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Study of Chemical Composition of Range Plants in the Eastern Province of Saudi Arabia

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ABSTRACT. The chemical composition and seed germination of range plants located in the Eastern Province of the Saudi Arabia together with the chemical analysis of soil associated with them was evaluated in this study. The distribution of the important range plants was found in three main locations in the Eastern Province. These locations were Naeeryah, Wadi Al-Mayah and Hofuf-Salwa Road.

The results of the study indicated that seven species are potentially useful grazing plants and hence they could be domesticated; of those, *Plantago ovata, Prosopis farcta* and *Hammada elegans*, had relatively high protein content ranging from 11.3 to 12.6% at maturity, while the other four, *Panicum turgidum, Pennisetum divisum, Stipagrostis plumosa* and *Rhanterium epapposum* had relatively low protein content, ranging from 6.5 to 7.4% at maturity. All species had a wide distribution and good palatability. Chemical analyses of plants included proximate analysis and determination of major and minor elements. Except for phosphorus, all of the selected seven species contained adequate amounts of the minerals required for animal nutrition, when sampled at maturity. Soil was analysed for pH, electrical conductivity and available cations. All samples had pH ranging from 7.95 to 8.68, while the electrical conductivity ranged between 0.26 to 1.92 mS/cm. Available Cu and Mn in the soil were found to be adequate, whereas available Fe was deficient and available Zn was borderline, according to the criteria of Lindsay and Norvell (1978).

Results of seed germination experiments carried out on five of the seven selected species showed a low percentage of germination, ranging from 0 to 40%. However, when the seeds were stored for a period of about 10 months, the germination percentage increased to about 65 to 90%. Representative photographs of seven of the studied species are shown.

Despite the harsh and unfavorable environmental conditions, extremely high temperatures, intensive light, severe and prolonged drought, characteristic of the Eastern Province of Saudi Arabia, this province is endowed with vast areas of range lands which are annually grazed by various animal stock in the period extending from January to April.

Previous studies on the range plants in the Eastern Province were entirely restricted to enumerations or check-lists of species (Chaudhary 1983, Chaudhary *et. al.* 1981, Giacomini *et al.* 1979a and 1979b, Italconsult, 1969a and 1969b). No attempt has yet been made to study the relative value of these plants as grazing material in terms of their chemical composition. Hence, the present study was undertaken to establish a data-base of available information on the chemical composition of range plants in the Eastern Province. Such information is valuable for the assessment of the relative merits of each species, so that species which prove potentially and chemically useful could be selected for domestication.

Materials and Methods

During 1985 and 1986 several trips were organized to Hofuf-Salwa Road, Wadi Al-Mayah and Al-Naeerya areas for the collection of material representing various developmental stages of 19 species of range plants and associated soil samples. A systematic listing of these species is given in (Table 1). The species were selected on the basis of their protein content, palatability and wide distribution to grazing camels and sheep as actually observed in the grazing area.

All 19 species were identified. Verification of their identification has been carried out using Migahid's (1978) flora of Saudi Arabia and more recent publications (*e.g.* Chaudhary 1984, Cope 1985). All plant and soil samples were chemically analyzed.

A. *Plants and Soil Chemical Analysis*

A total of 60 plant samples (approximately 3 specimens per species) were taken at different growth stages from the above-ground growth and all samples were washed with distilled water, dried and analyzed according to AOAC methods (1980) for the determination of crude protein, crude fiber, ash, ether extracts, major (P, Ca, Mg, Na and K) and minor (Cu, Mn, Fe, Zn and Mo) elements.

60 soil samples associated with the sampled plants were collected from the rhizosphere region at a depth of 0-30 cm and were analyzed according to Black

(1965) and Lindsay and Norvell (1978) for the determination of available cations (Cu, Mn, Fe and Zn), pH and E.C.

B. *Seed Germination Experiments*

Considerable amounts of seeds of each of the following five species: *Plantago ovata, Hammada elegans, Panicum turgidum, Stipagrostis plumosa* and *Rhanterium epapposum* were collected during the 1985 season and were stored in the laboratory at room temperature (20-25°C).

Seeds germination was first carried out in the laboratory using filter paper as a medium for germination. Poor germination was observed.

