Estimating the Nutritive Values of *Kochia indica* Hay in the Rations of Sheep

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Abstract. An *in vitro* trial and three digestibility and nitrogen balance trials were conducted on rams fed rations containing Kochia hay and/or rice straw and concentrate feed mixture. Digestion coefficients, nitrogen balance and some serum parameters for sheep fed experimental rations containing Kochia hay were determined. Results indicated that the use of Kochia hay (especially the ration including 50% Kochia hay with CFM) in sheep rations is useful and does not cause any abnormal condition on digestive tract, liver and kidney functions and animal performance as well.

Keywords: *Kochia indica*, *in vitro*, digestibility trial and blood parameters.

Introduction

*Kochia indica* (Wight) is an original habitat in north-western India, from Delhi to Indus, Deccan peninsula and salt soils at Coimbatore. It is an annual bushy herb which belongs to *Chenopodiaceae* or goosefoot family. It is a salt-tolerant bush and extremely drought tolerant. It grows in different habitats: saline lands, wastelands, canal banks, roadsides and railway sidings (Draz 1954).

*Kochia indica* is a potentially valuable forage plant on arid and semiarid land (Sherrod, 1973 and Rankins and Smith, 1991) because it yields digestible energy and protein comparable to alfalfa with about half the water requirement. Kochia grows in the salt affected and calcareous soils in Egypt (Abou Ziada,
1988) and grows as a wild plant (Draz, 1954). Kochia grows rapidly during cool season and widely adapted to many geographical zones as it serves under various temperatures as a grazing forage and for hay processing (Sherrod, 1973). This can allow growing it as fodder crop for ruminants in these areas and can partially cover a part of the gap between the available and required amounts of animal feeds in Egypt.

Higher dry matter intake by sheep of sundried Kochia was obtained as compared with fresh or concentrate supplemented Kochia (Nour, 1995). Digestibility coefficients %, total digestible nutrients (TDN) % and digestible crude proteins (DCP) % of fresh Kochia were higher than sundried or supplemented Kochia with concentrates (Nour, 1995). Addition of concentrates reduced digestibility of dry matter (DM), crude fiber (CF), crude protein (CP) and nitrogen free extract (NFE) and increased ether extract (EE) digestibility and nitrogen utilization in sheep (Nour 1995). Fahmy et al. (2001) reported that both sheep and goats were in a good nutritional status when fed on Kochia indica diet and it could be highly recommended to use Kochia indica hay particularly during the summer season as good quality roughage.

The present work aimed to evaluate the nutritional value of Kochia hay and Kochia hay supplemented with rice straw and concentrates feed mixture when they are incorporated in the rations of sheep.

**Materials and Methods**

This study was carried out in the experimental station of Milk Replaces Research Center, Faculty of Agriculture, Ain Shams University, Shoubra El Kheima, Kalubeya Province, Egypt. It aims to evaluate the nutritional value of Kochia hay and Kochia hay supplemented with rice straw and concentrate feed mixture.

The Kochia cultivation was performed in a barren saline site at the Experimental Station Farm of Desert Research Center at Wadi Sudr, South Sinai Governorate, Egypt during the two successive years 2002 and 2003. The experimental soil type was sandy clay in texture and highly calcareous having 49.75% CaCO₃. Electrical conductivity of soil was 25.61 mmhos/cm with pH of 7.85. The plant material used in this investigation was Kochia indica (Wight) seeds which were collected from kochia (bluebushes) plants grown naturally in desert areas. Seeds were sown in polyethylene bags containing sand and clay soil (1 : 1) in January 1st and 12th, 2002 and 2003, respectively under greenhouse conditions. Three months later, uniform and healthy seedlings (about 30 cm in height) were chosen and transplanted in the experimental site. Kochia seedlings were cultivated in rows 1 m apart and spaced 1 m within the row (1 m² was
devoted to each seedling). Plants were regularly irrigated 2, 4 and 6 weeks by in-
terval using under ground brackish saline water containing 4000 and 8000 ppm
dissolved salts. After good establishment and when the plants aged 4 months, the
shrubs were cut at stubble height of 30 cm. Thereafter, cutting was repeated each
2 and 3 months. Two cuts were harvested from each cutting treatment.

It could be concluded that irrigated kochia shrubs every two weeks with low
saline level (4000 ppm) and cut every three months gave the highest values of
total fresh and dry forage yields of kochia shrubs (19.768 ton/feddan and 5.955
ton/feddan) from fresh and dry forage yields, respectively.

