# Feed and Water Consumptions, Digestion Coefficients, Nitrogen Balance and Some Rumen Fluid Parameters of Ossimi Sheep Fed Diets Containing Different Sources of Roughages

Hamed A.A. Omer, Mohamed A. Tawila and Sawsan M. Gad

Animal Production Department, National Research Center, Dokki, Giza, Egypt
hamedomer2000@yahoo.com

**Abstract:** Five digestibility trials were carried out to investigate the effect of different roughage sources on feed and water intakes, water metabolism, nutrient digestibility coefficients, nitrogen utilization and some rumen fluid parameters. Twenty mature male Ossimi sheep were randomly assigned to five experimental groups (four animals in each treatment). Animals were fed on 3% DM of live body weight and received one of the following diets. All the experimental diets contained 50% concentrate feed mixture (CFM) plus 50% roughage. Control diet contained berseem hay (BH), while the other four experimental diets were replaced BH in control diet by peanut vein hay (PVH); beans straw (BS); kidney beans straw (KBS) or linseed straw (LS). Results showed that, source of roughage were affected on the chemical composition of the experimental diets. Diet contained BH showed the highest value of CP (15.69%), followed by PVH and LS diets (14.52 and 14.23%, respectively. On the other hand CP content of BS and KBS diets were in the same range (12.65 and 12.42%). Beans straw recorded the highest value of neutral detergent fiber (53.16%), acid detergent fiber (37.84%) and cellulose contents (28.30%), however, PVH diet showed the lowest value of ADL (7.30%). Inclusion PVH, BS, KBS and LS in sheep diet significantly increased ($P<0.05$) feed consumption as DM, TDN, CP and DCP intakes compared to the BH containing diet. Sheep received BS diet significantly increased ($P<0.05$) drinking water (4650 ml/h/day), total water intake (4829 ml/h/day) compared to the other diets. Inclusion different sources of roughage in sheep diet had no significant effect on DM digestibility. While, sheep received KBS diet significantly ($P<0.05$) increased OM, CP and CF digestibilities compared to the other different diets. Introduce PVH, BS, KBS and LS in sheep diets significantly decreased ($P<0.05$) total digestible nutrient and digestible crude protein values compared to the control diet. All groups were positive nitrogen balance and sheep received LS diet recorded the highest values of nitrogen retention (21.7 g) and nitrogen retention % of digested nitrogen (81.61%) compared to the other diets. Dietary treatments significant affected ($P<0.05$) on pH value, ammonia nitrogen ($NH_3$-N) and total volatile fatty acids (TVFA's) concentrations. Three hrs post feeding significantly ($P<0.05$) decreased ruminal pH value, while, it significantly ($P<0.05$) increased both ruminal $NH_3$-N and TVFA's concentrations. It could be concluded that we can using alternative sources of roughage successfully in sheep diets as a good sources of roughages instead of berseem hay with better feed intake, digestion coefficient, nitrogen utilization and ruminal fermentation. Also we can use the tested materials to formulate cheap diets for sheep.

[Hamed A.A. Omer, Mohamed A. Tawila and Sawsan M. Gad. **Feed and Water Consumptions, Digestion Coefficients, Nitrogen Balance and Some Rumen Fluid Parameters of Ossimi Sheep Fed Diets Containing Different Sources of Roughages.** *Life Sci J* 2012;9(3):805-816]. (ISSN: 1097-8135). http://www.lifesciencesite.com. 115

**Keywords:** Sheep, roughage sources, feed and water intakes, water metabolism, digestibility coefficients, nitrogen balance, ruminal fermentation.

## 1. Introduction

Ruminant species occupy an important niche in modern agriculture because of their unique ability to digest certain feedstuffs, especially roughages, efficiently. In future, the direct demands for grain by human beings will make efficient utilization of roughages increasingly important. A basic understanding of ruminant digestion is essential for good management and sound nutrition of beef cattle, sheep and goats (Visser, 2005).

One of the important limiting factors for animal production in Egypt is the availability of feedstuffs. Locally produced feeds are not sufficient to cover the nutritional requirements of livestock (Abou-Akkada, 1988).

In Egypt, the total area planted by clover hay reached about 2 million feddans (EMA, 2003). Recently, according to the national policy, the berseem area was decreased to increase the wheat area. Using non-traditional feed in animal feeding led to some advantages such as participates in solving the problem of feed shortage, decrease the cost of feeding and alleviate the pollution problems (Abdel-Magid et al., 2008).

Recently, the agricultural policy in Egypt aimed to increase the area cultivated by strategically crops on behalf of that cultivated by berseem. At the same time, several crops such as chick pea, pea, peanut, beans, kidney beans, linseed, lentil and others are cultivated in the newly reclaimed lands. So, significant amounts of the straws of these crops are produced annually as residues, about 25 thousand tons from chick pea straw (EMA, 2003) and 13 thousand tons from pea straw (AIEG, 2005).

Groundnut vines hay is one of the important feed resources grows in new reclaimed sandy soil. A vast amount 35 thousand tons from groundnut vines hay is produced annually as by-products (AIEG, 2005). Groundnut vines hay had been demonstrated as good animal feed for calves (Ahmed and Pallot, 1979), goat (Gelaye et al., 1990) and sheep (Awadalla et al., 1997; Etman and Soliman, 1999; Talha, 2001; Talha et al., 2001; Mahmoud et al., 2003 and Talha et al., 2005). All explored good response in animals performance when including it in their rations to replace almost other leguminous hay. Mahmoud et al. (2003) found no significant difference in feed intake, nutrients digestibility, daily gain and feed conversion with groundnut vines hay in contrast with alfalfa hay. Moreover, feeding groundnut vines hay was more economic.

On the other hand, several researches have shown that these straws such as chick pea straw, pea straw, peanut vein hay, beans straw, kidney beans straw, linseed straw, lentil straw and others had considerable amounts of nutrients that of suitable digestibilities (Etman and Soliman, 1999; Tawila 1999; Talha 2001; Talha et al., 2001; Mahmoud et al., 2003; Talha *et al* 2005 and Abdel-Magid 2005).

Several studies have investigated the effects of roughage source and/or level on DMI and performance by feedlot cattle fed high-concentrate diets, literature data make it clear that roughage source and level can have substantial effects on DMI by cattle fed concentrate diets (Defoor et al., 2002 and Galyean and Defoor, 2003) and El-Bedawy et al. (2004a) & (2004b); Abdel-Magid et al. (2008) and Khorshed (2008) with sheep.

The effect on dry matter intake of adding a concentrate supplement to forage depends on the digestibility of the forage. Concentrate added to forage of low digestibility tends to be consumed in addition to the forage, but when added to forage of high digestibility it tends to replace the forage (McDonald et al., 1995).

Roughage play a major role as feed for ruminants, also, seasonal patterns affect the availability and quality of the roughages, particularly during the dry season (Wanapat, 1999).

It is evident from the literature that forage or roughage alone can not supply sufficient energy especially for high producing animals, therefore concentrate supplementation is always needed for maximizing intake and consequently improving overall performance of ruminant animal (Morita et al., 1996).

Ruminal ammonia nitrogen ($NH_3$-N) has been reported to be an important compound in supporting efficient rumen fermentation and it is the major nitrogen source for microbial protein synthesis and growth (Wanapat and Pimpa, 1999). Perdok and Leng (1990) found that a higher level of ruminal $NH_3$-N (15-20 mg %) increased dry matter intake and digestibility in cattle fed with low quality roughage. Erdman et al. (1986) found that a higher level of $NH_3$-N can increase the rate of fermentation *in vivo*, depending on the potential fermentation of feed. Paengkoum et al. (2010) noticed that TVFA's was affected by type of roughage.