Seeds were treated to break their dormancy prior to planting in the glasshouse and in the field. Seed treatments were as follows: 1. Untreated (control). 2. Soaked in 10% sulphuric acid for a period of 5 minutes and washed with water. 3. Soaked in distilled water for 12 hours.

In April 1986 the treated seeds were sown in pots in both glasshouse and the field. For each species, a randomized complete block design with four replications was used. Poor germination was found in both the glasshouse and in the field.

In the light of poor germination in both the field and the glasshouse, seeds of the selected species were recollected at the end of April 1986 during the ripening stages. The seeds were cleaned and kept in the laboratory for about ten months. The seeds were examined under the microscope and 400 well developed seeds were chosen from each species. In the first week of March 1987, four hundred seeds for each of five of the selected species were sown in rows in four plastic trays at 100-seeds per tray containing sand and peat-moss in the ratio of 1:1. The trays were arranged in a randomized complete block design with four replications. The trays were placed outdoors and irrigated when required. The number of germination seeds was recorded.

Results and Discussion

Chemical Analysis of Plants and Soil

1. *Plant chemical analysis*

Chemical analysis of the 19 range plants included proximate analysis and nutrient element analysis. On the basis of protein content, palatability and wide distribution as criteria for selecting potentially useful grazing plants, seven species

were selected. They were: 1. *Plantago ovata,* 2. *Prosopis farcta,* 3. *Hammada elegans,* 4. *Panicum turgidum,* 5. *Pennisetum divisum,* 6. *Stipagrostis plumosa,* 7. *Rhanterium epapposum.*

A. *Proximate analysis*

The analyses included, crude protein, ether extract, crude fibre, ash and sand, and the results are presented in (Table 1).

Crude protein

The results in Table 1 show that *Plantago ovata, Prosopis farcta* and *Hammada elegans* contained the highest protein contents, compared with the other selected species, being 12.6, 12 and 11.3 percent, respectively. Generally, the crude protein contents of the plants decreased with ageing, reaching its maximum value in the vegetative or flowering stage and dropping to its minimum in the senescent stage. Some exceptions to this trend were found, (notably the grasses, *Stipagrostis plumosa* and *Ashterantherum forskalii*), but this can be attributed to large variations found between samples and location.

Ether extract

Table 1 reveals that ether extract ranged from 0.9% in *Hammada elegans* and *Stipagrostis plumosa* to 2.1% in *Plantago ovata,* indicating a relatively high lipid content in the latter species.

Crude fiber

The results in Table 1 indicate that *Plantago ovata* had the lowest crude fiber percentage compared with the other six selected species. Low crude fiber content tended to be associated with high protein except for *Atriplex leucoclada.*

Ash content

The data in Table 1 show that the ash content of the 7 selected species ranged from 6.2 to 26%; *Plantago ovata* produced the highest ash content, whereas *Prosopis farcta* gave the lowest. The very high value of 53.4% for *Atriplex leucoclada* was found to be caused by sand, (24.3%) lodged in its structure, even after washing; some samples of *Bassia muricata, Plantago ovata, Hammada elegans, Stipagrostis plumosa* and *Cyperuis conglomeratus,* retained up to 10% sand after being washed, but most plant samples contained less than 2% sand. A positive correlation was found between the sum of the mineral percentages and the ash content, (with a correlation coefficient of 0.71, which was significant at the 1% level, using data from Tables 1, 2 and 3), indicating that a higher ash content probably resulted from mineral accumulation.