Plots were harvested at 90 days after plantation and wild stands on a dry land
field and baled at the midbloom stage of maturity. Kochia hay and rice straw
were ground through a 1.5-2.0 cm screen and used in the experimental rations.
Chemical composition of Kochia hay, Berseem hay, rice straw and concentrate
feed mixture (CFM) were carried out according to the A.O.A.C. methods
(1990) and results are shown in Table 1.

Table 1. Chemical composition of kochia hay, berseem hay, rice straw and CFM used in the
work.

<table>
<thead>
<tr>
<th>Item</th>
<th>DM</th>
<th>Ash</th>
<th>OM</th>
<th>CP</th>
<th>CF</th>
<th>EE</th>
<th>NFE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kochia h.</td>
<td>94.2</td>
<td>15.8</td>
<td>84.2</td>
<td>15.4</td>
<td>24.9</td>
<td>2.2</td>
<td>41.7</td>
</tr>
<tr>
<td>Berseem h.</td>
<td>91.1</td>
<td>12.9</td>
<td>87.1</td>
<td>13.9</td>
<td>24.3</td>
<td>1.8</td>
<td>43.1</td>
</tr>
<tr>
<td>Rice straw</td>
<td>92.7</td>
<td>15.6</td>
<td>84.4</td>
<td>4.4</td>
<td>33.6</td>
<td>0.4</td>
<td>46.0</td>
</tr>
<tr>
<td>CFM</td>
<td>91.8</td>
<td>12.1</td>
<td>87.9</td>
<td>14.3</td>
<td>14.2</td>
<td>2.9</td>
<td>56.5</td>
</tr>
</tbody>
</table>

F: crude fiber, EE: ether extract, NFE: nitrogen free extract.

To determine the nutritive values of Kochia hay as animal feeds, two experi-
ments were conducted:

The First Experiment (in vitro trial)

In vitro dry matter (IVDMD) and organic matter (IVOMD) disappearance
were estimated for the tested plant using the two stages technique of Tilley and
Terry (1963). Kochia hay, Berseem hay, rice straw and concentrate feed mix-
ture were mixed to nine rations used in in vitro trials (Table 2).

The Second Experiment (digestibility trials)

Three digestibility and N-balance trials were conducted using three adult
rams per each trial to determine the digestibilities and the nutritive values of
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three experimental rations which were selected from the in vitro trial as the best resulted rations (T₇, T₈ and T₉). The animals were fed daily to cover their requirements for fat-tailed coarse-wool sheep. Each digestibility trial lasted for 35 days from which 28 days were considered as a preliminary period, followed by 7 days as a collection period. Animals were confined in individual metabolic crates during the experimental period. The experimental rations were offered ad libitum. Water was offered three times a day (at 8 a.m., 1 and 5 p.m.). Feces, urine and feed residues were quantitatively collected. During the collection period, urine was collected daily in jars, each containing about 5 ml of concentrated H₂SO₄, to prevent any loss of ammonia from urine. Five percent of urinary volume excreted were taken in a bottle, for each animal, for urinary-nitrogen determination. Representative samples of feces (10%) were taken daily and added to 5 ml H₂SO₄ (10% concentration) and 5 ml of toluene solution (10% concentration), and were dried at 60ºC for 48 h.

The following determinates were taken in this trial:

**Chemical Composition**

Chemical composition of dietary feed samples, feed residues and feces were analyzed for DM, CP, EE, CF and ash content according to the A.O.A.C. methods (1990). Urinary –N content also was analyzed according to the same reference.

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**Table 2. Formulation of the experimental rations used in in vitro trial (%).**

<table>
<thead>
<tr>
<th>Ration</th>
<th>Kochia hay</th>
<th>Berseem hay</th>
<th>Rice straw</th>
<th>CFM</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁</td>
<td>100</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>T₂</td>
<td>–</td>
<td>–</td>
<td>100</td>
<td>–</td>
</tr>
<tr>
<td>T₃</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>T₄</td>
<td>25</td>
<td>75</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>T₅</td>
<td>50</td>
<td>50</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>T₆</td>
<td>75</td>
<td>25</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>T₇</td>
<td>50</td>
<td>–</td>
<td>–</td>
<td>50</td>
</tr>
<tr>
<td>T₈</td>
<td>–</td>
<td>–</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>T₉</td>
<td>25</td>
<td>–</td>
<td>25</td>
<td>50</td>
</tr>
</tbody>
</table>

CFM = concentrate feed mixture consisted of undecorticated cotton seed cake 35%, coarse wheat bran 20%, yellow corn 17%, rice bran 25%, salt 1% and lime stone 2%.
Blood Serum Sampling and Analysis

Blood samples were taken from jugular vein at the end of the collection period from each animal at three times: At morning just before feeding (0 h), 3 and 6 h post feeding. Blood was left at room temperature for 45-60 min then centrifuged for 30 min at 4000 r.p.m. Serum was separated into clean dried glass vials (5-7 ml) and stored frozen (–20°C) until analysis. Total protein as described by Armstrong and Carr (1964) and albumin as described by Doumas et al. (1971) were analyzed. Globulins concentration and albumin / globulin ratio (A/G ratio) were calculated. Serum urea, creatinine and transaminases (AST and ALT) were determined as described by Reitman and Frankel (1957).