The objective of this study was carried out to evaluate the effect of using some agriculture by-products (peanut vein hay, beans straw, kidney beans straw and linseed straw instead of berssem hay in the diets as sources of roughage on feed and water consumption, digestion coefficients, nitrogen balance and ruminal fermentation.

## 2. Materials and Methods

Twenty mature male Ossimi sheep of about 52 kg live body weight approximately on average were used to investigate the effect of different roughage sources on feed and water intakes, water metabolism, nutrient digestibility coefficients, nitrogen utilization and some rumen fluid parameters. The animals were randomly assigned to five experimental groups (four animals in each treatment).

**Experimental diets**

Sheep fed diets contained 50% of concentrate feed mixture (CFM) that composed of 45% yellow corn, 35% undecorticated cotton seed meal, 17% wheat bran, 1.5% lime stone, 1% sodium chloride and 0.5% mineral and vitamins mixture. The five experimental groups were considered as the following:

$G_1$: 50% berseem hay+50% concentrate feed mixture. (BH).
$G_2$: 50% peanut vein hay+50% concentrate feed mixture. (PVH).
$G_3$: 50% beans straw+50% concentrate feed mixture (BS).
$G_4$: 50% kidney beans straw+50% concentrate feed mixture. (KBS).
$G_5$: 50% linseed straw+50% concentrate feed mixture. (LS).

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 14 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 at 8.00 a.m. followed by different roughage sources (BH, PVH, BS, KBS or LS) at 9.00 a.m. Water was offered 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 and water consumption were 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 was calculated by classical method.

Chemical composition and cell wall constituents (%) of ingredients and experimental rations are presented in Tables (1 and 2). Feeds and water intakes were also recorded during the digestibility trials.

**Rumen fluid parameters**

Rumen fluid samples were collected from all animals at the end of the digestibility trial before feeding and 3 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**

Chemical analysis of ingredients, experimental rations and feces samples were analyzed according to A.O.A.C. (2000) methods.

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 (1970). 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 (2000). Ruminal total volatile fatty acids (TVFA's) concentrations were determined by steam distillation according to Warner (1964).

**Statistical analysis**

Collected data of feed and water consumption, digestibility, nutritive values and nitrogen balance were subjected to statistical analysis as one way analysis of variance using the general linear model procedure of SPSS (1998). On the other hand, collected data of ruminal fluid parameters (pH, $NH_3$-N and TVFA's concentrations) were subjected to statistical analysis as two factors-factorial analysis of variance using the general linear model procedure of SPSS (1998). Duncan's Multiple Range Test (1955) was used to separate means when the dietary treatment effect was significant.

## 3. Results and Discussion

**Chemical analysis and cell wall constituents of feed ingredients and experimental rations**

Chemical analysis and cell wall constituents of feed ingredients are presented in Table (1) showed that berseem hay recorded the highest value of dry matter (92.63%), organic matter (90.83%), crude protein (15.19%) and nitrogen free extract (48.58%); however, it recorded the lowest value of ash (9.17). On the other hand peanut vein hay showed the highest value of ash content (14.11%). Beans straw showed the highest value of crude fiber (43.52%) and the lowest value of ether extract (0.61%). Meanwhile, kidney beans straw contained the lowest value of crude protein (8.65%). However, linseed straw showed the highest value of ether extract (3.14%).

Beans straw contained the highest values of NDF (66.39%), ADF (47.43% and cellulose contents (37.18%). But peanut vein hay showed the lowest value of ADL content (5.77%), however, linseed straw contained the lowest value of hemicelluose (5.10%).

These ingredients reasonably comparable in chemical composition to that reported by Ibrahim (2000); Talha et al. (2001 & 2002); El-Bedawy et al. (2004a & 2004b); Abdel-Magid (2005); Talha et al. (2005); Abdel-Magid et al. (2008).

Chemical analysis and cell wall constituents of the experimental rations are presented in Table (2). Results obtained showed that source of roughage was affected on the chemical composition of the experimental diets. Diet contained BH showed the highest value of CP (15.69%), followed by PVH and LS diets (14.52 and 14.23%), respectively. On the other hand CP content of BS and KBS diets were in the same range (12.65 and 12.42%). PVH diet contained the highest value of ash content (10.18%). However, BS diet contained the highest value of crude fiber (26.37%) followed by KBS diet contained 20.78% CF. Linseed straw (LS) diet showed the highest value of ether extract (4.62%) followed by KBS diet contained 4.09% EE.

Beans straw diet (BS) recorded the highest value of NDF (53.16%), ADF (37.84%) and cellulose content (28.30%). Also, our data cleared that PVH diet showed the lowest value of ADL (7.30%). Whoever, LS diet showed the lowest value of hemicelluose (8.39%). These variations in chemical composition of ration used in this study related to differ in chemical composition of ingredients that used in ration formulations.

**Table 1. Chemical analysis and cell wall constituents of feed ingredients**

| Item | CFM* | Berseem hay | Peanut vein hay | Beans straw | Kidney beans straw | Linseed straw |
|---|---|---|---|---|---|---|
| Dry matter | 90.36 | 92.63 | 91.56 | 90.69 | 90.52 | 90.74 |
| *Chemical analysis on DM basis* | | | | | | |
| Organic matter | 93.74 | 90.83 | 85.89 | 90.31 | 88.48 | 87.86 |
| Crude protein | 16.17 | 15.19 | 12.85 | 9.12 | 8.65 | 12.27 |
| Crude fiber | 9.22 | 25.23 | 24.78 | 43.52 | 32.34 | 28.28 |
| Ether extract | 6.09 | 1.83 | 2.04 | 0.61 | 2.08 | 3.14 |
| Nitrogen free extract | 62.26 | 48.58 | 46.22 | 37.06 | 45.41 | 44.17 |
| Ash | 6.26 | 9.17 | 14.11 | 9.69 | 11.52 | 12.14 |
| *Cell wall constituents* | | | | | | |
| *NDF* | 39.92 | 38.47 | 47.30 | 66.39 | 53.40 | 44.28 |
| *ADF* | 28.23 | 20.50 | 32.50 | 47.43 | 43.96 | 39.18 |
| *ADL* | 8.81 | 11.25 | 5.77 | 10.25 | 17.06 | 9.72 |
| Hemicellulose** | 11.69 | 17.97 | 14.80 | 18.96 | 9.44 | 5.10 |
| Cellulose*** | 19.42 | 9.25 | 26.73 | 37.18 | 26.90 | 29.46 |

*CFM: Concentrate feed mixture composed of 45% yellow corn, 35% undecorticated cotton seed meal, 17% wheat bran, 1.5% lime stone, 1% sodium chloride and 0.5% mineral and vitamins mixture.
NDF: Neural detergent fiber. ADF: Acid detergent fiber. ADL: Acid detergent lignin.
** Hemicellulose= NDF – ADF. ** *Cellulose= ADF – ADL.