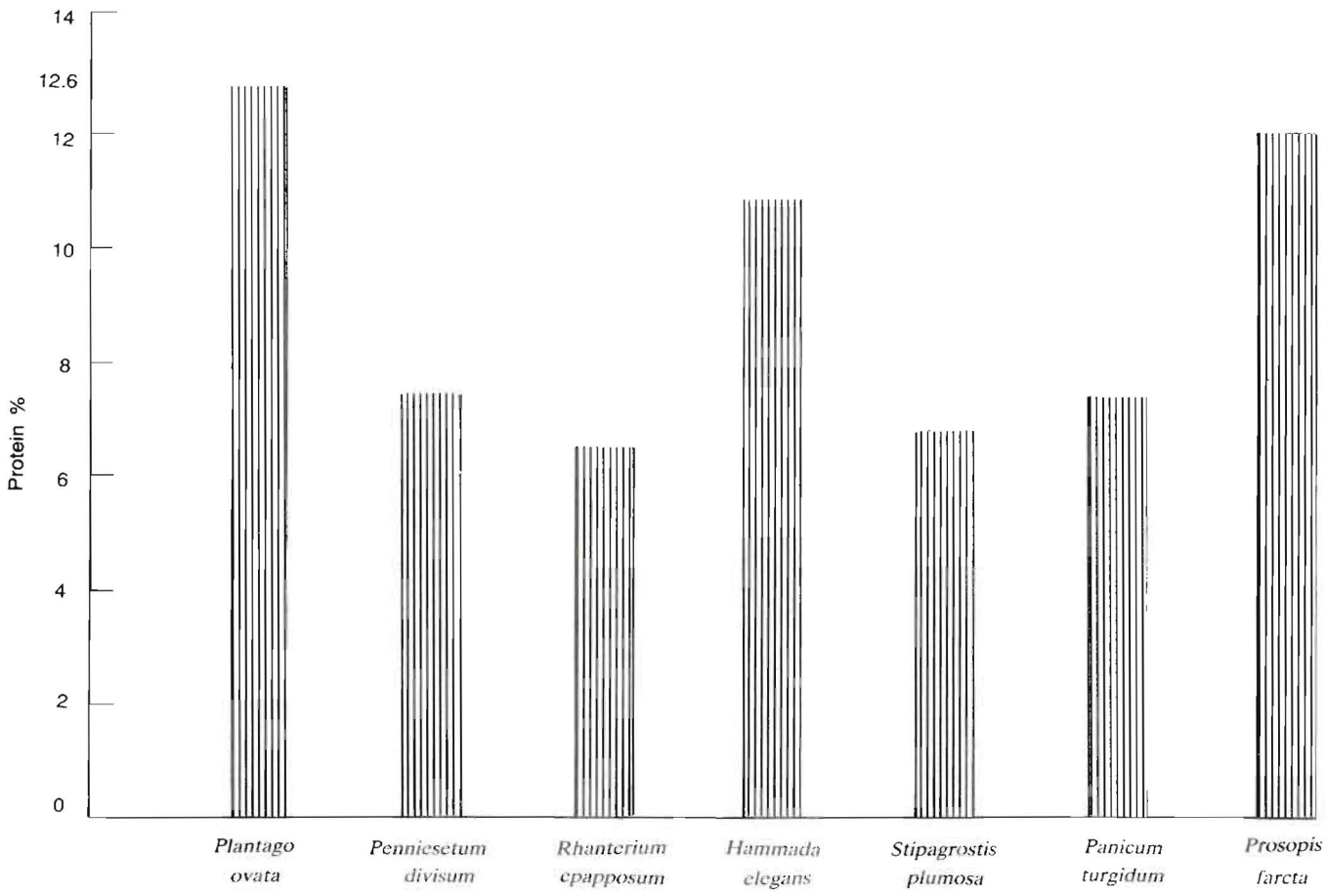

Fig. 1. Protein Content of the Seven Selected Grazing Plants at Maturity (as % Dm)