Statistical Analysis

The data were analyzed according to Statistical Analysis System Users Guide (SAS) (1998). Comparison between means was carried out using Duncan's Multiple Range test (Duncan, 1955).

Results and Discussion

In Vitro Trial

*In vitro* dry matter and organic matter disappearance of experimental treatments are presented in Table (3). Significant differences among the treatments (P < 0.05) were found.

Table 3. *In vitro* dry matter and organic matter disappearance of the experimental rations (%).

<table>
<thead>
<tr>
<th>Items</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>T4</th>
<th>T5</th>
<th>T6</th>
<th>T7</th>
<th>T8</th>
<th>T9</th>
</tr>
</thead>
<tbody>
<tr>
<td>IVDMD</td>
<td>37.91b</td>
<td>38.59b</td>
<td>32.11b</td>
<td>37.97b</td>
<td>49.59a</td>
<td>47.75a</td>
<td>58.92a</td>
<td>56.07a</td>
<td>55.24a</td>
</tr>
<tr>
<td>IVOMD</td>
<td>47.18bc</td>
<td>47.81bc</td>
<td>39.01bcd</td>
<td>40.72bcd</td>
<td>57.52b</td>
<td>57.00b</td>
<td>68.67a</td>
<td>60.20a</td>
<td>67.01a</td>
</tr>
</tbody>
</table>

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

The highest value of IVDMD (58.92) and IVOMD (68.67) were recorded for T7 (50% Kochia hay + 50% CFM). No significant differences (P > 0.05) were recorded among 100% hays (T1 and T2) and rice straw (T3). A similar trend was reported by Tag El-Din et al. (1991) and Nour et al. (1985). They reported that *in vitro* organic matter digestibility of 14 plants in Arab gulf region ranged between 39.0 to 54.0%.

Digestibility Trials

Digestibilities of Nutrients

Results of nutrients digestibilities of the different experimental rations are shown in Table 4. The apparent digestion coefficients of DM, CP, EE and NFE
Although not statistically significant (P > 0.05), it seems that digestibility of CF improved when mixing Kochia hay with rice straw in addition to CFM in (T9) by about 13% compared to (T7) (50% Kochia hay + 50% CFM). The higher nutrients digestibility of Kochia hay may be due to increased content of CP in Kochia hay, which reflected on CP, DM, EE, and NFE digestibilities.

### Table 4. Digestion coefficients % of experimental rations containing kochia hay.

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>T9</td>
<td>T8</td>
</tr>
<tr>
<td>DM</td>
<td>59.10a</td>
</tr>
<tr>
<td>CP</td>
<td>68.67a</td>
</tr>
<tr>
<td>CF</td>
<td>46.06a</td>
</tr>
<tr>
<td>EE</td>
<td>67.67a</td>
</tr>
<tr>
<td>NFE</td>
<td>73.48a</td>
</tr>
<tr>
<td>OM</td>
<td>65.57a</td>
</tr>
<tr>
<td>TDN</td>
<td>46.05a</td>
</tr>
<tr>
<td>DCP</td>
<td>13.51a</td>
</tr>
</tbody>
</table>

a, b and c: Means in the same row with different superscripts differ significantly (P < 0.05).

T7 = 50% Kochia hay + 50% CFM.

T8 = 50% Rice straw + 50% CFM.

T9 = 25% Kochia hay + 25% Rice straw + 50% CFM.

Although not statistically significant (P > 0.05), it seems that digestibility of CF improved when mixing Kochia hay with rice straw in addition to CFM in (T9) by about 13% compared to (T7) (50% Kochia hay + 50% CFM).