**Table 2 Chemical analysis and cell wall constituents of the experimental diets**

| Item | Experimental diet | | | | |
|---|---|---|---|---|---|
| | BH | PVH | BS | KBS | LS |
| Dry matter | 91.50 | 90.96 | 90.53 | 90.44 | 90.55 |
| *Chemical analysis on DM basis* | | | | | |
| Organic matter | 92.29 | 89.82 | 92.03 | 91.11 | 90.80 |
| Crude protein | 15.69 | 14.52 | 12.65 | 12.42 | 14.23 |
| Crude fiber | 17.23 | 17.00 | 26.37 | 20.78 | 18.75 |
| Ether extract | 3.47 | 4.07 | 3.36 | 4.09 | 4.62 |
| Nitrogen free extract | 55.90 | 54.23 | 49.65 | 53.82 | 53.20 |
| Ash | 7.71 | 10.18 | 7.97 | 8.89 | 9.20 |
| *Cell wall constituents* | | | | | |
| NDF | 39.20 | 43.61 | 53.16 | 46.66 | 42.10 |
| ADF | 24.37 | 30.37 | 37.84 | 36.10 | 33.71 |
| ADL | 10.04 | 7.30 | 9.54 | 12.94 | 9.27 |
| Hemicellulose | 14.83 | 13.24 | 15.32 | 10.56 | 8.39 |
| Cellulose | 14.33 | 23.07 | 28.30 | 23.16 | 24.44 |

BH: 50% berseem hay + 50% CFM. PVH: 50% peanut vein hay + 50% CFM. BS: 50% beans straw+ 50% CFM. KBS: 50% kidney beans straw + 50% CFM. LS: 50% linseed straw + 50% CFM.

**Feed intake**

Dry matter, TDN, CP, DCP intakes by the experimental groups fed the experimental diets are presented in Table (3). The results showed that inclusion PVH, BS, KBS and LS in sheep diet significantly increased (P<0.05) feed consumption as DM, TDN, CP and DCP intakes in comparison with the BH containing diet. Feeding sheep on PVH containing diet recorded the highest values of DM, TDN, CP and DCP intakes this may be related to high palatability of PVH by sheep compared to the other sources of roughage.

These results were agreement with those obtained by El-Basiony (1992) who found that calves fed berssem hay consumed less (P<0.05) DM and also, with those found by Abdel-Magid et al. (2008) who observed that Rahmani lambs fed berssem hay consumed less (P<0.05) DM compared to pea straw. Pathirana and Ørskov (1995) reported increased nutrient intake as a result of increases of forage legumes as supplements to low quality basal diets.

Bartle et al. (1994) fed alfalfa and cottonseed hulls at 10, 20, or 30% of the dietary DM to finishing beef cattle; they found that within each roughage level, DMI was decreased compared to control diet.

Guthrie et al. (1996) fed heifers diets with alfalfa, cottonseed hulls, and sorghum Sudan grass hay at either 7.5 or 15% of DM in whole shelled corn-based diets. The DMI was greater by heifers fed the cottonseed hull and sorghum Sudan grass hay diets than by those fed alfalfa.

Galyean and Defoor (2003) noted that formulating diets to a specific NDF concentration with different roughage sources probably accounts for most of the effect of roughage source and level on DMI, but it does not fully account for the aggregate of small differences in fiber sources that might affect chewing time and kinetics of digestion and passage of roughage and grain.

**Table 3. Dry matter, TDN, CP, DCP intakes by the experimental groups fed the experimental diets**

| Item | Experimental diets | | | | | SEM |
|---|---|---|---|---|---|---|
| | BH | PVH | BS | KBS | LS | |
| Animal No. | 4 | 4 | 4 | 4 | 4 | - |
| Live body weight, kg | 51.50 | 50.80 | 52.00 | 51.60 | 51.30 | 1.12 |
| *Feed consumption* (g/h/day) *as:* | | | | | | |
| Dry matter | $1289^{d}$ | $1819^{a}$ | $1709^{b}$ | $1571^{c}$ | $1675^{b}$ | 43.31 |
| TDN | $943^{d}$ | $1276^{a}$ | $1210^{ab}$ | $1140^{c}$ | $1182^{bc}$ | 25.83 |
| CP | $202^{d}$ | $264^{a}$ | $216^{c}$ | $195^{d}$ | $238^{b}$ | 6.06 |
| DCP | $145^{d}$ | $196^{a}$ | $155^{c}$ | $154^{cd}$ | $170^{b}$ | 4.28 |

a, b, c and d: Means in the same row having different superscripts differ significantly (P<0.05).
BH: 50% berseem hay + 50% CFM. PVH: 50% peanut vein hay + 50% CFM.
BS: 50% beans straw+50% CFM. KBS: 50% kidney beans straw + 50% CFM. LS: 50% linseed straw+50% CFM.

**Water intake and water metabolism**

Water consumptions and water metabolism by the experimental groups fed the experimental rations are presented in Table (4). Our data cleared that feeding sheep on BS containing diet significantly increased (P<0.05) drinking water (4650 ml/h/day), total water intake (4829 ml/h/day) compared to the other diets. Also the same group showed the highest value of and insensible losses (2785 ml/h/day), while group sheep that fed PVH containing diet recorded the lowest value of insensible losses (1109 ml/h/day). On the other hand, there were no significant effect (P>0.05) among groups that fed on BH, PVH, KBS and LS containing diets on drinking water and total water intake.

**Table 4 Water intake and water metabolism by the experimental groups fed the experimental diets**

| Item | Experimental diets | | | | | SEM |
|---|---|---|---|---|---|---|
| | BH | PVH | BS | KBS | LS | |
| Animal No. | 4 | 4 | 4 | 4 | 4 | - |
| Live body weight, kg | 51.50 | 50.80 | 52.00 | 51.60 | 51.30 | 1.12 |
| *Water consumption, ml:* | | | | | | |
| Drinking water | $3088^{b}$ | $3742^{b}$ | $4650^{a}$ | $3660^{b}$ | $3038^{b}$ | 167.2 |
| Feeds water | $119^{c}$ | $181^{a}$ | $179^{a}$ | $167^{b}$ | $175^{ab}$ | 5.43 |
| Total water intake | $3207^{b}$ | $3923^{b}$ | $4829^{a}$ | $3827^{b}$ | $3213^{b}$ | 169.6 |
| *Water metabolism:* | | | | | | |
| Urinary losses, ml | $867^{bc}$ | $1685^{a}$ | $1168^{b}$ | $525^{c}$ | $500^{c}$ | 120.8 |
| Feces water, ml | $920^{b}$ | $1129^{a}$ | $876^{b}$ | $734^{c}$ | $899^{b}$ | 33.16 |
| Total water losses, ml | $1787^{bc}$ | $2814^{a}$ | $2044^{b}$ | $1259^{d}$ | $1399^{cd}$ | 143.8 |
| Insensible losses, ml | $1420^{bc}$ | $1109^{c}$ | $2785^{a}$ | $2568^{a}$ | $1814^{b}$ | 160.2 |

a, b, c and d: Means in the same row having different superscripts differ significantly (P<0.05).
BH: 50% berseem hay + 50% CFM. PVH: 50% peanut vein hay + 50% CFM. BS: 50% beans straw+ 50% CFM. KBS: 50% kidney beans straw + 50% CFM. LS: 50% linseed straw + 50% CFM.

Because DMI and water intake are positively associated (NRC, 1996), the increased DMI noted with higher dietary concentrations of NDF from roughage could be linked to a positive effect on acid load simply by an associated increase in water intake and dilution of acid. Incomplete mixing of water with ruminal contents (Allen, 1997) would tend to lessen the effects of greater water intake. In addition, increased water intake might merely shift site of acid absorption (i.e., rumen vs. intestines) and thereby not greatly alter total metabolic acid load; however, the temporal pattern of acid absorption would perhaps be altered so as to spread the metabolic acid load more evenly over time (Galyean and Defoor, 2003).

