Effect of drinking saline water on performance, digestibility and nitrogen utilization of growing camels feed different quality roughages

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Abstract— This study was conducted to evaluate the effect of three roughages that were fed ad lib. with two types of water on feed intake, digestibility, water utilization and performance of growing she-camels. Twenty-four healthy growing she-camels (30-36 months old and 448.50 ± 29.30 kg body weight) were housed individually in metabolic cages and randomly allotted to three treatments. The experiment lasted for 60 days. Three roughages were Egyptian clover hay to represent optimum grazing conditions, rice straw to represent dry season grazing and Atriplex halimus to represent arid rangelands dominated by halophytes. Roughages offered to camels ad lib. The concentrates used were corn grains and cottonseed meal. Concentrate intakes calculated, per unit metabolic body weight (kg0.73). Final body weight and ADG were affected by roughages. Nutrients intake was affected (P<0.05) by roughage type but not for drinking water and their interaction. Camels fed Atriplex had higher (P<0.05) in dry matter intake, roughage intake and roughage (% DMI) than hay and straw. Corn intake was greater (P<0.05) in camels fed Atriplex and straw whereas, was lower (P<0.05) in camels fed hay. Camels fed hay had higher (P<0.05) in dry matter digestibility followed by straw and then Atriplex. Organic matter, crude fiber and Nitrogen free extract digestibility were higher (P<0.05) in camels fed hay and straw as compared to Atriplex whereas, crude protein was higher (P<0.05) in Atriplex and hay as compared to straw. Free water intake, feed water, total water intake and fecal water were higher (P<0.05) in camels fed Atriplex as compared to hay and straw. Urinary water was higher (P<0.05) in camels fed Atriplex followed by hay and then straw. Free water intake, feed water, total water intake and fecal water were higher (P<0.05) in camels fed Atriplex as compared to hay and straw. Urinary water excretion was higher (P<0.05) in camels fed Atriplex followed by hay and then straw. In conclusion, camels fed on Atriplex showed a clear improvement in growth, digestibility, and nitrogen utilization in a similar way to camels fed on hay.

Keywords— growing she-camels, roughages type, water type, intake, performance, water utilization.

1. INTRODUCTION

Dromedary camel (Camelus dromedarius) is an important livestock species that is exceptionally well adapted to harsh environmental conditions. They are functionally and metabolically ruminant herbivores. Ruminant herbivores are distinguished by their multipart stomach. This anatomical structure and the microorganisms that inhabit the rumen network allow for longer retention of ingested feed and anaerobic microbial digestion of cellulosic materials, and consequently production of volatile fatty acids and microbial protein synthesis. Camels are bred because of their extraordinary strength to withstand hunger and thirst for a long time in the environmental conditions [1] In addition, its high ability to convert scarce desert resources into milk and meat makes it even more important to pastoralists [2,3].

Camels are non-selective grazers with a digestive system that has evolved - adapt to unfavorable conditions and has a greater activity of cellulolytic bacteria [6,7] Camels had a greater capacity to utilize low-quality roughages that are high in NDF and ADF and less digestible[6,7]. Camels are typically associated with a
lower feed intake and greater efficiency of forage utilization, which may be due to their large body size and longer retention time, which gives more opportunity for microorganisms to digest non-structure carbohydrates [7]. On the other hand, camels prefer to consume salty bushes which are rich in moisture and salt. Salts present in such plants help meet the physiological functions of camels [8,9] reported that the high moisture content of salt bushes ensures a good portion of the camel water requirement in areas where water is the most limiting factor for animals. Feeding halophytes especially for camels can be an appropriate method in arid regions to reduce the problem of forage shortage. Camels have adapted rumen microbial communities that enable them to take advantage of the non-protein nitrogen found in halophytes.

Camels have adapted mechanisms that allow it to withstand prolonged water deprivation especially in the absence of readily available water and survive when feed resources are scarce or of poor quality [10]. Camels are able to replenish in a relative short period of time the water lost. Whereas changes of water metabolism, body fluid and its regulation, body temperature, kidney function, appetite and hormonal aspects during dehydration have been studied in the past [11-14].

