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Partial Replacing of Concentrate Feed Mixture by Potato Processing Waste in Sheep Rations

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Abstract: Two trials were carried out to investigate the effect of partial substitution of concentrate feed mixture (CFM) with potato peel waste (PPW) in sheep ration on *In vitro* and *In vivo* digestibility. In the first trial, chemical composition along with *In vitro dry matter* disappearance *(IVDMD)* and *In vitro organic matter* disappearance *(IVOMD)* were determined for CFM, PPW and Peanut vines hay (PVH). Three combinations were prepared to contain 50% PVH and the remainder from both CFM and / or PPW. Potato peel waste was used to replace 0, 25 and 50% of CFM in combinations 1, 2 and 3, respectively. Both *IVDMD* and *IVOMD* were determined also in these combinations. In the second trial fifteen mature male Ossimi sheep of about 63 kg live body weight were divided into three experimental groups, each of five animals. The control ration (R_1) composed of 50% CFM and 50% PVH, while PPW was used to replace 25 or 50% of CFM (W/W) in (R_2 and R_3), respectively. The results showed that, crude protein (CP) content of PPW was comparable to that of CFM. The higher crude fiber (CF) content was observed with PVH, while PPW showed the lowest CF content. The *IVDMD* and *IVOMD* for CFM, PPW and PVH were 58.4 & 63.75, 85.38 & 88.70 and 58.70 & 63.05%, respectively. The values of IVDMD and *IVOMD* of different combinations were ranged from 67.23 to 70.13 for *IVDMD* and from 68.57 to 72.5% for *IVOMD*. In the second trial, the results showed that there were no significant differences among the experimental rations concerning dry matter and water intakes, however total digestible nutrients (TDN) and digestible crude protein (DCP) intakes were tended to significant decreasing ($P<0.05$) with increasing the level of PPW. Crude protein digestibility coefficient was significantly decreased in R_3 in comparison with R_1 & R_2, while (DM, OM, CF, EE and NFE) digestibility coefficients were not significant affected by the dietary treatments. Increasing level of PPW in rations decreased nutritive values as TDN and DCP. All experimental animals were in positive Nitrogen balance. Sheep fed diet containing 25% PPW significantly increased ($P<0.05$) ruminal pH compared with sheep that fed 0 and 50% PPW containing diets. On the other hand, total volatile fatty acid's (TVFA's) tended to increase as the level of PPW increased in the rations, while ruminal ammonia nitrogen (NH_3-N) concentration tended to decrease. Sampling time at 4hrs significantly decreased ($P<0.05$) ruminal pH and NH_3-N however, significantly increased ($P<0.05$) ruminal TVFA's in comparison with zero time. There were significant interaction between dietary treatments (PPW levels) and sampling time for ruminal pH, NH_3-N and TVFA's. From these results it can be concluded that PPW can replace successfully up to 50% of CFM in sheep rations.

Key words: Potato peels waste · Sheep · *In vitro* · Digestibility · Rumen fermentation · Nitrogen balance

INTRODUCTION

Chronic feed deficient represent to animal production in many of the developing countries due to the population increase and consequently allocation of available for cereal production, thereby reducing the availability of cultivated land for animal fodder production. This situation demands the use of unconventional feed resources in livestock ration, especially from the industrial by products. Potato waste is one of these by products, that remaining after potatoes have been processed to produce frozen potato products for human consumption. The products can include peeling, cull potatoes, reject French fries and other potato products. Approximately 35% of the total processed potato crop is discarded as a waste during processing. This waste ferments rapidly and adds to the pollution problem if not properly utilized. The total world potato waste is estimated to 12 million ton per year [1]. Smith and Huxsoll [2] estimated the peeling losses of the potato chips industry which used abrasion peeling extensively to be 10%. Stanhope *et al*. [3] reported that potato processing residue can replace barley as an

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energy source for finishing beef cattle. Studies by Heinemann and Dyer [4] on steers indicated that potato processing slurry had a dry matter digestibility of 73.5% when fed at 19.2 to 37.5% of the diet dry matter. At these two levels, potato slurry had digestible energy values of 3.5 and 3.1 M cal / Kg, respectively. Also Gado *et al*. [5] reported that replacement of concentrate feed mixture by potato waste at level 25% of DM significantly increased digestibility of DM and nitrogen balance.