**Digestion coefficients and nutritive values**

Digestion coefficients and nutritive values of the experimental diets are illustrated in Table (5). Data showed that inclusion different sources of roughage in sheep diet had no significant effect on DM digestibility. Sheep received KBS containing diet significantly (P<0.05) increased OM, CP and CF digestibilities compared to the other different diets, and it was recorded the highest values of the same parameters of nutrient digestibilities. Sheep fed on PVH, KBS and LS containing diets significantly (P<0.05) decreased NFE digestibility, while it significantly (P<0.05) increased CF digestibility in comparison with the BH diet (control). Both PVH and KBS diets significantly (P<0.05) increased CP digestibility compared to the other diet (BH, BS and LS).

**Table 5 Digestion coefficients and nutritive values of sheep fed the experimental diets**

| Item | Experimental diets | | | | | SEM |
|---|---|---|---|---|---|---|
| | BH | PVH | BS | KBS | LS | |
| *1- Nutrient digestion coefficient* | | | | | | |
| DM | 69.83 | 67.84 | 68.40 | 69.21 | 68.38 | 0.32 |
| OM | $73.85^{ab}$ | $73.30^{ab}$ | $73.32^{ab}$ | $74.20^{a}$ | $72.23^{b}$ | 0.27 |
| CP | $70.79^{b}$ | $74.19^{a}$ | $70.63^{b}$ | $75.59^{a}$ | $70.48^{b}$ | 0.60 |
| CF | $46.59^{d}$ | $58.36^{c}$ | $62.31^{b}$ | $66.82^{a}$ | $56.64^{c}$ | 1.62 |
| EE | $87.13^{a}$ | $84.21^{b}$ | $81.64^{c}$ | $84.59^{b}$ | $80.30^{c}$ | 1.32 |
| NFE | $79.28^{a}$ | $76.92^{bc}$ | $78.19^{ab}$ | $75.60^{c}$ | $77.09^{bc}$ | 0.34 |
| *2- Nutritive values on (DM basis) %* | | | | | | |
| TDN | $73.12^{a}$ | $70.13^{c}$ | $70.18^{c}$ | $72.54^{b}$ | $70.54^{c}$ | 0.35 |
| DCP | $11.25^{a}$ | $10.77^{b}$ | $9.09^{e}$ | $9.81^{d}$ | $10.15^{c}$ | 0.18 |

a, b, c, d and e: Means in the same row having different superscripts differ significantly (P<0.05).
BH: 50% berseem hay +50% CFM. PVH: 50% peanut vein hay + 50% CFM. BS: 50% beans straw+50% CFM.
KBS: 50% kidney beans straw + 50% CFM. LS: 50% linseed straw + 50% CFM.

Abdel-Magid et al. (2008) fed sheep on chick pea straw (CPS) or pea straw (PS) instead of berseem hay (BH) as control. They found that pea straw (PS) containing diet and control containing berseem hay (BH) had similar values of digestibilities of OM, CP, CF and NEF of experimental diets, being higher than those of PS containing diets. Differences reached significances (P<0.05) with OM digestibility and NFE digestibilities. Foster et al. (1988) observed that lambs given 30% ground maize and 70% chopped forage of 0, 25, 50, 75 or 100% pea hay with Lucerne showed linear decrease in DM digestibility of the diet from 59.7 to 53.3% with increasing proportion of pea hay.

Santini et al. (1992) found that an increase in ADF intake led to a decrease DM digestibility. The lower digestibility of CF of animals fed berseem hay diet might be a result of their high intake of concentrate which might depress cellulolytic activity of rumen microbes (Stewart, 1977). Rapid starch fermentation probably reduced cellulolytic activity due to decrease pH values associated with accumulation of fermentation products. The higher digestion coefficients of other nutrients with clover hay diet might be due to the low CF and high NFE contents resulted in increase of apparent digestibility of CP and NFE (Taie et al., 2005).

Valdes et al. (2000) noted that, the digestibility of fiber in the total tract depends on the intrinsic characteristics of the ration, its passage rate and the microbial activity.

The higher CF digestibility might results from the slower passage rate in the rumen (Gado, 1992 and Taie et al., 1996).

Nutritive values of sheep fed the experimental rations are presented in Table (5). Data obtained showed that introduce PVH, BS, KBS and LS in sheep diets significantly decreased (P<0.05) total digestible nutrient (TDN) and digestible crude protein (DCP) values compared to the control diet that contained BH. These results were in agreement with those found by Taie (1993 and 1998) and Taie et al. (2005) that feeding sheep on clover hay containing diet lead to improvement in nutritive value could be due to one or more of the following; higher fermentation rate, better $NH_3$-N concentration or longer retention time and slower flow rate in the rumen. Abdel-Magid et al. (2008) noted that chick pea straw (CPS) diets showed lower TDN value than those obtained for PS diet with significant difference but without significance with control diet. Also, no significant difference in DCP content was found among experimental diets. However, the CPS diet tended to be lower in DCP content than the control or PS diets.

**Nitrogen utilization**

Data of nitrogen utilization by sheep fed the experimental diets are illustrated in Table (6) was affected by the dietary treatments and these due to the differences in nitrogen intake, fecal nitrogen (FN), urinary nitrogen (UN), total nitrogen excretion and digested nitrogen (DN) significantly differed among experimental animal groups.

On the other hand, sheep received PVH containing diet significantly increased ($P<0.05$) nitrogen intake (NI), fecal nitrogen, urinary nitrogen, total nitrogen excretion and digested nitrogen (DN). While, it significantly ($P<0.05$) decreased NR% of NI and NR% of DN in comparison with the other dietary treatments. These may be related to increase the total nitrogen excretion and N of PVH diet was utilized less efficient as compared with those of the other diets. All groups were positive nitrogen balance and sheep received LS containing diet recorded the highest values of NR (21.7 g) and NR % of DN (81.61%) compared to the other diets used.

**Table 6 Nitrogen utilization by sheep fed the experimental diets**

| Item | Experimental diets | | | | | SEM |
|---|---|---|---|---|---|---|
| | BH | PVH | BS | KBS | LS | |
| *3- Nitrogen balance* | | | | | | |
| Nitrogen intake (NI), g | $32.80^{de}$ | $42.20^{a}$ | $35.09^{c}$ | $32.59^{e}$ | $38.65^{b}$ | 0.89 |
| Fecal nitrogen (FN), g | $9.47^{b}$ | $12.28^{a}$ | $10.31^{b}$ | $7.95^{c}$ | $12.06^{a}$ | 0.40 |
| Urinary nitrogen (UN), g | $7.93^{b}$ | $14.86^{a}$ | $9.98^{b}$ | $4.71^{c}$ | $4.89^{c}$ | 0.91 |
| Total nitrogen excretion, g | $17.40^{bc}$ | $27.14^{a}$ | $20.29^{b}$ | $12.66^{d}$ | $16.95^{c}$ | 1.17 |
| Digested nitrogen (DN), g | $23.33^{c}$ | $29.92^{a}$ | $24.78^{c}$ | $24.64^{c}$ | $26.59^{b}$ | 0.57 |
| Nitrogen retention (NR),g | $15.40^{b}$ | $15.06^{b}$ | $14.80^{b}$ | $19.93^{a}$ | $21.70^{a}$ | 0.78 |
| NR % of NI | $46.95^{b}$ | $35.69^{c}$ | $42.18^{bc}$ | $61.15^{a}$ | $56.14^{a}$ | 2.33 |
| NR % of DN | $66.01^{b}$ | $50.33^{c}$ | $59.73^{b}$ | $80.88^{a}$ | $81.61^{a}$ | 2.99 |

a, b, c, d and e: Means in the same row having different superscripts differ significantly ($P<0.05$).
BH: 50% berseem hay + 50% CFM. PVH: 50% peanut vein hay + 50% CFM. BS: 50% beans straw+ 50% CFM. KBS: 50% kidney beans straw + 50% CFM. LS: 50% linseed straw + 50% CFM.