Lack of forage and water deprivation are important barriers to camel production in arid and semi-arid regions of the harsh climate. However, they are slowly being replaced by stable systems which should properly take into account the feeding of camels in these systems. Therefore, the present study was conducted to evaluate the effect of different forages and types of water on intake, nutrient digestibility, and performance of camels.

II. MATERIALS AND METHODS

The experiment was conducted at Maryout Research Station, Desert Research Center, Alexandria, Egypt.

Table 1. Proximate composition of feed ingredients, % DM basis.

| Proximate Constituents     | Corn grains | Cottonseed meal | Egyptian clover hay | Atriplex halimus | Rice straw |
|----------------------------|-------------|-----------------|---------------------|-----------------|------------|
| Dry matter                 | 86.65       | 90.88           | 86.08               | 34.98           | 87.43      |
| Ash                        | 1.71        | 24.73           | 13.35               | 25.37           | 21.68      |
| Organic matter             | 98.29       | 75.27           | 86.65               | 74.99           | 78.32      |
| Crude protein              | 10.76       | 15.84           | 14.26               | 11.70           | 4.55       |
| Crude fiber                | 3.77        | 19.30           | 34.23               | 28.62           | 28.86      |
| Ether extract              | 3.92        | 10.86           | 4.40                | 2.94            | 2.52       |
| N-free extract             | 79.84       | 29.27           | 33.76               | 31.37           | 42.39      |

1Un-decorticated, heat treated and mechanically pressed CSM, produced in a traditional oil mill,

2Leaves and succulent branches typically consumed by grazing animals.

2.1. Animals, diets, and experimental design

Twenty-four healthy growing she-camels (Camelus dromedarius) with an average initial body weight (BW) of 448.50 ± 29.30 kg and 30-36 months old were used and the experiment lasted for 60 days. Animals were housed individually in shaded floor pens for the duration of the experiment. The experiment was arranged as a 3 × 2 factorial experiment in a completely randomized design by using three forages and two types of water. Animal were weighed every two weeks after overnight fast and on two consecutive days and the average daily gain (ADG) was calculated.

The three roughages were used to represent the prevailing different grazing conditions in arid rangelands. Those were Egyptian clover hay to represent optimum grazing conditions, rice straw to represent dry season grazing and Atriplex halimus to represent arid rangelands dominated by halophytes. The concentrates used were corn grains and cottonseed meal selected as the commonly used energy and protein supplements, respectively. Roughages offered to camels ad lib. twice daily at 8:00 and 16:00 hours. Refusals were weighed at the following morning and daily intake was recorded on dry matter basis. Concentrate intakes calculated, per unit metabolic weight (kg 0.73), from a previous experiment [15], actual intake is presented below. in an attempt to control anticipated excessive soluble carbohydrates intake and possible adverse effects on rumen function and feed utilization [15]. The animals are drunk once every day, either tap water or salty 10,000 parts per million. The proximate composition of feed ingredients is presented in Table 1. Refusals were weighed daily, and feed intake was recorded. Samples of the roughages and concentrates were collected and analyzed for DM by drying to constant weight in a forced-air oven at 60°C for 48 h [16]. Samples were pooled for each camel.

2.2. Digestion trials

At the end of the experimental period, camels were placed in metabolic cages for 15 days, 8 days of adaptation to the metabolic cages and 7 days to collect faeces and urine. Total daily faecal output of each camel was collected thoroughly mixed and weighed. A 10% subsample of daily
faecal output was analyzed for DM by drying to constant weight in a forced-air oven at 60°C for 48 h [16]. Dried ingredients, orts and faecal samples were ground in a Wiley mill with a 1-mm screen. Samples were analyzed for ash, ether extract, crude fiber and crude protein according to [16]. Urine samples were collected in plastic containers containing 100 ml of H2SO4. Total daily urine output was weighed and recorded. A 10% subsample was collected and then analyzed for N [16].

2.3. Statistical analysis

Main effects and interactions were evaluated using the GLM repeated-measures analysis of variance procedures of the NCSS statistical package [17]. The type of roughage and concentrate levels were the independent variables, and type of water (water tap and saline water) levels were repeated within roughages. Newman-Keuls multiple comparison tests was applied to the means of the main effects, i.e. type of roughage, R-means, and level of concentrates, type of water (water tap and saline water) B-means. Statistical significance was declared at P≤0.05.