This study was designed to investigate the effect of partial replacement of common concentrate feed mixture by potato peel waste on *In vitro* dry matter and organic matter disappearance, feed and water intakes, nutrient digestibilities, nitrogen balance and some ruminal parameters of local sheep.

MATERIALS AND METHODS

Wet potato peel waste (PPW) was obtained from potato chips factory, 10^{th} of Ramadan City. The waste was spread in thin layers on trays and left for sun drying for the experimental purpose.

Chemical composition of feedstuffs used along with *In vitro* and *In Vivo* trials were carried out to evaluate the possibility of using PPW in sheep rations.

***In Vitro* Work:** Three combinations were prepared from concentrate feed mixture (CFM), potato peel waste (PPW) and peanut vines hay (PVH) in which PPW replaced CFM by 0.00%, 25.00% and 50.00% (W/W). The combinations of the experimental rations are presented in Table 2.

Samples of CFM, PPW, PVH and different combinations were tested for *In vitro* dry matter disappearance (*IVDMD*) and *In vitro* organic matter disappearance (*IVOMD)* according to the method of Tilley and Terry [6]. Fermentation media used was that described by Norris *et al.* [7] with the modification of adding the buffer and urea solution as described by Naga and El- Shazly [8].

***In Vivo* Work**

Animal and Experimental Rations: Fifteen mature male Ossimi sheep of about 63 kg live body weight on average were used in this experiment to investigate the effect of replacing CFM by different levels of PPW in sheep ration on feed and water intakes, nutrient digestibilities, nitrogen balance and some rumen fluid parameters. The animals were randomly assigned to three experimental groups (Five animals in each treatment). The same formulation of feeds which mentioned above (Table 2) was used in digestibility trials.

Apparent Digestibility, Nutritive Values and Nitrogen Balance: Animals were housed in individual metabolic cages. Cages allowed catching feces separately from the urine which was collected in attached glass containers containing 50 ml sulphoric acid 10%. The digestibility trial consisted of 15 days as a preliminary period followed by 7 days for feces and urine collection.

The animals were fed on 3% of live body weight. Rations were offered in two portions, CFM and/or PPW at 8.00 a.m. followed by PVH at 9.00 a.m. Water was offered

Table 1: Chemical analysis and cell wall constituents of feed ingredients (on DM basis)

Item	Concentrate feed mixture (CFM)*	Potato peel waste (PPW)	Peanut vines hay (PVH)
Chemical analysis			
Dry matter	90.00	90.11	88.50
Organic matter	89.20	88.50	90.75
Crude protein	14.60	14.00	8.93
Crude fiber	16.40	6.55	40.52
Ether extract	3.78	1.38	2.67
Nitrogen free extract	54.42	66.57	38.63
Ash	10.80	11.50	9.25
Cell wall constituents			
NDF	39.23	41.00	47.30
ADF	27.95	6.30	32.50
ADL	7.27	3.80	5.77
Hemicellulose	11.28	34.70	14.80
Cellulose	20.68	2.50	26.73

CFM* : The concentrate feed mixture used in formulating the experimental rations contained 25.00% Cotton seed meal; 35.00% Wheat bran; 4.00% Rice bran; 30.00% Yellow Corn 1.50% Lime stone; 1.00% Sodium chloride, 0.50% vitamins and mineral mixture and 3.00 Molasses. NDF, neutral detergent fiber; ADF, acid detergent fiber; ADL, acid detergent lignin. Hemicellulose = NDF – ADF; Cellulose = ADF- ADL

Table 2: Composition, chemical analysis and cell wall constituents of the experimental rations