Forster et al. (1988) mentioned that N retention was not affected by diet when lambs were fed 30% ground maize and 70% chopped forage of 0, 25, 50, 75 or 100% pea hay with Lucerne.

Abdel-Magid et al. (2008) showed that NB of lambs fed chick pea straw (CPS) was significantly lower compared among the other two diets berseem hay (BH) and pea straw (PS) which recorded no significant values. Also NB values expressed as % from N intake indicating that N of CPS diet was utilized less efficient as compared with those of the control or PS diets.

Taie et al. (2005) noted that the highest value of both N digested (ND) as well as NB followed the same pattern of NI, being the greatest for low clover hay level, the lowest for high clover hay level and intermediate for medium clover hay level (MH-groups). Differences were significant ($P<0.05$ & $P<0.01$). El-Sayed et al., (2002) indicated that NB values were 3.01; 5.91and5.71 for adult goats fed four different biological treated roughages.

**Rumen fluid parameters**

**Ruminal pH value**

Effects of dietary treatments on rumen fluid parameters of the experimental rations are shown in Tables (7). Data obtained showed that dietary treatments significant affected ($P<0.05$) on pH value, ammonia nitrogen ($NH_3$-N) and total volatile fatty acids (TVFA's) concentrations. Sheep received BS containing diet significantly ($P<0.05$) increased pH value compared to the other experimental diets.

On the other hand sheep fed PVH diet recorded the lowest pH value (5.65). There were no significant effects on ruminal pH value among sheep fed BH, KBS or LS diets.

Ruminal pH was maintained within the values of 6.6 to 6.9, the optimal value for microbial growth and digestion of fiber pH 6.0-7.0 (Weimer, 1996). Mould and Orskov (1984) demonstrated that cellulose digestion was limited when ruminal pH was below 6.0.

Staples et al. (1984) noted that the optimum pH value for rumen cellulolytic bacteria was ranged "between" 5.8-6.3. This range was almost in the same range to that obtained in our study.

Allen (1997) noted that the balance between production of fermentation acids and secretion of salivary buffers was the primary determinant of ruminal pH. Hence, with a higher NDF intake per unit of grain, one might expect a higher, or at least more stable, ruminal pH. The resulting lower metabolic acid load also could be lower simply because the proportion of fermentable substrate per bite would be less, and the greater proportion of NDF in each bite might stimulate more chewing and saliva secretion. If the total number of bites increases until acid load becomes limiting, total energy intake might exceed what would be expected from compensation for energy dilution alone. The level of NDF from roughage required to elicit overcompensation in DMI likely differs among roughage sources and within a roughage source as NDF concentration of the source changes with maturity (Galyean and Defoor**,** 2003).

Galyean and Defoor (2003) and Moor et al. (1987) found that ruminal pH was numerically greater for the diet containing wheat straw than for those containing alfalfa or cottonseed hulls (6.2 vs. 5.9 and 5.8, respectively), but did not differ among the three roughage sources. Thus, wheat straw, but not cottonseed hulls, seemed to alter chewing time and ruminal pH, even though both of these high-NDF roughages tended to increase DMI relative to alfalfa. Similarly, Shain et al. (1999) reported that steers fed a dry-rolled corn-based diet containing wheat straw spent more total time ruminating than steers fed a dry-rolled corn-based diet containing alfalfa; however, ruminal pH did not differ between cattle fed diets containing alfalfa or wheat straw ground to pass through a 2.54-cm screen. Pitt et al. (1996) reported a fairly strong relationship between ruminal pH and the NDF concentration of dairy, beef, and sheep diets. In contrast, Nocek (1997) reported that NDF accounted for approximately 5% of the variation in ruminal pH in lactating dairy cows.

Allen (1997) noted that forage NDF as a percentage of the DM was significantly related to ruminal pH, which supports the concept that NDF from roughage might be related to ruminal pH, thereby accounting, at least in part, for the relationship that we observed between NDF from roughage and DMI by beef cattle fed high-concentrate diets. The statistical analyses conducted by Pitt et al. (1996), Allen (1997) and Nocek (1997) did not seem to use mixed-model methodology that would have allowed random study effects to be accounted for, which might explain some of the variation in results among these studies. In addition, animal-to-animal variation in ruminal pH and the ability to handle an acid load seems fairly substantial, even in model systems where a relatively constant acid load is applied (Brown et al., 2000). Such variation, as well as potentially large diurnal fluctuations in ruminal pH, would decrease the ability of dietary NDF to account for a substantial proportion of the variation in mean ruminal pH.

**Table 7 Effect of dietary treatments and sampling time on rumen fluid parameters of the experimental rations**

| Item | Sampling time | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Before feeding | | | | | 3 hrs post feeding | | | | | | |
| | BH | PVH | BS | KBS | LS | BH | PVH | BS | KBS | LS | SEM | P<0.05 |
| pH | $6.60^{a}$ | $5.83^{c}$ | $6.60^{a}$ | $6.45^{a}$ | $6.50^{a}$ | $5.70^{cd}$ | $5.47^{d}$ | $6.20^{b}$ | $5.55^{d}$ | $5.65^{cd}$ | 0.07 | * |
| $NH_3$-N (mg/dl) | $18.11^{bcd}$ | $16.93^{cd}$ | $13.03^{e}$ | $11.03^{e}$ | $16.44^{d}$ | $25.53^{a}$ | $18.93^{bcd}$ | $20.05^{b}$ | $20.22^{b}$ | $24.10^{a}$ | 0.73 | * |
| TVFA's (meq/dl) | $7.35^{e}$ | $4.40^{f}$ | $8.25^{de}$ | $10.10^{c}$ | $7.90^{de}$ | $9.00^{cd}$ | $10.23^{bc}$ | $10.25^{bc}$ | $14.60^{a}$ | $11.65^{b}$ | 0.44 | * |

a, b, c, d, e and f: Means in the same row having different superscripts differ significantly (P<0.05).
BH: 50% berseem hay + 50% CFM. PVH: 50% peanut vein ha y + 50% CFM. BS: 50% beans straw+50% CFM
KBS: 50% kidney beans straw + 50% CFM. LS: 50% linseed straw + 50% CFM.

Wanapat et al. (2000) found that the rumen samples of microbial populations, obtained from animals kept under traditional village conditions in the Northeast of Thailand, had similar pH value for both species, but had significantly difference in the numbers of microorganism.

**Ruminal ammonia nitrogen ($NH_3$-N) concentration**

Data obtained of ruminal $NH_3$-N concentration (Table 7) cleared that, dietary treatment significantly (P<0.05) affected ruminal $NH_3$-N concentration among different experimental groups. Sheep received LS diet had no significant effect on $NH_3$-N concentration compared to BH diet, however, it significantly (P<0.05) increased in comparison with PVH, BS and KBS diets. KBS diet showed the lowest content of ruminal $NH_3$-N concentration (15.62).