III. RESULTS

Chemical composition of the roughages is presented in Table 1. Three forages were selected differ in their crude protein content. Crude protein was higher for clover hay, intermediate for the Atriplex halimus, and lowest for rice straw. Two concentrates were selected differ in their chemical composition Table 1. Cottonseed meal was higher in their contents of crude protein, ash, crude fiber, and lower in nitrogen free extract compared with corn grain.

Effects of roughages type and drinking saline water on the performance of the camels are presented in Table 2. Initial body weight was not affected whereas, final body weight and ADG were affected by roughages type (P<0.05) but not for drinking water and their interaction.

Effects of roughages type and drinking saline water on the feed intake of the camels are presented in Table 3. Feed intake was affected (P<0.05) by roughage type but not for drinking water and their interaction. Camels fed Atriplex had higher (P<0.05) intake of dry matter, roughage intake and roughage (% DMI) than hay and straw. Corn intake was greater (P<0.05) in camels fed Atriplex and straw whereas, was lower (P<0.05) in camels fed hay.

Effects of roughages type and drinking saline water on the components of are presented in Table 4. Organic matter, crude protein, crude fiber, rumen degradable protein, rumen un-degradable protein intakes were affected (P<0.05) by roughage type but not for drinking water and their interaction. Camels fed Atriplex had higher values (P<0.05) of organic matter intake and crude fiber intake than hay and straw. Crude protein intake, rumen degradable protein intake and rumen un-degradable protein were greater (P<0.05) in camels fed Atriplex and hay whereas, were lower (P<0.05) in camels fed straw.

Effects of roughages type and drinking saline water on the apparent digestion coefficients of diets consumed by camels are presented in Table 5. Digestion coefficients of diets was affected (P<0.05) by roughage type but not for drinking water and their interaction. Camels fed hay had higher (P<0.05) in dry matter digestibility followed by straw and then Atriplex. Organic matter, crude fiber and nitrogen free extract digestibility were higher (P<0.05) in camels fed hay and straw as compared to Atriplex whereas, crude protein was higher (P<0.05) in Atriplex and hay as compared to straw.

Effects of roughages type and drinking saline water on the nitrogen utilization are presented in Table 6. Nitrogen utilization was affected (P<0.05) by roughage type but not for drinking water and their interaction. Nitrogen intake and digested nitrogen were higher (P<0.05) in camels fed hay and Atriplex as compared to straw whereas, fecal nitrogen, urinary nitrogen and nitrogen balance were not affected.

Effects of roughages type and drinking saline water on the water intake and excretion are presented in Tables 7 and 8. Water intake and excretion were affected (P<0.05) by roughage type but not for drinking water and their interaction. Free water intake, feed water, total water intake and fecal water were higher (P<0.05) in camels fed Atriplex as compared to hay and straw. Urinary water was higher (P<0.05) in camels fed Atriplex followed by hay and then straw.

IV. DISCUSSIONS

The present experiment showed that final body weight and ADG were affected by the type of roughages. Similar results were observed by [18] who reported that ADG g/day of camels fed hay and Atriplex were higher than those of their mates fed rice straw with limiting concentrate offered to 50%. In agreement with [19,15,7] the straw is characterized by its poor of digestion, a longer retention time in the rumen and its low nutritional value, which negatively affected the performance.

Effect of saline water on ADG camels fed straw and drinking salt water was lower final body weight and ADG Similar findings were reported by [20] who reported that female camels lost 1.9% of their initial live body weight when drinking saline water.
Our results indicate that camels consumed higher amounts of Atriplex compared to hay and straw. This is consistent with similar findings found by [21, 22] reported that camels need salt more than other livestock in their diets, which they get from Atriplex, which contain salts that may reach 25% of DM [23].

