Evaluation of Silages of Potato, Sweet Potato and Turnip with Rice Straw or Wheat Straw with or without Urea and Studies the Effect of Rations Containing Its Silages on Digestion Coefficients and Rumen Fermentation in Sheep

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Received: 21/5/2020

Abstract: The objectives of this study were evaluation the silages containing of non-commercial potato tubers, sweet potato roots, and turnip roots. Silages were making manually in jars in the 1st experiment with mixing cutting tubers or roots with rice straw or wheat straw with urea additives at levels 0, 0.5% and 1% for determining chemical composition and fermentation characteristics of silages. In the 2nd experiment, silages were making manually in bags with mixing cutting tubers or roots with rice straw + 2% molasses with 0 or 0.5% urea for evaluating seven rations by rams as follows: Ration A 100% of CP requirements according to NRC (1985) from concentrate feed mixture (CFM) + rice straw ad lib. Rations B, C and D were 60% of CP requirements from CFM + silages of potato, sweet potato and turnip, respectively. Rations E, F and G were 60% of CP requirements from CFM + silages of potato, sweet potato and turnip containing 0.5% urea, respectively. Silages were fed ad lib. Digestion coefficients and rumen fermentation were conducted to evaluate rations A, B, C, D, E, F and G using 21 local rams (3 in each) averaged weight 49 kg. Results explained that DM% of potato tubers, sweet potato and Turnip roots were 18.18, 20.08 and 7.50%, respectively and CP% was 13.31, 10.46 and 13.46%, respectively. DM of potato silage ranged from 34.31 to 35.68%, sweet potato silage ranged from 34.39 to 35.73% and Turnip silage ranged from 31.57 to 37.71%. CP in silage with urea was higher than silage without urea. Silage fermentation characteristics explained that pH ranged from 3.80 to 4.20, Ammonia-N% of total N ranged from 9.61 to 16.22%, Acetic acid ranged from 2.36 to 3.52 g/100g DM, Butyric acid ranged from 0.28 to 1.34 g/100g DM and lactic acid ranged from 6.31 to 9.65 g/100g DM. Ammonia-N as g/100g DM was increased with increasing urea levels. The differences of DM intake as % of LBW among all rations containing silages were not significant. Digestion coefficients of DM, OM of ration A was significantly (P<0.05) higher than all rations and the differences among other rations containing silages were not significant. Digestion coefficients of DM containing silages ranged from 52.88 to 56.94%, OM ranged from 54.69 to 59.03% and CP ranged from 58.61 to 64.8%. TDN of control was 0.49 and other rations containing silages ranged from 51.61 to 55.83%. DCP of control was 8.08 and other rations ranged from 7.79 to 9.58%. Digestion coefficients and nutritive values were not affected with urea additives. Ruminal parameters indicated that the differences of ruminal pH among all rations were not significant at 4h post feeding. The differences of NH₃-N and Total VFA's among rations B, C and D were not significant and the differences among rations E, F and G were not significant at 2 and 4h post feeding. The NH₃-N and VFA's of rations containing silages with urea was significantly (P<0.05) higher than control and rations containing silages without urea. The differences of Microbial protein among all rations were not significant except ration B was lower than other rations.

Keywords: Potato, sweet potato, turnip, silage, urea, rams, digestion coefficients, ruminal parameters

INTRODUCTION

The shortage in animal local feed sources and high price of traditionly feeding especially concentrates are limiting animal production in Egypt. Therefore, the untraditionally feed is necessary for animal feeding. The crop residues such as corn stover, wheat straw and rice straw are utilizing in animal feeding with or without treatments. On the other side, by-products of roots and tubers could be utilizing in animal nutrition. The main problem in these products is produce in short time during harvesting of the crop. Moreover, these by-products had a high content of moisture. Leonel et al. (2017) found that DM of Potato tubers ranged from 11.89 to 21.83%, Samy et al. (2014) found that the DM of different cultivars of sweet potato roots ranged from 17.0 to 26.5% and Penno et al. (1996) mentioned that DM of turnip roots ranged from 8.6 to 8.7%. Therefore, these tubers and roots could be ensiled with dry crop residues such as rice straw and wheat straw for produce optimum DM in silages. Sadri et al. (2018) found that DM of silage contained potato and wheat straw was 32.2%, Mutavhatsindi et al. (2018) found that DM of silage contained Potato hash and wheat bran was 35.2%, Babaeinasab et al. (2015) found that DM of silage contained Potato+wheat straw was 32.2% and Hart and Horn (1987) mentioned that DM of silage containing turnip and wheat straw was 33.2%. Recently studies explained that silage fermentation characteristics of mixing tubers with crop residues lie in the good quality silage (Sadri et al., 2018; Rui-rui et al., 2018; Mutavhatsindi et al., 2018; Babaeinasab et al., 2015). HaiYan et al. (1998) noticed that no significant differences in ammonia-N concentration among different silages of turnip containing 6, 12 and 18% rice straw. Adding molasses improved the ensiling fermentation of potato+wheat straw silage (Babaeinasab et al., 2015). Hart and Horn (1987) found that pH and NH₃-N were increased and lactic acid was decreased with increasing levels of wheat straw in straw ensiled straw while the acetic and butyric acids not affected. Ruiz et al. (1981) found that acetic, butyric and lactic acids were fluctuated with different levels of