Briggs et al. (1957) noted 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 (1967).

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 (Allam et al., 1984).

It is unknown whether roughage source and level affects absorption of acids from the rumen or acidity in the small and large intestines. It seems unlikely that increasing NDF supplied by roughage in a high-concentrate diet would directly affect absorption of VFA from the rumen. Similarly, direct effects of roughage on absorption of acids from the intestines seem unlikely (Galyean and Defoor, 2003). Allen (1997) suggested that changes in ruminal papillae surface area among diets might affect the susceptibility of cattle to acidosis, which could be related to differences resulting from dietary NDF supplied by roughage. Whether roughage source or level in feedlot finishing diets affects ruminal surface area for absorption is unknown. The NDF supplied by roughage might exert effects on digesta kinetics and associated water flux that affect digesta flow through the intestines and absorption of acid post ruminally.

**Ruminal total volatile fatty acids (TVFA's) concentration**

Data of total volatile fatty acids (TVFA's) concentration of Table (7) established that KBS diet significantly ($P<0.05$) increased TVFA's concentration compared to the other dietary treatments. Sheep received PVH diet recorded the lowest value of TVFA's (7.32), while KBS diet showed the highest value of TVFA's (12.35). Slyter et al. (1979) and Pan et al. (2003) demonstrated that increased ruminal $NH_3$-N (22.5 mg %) might increase ruminal pH, TVF's production and stimulated cellulolytic bacteria activity in the rumen. Wanapat and Pimpa (1999) also found that higher levels of ruminal $NH_3$-N at 17.6 mg% resulted in the highest total purine derivatives, indicating highest rumen microbial protein synthesis. Kajanapruthipong and Leng (1998) showed that protozoan, fungal and bacterial populations in the rumen were influenced by the levels of ruminal $NH_3$-N.

**Effect of sampling time on rumen fluid parameters**

Effect of sampling time on rumen fluid parameters is presented in Table (7). Results obtained showed that 3hrs post feeding significantly ($P<0.05$) decreased ruminal pH value, while, it significantly ($P<0.05$) increased both ruminal $NH_3$-N and TVFA's concentrations. These results were agreement with those recorded by Taie et al. (2005) who noticed that values of pH were higher before feeding in all groups then declined after feeding to reach their lowest values at 4 hrs in low clove hay diet group and 6 hrs for both medium and high levels of clover hay diet groups. Taie (1993 and 1998) found that the values of pH declined at 3-4 hr post- feeding and then increased in sheep fed corn-cobs or clover hay containing diets.

Khorshed (2008) found that pH value was significantly ($P<0.05$) decreased after 3hrs post feeding compared to before feeding (zero hrs), the reduction in pH values with advancing sampling time post feeding was mainly due to increase fermentation after feeding

Taie et al. (2005) reported that within the experimental groups, the highest TVFA's concentration was observed at 4 hrs post-feeding for low clover hay level diet, whereas it was at 6 hrs post-feeding for medium and high clover hay levels diets. Also, similar trends of TVFA's values and relationship with the time were observed by Taie (1993 and 1998); however, TVF's levels were lower than theirs which may be due to differences in dietary CF levels. The overall averages of TVFA`s concentration proved that the LH diet had higher fermentable materials which usually are degraded to TVFA's by the rumen microorganisms during digestion (Sultan and Loerch 1992). The increases in TVFA's post- feeding were associated with a decrease in rumen pH. This in agreement with the findings of Bonsembinate et al. (1988) and Taie (1993) and Taie et al. (2005) that the increase in TVFA`s concentrations is paralleled the reduction in ruminal pH. The TVFA`s concentrations were generally increase as the proportion of concentrate mixture of the experimental diets increase (Punia and Sharm, 1990 and Taie et al., 2005).

The peak concentration of ammonia-nitrogen at 3 hrs after feeding may be because of degradation of protein and hydrolysis of NPN substances (Reddy et al., 1989). On the other hand Chandra et al. (1991) noted that the peak of ruminal $NH_3$-N at 3 hours after feeding may be due to deamination of amino acids in the rumen. Gado et al. (2007) noted that values of sampling time on ammonia-N concentrations were at the minimum at 0 hrs before feeding and increased to its maximum levels at 4hrs after feeding then values tended to decrease gradually as the time passed up to 6 hrs after feeding.

It is worthy to notice that the balance between $NH_3$-N and TVFA's concentrations reflect the pH values in the rumen liquor and effect of fungi might be related to the more utilization of the dietary energy and positive fermentation in the rumen (El-Shafie et al., 2007).

Obtained data also, showed that there were significant interaction ($P<0.05$) between roughage sources and sampling time on ruminal pH, $NH_3$-N and TVFA's concentrations (Table 7).

## 4. Implications

Changes in roughage source affect dry matter intake, water intake and metabolism, nutrient digestibility coefficients, nitrogen utilization and ruminal fermentation by sheep. Although neutral detergent fiber supplied by roughage might provide a useful basis for exchanging roughages in sheep diets, the biological reasons for changes in dry matter intake associated with changes in roughage source need further study.

From this study, it could be concluded that we can using alternative sources of roughage successfully in sheep diets as a good sources of roughages instead of berseem hay with better feed intake, digestion coefficient, nitrogen utilization and ruminal fermentation. Also we can use the tested materials to formulate cheap diets for sheep.

**Corresponding author**
**Hamed A.A. Omer**
Animal Production Department, National Research Center, Dokki, Giza, Egypt
hamedomer2000@yahoo.com