Table 2. Effect of type roughages and drinking water and saline water on the performance of the camels.

| Water type (B)     | Roughage, ad lib. (R) | Water Average | R  | B  | RxB |
|--------------------|-----------------------|---------------|----|----|-----|
|                    | Atriplex | hay | Straw |     |     |     |
| Initial body weight (kg) |         |     |       |     |     |     |
| Fresh              | 448     | 446 | 446   | 447 | 0.35 | 0.61 | 0.33 |
| Saline             | 446     | 447 | 446   | 446 |     |     |     |
| Roughage average   | 447     | 446 | 446   | 447 |     |     |     |
| ± SEM              | 15.9    |     |       |     |     |     |     |
| Final body weight (kg) |         |     |       |     |     |     |
| Fresh              | 480     | 483 | 468   | 477 | <0.01 | 0.43 | 0.21 |
| Saline             | 470     | 470 | 456   | 469 |     |     |     |
| Roughage average   | 475     | 481 | 462   | 473 |     |     |     |
| ± SEM              | 85.8    |     |       |     |     |     |     |
| Average daily gain (g/day) |         |     |       |     |     |     |
| Fresh              | 531     | 608 | 360   | 500 | <0.01 | 0.52 | 0.13 |
| Saline             | 400     | 550 | 172   | 347 |     |     |     |
| Roughage average   | 465     | 579 | 266   | 437 |     |     |     |
| ± SEM              | 74.5    |     |       |     |     |     |     |

*Probability values associated with roughage (R), water type (B), and roughage × water type interaction (RxB).

a–e Mean separation by Tukey MRT (P<0.05), valid comparison are between roughage average and between water watering an experiment.

Table 3. Average daily feed intake during the digestion trials, g/d/kg^{0.75}

| Water type (B)     | Roughage, ad lib. (R) | Water Average | R  | B  | RxB |
|--------------------|-----------------------|---------------|----|----|-----|
|                    | Atriplex | Hay | Straw |     |     |     |
| Dry matter intake(DMI) |         |     |       |     |     |     |
| Fresh              | 85.5    | 63.5| 56.0  | 68.3| <0.01 | 0.29 | 0.45 |
| Saline             | 96.9    | 63.4| 57.9  | 72.7|     |     |     |
| Roughage average   | 91.2    | 63.4| 56.9  | 70.5|     |     |     |
| ± SEM              | 4.58    |     |       |     |     |     |     |
| Roughage (DMI)     |         |     |       |     |     |     |
| Fresh              | 56.3    | 34.7| 27.1  | 39.4| <0.01 | 0.28 | 0.38 |
| Saline             | 67.6    | 34.6| 28.1  | 43.4|     |     |     |
| Roughage average   | 61.9    | 34.6| 27.6  | 41.4|     |     |     |
| ± SEM              | 4.18    |     |       |     |     |     |     |
| Roughage (%) in DMI |         |     |       |     |     |     |
| Fresh              | 65.5    | 54.6| 48.3  | 56.1| <0.01 | 0.28 | 0.34 |
| Saline             | 69.8    | 54.6| 48.5  | 57.6|     |     |     |
| Roughage average   | 67.6    | 54.6| 48.4  | 58.9|     |     |     |
| ± SEM              | 1.51    |     |       |     |     |     |     |
| Corn (DMI)         |         |     |       |     |     |     |
| Fresh              | 23.8    | 20.6| 22.3  | 22.2| 0.01  | 0.67 | 0.85 |
| Saline             | 23.9    | 20.6| 22.9  | 22.5|     |     |     |
| Roughage average   | 23.8    | 20.6| 22.6  | 22.3|     |     |     |
| ± SEM              | 0.64    |     |       |     |     |     |     |
| Cotton seed meal (DMI) |         |     |       |     |     |     |
| Fresh              | 5.37    | 8.24| 6.70  | 6.77| <0.01 | 0.64 | 0.78 |
| Saline             | 5.39    | 8.22| 6.90  | 6.84|     |     |     |
| Roughage average   | 5.38    | 8.23| 6.80  | 6.80|     |     |     |
| ± SEM              | 0.16    |     |       |     |     |     |     |
| Concentrate (DMI)  |         |     |       |     |     |     |
| Fresh              | 29.2    | 28.8| 28.9  | 28.9| 0.67  | 0.66 | 0.83 |
| Saline             | 29.3    | 28.8| 29.8  | 29.3|     |     |     |
| Roughage average   | 29.2    | 28.8| 29.4  | 29.1|     |     |     |
| ± SEM              | 0.79    |     |       |     |     |     |     |

*Probability values associated with roughage (R), water type (B), and roughage × water type interaction (RxB).

