Table 2). A study of data indicated that DM and OM digestibility was not significantly different among the control, 20 and 30 UTPL diets (Table 3). While these groups were significantly (p<0.05) higher than those fed with 10 UTPL diet. The study results disagree with the finding of Pascual *et al.*[4] who showed that the DM digestibility of goats fed with date palm fractions was 48.65%. Paengkoum *et al.*[27] found that the addition of 30 g urea kg^{-1} Oil Palm Frond (OPF) increased in the DM and OM digestibility of goats but decreased (p<0.05) when the rate of urea increased to 40 and 50 g kg^{-1} OPF. The values of OM and DM digestibility in their study were much lower than the values found in the present

Table 3: Apparent nutrient digestibility coefficients of Ardi goats fed pelleted diets supplemented with Urea Treated Palm Leaves (UTPL)

	Inclusion of UTPL (%)			
Items	0	10	20	30
Dry matter (%)	72.80±0.45[a]	66.13±1.38[b]	72.23±0.52[a]	72.09±0.74[a]
Organic matter (%)	73.57±0.59[a]	67.04±1.92[b]	74.06±0.45[a]	74.23±0.76[a]
Crude protein (%)	65.14±0.95[c]	69.01±0.44[b]	72.79±0.89[a]	75.03±0.64[a]
Crude fiber (%)	58.66±2.24[a]	48.20±0.73[b]	57.31±1.44[ab]	51.77±2.98[b]
Neutral detergent fiber (%)	75.67±0.96[a]	69.56±0.58[b]	72.41±1.29[b]	75.87±0.27[a]
Acid detergent fiber (%)	67.24±1.32[a]	60.67±0.39[b]	60.01±1.11[b]	65.89±1.04[a]
Fat (%)	78.90±1.20	76.10±1.87	78.55±3.65	77.82±3.58
Nitrogen free extract (%)	73.57±0.95[a]	63.02±4.01[b]	76.48±0.93[a]	71.50±1.49[a]
Ash (%)	46.25±2.92	45.84±1.65	44.83±1.44	45.26±0.50
DCP (%)	9.15±0.13[d]	9.73±0.06[c]	10.20±0.13[b]	10.69±0.09[a]
TDN (%)	71.64±0.56[a]	65.21±1.31[b]	70.95±0.28[a]	69.84±0.45[a]

[a,b]Means within a row with different superscripts are significantly different at $p<0.05$

study which may be attributed to the chemical composition of palm leaves used and the animal species. The values of dry matter digestibility from the present study contradicted with the finding of Ziaei and Hosseini[6] who found the highest *in vitro* dry matter digestibility of 16% and attributed this reduction to palm leaves containing large amount of cellulose, hemicellulose and lignin. The finding of this study showed that feeding goats with urea treated palm leaves (40 g urea kg^{-1} UTPL) up to 30% substitution of alfalfa hay did not show any negative effect on digestibility. The CP digestibility was significantly ($p<0.05$) higher for goats fed with 20 and 30 UTPL diets compared to those fed with control and 10 UTPL. However, the CP digestibility was significantly more in goats fed with 10 UTPL than those fed the control diet. This positive result on CP digestibility of treatments 20 and 30 UTPL with 4% urea may help in hydrolyzing urea thus increasing the CP digestibility. In addition to this, it was recognized that a considerable amount of crude protein is associated with fiber fraction which reduced their availability to animals. Because palm leaves treated with urea increases the fiber digestibility which probably increased the degradation of large amount of protein associated with the fiber fraction. Accordingly McDonald *et al.*[36] reported that an increase in protein consumption results in increased digestion coefficient of crude protein, especially if the protein concentration of the diet consumed is marginal. Djajanegara *et al.*[37] stated that supplementing urea or urea treatment of diet improved the intake, rate of digestion and digestibility of nutrients as indicated by higher digestibility of DM, OM and CP. Also, increased CP digestibility of UTPL did not agree with the finding of Yadete[38] who did not observe any significant difference in CP digestibility of wheat straw with and without urea treatment. However, Paengkoum *et al.*[27] reported that CP digestibility of OPF treated with 30 g urea was lower than that obtained in the current study. Overall, higher values of CP digestibility in this study may be due to the addition of more quantity of urea (40 g kg^{-1} UTPL) thus releasing more protein from fiber fraction for the microbial activity. Goats fed with control and 30 UTPL diets showed significantly ($p<0.05$) higher NDF and ADF digestibility than those fed with 20 and 10 UTPL diets, while there was no significant ($p>0.05$) difference in these parameters between the control and 30 UTPL diets. However, increased NDF and ADF digestibility in goats fed with 30 UTPL may be attributed to increased ruminal degradable protein (RDP) by urea treatment which enhanced the mtcrobial activity and ultimately the fiber digestibility. In contrast to this study, Chanjula and Ngampongsai[39] found that goats fed with elephant grass supplemented with 1, 2 and 3% urea did not show any significant difference in NDF and ADF digestibility. In their study, the nitrogen free extract was lower as compared to the present study which may result in low digestibility of NDF and ADF due to NFE as energy source for the action of ruminal microbes. Moreover, Yadete[38] found that lamb fed with urea treated straw showed higher ADF digestibility compared to those fed with untreated straw. Paengkoum *et al.*[27] found that NDF digestibility increased ($p<0.05$) with the addition of 30 g of urea to 1 kg of OPF and then decreased with increasing the addition of urea from ($p<0.05$) 40-50 g urea kg^{-1} OPF. Besides, there was no significant difference in ADF digestibility among the different dietary treatments. Furthermore, the digestibility coefficients of EE and ash were not significantly different among the dietary treatments. The digestibility coefficients of NFE were 63.02, 76.48, 71.50 and 73.57 for 10, 20 and 30 UTPL and the control diets, respectively. Also, there was no significant difference among goats fed with control, 20 and 30 UTPL diets but these three groups showed significantly ($p<0.05$)