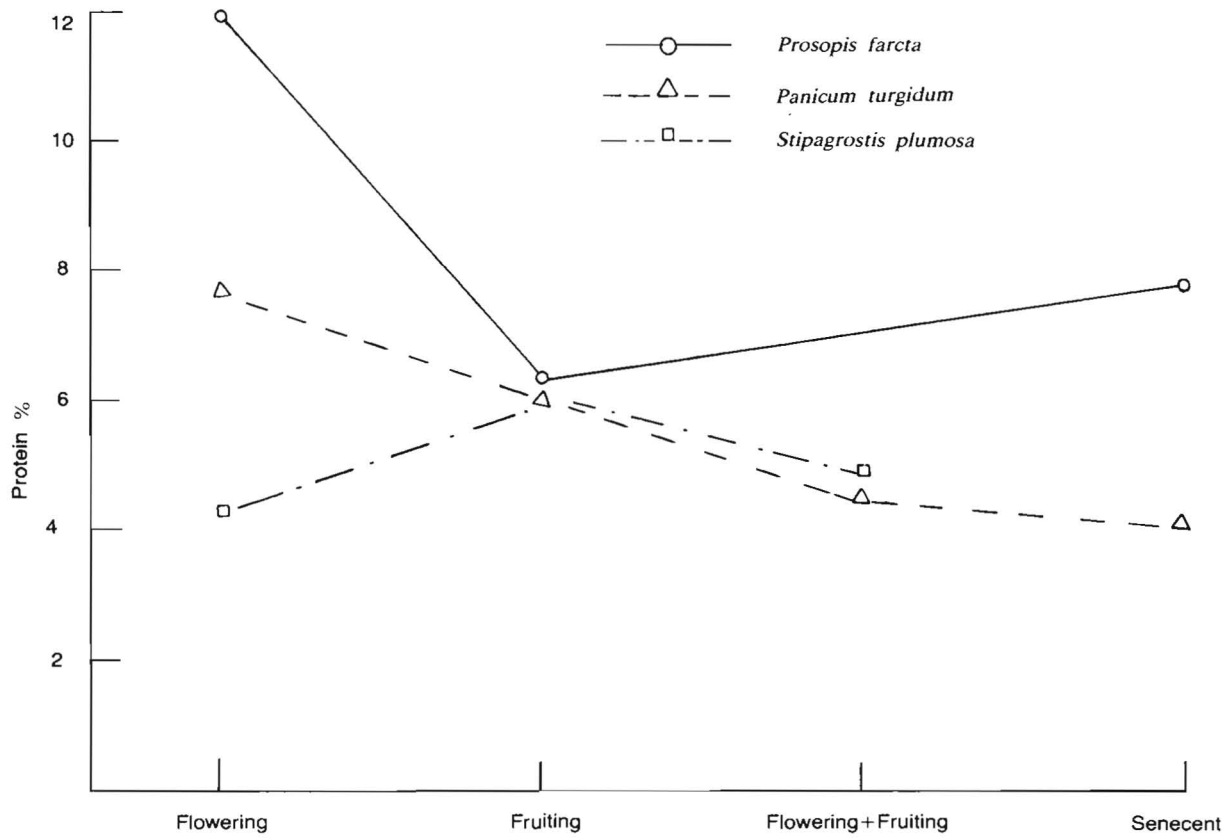

Fig. 1. Protein Content of the Seven Selected Grazing Plants at Maturity (as % Dm)

Table 1. Means of proximate chemical analysis of the 19 studied range plant species at maturity (as percent dry matter)

Species	Crude Protein	SD*	Ether Extract	SD	Crude Fiber	SD	Ash	SD	Sand	SD
Plantago ovata	12.6	3.5	2.1	0.7	26.8	4.5	22.0	2.8	8.9	1.5
Prosopis farcta	12.0	3.7	1.2	0.1	31.6	4.2	6.2	0.1	0.0	0
Hammada elegans	11.3	2.1	0.9	0.3	31.4	7.7	16.0	2.8	0.2	0.05
Panicum turgidum	7.4	2.4	1.8	0.5	38.1	2.9	7.9	1.7	2.4	0.34
Pennisetum divisum	7.4	1.2	1.2	0.1	38.0	0.7	10.3	0.7	1.4	0.64
Stipagrostis plumosa	7.3	2.7	0.9	0.6	31.4	3.5	16.0	5.6	4.46	1.42
Rhanterium epapposum	6.5	3.7	1.4	0.7	39.0	12.4	8.1	2.5	1.0	0.26
Schismus barbatus	11.1	5.4	2.7	0.4	23.9	2.5	10.1	0.4	0.0	0
Bassia muricata	10.0	–	1.4	–	29.8	–	21.3	–	9.2	–
Tamarix aphylla	8.6	–	1.9	–	30.8	–	14.2	–	0.3	–
Dipterygium glaucum	8.5	–	1.7	–	45.6	–	11.3	–	0.0	–
Atriplex leucoclada	8.4	–	1.3	–	18.6	–	53.4	–	24.3	–
Monsonia nivea	8.0	–	1.4	–	35.2	–	8.0	–	2.7	–
Atriplex canescense	7.8	9.1	0.9	1.3	40.6	17.0	13.0	10.2	0.2	–
Calligonum comosum	6.4	0.4	1.2	0.2	39.8	5.1	6.9	1.1	0.5	0.01
Heliotropium diqynum	6.3	–	1.0	–	51.8	–	6.9	–	1.3	–
Seidlitzia rosmarinus	6.2	–	0.7	–	23.2	–	26.2	–	0.3	–
Ashterantherum forskalii	4.6	8.7	1.1	1.5	38.2	11.8	7.3	7.1	2.3	0.88
Cyperuis conglomeratus	3.6	0.6	2.7	1.0	25.8	6.5	17.3	3.8	7.0	1.79