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urea in sweet potato silage treated with urea levels 0, 0.4, 0.8 and 1.2%. The silages containing tubers and roots were good palatability by ruminants (Sadri et al., 2018; Nkosi et al., 2010 with sheep and Aibibula, et al., 2007; Nelson et al., 2000 with cattle). A little information was found on digestion coefficient and rumen fermentation of rations containing silages of potato tubers or sweet potato and turnip roots. Sadri et al. (2018) found that digestion coefficients of DM and CP were 67.7 and 67.0% of ration containing 30% potato-wheat straw silage + CFM + alfalfa by sheep. Nkosi et al. (2010) found that digestion coefficients of DM and CP were 49.30 and 40.40% of silage containing 80% potato hash + 20% hay by sheep. Hart and Horn (1987) found that OM digestibility was 63.0%, ruminal pH was 6.72 and ruminal total VFA was 82.6 mmol/L of sheep fed silage containing 72.3% turnip and 27.7% wheat straw.

However, there is limited information on ensiling these tubers and roots with or without additives. So, the aim of this study was evaluation the silages containing non-commercial potato tubers, sweet potato roots, and turnip roots with rice straw and wheat straw with or without urea additives and effect of rations containing its silages on digestion coefficients and rumen fermentation in sheep.

**MATERIALS AND METHODS**

This study was carried out at Animal Production Research Institute, Agricultural Research Center, Egypt. Two experiments were conducted:

1st experiment for making silage in jars:

This experiment was carried out at Animal Nutrition Unite of Ismailia Research Station (Ismailia governorate) (Animal Production Research Institute). Potato tubers, sweet potato roots and turnip roots were obtained from Ismailia market then cutting by using knives and mixed with chopped rice straw or wheat straw, then mixed with urea at levels 0, 0.5 and 1% on fresh basis in 18 treatments (9 with rice straw and 9 with wheat straw). The silage contents were calculated to give silage containing 35% DM. Every mixture put in jar capacity 1 kg (three jars in each treatment) with good pressing, and then closes every jar tightly to provide a non aerobic environment. The jars were opened after 45 days for measuring chemical composition and silage fermentation characteristics.

2nd experiment for making silage in bags:

This experiment was carried out at Animal Nutrition Research Department (Animal Production Research Institute). Potato tubers, sweet potato roots and turnip roots were obtained from Aloboor market then cutting by using knives and mixed with chopped rice straw in six mixtures as follows:

1-75% Potato and 25% rice straw + 2% molasses. 2-75% sweet potato and 25% rice straw + 2% molasses. 3-75% turnip and 25% rice straw + 2% molasses. 4-75% Potato and 25% rice straw + 2% molasses + 0.5% urea. 5-75% sweet potato and 25% rice straw + 2% molasses + 0.5% urea. 6-75% turnip and 25% rice straw + 2% molasses + 0.5% urea, then every mixture was putted into a plastic bag capacity 250 kg with a good pressing and still 45 days before opening. These silages were evaluated. Seven experimental rations were evaluated by using rams as follows:

Ration A: 100% of CP requirements according to NRC (1985) from Concentrate Feed Mixture (CFM) + Rice straw ad lib.