	Experimental rations		
Item	Ration (1)	Ration (1)	Ration (1)
Composition (%) of the experimental rations			
Peanut vines hay	50.00	50.00	50.00
Concentrate feed mixture	50.00	37.50	25.00
Potato peel waste	--	12.50	25.00
Chemical analysis (%) on DM basis			
DM	89.25	89.26	89.27
OM	89.97	89.88	89.86
CP	13.18	12.32	11.64
CF	28.35	28.78	27.46
EE	3.22	2.94	2.62
NFE	45.22	45.84	48.14
Ash	10.03	10.12	10.14
Cell wall constituents			
NDF	43.27	43.49	43.71
ADF	30.23	27.52	24.82
ADL	6.53	6.10	5.66
Hemicellulose	13.04	15.97	18.89
Cellulose	23.70	21.42	19.16

NDF, neutral detergent fiber; ADF, acid detergent fiber; ADL, acid detergent lignin; Hemicellulose = NDF – ADF; Cellulose = ADF – ADL

twice daily at 11.00 a.m. and 2.00 p.m. During the collection period, feces and urine were quantitatively collected from each animal once a day at 7.00 a.m. before feeding. Actual quantity of feed intake was recorded, water consumption was also recorded. A sample of 10% of the collected feces from each animal was sprayed with 10% sulphoric acid and 10% formaldehyde solutions and dried at 60° C for 24 hrs. Samples were mixed and stored for chemical analysis. Composite samples of feeds and feces were finely ground prior to analysis. Also 10% of the daily collected urine from each animal was preserved for nitrogen determination.

The nutritive values expressed as the total digestible nutrient (TDN) and digestible crude protein (DCP) of the experimental rations were calculated by classical method. Chemical composition and cell wall constituents (%) of ingredients and experimental rations are presented in Tables 1, 2.

Rumen Fluid Parameters: Rumen fluid samples were collected from all animals at the end of the digestibility trial before feeding and 4 hrs post feeding via stomach tube and strained through four layers of cheesecloth. Samples were separated into two portions, the first portion was used for immediate determination of ruminal pH and ammonia nitrogen concentration, while the second portion was stored at –20° C after adding a few drops of toluene and a thin layer of paraffin oil till analyzed for TVFA's .

Analytical Procedures: Representative samples of ingredients and experimental rations were analyzed for DM, CP, CF, EE, and ash according to A.O.A.C [9] methods. Nitrogen free extract (NFE) was calculated by differences. Neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were determined in ingredients and experimental rations according to Goering and Van Soest [10]. Hemicellulose was calculated as the difference between NDF and ADF, while cellulose was calculated as the difference between ADF and ADL. Ruminal pH was immediately determined using digital pH meter. Ruminal ammonia nitrogen (NH_3–N) concentrations were determined applying NH_3 diffusion technique using Kjeldahle distillation method according to A.O.A.C [9]. Ruminal total volatile fatty acids (TVFA's) concentrations were determined by steam distillation according to Warner [11].

Statistical Analysis: Data collected were subjected to statistical analysis as one way analysis of variance according to Snedecor and Cochran [12]. Duncan's Multiple Range Test [13] was used to separate means when the dietary treatment effect was significant according to the following model:

$$Y_{ij} = \mu + P_i + e_{ij} \text{ (model 1)}$$

On the other hand, ruminal data was subjected to statistical analysis as two factor factorial analysis of variance according to the following model:

$$Y_{ijk} = \mu + P_i + T_j + (PT)_{ij} + e_{ijk} \text{ (model 2)}$$

Where:

Y_{ij} = Observation.
μ = Overall mean.
P_i = Effect of dietary potato peel waste (PPW) level for i = 1 – 3, 1 = No (PPW),
2 = 25% (PPW) of CFM and 3 = 50% (PPW) of CFM.
e_{ij} = The experimental error. (model 1).
T_j = Effect of sampling time for j = 1 – 2, 1 = before feeding and 2 = 4 hrs post feeding.
$(PT)_{ij}$ = The interaction of PPW level x sampling time.
e_{ijk} = The experimental error. (model 2).