## References


1. Abdel-Magid, Soha S., 2005. Nutritional studies on leguminous straw in feeding growing rabbits. Ph.D Thesis, Cairo Univ.
2. Abdel-Magid, Soha S., Abd El-Rahman, H.H., Mohamed, M.I. and Awadalla, I.M., 2008. Utilization of chick pea straw and pea straw in feeding growing Rahmani lambs. American-Eurasian J. Agric. & Environ. Sci., 4 (2): 214-217.
3. Abou-Akkada, A.R., 1988. For national strategic for increasing feedstuff in Egypt. 1st National Conf. On Role Of Scientific Research in Developing Animal Health, Academy of Scientific Research and Technology, 25-29 Sep. Cairo Egypt (In Arabic).
4. Abou-Akkada, A.R. and Osman, H.E., 1967. The use of ruminal ammonia and blood urea as an index of the nutritive value of proteins in some feedstuffs. Journal of Agricultural Science 69: 25-31.
5. Ahmed, F.A. and Pallott, G.E., 1979. The performance of yearling Kenana (*Sudon Zebu*) calves given three levels of crude protein as a concentrate supplement to *ad libitum* groundnut hay. Tropical Animal Production, 4:65.
6. A.I.E.G., 2005. Agricultural Income Estimates at Governorate Level. (In Arabic). AG. Research Center. AGR. Econ. Research Institute. May, 1993.
7. Allam, S.M., Abou-Raya, A.K., Gihad, E.A. and El-Bedawy, T.M., 1984. Nutritional studies by sheep and goats fed Na OH treated straw. 1st Egyptian British Conference on Animal and Poultry Production, Zagazig, 11-13 Sep. P. 53.
8. Allen, M.S., 1997. Relationship between fermentation acid production in the rumen and the requirement for physically effective fiber. J. Dairy Sci. 80:1447–1462.
9. A.O.A.C., 2000. Official Methods of Analysis, 17th ed. Association of Official Analytical Chemists, Washington, DC, USA.
10. Awadalla, I.M., Mohamed, M.I., Ibrahim, M.A.M. and El-Asheeri, Amal K., 1997. Efficiency of using groundnut hay in rations of Rahmani lambs. Egyptian J. Anim. Prod., 34: 125-134.
11. Bartle, S.J., Preston, R.L. and Miller, M.F., 1994. Dietary energy source and density: Effects of roughage source, roughage equivalent, tallow level, and steer type on feedlot performance and carcass characteristics. J. Anim. Sci. 72:1943–1953.
12. Bonsembiante, M., Bittante, G., Ramanzin, M. and Andrighetto, I., 1988. Utilization of energy in growing lambs: Results Infra Vitam. Zootecnicae Nutrizione Animale, 14: 387-406.
13. Briggs, P.K., Hogan, J.P. and Reid, R.L., 1957. The effect of volatile fatty acids, lactic acid and ammonia on ruminal pH in sheep. Australian Journal Agricultural. Research 8: 674.
14. Brown, M.S., Krehbiel, C.R., Galyean, M.L., Remmenga, M.D., Peters, J.P., Hibbard, B., Robinson J. and Moseley, W.M., 2000. Evaluations of models of acute and sub acute acidosis on dry matter intake, ruminal fermentation, blood chemistry, and endocrine profiles of beef steers. J. Anim. Sci. 78:3155–3168.
15. Chandra, S., Reddy, M.R. and Reddy, G.V.N., 1991. Effect of fungal treatment of Paddy straw on nutrient utilization in complete rations for sheep. Indian Journal of Animal Science 61:1330.
16. Defoor, P.J., Galyean, M.L., Salyer, G.B., Nunnery, G.A. and Parsons, C.H., 2002. Effects of roughage source and concentration on intake and performance by finishing heifers. J. Anim. Sci. 80:1395–1404.
17. Duncan, D.B. (1955). Multiple Rang and Multiple F–Test Biometrics, 11: 1- 42.
18. El-Basiony, A.Z., 1992. Fenugreek (*Trigonellagroceum)* straw and other roughages in buffalo calves rations. International Symposium on Prospects of Buffalo Production in the Mediterranean and the Middle East. Cairo, Egypt. 9-12 Nov., pp: 286.
19. El-Bedawy, T.M, Ahmed, Sawsan M., Salem, M.A.I. and Omer, H.A.A., 2004a. Effect of dietary protected fat and roughage level on digestion, rumen metabolism and plasma lipids of growing–finishing lambs. Egyptian J. Anim. Prod., 41, Suppl. Issue: 219–236. The 12th Conference of the Egyptian Society of Animal Production. 30 November –2 December 2004 (Mansoura, Egypt).
20. El-Bedawy, T.M, Salem, M.A.I., Ahmed, Sawsan M. and Omer, H.A.A., 2004b. Effect of dietary protected fat and roughage level on growth performance and carcass characteristics of growing – finishing lambs. Egyptian J. Anim. Prod., 41, Suppl. Issue: 237–252. The 12th Conference of the Egyptian Society of Animal Production. 30 November –2 December 2004 (Mansoura, Egypt).
21. El-Sayed, H.M., El-Ashry, M.A., Metwally, H.M., Fadel, M. and Khorsed, M.M., 2002. Effect of chemical and biological treatments of some crop-residues on their nutritive value. 3- Digestion coefficient, rumen and blood serum parameters of goats. Egyptian J. Nutrition and Feeds. 5 (1): 55-69
22. El-Shafie, M.H., Mahrous, A.A. and Abdel-Khalek, T.M.M., 2007. Effect of biological treatments for wheat straw on performance of small ruminants. Egyptian Journal of Nutrition and Feeds 10 (2) Special Issue: 635-648.
23. E.M.A., 2003. Egyptian Ministry of Agricultural, Statistical Yearling Book. Ministry of Agricultural, Cairo (In Arabic).
24. Erdman, R.A., Proctor, G.H. and Vandersall, J.H., 1986. Effect of rumen ammonia concentration on *in situ* rate and extent of digestion of feedstuffs. J. Dairy Sci., 69: 2312-2320.
25. Etman, K.E. and Soliman, E.S., 1999. Effect of feeding peanut (*Arachis hypogaea* L) tops with different levels of concentrate on performance of growing lambs. Egyptian J. Nutrition and Feeds, 2 (Special Issue): 223-231.

26. Forster, L.A., Perry, H.P. and Fontento, I.P., 1988. Nutritional value of flat pea hay for ruminants. Nut. Abs & Rev. Series, B: 58 No. 3:172.
27. Gado, H., 1992. The effects of forage to concentrate ratios on intake, digestibility and milk production of local goats. J. Agric. Sci., Mansoura Univ., 17 (1): 42-48.
28. Gado, H. M., Metwally H.M., El Basiony, A.Z., Soliman, H.S. and Abd El Galil, Etab R.I., 2007. Effect of biological treatments on sugarcane bagasse digestibility and performance of Baladi goats. Egyptian Journal of Nutrition and Feeds 10 (2) Special Issue: 535-551.
29. Galyean, M. L. and Defoor P.J., 2003. Effects of roughage source and level on intake by feedlot cattle. Anim. Sci., 81: 8-16.
30. Gelaye, S., Amoah, E.A. and Guthrie, P., 1990. Performance of yearling goats fed alfalfa and florigraze rhizoma peanut hay. Small Rumin. Res., 3: 353-361.
31. Goering, H. K. and Van Soest, P.J., 1970. Forge fiber analysis (apparatus, reagents, procedure and some applications). Agric. Hand book 379, USDA, Washington, and DC., USA.
32. Guthrie, M.J., Galyean, M.L., Malcolm-Callis, K.J. and Duff, G.C., 1996. Roughage source and level in beef cattle finishing diets. Prof. Anim. Sci., 12:192–198.
33. Ibrahim, M.R.M., 2000. Efficiency of using peanut hay and carrot-tops hay for feeding growing rabbits. Egyptian J. Rabbits Sci., 10:147.
34. Kanjanapruthipong, J. and Leng, R.A., 1998. The effects of dietary urea on microbial populations in the rumen of sheep. Asian- Australasian Journal of Animal Science, 11: 661-672.
35. Khorshed, M.M., 2008. Does the roughage sources affect digestibility, nitrogen utilization and some metabolic parameters in ruminants?. Egyptian J. Nutrition and Feeds, 11 (1): 73-91.
36. Mahmoud, S.A., El-Santeil, G.A., N.M., Eweedah, Kilany, S.F. and El-Awady, H.K., 2003. Efficiency of using groundnut vine hay in rations of growing Barki lambs under desert farming systems. Egyptian J. Nutrition and Feeds, 6 (Special Issue): 795-802.
37. McDonald, M., Edwards, P., Greenhalgh, J.F.D., and Morgan, C.A., 1995. Animal Nutrition. Longman, London.
38. Moore, J.A., Poore, M.H. and Swingle, R.S., 1987. Influence of roughage source in 65 or 90% concentrate diets on rumination time, rumen pH, and *in situ* neutral detergent fiber digestion in beef steers. Proc. West. Sec. Am. Soc. Anim. Sci. 38: 277–280.
39. Morita, S., Devir, S., Louwere, C.C.K., Smith, A.C., Hogeveen, H. and Metz, J.H.M., 1996. Effects of concentrate intake on subsequent roughage intake and eating behavior of cows in automatic milking system. J. Dairy Sci., 79: 1572.
40. Mould, F.L. and Orskov, E.R., 1984. Manipulation of rumen fluid pH and its influence on cellulolysis *in sacco,* dry matter degradation and the rumen microflora of sheep offered either hay or concentrate. Animal Feed Science and Technology 10: 1-14.
41. Nocek, J.E., 1997. Bovine acidosis: Implications for laminitis. J. Dairy Sci., 80: 1005–1028.
42. N.R.C., 1996. Nutrient Requirements of Beef Cattle. 7*th* ed. Natl. Acad. Press, Washington, DC.
43. Paengkoum, S., Metha W., Chalong W. and Ngarmnit N., 2010. The effect of roughage and urea solution infusion levels on ruminal $NH_3$-N concentration and nutrient digestibility in beef cattle and swamp buffaloes. Silpakorn U Science & Tech J Vol. 4 (1): 47-55.
44. Pan, J., Suzuki, T., Koike, S., Ueda, K. and Kobayashi, Y., 2003. Effect of urea infusion into the rumen on liquid-and particle associated fibrolytic enzyme activities in steers fed low quality grass hay. Animal Feed Science and Technology 104: 13-27.
45. Pathirana, K.K., Ørskov, E.R., 1995. Effect of supplementing rice straw with urea and glyricidia forage on intake and digestibility by sheep. Livestock Res. Rural Develop. 7, 2.
46. Perdok, H.B. and Leng, L.A., 1990. Effect of supplementation with protein meal on the growth of cattle given a basal diet of untreated ammoniated rice straw. Asian- Australasian Journal of Animal Science 3: 269-279.
47. Pitt, R.E., Van Kessel, J.S., Fox, D.G., Pell, A.N., Barry, M.C. and Van Soest, P.J., 1996. Prediction of ruminal volatile fatty acids and pH within the net carbohydrate and protein system. J. Anim. Sci. 74:226–244.
48. Punia, B.S and Sharm, D.D., 1990. Influence of dietary energy on ruminal VFA production rate in buffaloes and cattle .Indian J. Anim. Sci., 42: 911.
49. Reddy, C.N., Reddy, M.R. and Reddy, G.V.N., 1989. Ammoniation of sorghum straw with urea anhydrous ammonia for improved utilization among crossbred cattle. Indian Journal of Animal Science 59: 986.
50. Santini, F.J, Lu, C.D., Potchoiba, M.J., Fernandez, J.M. and Coleman, S.W., 1992. Dietary fiber and milk yield, mastication, digestion, and rate of passage in goats fed alfalfa hay. J. Dairy Sci., 75:1, 209-219.
51. Shain, D.H., Stock, R.A., Klopfenstein, T.J. and Herold, D.W., 1999. The effect of forage source and particle size on finishing yearling steer performance and ruminal metabolism. J. Anim. Sci. 77:1082–1092.
52. Slyter, L.L., Satter, L.D. and Dinius, D.A., 1979. Effect of ruminal ammonia concentration on nitrogen utilization by steers. Journal of Animal Science 48: 906-912.
53. S.P.S.S., 1998. Statistical package for Social Sciences, Chicago, U.S.A.
54. Staples, C.R, Fernando, R.L., Fahey, G.C., Berger, L.L. and Jaster, E.H., 1984. Effect of intake of a mixed diet by dairy steers on digestion events. J. Dairy Sci., 67: 995.