**Nutritive Values**

Data of the nutritive values on terms of total digestible nutrients (TDN) and digestible crude protein (DCP) are illustrated in Table 4. The results of digestibilities of nutrients were reflected on nutritive values of the rations. When TDN and DCP were expressed as percentages, the highest TDN and DCP values were recorded for sheep fed (T7) (averaged 46.05% and 13.51%). This means that animals better utilized Kochia hay when supplemented with CFM than rice straw with CFM. These results are in agreement with Nour (1995), Fahmy (2002) and Eid (2003).
**Nitrogen Utilization**

Data on nitrogen intake, nitrogen excretion and nitrogen balance are shown in Table 5. Nitrogen intake was affected significantly by the experimental rations. The higher nitrogen intake in (T₇) may be attributed mainly to two factors: a) higher dry matter intake, and b) higher crude protein content in Kochia hay than that in rice straw.

**Table 5. Nitrogen balance of sheep fed the experimental rations during the digestibility trial.**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Parameters</th>
<th>T₇</th>
<th>T₈</th>
<th>T₉</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of animals</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Nitrogen intake (g/d)</td>
<td>22.84a</td>
<td>19.12b</td>
<td>21.24ab</td>
<td></td>
</tr>
<tr>
<td>Nitrogen excretion (g/d)</td>
<td>Faeces</td>
<td>7.16</td>
<td>9.80</td>
<td>7.70</td>
</tr>
<tr>
<td></td>
<td>Urine</td>
<td>10.67</td>
<td>5.61</td>
<td>9.22</td>
</tr>
<tr>
<td>Total-N excretion (g/d)</td>
<td>7.83a</td>
<td>15.41c</td>
<td>16.92b</td>
<td></td>
</tr>
<tr>
<td>N-balance (g/d)</td>
<td>5.01a</td>
<td>3.71c</td>
<td>4.32b</td>
<td></td>
</tr>
<tr>
<td>N-balance % of N-intake</td>
<td>21.9a</td>
<td>19.4c</td>
<td>20.3b</td>
<td></td>
</tr>
</tbody>
</table>

a, b and c: Means in the same row with different superscripts differ significantly (P < 0.05).

T₇ = 50% Kochia hay + 50% CFM.
T₈ = 50% Rice straw + 50% CFM.
T₉ = 25% Kochia hay + 25% Rice straw + 50% CMF.

The differences between treatments in total nitrogen excretion were significant (P < 0.05). The highest values of total nitrogen excretion were recorded for T₇ and the lowest for T₈. Concerning nitrogen balance, there were significant (P < 0.05 ) differences between treatments. It seems that all sheep were in positive nitrogen balance and the maximum value of nitrogen balance was recorded for animals fed on T₇ only, followed by animals fed on Kochia hay with rice straw (T₉), while animals fed on rice straw (T₇) had the lowest values. The improved positive nitrogen balance is in agreement with Nour (1995) and Fahmy (1998).

Generally, the superiority in N balance due to a ration than another is affected by several factors. From these, possible production of microbial protein synthesis or increased presence of fermentable energy (Hagemeister, *et al.*, 1981), difference in availability of fermentable energy (Tagari, *et al.*, 1976), variability in nitrogen that might escape fermentation from the rumen or an increased utilization of ammonia in the rumen (Holzer, *et al.*, 1986), and the effect of the free fats in protein synthesis (Sutton, *et al.*, 1983).
Blood Serum Parameters

Average values of blood serum analysis are presented in Table 6. Values of serum total protein and albumin for T₈ and T₉ were higher (P < 0.05) than that of T₇. However, values of serum globulins for T₈ were higher (P < 0.05) than that for T₇ and T₉. It can be noticed that, T₉ recorded the highest value of serum A/G ratio followed by T₇ and T₈. There were no differences between the values of serum A/G ratio in T₇ and T₈. These results were parallel with the results of OM and CP digestibility (Table 4) which indicates better utilization of dietary protein. There were significant differences (P < 0.05) in serum protein fraction concentrations among the sampling times. The values were at their minimum at zero h (before feeding) and increased to their maximum levels 3 h after feeding, then the values tended to decrease 6 h after feeding except for A/G ratio. The present estimates lie within the normal range of total protein (6-8 g/dl) reported by Recce (1991). The present results agree with that obtained by Rankins, et al. (1991) and Shehata, et al. (2001).