RESULTS AND DISCUSSION

Composition, Chemical Analysis and Cell Wall Constituents: Chemical analysis and cell wall constituents of feed ingredients are shown in Table 1. Potato peel waste (PPW) contained 14.00% CP, 6.55% CF, 1.38% EE, 66.57% NFE, 11.50% ash, 41% NDF, 6.30% ADF, 3.80 ADL, 34.70% hemicellulose and 2.50% cellulose. Also results indicated that, PPW had CP content similar to that of CFM. In addition PPW had higher NFE, ash, hemicellulose and lower CF, ADF, lignin and cellulose contents than those of CFM and PVH.

Composition, chemical analysis and cell wall constituents of the experimental rations are presented in Table 2. Experimental rations were contained 13.18, 12.32 and 11.64% CP for R_1, R_2 and R_3, respectively. The ether extract contents were 3.22, 2.94 and 2.62% for the same three experimental rations. NFE and NDF were in the same trend for the three experimental rations. Acid detergent fiber (ADF) and acid detergent lignin was decreased in the experimental ration with increasing the level of PPW in the ration, however hemicellulose and cellulose were increased. These results are in the same trend with those found by Gado *et al.* [5], who found that NDF, ADF and ADL for potato waste were 41.5, 6.4 and 3.9%, respectively. Also, These results in agreement with those obtained by Onwubuemeli *et al.* [14]; Scott *et al.* [15]; Duynisveld and Charmley [16] and Boyles [17], they recorded that CP ranged between 4% to 14.3% and CF ranged between 1.6% to 17.5%.

In Vitro Evaluation: Results concerning *IVDMD* and *IVOMD* for CFM, PPW, PVH and the different combinations from them are shown in Table 3. The *IVDMD* and *IVOMD* of PPW were better than those obtained for CFM or PVH. This may related to relatively lower CF, ADF and ADL contents of PPW compared with CFM and PVH [18, 19].

The *IVDMD* and *IVOMD* values of CFM or PVH were nearly similar, there were positive effects in *IVDMD* and *IVOMD*. In addition *IVOMD* was improved as the level of PPW increased, that may be due to rapid digestible potato starch [5].

Feed and Water Intakes: Dry matter and water intakes by the experimental group sheep are presented in Table 4 . The data illustrated that the average daily dry matter intake (DMI) expressed as g/h/day was highest for sheep fed control ration (R_1) compared with the other groups. This means that replacing 50% of CFM with PPW R3 did

Table 3: *In vitro* dry matter (IVDMD) and organic matter (IVOMD) disappearance of feed ingredients and the different combinations of the experimental rations

Item	IVDMD	IVOMD
Feed ingredients		
Concentrate feed mixture (CFM)	58.40	63.75
Potato peel waste (PPW)	85.38	88.70
Peanut vines hay (PVH)	58.70	63.05
Combinations		
R_1	68.34	68.57
R_1	70.13	70.47
R_1	67.23	72.50
SEM	0.78	1.48
Significant	NS	NS

R_1: (50% CFM+ 50% PVH). R_2: (37.50% CFM+ 12.50%PPW+ 50% PVH).
R_3: (25.00% CFM+ 25.00%PPW+ 50% PVH). NS: Non significant at (P<0.05).
SEM, standard error of the mean.

Table 4: Effect of dietary treatments on feed and water intakes by the experimental groups

	Experimental rations				
Item	Ration (1)	Ration (2)	Ration (3)	SEM	P< 0.05
Live body weight, kg (LBW)	63	63	63	1.38	NS
Feed intake, g of:					
Peanut vines hay	858	856	819	----	----
Concentrate feed mixture	983	709	495	----	----
Potato peel waste	----	270	496	----	----
Dry matter intake (DMI) as:					
g/h/day	1841	1835	1810	14.80	NS
kg/100 kg LBW	2.936	2.920	2.887	0.08	NS
Total digestible nutrient intake (TDNI) as:					
g/h/day	1287[a]	1273[a]	1171[b]	21.6	*
kg/100 kg LBW	2.040	2.025	1.869	0.06	NS
Digestible crude protein intake (DCPI) as:					
g/h/day	177.6[a]	155.7[b]	123.8[c]	7.89	*
kg/100 kg LBW	283[a]	248[a]	197[b]	13.5	*
Water intake as:					
ml/h/day	4349	4225	4108	157	NS
L/100 kg LBW	6.974	6.713	6.499	0.27	NS
L/kg DMI	2.359	2.304	2.313	0.09	NS

a, b and c: Means in the same raw having different superscripts differ significantly at (P<0.05).
NS: Non significant *: significant at level (P<0.05). S.E.M., standard error of the mean