* SD – Standard Deviation

Table 2. Means of major elements of the seven selected range plants in which phosphorus are in ug/g and the rest of elements are in percent

(on dry matter basis)

Species	Major elements									
	ug/g		Percentage							
	P	SD	Ca	SD*	Mg	SD	Na	SD	K	SD
Plantago ovata	1182.0	434	1.96	1.50	0.31	0.11	0.30	0.35	2.0	0.23
Prosopis farcta	1036.5	245	1.00	0.10	0.16	0.01	0.12	0.02	0.62	0.06
Hammada elcgans	365.2	304	2.36	0.85	1.24	0.35	0.87	0.42	0.77	0.25
Panicum turgidum	757.4	438	0.55	0.28	0.28	0.30	0.98	0.04	0.46	0.26
Pennisetum divisum	587.0	394	0.55	0.16	0.19	0.09	0.10	0.04	0.62	0.30
Stipagrostis plumosa	484.0	462	1.03	0.79	0.29	0.24	0.26	0.24	0.47	0.23
Rhanterium epapposum	525.0	630	0.84	0.23	0.17	0.07	0.17	0.26	0.62	0.24

* SD – Standard Deviation

B. *Mineral analysis*

The results of the mineral analysis are given in Tables 2 and 3. Major elements determined were phosphorus, calcium, magnesium, sodium and potassium and the minor elements included, copper, manganese, iron, zinc and molybdenum.

The results clearly show that *Plantago ovata* contained adequate amounts for ruminant nutrition for all the measured elements, whereas the other six species contained adequate amounts of the measured elements for animal nutrition with the exception of phosphorus, the level of which was about 1/3 to 1/2 the amount required for ruminant nutrition, (Tables 4 and 5). Tables 2 and 3 show that *Plantago ovata* contained the highest level of phosphorus, potash, iron, copper and molybdenum as compared with the other six selected species, whereas, *Hammada elegans* contained the highest amount of magnesium.

2. *Soil Analysis*

The results presented in Table 6 show that all samples gave an alkaline aqueous extract ranging in pH from 7.95 to 8.68. The electrical conductivity was found to range between 0.26 and 1.92 mS/cm. The results also revealed that the available concentrations of copper, manganese, iron and zinc in the soil ranged between 0.24 to 0.96, 2.1 to 9, 2.4 to 3.4 and 0.26 to 0.70 microgram/gram of dry soil, respectively.

The results above can be discussed with reference to the critical values of these trace elements thought to be necessary for adequate plant nutrition. The

Table 3. Means of minor elements of the seven selected range plants in which elements are in ug/g (on dry matter basis)

Species	Minor elements									
	ug/g									
	Cu	SD*	Mn	SD	Fe	SD	Zn	SD	Mo	SD
Plantago ovata	20.4	4.3	87.0	21.1	2500	348	175.0	50.9	6.2	2.3
Prosopis farcta	14.5	1.9	51.0	4.2	375	203	28.0	0.1	1.3	0.7
Hammada elegans	7.5	2.6	71.0	53.3	291	189	11.0	5.0	1.2	2.0
Panicum turgidum	9.6	6.6	22.7	10.2	297	305	65.4	11.3	1.5	0.8
Pennisetum divisum	7.1	3.0	22.5	3.5	382	35	65.0	2.5	1.5	0.3
Stipagrostis plumosa	6.9	1.7	45.0	15.8	724	474	45.0	15 3	1.5	0.7
Rhanterium epapposum	14.5	3.1	43.0	17.2	1266	592	139.0	10.0	2.9	1.9

* SD – Standard Deviation

values given by Lindsay and Norvell (1978) are (for response to corn and sorghum) copper (0.2 ppm), Manganese (1.0 ppm), Iron (4.5 ppm) and Zinc (0.6 ppm).