Ration B: 60% of CP requirements according to NRC (1985) from CFM + silage of potato (1)

Ration C: 60% of CP requirements according to NRC (1985) from CFM + silage of sweet potato (2)

Ration D: 60% of CP requirements according to NRC (1985) from CFM + silage of turnip (3)

Ration E: 60% of CP requirements according to NRC (1985) from CFM + silage of potato contained 0.5% urea (4)

Ration F: 60% of CP requirements according to NRC (1985) from CFM + silage of sweet potato contained 0.5% urea (5)

Ration G: 60% of CP requirements according to NRC (1985) from CFM + silage of turnip contained 0.5% urea (6)

Digestibility trials were conducted to evaluate the rations A, B, C, D, E, F and G using 21 Local rams (3 rams in each) averaged weight 49 kg. Rams were individually housed in metabolic cages. Preliminary period was 21 days and collection period were 5 days, followed 3 days for rumen fermentation studies. Concentrate feed mixture (CFM) was daily offered to the animals in two equal portions at 8 am and 4 pm. The silages were weighed and offered ad lib. Residual were collected and weighed daily. Drinking water was available all time.

Composite samples of CFM, rice straw, wheat straw, potato, sweet potato, turnip and silages of experimental jars and bags were dried in oven at 60°C for 24 h. Samples of daily feces were collected and dried in oven at 60°C for 24 h. Composite samples of feeds and feces were milling to pass through 1 mm screen and stored for chemical analysis. Chemical composition of representative samples was determined according to AOAC (1995) procedures.

Analytical samples were collected at the time when experimental jars and plastic bags were opened for determine silage characteristics. All samples were prepared for analysis by extracting homogenized 50 gm (wet material) with 500 ml distilled water for 10 minutes in a warming blender (Waldo and Schultz, 1956) the homogenate was filtered through four-layer cheese cloth. The filtrate was used to determine pH directly using a digital pH meter. Ammonia nitrogen (NH₃-N) was determined according to AOAC (2016). The acetic, butyric and lactic acids were determined by the distillation method as reported by Research Institute for cattle feeding at Hoorn, Holland (1961) as described by Nowar (1969).

Rumen fluid samples were taken from rams using a stomach tube at 0 time (before feeding), 2 h and 4h post feeding. These samples were filtered through three layers of surgical gauze without squeezing. Ruminal pH
was immediately estimated by digital pH meter. Rumen ammonia-N was determined according to Conway (1957). Total volatile fatty acids (TVFAs) were measured by the steam distillation method as described by Warner (1964). Microbial protein was determined by the sodium tungstate method according to Shultz and Shultz (1970).

All data were subjected to analysis was performed using the General linear Models (GLM) procedure of the SPSS 24. Mean differences were compared using Duncan multiple range test (Duncan, 1955). Data were analyzed using the following mathematical model:

\[ Y_{ij} = \mu + T_i + e_{ij} \]

**RESULTS AND DISCUSSION**

Chemical analysis of ingredients is presented in Table (1). DM contents of potato (18.18%) and Sweet potato (20.08%) were higher than turnip (7.50%). OM of potato (81.85%) and sweet potato (79.58%) were lower than turnip (88.53%). CP of potato (13.31%) and turnip (13.46%) was higher than sweet potato (10.46%). DM% of potato tubers lie within the range values obtained by Leonel et al. (2017). The DM% of sweet potato roots lie within the range values obtained by Samy et al. (2014). The CP% of potato was nearly with CP% obtained by Charmley et al. (2006). The CP% in sweet potato roots lie within the range values obtained by Samy et al. (2014). The CP% of turnip roots lie within the data obtained by Ali et al. (2014), Altinok and Karakaya (2003) and Jacobs et al. (2001).

| Items         | Potato tubers | Sweet potato roots | Turnip roots | CFM* | RS | WS |
|---------------|---------------|--------------------|--------------|------|----|----|
| DM            | 18.18         | 20.08              | 7.50         | 92.21| 89.36 | 90.70 |
| OM            | 81.85         | 79.58              | 88.53        | 91.65| 86.25 | 87.21 |
| CP            | 13.31         | 10.46              | 13.46        | 16.81| 3.25  | 3.42 |
| EE            | 1.10          | 0.80               | 0.93         | 3.80 | 1.86  | 2.10 |
| CF            | 7.10          | 7.02               | 14.67        | 12.38| 38.23 | 35.39 |
| NFE           | 60.34         | 61.30              | 59.47        | 58.66| 42.91 | 46.30 |
| Ash           | 18.15         | 20.42              | 11.47        | 8.35 | 13.75 | 12.79 |