Table 5: Nutrient digestibility and nutritive values of the experimental rations

	Experimental rations				
Item	Ration (1)	Ration (2)	Ration (3)	SEM	P< 0.05
Nutrient digestibilities coefficient					
DM	71.23	71.05	68.00	0.72	NS
OM	74.26	74.07	72.21	0.56	NS
CP	73.25[a]	68.88[a]	58.81[b]	2.29	*
CF	63.53	71.30	65.97	1.76	NS
EE	78.47	77.64	71.37	1.89	NS
NFE	78.07	80.95	78.73	0.82	NS
Nutritive values					
TDN%	69.95[a]	69.37[a]	64.69[b]	0.92	*
DCP%	9.66[a]	8.49[b]	6.85[c]	0.42	*

a, b and c: Means in the same raw having different superscripts differ significantly at (P<0.05).
NS: Non significant *: significant at level (P<0.05). SEM, standard error of the mean

not change feed intake significantly, which may due to the high palatability of rations containing PPW. Meantime sheep fed R_3 consumed lower (P<0.05), total digestible nutrient (TDN) as compared to those fed $R_1$and R_2. Also the data show that replacement 25 or 50% of CFM with PPW (R_2 and R_3) significantly decreased digestible crude protein intake compared with control ration (R_1). These results were agreement with those obtained by [4 , 20], they noted that using alkali–peeled potato by–product with cattle up to 40% of a high concentrate diets (DM basis) did not affect intake. However, addition of 50% or more had a negative affect. On the other hand, Sauter *et al.* [21], Radunz *et al.* [22] and Duynisveld *et al.* [23] recorded that inclusion potato by–products in finishing diets of cattle decrease the feed intake. However, Nelson *et al.* [24] reported an increasing of dry matter intake with a 10% addition of ensiled potato pieces, in corn–based diets.

The results of water intake by the experimental groups showed that, replacement of CFM by PPW at 25 and 50% decreased the water intake (expressed as ml/h/day, L/100 kg BW and L/kg DM intake), the differences between the groups were not significant. Increasing level of PPW in the diet gradually insignificant decreased (P>0.05) water intake. Water intake values by the experimental groups were 4349, 4225 and

4108 ml/h/day for R_1, R_2 and R_3, respectively. Feeding sheep on diets containing PPW decreased (P>0.05) daily water intake by about 2.85% and 5.54% for R_2 and R_3 in comparison with R_1, respectively. On the other hand, daily water intake decreased by 2.77% for R_3 compared with R_2. Holzer *et al.* [25] reported that total water consumption increased as dietary moisture increased for 10 to 75%.

Apparent Digestibility and Nutritive Values: Results of apparent digestibilities and nutritive values in terms of TDN and DCP of the experimental rations are presented in Table 5. No significant differences among rations were detected for DM, OM, CF, EE and NFE digestibilities. The digestibility of CP was significantly lower (P<0.05) in R_3 than in R_1 and R_2, but insignificantly lower CP digestibility was observed when the ration included PPW as substitution of CFM at 25% level (R_2) compared with R_1. The lowest CP digestibility observed in R3 may be related to the lower protein intake by the animals that given R_3. These results were in agreement with those found by Radunz et al [26] who, attributed the decrease in total apparent nitrogen disappearance with increasing potato waste levels in beef finishing diets to a less digestible protein with potatoes or more bacterial fermentation in the large intestine which would lead to greater fecal nitrogen extraction. The CP digestibility was closely related to dietary CP and source [27, 28]. On the other hand, Stanhope *et al.* [3] and Makkar *et al.* [29] found that DM, CF and EE digestibilities did not differ significantly.