55. Stewart, C.S., 1977. Factors affecting the cellulolytic activity of rumen contents. Appl. Environ. Microbiol., 33: 497.
56. Sultan, J.I. and Loerch, S.C., 1992. Effects of protein and energy supplements of wheat straw-based on site of nutrient digestion and nitrogen metabolism of lambs. J. Anim. Sci., 70:2228.
57. Taie, H.T., 1993. Digestibility and rumen fermentation as affected by urea-treated corn cobs in comparison to berseem hay in fistulated sheep. Menofiya J. Agric. Res., Vol. 18 No. (1): 2385-2402.
58. Taie, H.T., 1998. Effect of dietary levels of protein and fiber on digestion, performance and carcass traits of sheep Egyptian J. Nutri. and feeds, 1: 23-32.
59. Taie, H.T., Ahmed, B.M. and Kewan, K.M., 1996. Rumen activity and microbial protein synthesis as affected by dietary protein and fiber levels. Proc. 9$^{th}$ Sci. Conf. the Egyptian Society of Animal
60. Taie, H.T., Abdel Rahman, K.M. and El-Sheikh, Hanim A (2005). Digestibility, nitrogen balance and ruminal constituents of goats fed different clover hay levels. Egyptian J. Nutrition and Feeds, 8 (Special Issue): 325-335.
61. Talha, M.H., 2001. Effect of feeding rations containing different levels of groundnut vines hay on performance of growing lambs. Egyptian J. Nutrition and Feeds, 4 (Special Issue): 275-284.
62. Talha, M.H., Abu El-Ella, A.A. and Moawd, R.I. 2005. Effect of feeding diets containing different proportions from peanut viens hay on productive and reproductive performance of sheep. Egyptian J. Nutrition and Feeds, 8 (1) Special Issue: 379-403
63. Talha, M.H, Moawad, R.I., El-Tahan, A.A.H and Morghany, M., 2002. Effect of feeding lactating buffaloes on diets containing different levels and concentrate feed mixture of groundnut vines hay on milk production. J. Agric. Sci. Mansoura Univ., 27 (2): 833-840.
64. Talha, M.H, Moawad, R.I., Marghany, M. and Etman, K.E.I., 2001. Some nutrition studies on groundnut vines hay in sheep rations. Egyptian J. Nutrition and Feeds, 4 (Special Issue): 677-684.
65. Tawila, M.A., 1999. Evaluation of lentil (*lens culinaris med*) straw as untraditional roughage source in ruminant rations. J. Agric. Mansoura Univ., 24 (12): 7247-7255.
66. Valdes, C., Carro, M.D., Ranilla, M.J. and Gonzalez, J.S., 2000. Effect of forage to concentrate ratio in complete diets offered to sheep on voluntary feed intake and some digestive parameters. J. Anim. Sci., 70: 119.
67. Visser, D.P., 2005. Ruminant digestion. Department of Agriculture: Livestock Improvement Schemes. Copyright by DAEA Privacy Statement. http://agriculture.kzntl.gov.za/portal/AgricPublications/ProductionGuidelines/DairyinginKwaZuluNatal/RuminantDigestion/tabid/247/ctl/Privacy/Default.aspx.
68. Wanapat, M., 1999. The ruminants in the tropics based on local feed resources. Khon Kaen Publishing Comp. Ltd., Khon Kaen, Thailand, P. 236.
69. Wanapat, M. and Pimpa, O., 1999. Effect of ruminal $NH_3$-N levels on ruminal fermentation, purine derivatives, digestibility and rice straw intake in swamp buffaloes. Asian- Australasian Journal of Animal Science 12: 904-907.
70. Wanapat, M., Ngarmsang, A., Kokhuntot, S., Nontaso, N., Wachirapakorn, C. and Rowlinson, P., 2000. A comparative study on the ruminal microbial population of cattle and swamp buffalo raised under traditional village conditions in the NE of Thailand. Asian-Australasian Journal of Animal Science, 13: 918-921.
71. Warner, A.C., 1964. Production of volatile fatty acids in the rumen, methods of measurements. Nutr. Abstr. and Rev., 34: 339.
72. Weimer, P.J., 1996. Why don't ruminal bacteria digest cellulose faster. Journal of Dairy Science 79: 1496-1502. Winter, K. A. and Pigden, W.

5/3/2012