CFM: concentrate feed mixture, RS: rice straw, WS: wheat straw
* CFM was formulated from 24% Sunflower meal, 15% wheat bran, 55% yellow corn, 3% molasses, 2% lime stone and 1% common salt

Chemical analysis of silages of Potato, Sweet potato and turnip with RS or WS with or without urea additives ensiling in jars experiment is presented in Table (2). DM of potato silage ranged from 34.31 to 35.68%, DM of sweet potato silage ranged from 34.39 to 35.73% and DM of turnip silage ranged from 31.57 to 37.71%. The chemical composition explained that OM% of potato silage and sweet potato silage was lower than OM% in turnip silage with or without urea. The CP% of potato silage was higher than sweet potato silage, and CP% of sweet potato silage was higher than turnip silage with or without urea. As expected, the CP% in all silages was increased with increasing urea levels. However, the chemical composition values of silages with RS or WS was nearly similar.

Fermentation characteristics of silages in jars as presented in Table (3) explained that pH values ranged from 3.8 to 4.2 of all treatments with no significant differences among all silages. Ammonia-N values as g/100g DM in silages were increased with increasing urea levels. Ammonia-N in potato silage with rice straw significantly (P<0.05) increased from 0.23 without urea to 0.32 g/100g DM with 1% urea. Ammonia-N in sweet potato silage significantly (P<0.05) increased from 0.21 without urea to 0.32 g/100g DM with 1% urea. Ammonia-N in turnip silage significantly (P<0.05) increased from 0.20 without urea to 0.32 g/100g DM with 1% urea. Ammonia-N % of total N of sweet potato silage and turnip silage with rice straw with 1% urea was significantly (P<0.05) higher than all silages. Acetic acid of sweet potato was significantly (P<0.05) higher than potato and turnip silages without urea while turnip silage was significantly (P<0.05) higher than potato and sweet potato silages with 1% urea. Butyric acid and lactic acid of turnip silages with rice straw without or with 1% urea was significantly (P<0.05) higher than potato and sweet potato silages. The effect of urea additives on lactic acid was not clear.
Table (2): Chemical composition (% on DM basis) of experimental silages of potato, sweet potato and turnip with or without urea ensiling in jars

Table (3): Silage fermentation characteristics of different silages with rice straw or wheat straw with or without urea in jars
On the other hand, ammonia various ranged from 10 to 20.7 from total N and Nicholson and Rigueira which was 15.52 and 16.22%. These results agreed with potato and turnip silages containing RS with 1% urea of total N in this study was less than 15% except sweet Kung (2006) and Hart and Horn (1987). Ammonia values agree with tho study ranged from 0.15 to 0.32 and Rural Development 2004). Ammonia silage. Generally, good quality silage straw was lower than that pH value of silage containing turnip and wheat straw was lower than that obtained by Rui-ru et al. (2018), Babainsab et al. (2015) and Giang et al. (2004). However, Kung et al. (2018) mentioned that NH3-N usually less than 15% of total N of silage and Mahanna (1994) mentioned that silages containing 10-15% ammonia-N of total N are considered of good quality silage. Generally, ammonia-N from silage with available energy in the rumen is using by rumen microorganisms for synthesis microbial protein. Acetic acid in silage in this study ranged from 2.36 to 3.52 g/100g DM. These values agree with those obtained by Giang et al. (2004) and Hart and Horn (1987) and were higher than that obtained by Rui-ru et al. (2018), Nkosi and Meeske (2010) and Okine et al. (2007). However, Ruiz et al. (1981) mentioned that there are no norms indicating optimum or maximum values of acetic acid in good quality silages. Generally, the effect of high acetic acid concentration on intake of silage remains unclear (Alberta Agriculture Food and Rural Development 2004). Kung et al. (2018) explained that acetic acid of silage absorbed from the rumen and can be used for energy source in ruminants. Butyric acid in this study was less than 1% of DM in all silages with rice straw without urea. Similar results were showed by Kung et al. (2018) and Nicholson and Macleo (1966). On the other side, Butyric acid in silage with urea was higher than that without urea. The same trend was showed by Ruiz et al. (1981) who found that butyric acid production was increased with increasing urea levels in sweet potato silage and Hart and Horn (1987) who found that butyric acid of silage containing turnip and ammouniated wheat straw was higher than silage of turnip and wheat straw without ammonia. Giang et al. (2004) found that butyric acid ranged from 0.33 to 0.47 g/kg DM of sweet potato silage while Ruiz et al. (1981) found that butyric acid ranged from 1.14 to 3.28% on DM basis of sweet potato silage. Lactic acid in silages