a–e Mean separation by Tukey MRT (P<0.05), valid comparison are between roughage average and between water watering an experiment.
Table 4. Components of diets g/d/kg

| Water type (B) | Roughage, ad lib. (R) | Water average | P-value1 | R  | B  | Rx B |
|---------------|-----------------------|---------------|----------|----|----|------|
|               | Atriplex | Hay | Straw |               |           |           |          |          |          |          |
| Organic matter intake (OMI) |           |           |           |          |          |          |          |          |          |          |
| Fresh         | 69.5     | 56.6   | 49.6    | 58.6       | <0.01    | 0.29     | 0.47    |
| Saline        | 77.9     | 56.5   | 51.2    | 61.9       |          |          |         |
| Roughage average | 73.7b  | 56.6b  | 50.4b   | 60.2       |          |          |         |
| ± SEM         | 3.51     |        |         |            |          |          |         |
| Crude protein intake (CPI) |           |           |           |          |          |          |          |          |          |          |
| Fresh         | 7.61     | 8.64   | 4.75    | 6.67       | <0.01    | 0.29     | 0.46    |
| Saline        | 8.47     | 8.61   | 4.89    | 7.33       |          |          |         |
| Roughage average | 8.04b  | 8.62b  | 4.82b   | 7.16       |          |          |         |
| ± SEM         | 0.35     |        |         |            |          |          |         |
| Crude fiber intake (CFI) |           |           |           |          |          |          |          |          |          |          |
| Fresh         | 17.9     | 13.8   | 10.3    | 14.0       | <0.01    | 0.47     | 0.40    |
| Saline        | 21.1     | 13.8   | 10.6    | 15.2       |          |          |         |
| Roughage average | 19.5b  | 13.8b  | 10.4b   | 14.6       |          |          |         |
| ± SEM         | 1.20     |        |         |            |          |          |         |
| Rumen degradable protein intake (RDPI) |           |           |           |          |          |          |          |          |          |          |
| Fresh         | 5.49     | 6.23   | 2.90    | 4.87       | <0.01    | 0.30     | 0.44    |
| Saline        | 6.13     | 6.21   | 2.99    | 5.11       |          |          |         |
| Roughage average | 5.81b  | 6.22b  | 2.94b   | 4.99       |          |          |         |
| ± SEM         | 0.001    |        |         |            |          |          |         |
| Rumen un-degradable protein (RUPI) |           |           |           |          |          |          |          |          |          |          |
| Fresh         | 2.12     | 2.41   | 1.85    | 2.83       | 0.02     | 0.28     | 0.51    |
| Saline        | 2.34     | 2.40   | 1.91    | 2.22       |          |          |         |
| Roughage average | 2.23b   | 2.40b  | 1.88b   | 2.17       |          |          |         |
| ± SEM         | 0.01     |        |         |            |          |          |         |

1 Probability values associated with roughage (R), water type (B), and roughage × water type interaction (R×B).

Table 5. Apparent digestion coefficients of diets consumed by camels, %

| Water type (B) | Roughage, ad lib. (R) | Water average | P-value1 | R  | B  | Rx B |
|---------------|-----------------------|---------------|----------|----|----|------|
|               | Atriplex | Hay | Straw |               |           |           |          |          |          |          |
| Dry matter    |           |     |       |               |           |           |          |          |          |          |
| Fresh         | 58.2     | 67.9 | 63.0  | 63.1        | 0.02     | 0.82     | 0.73    |
| Saline        | 58.1     | 71.2 | 61.6  | 63.6        |          |          |         |
| Roughage average | 58.1b   | 69.6b | 62.3b | 63.3       |          |          |         |
| ± SEM         | 2.97     |        |         |            |          |          |         |
| Organic matter |           |     |       |               |           |           |          |          |          |          |
| Fresh         | 55.5     | 69.4 | 67.2  | 64.1        | 0.01     | 0.71     | 0.76    |
| Saline        | 54.6     | 72.8 | 67.5  | 64.9        |          |          |         |
| Roughage average | 55.1b  | 71.1b | 67.3b | 64.5       |          |          |         |
| ± SEM         | 2.94     |        |         |            |          |          |         |
| Crude protein |           |     |       |               |           |           |          |          |          |          |
| Fresh         | 63.9     | 63.3 | 45.3  | 57.5        | 0.03     | 0.79     | 0.74    |
| Saline        | 60.4     | 65.9 | 49.7  | 58.7        |          |          |         |
| Roughage average | 62.1b   | 64.6b | 47.5b | 58.1       |          |          |         |
| ± SEM         | 5.22     |        |         |            |          |          |         |
| Crude fiber   |           |     |       |               |           |           |          |          |          |          |
| Fresh         | 28.8     | 57.5 | 58.4  | 48.2        | 0.01     | 0.42     | 0.51    |
| Saline        | 37.6     | 66.1 | 54.1  | 52.6        |          |          |         |
| Roughage average | 33.2b   | 61.8b | 56.3b | 50.4       |          |          |         |
| ± SEM         | 6.10     |        |         |            |          |          |         |
| Nitrogen free extract |           |     |       |               |           |           |          |          |          |          |
| Fresh         | 63.5     | 75.5 | 72.6  | 70.5        | 0.03     | 0.71     | 0.59    |
| Saline        | 59.6     | 76.6 | 73.1  | 69.8        |          |          |         |
| Roughage average | 61.6b   | 76.1b | 72.8b | 70.2       |          |          |         |
| ± SEM         | 2.48     |        |         |            |          |          |         |