Significant decrease were observed in nutritive values as TDN and DCP values of 50% PPW (R3) compared to R1 and R2, which mainly due to the decrease in CP digestibility. The control ration (R_1) had the highest DCP followed by R_2, then R_3. Replacement CFM by PPW at 50% decreased TDN by 7.52% and by 29.09% for DCP, respectively, compared to the control ration R_1.

Nitrogen Utilization: Results of nitrogen utilization are presented in Table 6. Sheep fed R_3 had lower (P<0.05) nitrogen intake than those fed R_1, while there were no significant differences among R_1 and R_2 as well as R_2 and R_3 in this respect. Fecal, urinary nitrogen and total nitrogen excretion did not significantly differ in all experimental groups. The highest nitrogen intake with the lowest fecal nitrogen out put lead to more digested nitrogen in control ration. Nitrogen retention was lowest with sheep fed R_3 followed by sheep fed R_2 and the highest was obtained by animal fed R_1 which was significantly higher than those fed R_3. The decrease of nitrogen balance in R_3 may be due to the decrease of nitrogen intake. Nitrogen retention as a percentage of nitrogen intakes (NI) was better with animals fed R_1 followed by animals fed R_2 and the lowest value was recorded by group 3. In another way it could be concluded that sheep can utilize nitrogen of the control ration by 19.50% and 41.21% more than of ration included 25 or 50% PPW in replacement of CFM, respectively. Generally, the superiority in nitrogen retention due to a

Table 6: Nitrogen utilization by the experimental groups

	Experimental rations				
Item	Ration (1)	Ration (2)	Ration (3)	SEM	P< 0.05
Nitrogen intake, g (NI)	40.38^{a}	38.31^{ab}	34.36^{b}	1.11	*
Fecal nitrogen, g (FN)	10.84	12.03	14.17	0.71	NS
Urinary nitrogen, g (UN)	13.28	13.19	10.63	0.63	NS
Total nitrogen excretion, g	24.12	25.22	24.80	0.76	NS
Digestible nitrogen, g (DN)	29.54^{a}	26.28^{b}	20.19^{c}	1.39	*
Nitrogen retention, g (NR)	16.26^{a}	13.09^{ab}	9.56^{b}	1.14	*
NR, % of NI	40.27^{a}	34.17^{ab}	27.82^{b}	2.33	*
NR, % of DN	55.04	49.81	47.35	2.19	NS

a, b and c: Means in the same raw having different superscripts differ significantly at (P<0.05).
NS: Non significant *: significant at level (P<0.05) SEM, standard error of the mean..

Table 7: Mean effects of dietary treatments on rumen fluid parameters of the experimental rations

	Potato processing waste levels				Sampling time		
Item	R_1	R_2	R_3	SEM	Before feeding	4hrs post feeding	SEM
pH	6.78^{b}	7.03^{a}	6.65^{b}	0.06	6.97^{a}	6.67^{b}	0.06
NH_3–N (mg /dl)	20.13	19.78	18.60	1.93	22.78^{a}	16.22^{b}	1.93
TVFA's (meq./dl)	7.10	8.20^{b}	12.00^{a}	0.61	8.08^{b}	10.12^{a}	0.61

a and b: Means in the same raw witin each treatment having different superscripts differ significantly at level (P<0.05).
SEM, standard error of the mean. NH_3-N, ruminal ammonia nitrogen. TVFA's, ruminal total volatile fatty acids.

Table 8: Effect of dietary treatments on rumen fluid parameters of the experimental rations

	Sampling time							
	Before feeding			4 hrs post feeding				
Item	R_1	R_2	R_3	R_1	R_2	R_3	SEM	P<0.05
pH	7.00[a]	7.05[a]	6.85[b]	6.55[c]	7.00[a]	6.45[c]	0.06	*
NH_3–N (mg /dl)	15.05[b]	29.05[a]	24.25[a]	25.20[a]	10.50[b]	12.95[b]	1.93	*
TVFA's (meq./dl)	6.15[d]	6.35[d]	11.75[a]	8.05[c]	10.05[b]	12.25[a]	0.61	*

a, b, c and d: Means in the same raw having different superscripts differ significantly at (P<0.05).