| Items                        | Potato silage | Sweet potato silage | Turnip silage | Potato silage | Sweet potato silage | Turnip silage |
|------------------------------|---------------|---------------------|---------------|---------------|---------------------|---------------|
| Without urea                 | With 0.5 % urea |                     |               |               |                     |               |
| DM (g/kg DM)                 |               |                     |               |               |                     |               |
| OM (g/kg DM)                 |               |                     |               |               |                     |               |
| CP (g/kg DM)                 |               |                     |               |               |                     |               |
| EE (g/kg DM)                 |               |                     |               |               |                     |               |
| CF (g/kg DM)                 |               |                     |               |               |                     |               |
| NFE (g/kg DM)                |               |                     |               |               |                     |               |
| Ash (g/kg DM)                |               |                     |               |               |                     |               |
| Chemical composition (%) on DM basis |               |                     |               |               |                     |               |
| pH value                     |               |                     |               |               |                     |               |
| Ammonia-N (%) of total N     |               |                     |               |               |                     |               |
| Acetic acid (g/100g DM)      |               |                     |               |               |                     |               |
| Butyric acid (g/100g DM)     |               |                     |               |               |                     |               |
| Lactic acid (g/100g DM)      |               |                     |               |               |                     |               |

**Notes:**
- Means in the same row with different superscripts are significantly different (P < 0.05)
- DM percent of silages in this study was nearly similar with Mutavhatsindi et al. (2018) (35.2%), Sadri et al. (2018) (32.2%), Babainsab et al. (2015) (32.2-36.0%), Hough et al. (1994) (38.2%) and Hart and Horn (1987) (32.2%). However, the chemical composition of silage is affected with difference of silage components. Pen et al. (2006) found that CP was 14.40% in silage containing potato by-products. Hadgu et al. (2015) found that CP in sweet potato silage ranged from 10.9 to 16.2%. Hart and Horn (1987) found that CP ranged from 7.7 to 10.5% in turnip-wheat straw silage.

Silage fermentation characteristics

| Items                        | Potato silage | Sweet potato silage | Turnip silage | Potato silage | Sweet potato silage | Turnip silage |
|------------------------------|---------------|---------------------|---------------|---------------|---------------------|---------------|
| pH value                     |               |                     |               |               |                     |               |
| Ammonia-N (%) of total N     |               |                     |               |               |                     |               |
| Acetic acid (g/100g DM)      |               |                     |               |               |                     |               |
| Butyric acid (g/100g DM)     |               |                     |               |               |                     |               |
| Lactic acid (g/100g DM)      |               |                     |               |               |                     |               |
of potato, sweet potato and turnip in this study ranged from 6.31 to 9.65 g/100g DM (6.31 to 9.65%). Similar values were found by Mutavhatsindi et al. (2018), Okine et al. (2005), Abo-Donia et al. (2004) and Hart and Horn (1987). However, these values lie within the normal data of good quality silage as reported by Zobell et al. (2005) who stated that the high levels of lactic acid concentration between 3 - 14% DM characterize good quality silage. Also, McDonald et al. (2010) mentioned that the lactic acid contents generally lie in the range 8-12% of silage DM. The effect of urea on lactic acid was fluctuated. The same trend was showed by Ruiz et al. (1981). Generally, lactic acid from silage is converted to propionic acid in the rumen under normal feeding conditions (Kung et al., 2018).

The values of DM intake (Table 5) as g/head/day, % of LBW and g/kg W\(^{0.75}\) of ration A (control) (containing CFM+ RS) were significantly (P<0.05) higher than all rations (containing CFM + silages). The differences of DM intake as % of LBW and g/kg W\(^{0.75}\) among all rations containing silages (B, C, D, E, F and G) were not significant and silages intakes were nearly similar. The differences of DM intake among the rations containing silages with or without urea were not significant. The same trend was showed by Sugimoto et al. (2007) who noticed that treating of potato pulp silage with urea did not affect the DM intake. However, Sadri et al. (2018) found that the daily intake of DM was not significantly affected by different levels of potato wheat straw silage in the rations.