1 Probability values associated with roughage (R), water type (B), and roughage × water type interaction (R×B).

* Mean separation by Tukey MRT (P<0.05), valid comparison are between roughage average and between water watering an experiment.
### Table 6. Nitrogen utilization, mg N/day/kg

| Water type (B) | Roughage, ad lib. (R) | Water average | R     | B     | Rx B   |
|---------------|-----------------------|---------------|-------|-------|--------|
|               | Atriplex | Hay | Straw |         |        |        |
| Nitrogen intake | Fresh | 1217 | 1382 | 760 | 1120 | <0.01 | 0.29 | 0.46 |
|                | Saline | 1355 | 1378 | 783 | 1172 |        |       |      |
|                | Roughage average | 1286<sup>a</sup> | 1380<sup>a</sup> | 772<sup>b</sup> | 1145 |        |       |      |
|                | ± SEM   | 56.1 |       |      |       |        |       |      |
| Fecal nitrogen | Fresh   | 432  | 507  | 415 | 451  | 0.16  | 0.66  | 0.26 |
|                | Saline  | 538  | 470  | 393 | 467  |        |       |      |
|                | Roughage average | 485 | 488  | 404 | 459  |        |       |      |
|                | ± SEM   | 42.4 |       |      |       |        |       |      |
| Digested nitrogen | Fresh | 785  | 875  | 345 | 668  | <0.01 | 0.59  | 0.99 |
|                | Saline  | 817  | 908  | 390 | 705  |        |       |      |
|                | Roughage average | 801<sup>a</sup> | 891<sup>a</sup> | 368<sup>b</sup> | 687 |        |       |      |
|                | ± SEM   | 78.6 |       |      |       |        |       |      |
| Urinary nitrogen | Fresh | 457  | 734  | 240 | 477  | 0.11  | 0.74  | 0.34 |
|                | Saline  | 763  | 521  | 285 | 523  |        |       |      |
|                | Roughage average | 610 | 627  | 263 | 500  |        |       |      |
|                | ± SEM   | 159  |       |      |       |        |       |      |
| Nitrogen balance | Fresh | 328  | 141  | 105 | 191  | 0.66  | 0.95  | 0.38 |
|                | Saline  | 54.6 | 387  | 105 | 183  |        |       |      |
|                | Roughage average | 191 | 264  | 105 | 187  |        |       |      |
|                | ± SEM   | 172  |       |      |       |        |       |      |

<sup>1</sup> Probability values associated with roughage (R), water type (B), and roughage × water type interaction (R×B).
<sup>a</sup> Mean separation by Tukey MRT (P<0.05), valid comparison are between roughage average and between water watering an experiment.