Table 6. Effect of experimental ration on some serum parameters at different sampling time.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Parameters</th>
<th>T. protein (g/dl)</th>
<th>Alb. (g/dl)</th>
<th>Glob. (g/dl)</th>
<th>A/G ratio</th>
<th>Urea (mg/dl)</th>
<th>AST (U/l)</th>
<th>ALT (U/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₇</td>
<td></td>
<td>7.13ᵇ</td>
<td>4.10ᵇ</td>
<td>3.03ᵇ</td>
<td>1.35ᵇ</td>
<td>36.1ᵇ</td>
<td>43.2ᵇ</td>
<td>21.8ᵇ</td>
</tr>
<tr>
<td>T₈</td>
<td></td>
<td>7.41ᵃ</td>
<td>4.21ᵃ</td>
<td>3.20ᵃ</td>
<td>1.31ᵇ</td>
<td>38.0ᵃ</td>
<td>45.7ᵃ</td>
<td>20.7ᵇ</td>
</tr>
<tr>
<td>T₉</td>
<td></td>
<td>7.31ᵃ</td>
<td>4.32ᵃ</td>
<td>2.99ᵇ</td>
<td>1.44ᵃ</td>
<td>38.3ᵃ</td>
<td>41.3ᶜ</td>
<td>23.9ᵃ</td>
</tr>
</tbody>
</table>

Sampling time

<table>
<thead>
<tr>
<th></th>
<th>0 hr</th>
<th>3 hrs</th>
<th>6 hrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₇</td>
<td>7.11ᵇ</td>
<td>7.51ᵃ</td>
<td>7.21ᵇ</td>
</tr>
<tr>
<td>T₈</td>
<td>4.20ᵇ</td>
<td>4.41ᵃ</td>
<td>4.22ᵇ</td>
</tr>
<tr>
<td>T₉</td>
<td>2.91ᵃ</td>
<td>3.10ᵃ</td>
<td>2.99ᵃ</td>
</tr>
</tbody>
</table>

a, b and c: Means in the same raw with different superscripts differ significantly (P< 0.05).
T₇ = 50% Kochia hay + 5 % CFM.
T₈ = 50% Rice straw + 50% CFM.
T₉ = 25% Kochia hay + 25% Rice straw + 50% CMF.

Values of serum urea-nitrogen concentration for T₈ and T₉ were higher than that of T₇. Results of serum urea-N concentration indicated that feeding sheep on Kochia hay had no adverse effect on kidney function. Results are close to those obtained by Rankins, et al. (1991), Shehata, et al. (2001) and Eid (2003), who reported that blood urea nitrogen of sheep fed on halophytic plants did not change. However these results are in disagreement with El-Shaer, et al. (1991).
who found an increase in blood urea nitrogen of sheep and goats after feeding on halophytic plants.

Although values of protein fractions and urea concentrations were within normal levels, it can be observed that there were significant differences between treatments (T7, T8, T9). This might be caused by the interaction effect between Kochia hay and rice straw (T9) or Kochia hay and CFM (T7).

There were significant (P < 0.05) differences among the overall means of serum AST and ALT concentration for different treatments. Values of serum AST for T8 was higher than T7 followed by T9. However the concentration of ALT for T9 was higher than T7 and T8.

Regarding the effect of sampling times on AST and ALT concentration, there were significant (P < 0.05) differences between the sampling times.

In general, the values recorded for AST and ALT were within the normal range reported by Abd El-Kareem (1990) for AST (24-65 U/l ) and ALT (19-37 U/l) in goats. Results are close to those obtained by Fahmy (1998), Youssef (1999) and Eid (2003) who found no effect of feeding salt marsh plants on both AST and ALT indicating non adverse effect on liver functions.

**Conclusion**

It can be concluded that *Kochia indica* is a good quality roughage and it can be fed as dried till 50% of sheep rations. Ration containing kochia hay recorded normal metabolites values in blood serum.

**References**


تقدير القيمة الغذائية لدريس نبات الكوخيا في علائق الأغنام

محمود خورشيد، وشكري رياض ، و محمد ياسين، وأحمد الحسيني
وأحمد خريشي
قسم الإنتاج الحيواني - قسم المحاصيل، كلية الزراعة - جامعة عين شمس
قسم إدارة المراعي - مركز بحوث الصحراء، القاهرة - جمهورية مصر العربية

المستخلص. تم إجراء تجارب الهضم المعملية وثلاث تجارب هضم وميزان
أزوت على تسع ذكور الأغنام التي تتناول علائق تحتوي على درس
نبات الكوخيا أو/وقس الأرز مع العلف المركزي وقامت دراسة معاملات
الهضم وميزان الأزوت وبعض قياسات الدم على الأغنام المغذاة على
العلائق المختبرة والمحتوية على درس نبات الكوخيا. ذلك نتائج تلك
دراسة على أنه يمكن استخدام درس نبات الكوخيا (خاصة العلائق
المحتوية على 70% درس الكوخيا مع 30% علف مركزي) في علائق
الأغنام بنجاح دون ظهور أي تأثير غير مزعج على نشاط القناة الهضمية
أو وظائف الكبد والكلي وكان أداء الحيوانات جيدا.