Table (5): Intake, digestion coefficients and nutritive values of experimental rations by rams

| Items                  | Ration A | Without urea additives | With 0.5% urea additives |
|------------------------|----------|------------------------|-------------------------|
|                        | Ration B | Ration C | Ration D | Ration E | Ration F | Ration G |
| DM intake              | 62.67\(\pm\) 56.94\(\pm\) 54.09\(\pm\) 53.38\(\pm\) 54.98\(\pm\) 54.45\(\pm\) 52.88\(\pm\) | 0.47 0.25 0.73 2.75 1.11 0.71 1.02 | 63.32\(\pm\) 59.03\(\pm\) 54.69\(\pm\) 56.42\(\pm\) 56.66\(\pm\) 55.27\(\pm\) 55.57\(\pm\) | 0.47 0.24 0.71 2.57 1.08 0.69 0.96 |
| OM                     | 64.57\(\pm\) 64.48\(\pm\) 60.64\(\pm\) 55.27\(\pm\) 63.62\(\pm\) 58.61\(\pm\) 60.88\(\pm\) | 0.46 0.20 0.06 2.69 0.94 0.64 0.86 | 58.87\(\pm\) 51.62\(\pm\) 51.71\(\pm\) 47.30\(\pm\) 49.17\(\pm\) 48.14\(\pm\) 45.53\(\pm\) | 0.51 0.49 0.97 2.99 1.23 0.81 1.16 |
| CP                     | 89.10\(\pm\) 86.97\(\pm\) 88.11\(\pm\) 87.85\(\pm\) 85.09\(\pm\) 82.79\(\pm\) 86.51\(\pm\) | 0.14 0.08 0.17 0.72 0.42 0.27 0.29 | 63.20\(\pm\) 58.67\(\pm\) 52.28\(\pm\) 57.80\(\pm\) 55.84\(\pm\) 55.49\(\pm\) 55.53\(\pm\) | 0.47 0.23 0.70 2.51 1.15 0.69 0.97 |
| EE                     | 60.49\(\pm\) 55.83\(\pm\) 51.61\(\pm\) 54.91\(\pm\) 53.44\(\pm\) 51.74\(\pm\) 53.73\(\pm\) | 0.43 0.21 0.62 2.36 0.99 0.62 0.88 | 8.08\(\pm\) 9.37\(\pm\) 8.55\(\pm\) 7.79\(\pm\) 9.58\(\pm\) 8.62\(\pm\) 8.99\(\pm\) | 0.06 0.04 0.08 0.39 0.16 0.10 0.13 |
| NFE                    | 0.75 65.72\(\pm\) 48.92\(\pm\) 51.87\(\pm\) 48.61\(\pm\) 49.03\(\pm\) 51.82\(\pm\) 45.55\(\pm\) | 0.75 60.49\(\pm\) 55.83\(\pm\) 51.61\(\pm\) 54.91\(\pm\) 53.44\(\pm\) 51.74\(\pm\) 53.73\(\pm\) | 0.25 0.73 2.75 1.11 0.71 0.69 0.96 | 0.75 64.57\(\pm\) 64.48\(\pm\) 60.64\(\pm\) 55.27\(\pm\) 63.62\(\pm\) 58.61\(\pm\) 60.88\(\pm\) | 0.46 0.20 0.06 2.69 0.94 0.64 0.86 | 58.87\(\pm\) 51.62\(\pm\) 51.71\(\pm\) 47.30\(\pm\) 49.17\(\pm\) 48.14\(\pm\) 45.53\(\pm\) | 0.51 0.49 0.97 2.99 1.23 0.81 1.16 | 63.20\(\pm\) 58.67\(\pm\) 52.28\(\pm\) 57.80\(\pm\) 55.84\(\pm\) 55.49\(\pm\) 55.53\(\pm\) | 0.47 0.23 0.70 2.51 1.15 0.69 0.97 |

Digestion coefficients of experimental rations as shown in Table (5) explained that digestion coefficients of DM and OM% of ration A (control) were significantly (P<0.05) higher than all rations and the differences among other rations containing silages were not significant. The differences of CP digestibility among rations C, D, E and G were not significant. Also, the differences of CP digestibility among rations A, B, C, E and G were not significant. However, the digestion coefficients of DM of rations containing silages ranged from 52.88 to 56.94%, OM ranged from 54.69 to 59.03% and CP ranged from 58.61 to 64.8%. Similar values were obtained by Nkosi et al. (2010) who found that digestion coefficients of DM ranged from 49.30 to 59.31%, OM ranged from 48.95 to 59.51% and CP ranged from 40.4 to 65.3% in the rations containing silage potato hash. Sugimoto et al. (2007) found that digestion coefficients of DM, OM and CP were 58.3, 60.1 and 71.90%, respectively of ration containing potato pulp silage while Sugimoto et al. (2010) found that digestion coefficients of DM, OM and CP were 63.7, 65.1 and 41.8%, respectively of ration containing potato pulp silage. The CF digestibility of ration A was significantly (P<0.05) higher than other rations while the differences among all rations containing silages were not significant except ration G which was significantly