### Table 7. Water intake and execration, mg N/day/kg

| Water type (B) | Roughage, ad lib. (R) | Water average | P-value<sup>1</sup> | R     | B     | Rx B   |
|---------------|-----------------------|---------------|----------------------|-------|-------|--------|
|               | Atriplex | Hay | Straw |         |        |        |
| Nitrogen intake | Fresh | 148  | 111  | 125 | 128  | 0.01  | 0.23  | 0.63 |
|                | Saline  | 143  | 108  | 108 | 119  |        |       |      |
|                | Roughage average | 146<sup>a</sup> | 109<sup>b</sup> | 116<sup>b</sup> | 124 |        |       |      |
|                | ± SEM   | 7.69 |       |      |       |        |       |      |
| Fecal water   | Fresh   | 73.5 | 20.2 | 13.5 | 35.7 | <0.01 | 0.87  | 0.58 |
|                | Saline  | 75.3 | 16.8 | 14.1 | 35.4 |        |       |      |
|                | Roughage average | 74.4<sup>a</sup> | 18.5<sup>b</sup> | 13.8<sup>b</sup> | 35.6 |        |       |      |
|                | ± SEM   | 2.48 |       |      |       |        |       |      |
| Total water intake | Fresh | 234  | 144  | 149 | 176  | <0.01 | 0.34  | 0.73 |
|                | Saline  | 233  | 138  | 133 | 168  |        |       |      |
|                | Roughage average | 233<sup>a</sup> | 141<sup>b</sup> | 141<sup>b</sup> | 172 |        |       |      |
|                | ± SEM   | 9.21 |       |      |       |        |       |      |
| Fecal water   | Fresh   | 29.8 | 17.4 | 12.7 | 19.9 | <0.01 | 0.46  | 0.27 |
|                | Saline  | 36.6 | 13.5 | 15.6 | 21.9 |        |       |      |
|                | Roughage average | 33.2<sup>a</sup> | 15.4<sup>b</sup> | 14.1<sup>b</sup> | 20.9 |        |       |      |
|                | ± SEM   | 3.02 |       |      |       |        |       |      |
| Urinary water | Fresh   | 45.1 | 56.9 | 29.3 | 43.8 | 0.02  | 0.11  | 0.04 |
|                | Saline  | 110  | 44.7 | 32.4 | 62.4 |        |       |      |
|                | Roughage average | 77.6<sup>a</sup> | 50.8<sup>b</sup> | 30.8<sup>c</sup> | 53.1 |        |       |      |
|                | ± SEM   | 11.9 |       |      |       |        |       |      |

<sup>1</sup> Probability values associated with roughage (R), water type (B), and roughage × water type interaction (R×B).
<sup>a</sup> Mean separation by Tukey MRT (P<0.05), valid comparison are between roughage average and between water watering an experiment.
This was confirmed by [24] who explained that camels need 6 to 8 times the amount of salt than other livestock requirement, and also indicated that camels that do not regularly receive salty feed need about 140 grams of salt per dat. Moreover, Atriplex is a green plant more palatable and preferred for camels than alfalfa hay and rice straw as indicated by [22].

Our results indicate that the camels fed on clover hay had higher digestibility values, as clover hay is considered a good-quality roughage that is high in its available content of nutrients, which explains the high digestion parameters. These results are consistent with [18]

Camels can efficiently digest low quality roughage that is low in nutritional value, which explains the high fiber digestibility coefficient of camels fed straw. The more efficient utilization of low quality roughage by camels is mainly the result of a higher cellulosic activity of the microorganisms [5] and to a longer retention time of solid particles [6,7]. Camels fed Atriplex showed improved protein digestibility, which may be due to their content of non-protein nitrogen (NPN). [7] reported that Atriplex differs from conventional forage in terms of its high NPN content and About 44.5% of the protein content is NPN. The NPN compounds are degraded and used as a source of N for the synthesis of microbial protein. The effective uptake of non-protein nitrogen by rumen microbes and subsequent conversion to microbial protein, diets should contain suitable and adequate source of energy [25-28]. This also explains the increase in corn intake in camels group fed Atriplex.

Our results indicated that camels fed on Atriplex and hay had higher values of nitrogen intake and digested nitrogen more than straw. These could mainly be due to the type of forage and its content of [29,23]

The roughage type significantly affected the water intake and excretion. Atriplex camels group recorded the highest free water intake. Because Atriplex had high salt content [30]. Camels can be fed on a high tolerance saline fodder than any other animal [31]. Camels fed this diet drink a lot of water in order to eliminate the salts ingested.