*: significant at level (P<0.05). S.E.M., standard error of the mean. PPW, potato processing waste levels. ST, sampling time

NH_3-N, ruminal ammonia nitrogen. TVFA's, ruminal total volatile fatty acids.

specific ration is affected by several factors such as possible production of microbial protein synthesis, increasing presence of fermentable energy [30], differences in availability of fermentable energy [31], variability in nitrogen that might escape fermentation from the rumen, an increased utilization of ammonia in the rumen [32] and the effect of free fats in protein synthesis [33].

Rumen Fluid Parameters: Results of mean effects of dietary treatment on rumen fluid parameter of the experimental rations (Table 7) indicated that feeding sheep on 25% potato peel waste (PPW) containing diet R_2 significantly increased (P<0.05) ruminal pH compared with R_1 and R_3 . Ammonia nitrogen (NH_3–N) concentration was not significant decreased with increasing the level of PPW in the diets. However Total volatile fatty acids (TVFA's) concentration was increased with increasing the level of PPW in the diets. These results were associated with TVFA's values as suggested by Briggs *et al.* [34], who observed that an increasing in ruminal TVFA's concentration caused a reduction in ruminal pH value. Ruminal pH is one of the most important factors affecting the fermentation and influences its functions. It varies in a regular manner depending on the nature of the diet and on the time it is measured after feeding and reflects changes of organic acids quantities in the ingesta. The level of NH_3-N and TVFA's as end products of fermentation and breakdown of dietary protein, have been used as parameters of ruminal activity by Abou-Akkada and Osman [35]. On the other hand, Radunz *et al.* [26] found that increasing levels of PW increased ruminal TVFA's concentration (linear, P<0.01, quadratic, P = 0.03). Also, Fadel *et al.* [36] reported that the increasing of ruminal TVFA's concentration is an indicator for better utilization of dietary carbohydrate.

Sampling time was significant effect on rumen fluid parameters. Potato peel waste (PPW) containing diets significantly decreased (P<0.05) ruminal pH and NH_3–N concentrations at 4 hrs post feeding compared with before feeding. However, it was significantly increased (P<0.05) TVFA's at 4 hrs post feeding compared with before feeding. It should be noted that, TVFA's concentration in the rumen is governed by several factors such as dry matter digestibility, rate of absorption, rumen pH, transportation of the digesta from the rumen to the other parts of the digestive tract and the microbial population in the rumen and their activities [37].

From the present results, the higher ruminal NH_3-N before feeding is revealing the presence of more un utilizable nitrogen in the rumen which might be due to failure of rumen microbes to get use hydrolyzed carbohydrate of PPW rations for microbial protein synthesis. While the decrease in rumen NH_3-N due to PPW feeding at 4 hrs post feeding may indicate low ruminal activity or may be due to that CP of potato processing residue was poorly digested [3]. On the other hand Onwubuemeli *et al.* [14] suggested that, potato starch fermentation rate was faster than corn starch causing a decrease in ruminal ammonia. Hungate [38] reported that, the main part of CP in the diet was degraded to NH_3-N in the rumen by the micro organisms and it depends to large extent on the physical and chemical nature of each protein.

Significant interaction was found between dietary treatments levels and sampling time (PPW x ST) on ruminal pH, NH3–N and TVFA's concentrations (Table 8). Ruminal pH value, NH_3–N and TVFA's concentrations ranged from 6.45 to 7.05; 10.50 to 29.05 mg/dl and 6.15 to 12.25 meq./dl for ruminal pH, Nh_3–N and TVFA's, respectively. These results were not agreement with those

noticed by Radunz *et al.* [26], they recorded that, there were no (time x treatment) interactions for any ruminal characteristics.

CONCLUSION

From this study it concluded that the partial replacement of common concentrate feed mixture with sun-dried potato peel waste at 25% level is highly recommended in ruminant ration. But using 50% of PPW in the ration had adverse effect on sheep performance.

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