\(^{ab,cd}\) means in the same row with different superscripts are significantly different (P<0.05)
Rumen fermentation parameters of rams are presented in Table (6). The maximum pH values were recorded at 0h (before feeding) with all groups, then significantly (P<0.05) decreased at 2h then increased at 4h post feeding. The same trend was showed by Sugimoto *et al.* (2007) who found that the maximum ruminal pH was recorded at 0 time then decreased at 2 h post feeding and Osman *et al.* (2007) who found that the maximum ruminal pH was recorded at 0 time then decreased at 2h post feeding then increased at 4h post feeding. The differences of ruminal pH at 2 h post feeding among rations A, B, C and D (without urea) were not significant, also the differences among rations E, F and G (with urea) were not significant. The differences at 4h post feeding of pH among all rations were not significant. Sugimoto *et al.* (2007) noticed that urea-treated did not significantly change the pH in the rumen. Ruminal pH values in all rations ranged from 5.52 to 7.2. These values are lie within the normal pH in the rumen as mentioned by Hungate (1966) who mentioned that the normal pH for normally functioning in the rumen is ranged from 5.5 to 7.3. The lowest values of ruminal NH$_3$N were recorded at 0h of all rations, then significantly (P<0.05) increased at 2h and 4h post feeding. Sugimoto *et al.* (2008) and Osman *et al.* (2007) noticed that the maximum ruminal NH$_3$N concentration was showed at 2h post feeding then decreased. The differences among rations B, C and D (without urea) were not significant. Also, the differences among rations E, F and G (with urea) were not significant at 2 and 4h post feeding. Ruminal NH$_3$N of rations containing silages with urea was significantly (P<0.05) higher than control and rations containing silages without urea.

Table (6): Rumen fermentation parameters in rumen fluid of rams fed experimental rations with or without urea additives

| Rumen parameters | Time | Ration A | Without urea additives | With 0.5% urea additives |
|------------------|------|----------|------------------------|-------------------------|
|                  |      | Ration B | Ration C | Ration D | Ration E | Ration F | Ration G |
| pH               | 0    | 6.89$^{ABC}$ | 7.09$^{A}$ | 7.20$^{A}$ | 7.06$^{A}$ | 7.08$^{AB}$ | 7.12$^{AB}$ | 7.06$^{AB}$ |
|                  | 0.04 | 0.02 | 0.02 | 0.03 | 0.04 | 0.03 | 0.04 |
|                  | 2    | 5.93$^{ABC}$ | 5.88$^{A}$ | 5.82$^{A}$ | 5.89$^{A}$ | 5.54$^{B}$ | 5.52$^{B}$ | 5.59$^{B}$ |
|                  | 0.04 | 0.02 | 0.02 | 0.03 | 0.05 | 0.07 | 0.05 |
|                  | 4    | 6.50$^{AB}$ | 6.69$^{A}$ | 6.75$^{A}$ | 6.64$^{A}$ | 6.61$^{A}$ | 6.55$^{A}$ | 6.61$^{A}$ |
|                  | 0.12 | 0.04 | 0.12 | 0.05 | 0.06 | 0.06 | 0.05 |
| Ammonia-N (NH$_3$N) (mg/100ml) | 0 | 26.13$^{ABC}$ | 26.60$^{A}$ | 29.40$^{A}$ | 30.80$^{A}$ | 28.93$^{B}$ | 27.53$^{B}$ | 31.73$^{B}$ |
|                  | 1.56 | 1.88 | 3.45 | 3.15 | 2.57 | 1.68 | 2.47 |
|                  | 2    | 33.60$^{ABC}$ | 37.33$^{A}$ | 38.27$^{A}$ | 40.60$^{A}$ | 41.07$^{A}$ | 42.93$^{A}$ | 45.27$^{A}$ |
|                  | 1.25 | 2.25 | 2.57 | 0.96 | 2.25 | 1.18 | 0.86 |
|                  | 4    | 37.33$^{ABC}$ | 37.80$^{A}$ | 35.00$^{A}$ | 37.80$^{A}$ | 42.93$^{A}$ | 42.00$^{A}$ | 43.40$^{A}$ |
|                  | 3.00 | 1.20 | 2.68 | 2.48 | 1.87 | 2.40 | 2.37 |
| Total volatile fatty acids (TVFA’s) (mEq/100ml) | 0 | 7.50$^{AB}$ | 7.00$^{A}$ | 6.67$^{A}$ | 6.25$^{A}$ | 11.13$^{A}$ | 11.04$^{A}$ | 10.67$^{A}$ |
|                  | 0.30 | 0.37 | 0.75 | 0.34 | 0.41 | 1.12 | 0.96 |
|                  | 2    | 8.33$^{AB}$ | 8.00$^{A}$ | 7.96$^{A}$ | 8.13$^{A}$ | 12.13$^{A}$ | 12.62$^{A}$ | 11.59$^{A}$ |
|                  | 0.33 | 0.35 | 0.79 | 0.61 | 0.55 | 0.51 | 0.43 |
|                  | 4    | 8.26$^{AB}$ | 8.58$^{A}$ | 8.92$^{A}$ | 8.83$^{A}$ | 12.02$^{A}$ | 12.27$^{A}$ | 11.92$^{A}$ |
|                  | 0.25 | 0.69 | 0.89 | 0.78 | 1.50 | 0.65 | 0.58 |
| MP(g/100ml) | 4    | 0.72$^{A}$ | 0.33$^{A}$ | 0.52$^{A}$ | 0.56$^{A}$ | 0.53$^{A}$ | 0.54$^{A}$ | 0.64$^{A}$ |
|                  | 0.10 | 0.04 | 0.07 | 0.14 | 0.09 | 0.07 | 0.09 |