**Table 8. water intake, ml/day/kg**

| Water type (B)         | Roughage, ad lib. (R) | Water average | P-value* |
|------------------------|-----------------------|---------------|----------|
|                        | Atriplex  | hay         | Straw    | R   | B   | Rx B |
| Free water intake (FWI)|          |             |          |     |     |      |
| Fresh                  | 147.74   | 110.97      | 124.74   | 127.82 | 0.007 | 0.233 | 0.628 |
| Saline                 | 143.32   | 107.65      | 107.55   | 119.51 |       |       |       |
| Roughage average       | 145.53   | 109.31      | 116.14   | 123.66 |       |       |       |
| ± SEM                  | 7.687    |             |          |       |       |       |       |
| Feed water (FDWI)      |          |             |          |     |     |      |
| Fresh                  | 73.48    | 20.18       | 13.54    | 35.73  | 0.0000 | 0.875 | 0.577 |
| Saline                 | 75.32    | 16.78       | 14.11    | 35.40  |       |       |       |
| Roughage average       | 74.40    | 18.48       | 13.82    | 35.37  |       |       |       |
| ± SEM                  | 2.482    |             |          |       |       |       |       |
| Metabolic water (MWI)  |          |             |          |     |     |      |
| Fresh                  | 12.73    | 12.95       | 11.02    | 12.23  | 0.254  | 0.457 | 0.937 |
| Saline                 | 14.07    | 13.50       | 11.57    | 13.05  |       |       |       |
| Roughage average       | 13.40    | 13.22       | 11.29    | 12.64  |       |       |       |
| ± SEM                  | 1.255    |             |          |       |       |       |       |
| Total water intake (TWI)|          |             |          |     |     |      |
| Fresh                  | 233.96   | 144.10      | 149.30   | 175.79 | 0.0007 | 0.339 | 0.727 |
| Saline                 | 232.71   | 137.93      | 133.23   | 167.96 |       |       |       |
| Roughage average       | 233.34   | 141.02      | 141.27   | 171.87 |       |       |       |
| ± SEM                  | 9.208    |             |          |       |       |       |       |
| TWI/GE                 |          |             |          |     |     |      |
| Fresh                  | 1.256    | 0.915       | 1.112    | 1.096  | 0.001  | 0.013 | 0.272 |
| Saline                 | 1.108    | 0.885       | 0.961    | 0.984  |       |       |       |
| Roughage average       | 1.182    | 0.899       | 1.039    | 1.040  |       |       |       |
| ± SEM                  | 0.0392   |             |          |       |       |       |       |
| TWI/DE                 |          |             |          |     |     |      |
| Fresh                  | 2.229    | 1.313       | 1.669    | 1.737  | 0.002  | 0.130 | 0.836 |
| Saline                 | 1.991    | 1.212       | 1.415    | 1.539  |       |       |       |
| Roughage average       | 2.110    | 1.262       | 1.542    | 1.638  |       |       |       |
| ± SEM                  | 0.1381   |             |          |       |       |       |       |

* Probability values associated with roughage (R), water type (B), and roughage × water type interaction (Rx B).

* Mean separation by Tukey MRT (*P<0.05), valid comparison are between roughage average and between water watering an experiment.
Atriplex camels group recorded significantly higher feed water intake than those hay and straw groups due to that Atriplex had higher moisture content about 65% similar findings were recorded by [21]. Camels consumed Atriplex recorded higher water excretion values than those fed on straw or hay. These results indicated that camels’ kidneys seem to be better adapted to handling salt load especially when they fed on halophytic plants [32,33] pointed out that increasing water excretion through the urinary pathway is believed to be an adaptive mechanism assisting the animal in getting rid of excess salts and maintain osmolality of food and other body fluids. In addition, [34,35] reported that increasing salts increased water excretion in urine and faeces.

V. CONCLUSION

In conclusion, the results indicate that drinking saline water did not affect feed intake, digestibility and nitrogen utilization, whereas, roughages type had effect intake, digestibility and nitrogen utilization. Camels fed on Atriplex showed a clear improvement in growth, digestibility, and nitrogen utilization in a similar way to camels fed on hay. As for the camels fed on straw, they had the least effect on growth, digestibility, and nitrogen utilization.

VI. REFERENCES

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