These criteria would place the available copper and available manganese as adequate, whereas, available iron would be deficient and available zinc would be borderline.

Apart from there being a noticable deficiency in soil available iron (Table 6), the criteria of Lindsay and Norvell seem to reflect an adequate micronutrient level for plant nutrition. However, low available soil mineral content is not reflected in low plant tissue concentrations implying that the critical values of Lindsay and Norvell (1978) are probably too high and inappropriate for these range plants.

3. *Seed Germination Experiments*

Three experiments on the germination of seeds from five of the seven selected species were carried out in the laboratory, glasshouse and in the field. In all these experiments seed germination was found to be very poor for all the five species. This can be attributed to seed dormancy or immaturity. However, when the seeds were kept in the laboratory for about 10 months and fully matured seeds were

Table 4. Required levels of elements for adequate nutrition (levels given in % on dry matter basis)

Element	Deficient	Theoretically adequate
Phosphorus	0.10	0.14 (1400 mg/gram)
Calcium	0.15	0.20
Magnesium	–	0.10
Sodium	0.01	0.02
Potassium	–	0.35

Table 5. Approximate concentrations (ppm) of elements in mature leaf which may be considered as deficient, adequate or excessive for plant growth (Benton Jones 1972)

Element	Deficient	Adequate	Excessive or Toxic
Copper	4	5-20	20+
Manganese	50	50-250	500+
Iron	20	20-500	Not known
Zinc	20	25-150	400+
Molybdenum	0.1	0.5-7	Not known

Table 6. Available cations (DTPA extract) (As microgram/gram of dry soil)

Sample	Copper	Mn	Iron	Zinc	pH	Electrical conductivity (E.C)
1	0.44	2.9	3.2	0.70	8.31	0.34
2	0.78	5.0	2.4	0.64	8.03	0.88
3	0.28	2.0	3.0	0.36	8.54	0.26
4	0.32	2.1	2.6	0.26	8.68	0.63
5	0.24	2.7	2.9	0.48	8.54	0.325
6	0.28	3.1	2.9	0.32	8.68	0.335
7	0.32	2.5	2.4	0.28	8.10	1.490
8	0.96	9.0	3.4	0.52	7.95	1.920
9	0.26	3.5	2.5	0.48	8.18	0.390

Table 7. Means of seed germination of some grazing species

Species	Seed germination %	
	Before storage	After storage
Plantago ovata	40	90
Rhanterium epapposum	6	80
Stipagrostis plumosa	5	70
Panicum turgidum	0	65
Hammada elegans	0	71

Table 7a. Mean effect of germination percentage of seed before and after storage of five grazing plants

Seed	Mean value of seed germination
Before storage	10.3b
After storage	75.2a
Significant at 0.01	***

L.S.D.: 4.35
S.E. : 5.64
Means of the same letters are not significantly different.

selected under the microscope, good germination was obtained for five of the selected species (Table 7). This indicated that the long period of storage resulted in breaking seed dormancy.

Photographs of the selected species are presented in Plates 1-7.

Conclusion

In the light of the investigations conducted in the three grazing areas, it was observed that the vegetative cover was generally relatively good and included some range species of high palatability and nutritive value. It was also noticed that Naeeryah and Wadi Al-Meyah areas had better vegetative cover, and good grazing species compared with Hofuf-Salwa road area. This can be attributed to higher rainfall, lower evapotranspiration and better soil.

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Plate 1

Plate 1-1. *Panicum turgidum*

Plate 1-2. *Stipagrostis plumosa*. The inflorescence.

Plate 1-3. *Pennisetum divisum*. The inflorescence.

Plate 1-5. *Prosopis farcta*, young and old fruits.