higher NFE digestibility than those fed with 10 UTPL. The values of NFE digestibility in this study for the dietary treatments were lower than the finding of Al-Suwaiegh[18] but higher than those reported by Mahmoud and El-Bana[40] who fed barley and palm leaves to camels. Goats fed with 10 UTPL diet showed significantly ($p<0.05$) low DCP value among the dietary treatments. The DCP value of goats fed with 30 UTPL diet was significantly the highest than the control and dietary treatments. But the DCP was higher in goat fed with 20 UTPL diet when compared to the control. Overall, the DCP contents of this study were higher than those reported by Mahmoud and El-Bana[40] who fed palm leaves and barley to camels. The higher DCP value in this study may be attributed to the animal species, urea treatment and the overall chemical composition of experimental diets. In term of TDN value, goats fed with 10 UTPL diet was significantly low in TDN compared to other dietary treatments. But the difference in TDN values was not significant among the other dietary treatments. The findings of the current study did not agree with the finding of Al-Suwaiegh[18] who found that feeding goats with 10/10, 20/20 and 30/30 UTPL and date pits did not show any significant difference in TDN among the different animal dietary treatments. The higher TDN values for the 20 and 30 UTPL may be due to the hydrolyzing effect of urea for the linkage between cellulose and lignin and, hemicellulose and lignin. This process enhanced the total CP amounts to animal which caused an increase in fiber digestibility thus increasing the energy supply to animals.

CONCLUSION

Due to high feed costs in the world and inadequate supply of feed on regular basis to animal breeders, finding another local feed sources would be encouraging. One of these local feed source in Saudi Arabia is palm leaves. Feeding urea treated palm leaves to lactating goats up to 30% replacing alfalfa hay did not show any adverse effect on animal health and performance. It is, therefore, recommended that animal breeders should benefit by feeding their animal with this feed as long as the farmers can benefit from selling their palm leaves.

SIGNIFICANT STATEMENTS

The effect of substituting Urea Treated Palm Leaves (UTPL) with regular feed was determined on milk production, milk composition and the performance of Ardi goats. Dry matter intake and milk yield of goats fed with 10 UTPL was significantly ($p<0.05$) low than the control and other diets. However, milk fat, protein, digestibility of dry matter and organic matter were significantly affected by substituting UTPL with hay at different ratios. Goats fed with control and 30 UTPL diet showed significantly ($p<0.05$) higher NDF, ADF digestibility and DCP than those fed with 20 and 10 UTPL diets. Goats fed with control, 20 and 30 UTPL diets were significantly ($p<0.05$) higher in NFE digestibility than those fed with 10 UTPL diet. Overall, urea treated palm leaves can replace up to 30% of alfalfa hay without affecting the animal health, milk composition, crude protein digestibility and overall performance.

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