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

*Means in the same column with different superscripts are significantly different (P<0.05).*
The same trend was showed by Sugimoto et al. (2007) who found that ruminal NH$_3$-N was higher in Potato pulp silage with urea than that without urea. Total VFA's concentrations in the rumen liquor at 2h and 4h post feeding was significantly ($P<0.05$) higher than at 0h time of all rations. The increase of VFA's in the rumen after feeding due to the fermentation of feed carbohydrates to VFA's. Moreover, the silage is containing VFA's. Also, lactic acid from silage is converting to propionic acid in the rumen as mentioned by Kung et al. (2018). Sugimoto et al. (2008) noticed that total VFA concentrations was increased after feeding and ranged from 9 to 11 mmol/L at 2h post feeding. The differences of total VFA among rations A, B, C and D were not significant and the differences among rations E, F and G were not significant. Total VFA's of rations containing silages with urea was significantly ($P<0.05$) higher than control and rations containing silages without urea. The same trend was noticed by Sugimoto et al. (2007). The differences of Microbial protein among all rations were not significant except ration B was lower than other rations. However, the synthesis of rumen microbial protein can be affected by synchronizing of energy releasing by fermentation of carbohydrates and N availabilities from nitrogen sources in the rumen as reported by Harun and Sali (2019) and Pathak (2008).

**CONCLUSION**

It could be concluded that:
1. Non-commercial tubers and roots such as small and very large, broken and unmarketable of Potato, sweet potato and turnip could be ensiling with crop residues such as rice straw and wheat straw.
2. The suitable silages should be containing about 25% dry crop residues such as rice straw and 75% fresh tubers or roots.
3. The feeding 60% of requirements from concentrate feed mixture (CFM) with silages of potato, sweet potato and turnip mixing with rice straw was suitable and safe rations for feeding sheep.
4. The use of urea as a silage additive is requiring more studies.
5. Further studies are recommended to evaluate silages of tuber and roots and its by-products on animal performance and its economical return.

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تقييم سilage البطاطس والبطاطس والفلت مع قش الأرز أو قش الفمج مع أو بدون البوريا ودراسة تأثير العلاج المحتوى على السilage مع معالات الهضم وتكتلات الكرش في الأغنام

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**Terdapat perbedaan di antara bahan pangan pertama yang diberikan, baik dalam bentuk campuran benih maupun dalam bentuk campuran campuran benih yang diberikan, serta penggunaan bahan pangan pertama yang diketahui akan mempengaruhi kualitas silage.**

**Zaki et al., 2020**

**Anim. Sci., 85: 69-74.**

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