Plate 1-4. *Hammada elegans*

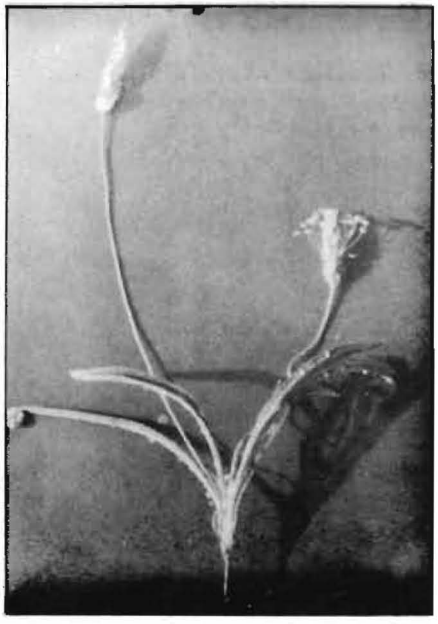

Plate 1-6. *Plantago ovata*

Plate 1-7. *Rhanterium epapposum*

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دراسة التركيب الكيميائي للنباتات الرعوية الطبيعية بالمنطقة الشرقية بالمملكة العربية السعودية

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أجريت دراسة على التركيب الكيميائي لأنواع من النباتات الرعوية الطبيعية بالمنطقة الشرقية بالمملكة العربية السعودية وعلى تحليل التربة التي تنمو عليها تلك النباتات. ومن خلال هذه الدراسة وجد أن إنتشار هذه النباتات الرعوية يتركز في ثلاث مناطق رئيسية بالمنطقة الشرقية هي النعيرية و وادي المياه وطريق سلوى ومن نتائج الدراسة تبين أن سبع نباتات رعوية هي أفضل الأنواع للرعي ومن ثم يمكن إستئناسها.

ومن هذه النباتات :

١ ـ الربل *Plantago ovata*

٢ ـ البرسوبس فاركتا *Prosopis farcta*

٣ ـ الرمث *Hamada elegans* وتحتوي على كميات عالية نسبياً من البروتين والتي تتراوح بين ١١,٣ و ١٢,٦ ٪ عند النضج والأربع الأخرى هي :

٤ ـ الثمام *Panicum turgidum*

٥ ـ الدخن البري *Pennisetum divisum*

٦ ـ النصى *Stipagrostis plumosa*

٧ ـ العرفج *Rhanterium epapposum* وتحتوي على كمية منخفضة نسبياً من البروتين الخام والتي تتراوح ما بين ٦,٥ و ٧,٤ ٪ عند النضج .

وتميزت كل هذه الاصناف بالإنتشار الواسع والاستساغة الجيدة وفي ضوء ذلك أجريت تحاليل كيميائية دقيقة على هذه الأنواع السبعة لتقدير محتوى أغلب العناصر الكبرى والصغرى ومدى كفاية هذا المحتوى لتلبية احتياجات حيوانات الرعي . وبإستثناء عنصر الفوسفور تبين أن جميع الانواع المختارة تحتوي على كميات كافية من العناصر اللازمة لتغذية الحيوان. كما تم تحليل التربة التي تنمو فيها هذه النباتات لتقدير الحموضة والملوحة، وكانت درجة الحموضة تتراوح ما بين pH ٧,٩٥ و pH ٨,٦٨ بينما الملوحة تتراوح بين ٠,٢٦ و ١,٩٢ ملليموز للسنتيميتر. كما وجد أن التربة تحتوي على كمية كافية من النحاس والمنجنيز بينما هناك نقص في عنصر الحديد في حين أن كمية عنصر الزنك كانت على حافة المستوى الحرج وذلك وفقاً للطريقة التي أتبعها العالمان Lindsay and Norvell (١٩٧٨).

كما أجريت تجارب على إكثار هذه الأنواع بالبذور وكانت النسبة المئوية للانبات ضعيفة حيث تراوحت ما بين صفر ٪ إلى ٤٠ ٪ ولم ترتفع إلا بعد تخزين البذور لمدة حوالي ١٠ شهور حيث تفاوتت نسبة الانبات بين ٦٥ ٪ و ٩٠ ٪ .