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Investigating the nutritional potential and vegetation blueprint mapping of *Acacia tortilis* and *Acacia ehrenbergiana* from the origin of Fujairah, UAE, for Arabian Tahr as native fodder plants

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Abstract

Background: *Acacia ehrenbergiana* and *Acacia tortilis* are the native plant of the Emirates of Fujairah, UAE. The qualities of these plants of bearing harsh environmental conditions makes it prime focus for native fodder plants for Arabian tahr and the priority plants for the Higher authorities in Fujairah.

Methods: The following study has assessed the comparative nutritional values of *Acacia tortilis* and *Acacia ehrenbergiana*. The analyses have been determined by international standard procedures using Gravimetry, Soxhlet extraction, HPLC, and ICP-OES(AOAC 962.09, AOAC 941.12). The vegetation mapping for the blooming period has been done by NVDI using data from Sentinel-2 satellite. The statistics of agricultural and non-agriculture areas in kilometer square (km^2) have been found to confirm the findings of the NDVI using the satellite images.

Results: The study has highlighted the importance of these native plants as a fodder plant for Arabian tahr as potential source of potassium, calcium, and magnesium and phosphorus. Furthermore, the native plant's mapping showed Emirates of Fujairah's vegetation during March to May 2022.

Conclusion: Results shows that the *A. ehrenbergiana* is comparatively healthier diet for Arabian Tahr than *Acacia tortilis*. Tahr can get on average 400 mg/100g of four important minerals including K, Ca, P and Mg while Acacia tortilis could provide 174 mg/100g. Moreover, the native plant's vegetation mapping can work as blueprint and will help identify plant dispersion and expansion planning.

Introduction

Through its five-decade long journey, the UAE has kept a close watch on its biodiversity, with animals and plants remaining a key part of its identity. Arabian tahrs are native to eastern Arabia. These animals live on steep rocky slopes of the Al Hajar Mountains in Oman and the United Arab Emirates. They are also found in the area of Jebel Hafeet-a Mountain in the region of Tawam, on the border of the United Arab Emirates and Oman [1].

Arabian tahrs are considered browsers, feeding on grass, shrubs, leaves and tree fruits (Figure 1). They also impact vegetation communities through their browsing [2]. Interestingly, the Arabian tahr are an indicator of the condition of their habitat, which means their presence helps determine the overall health of the ecosystem they live in. These species can be found at high elevations (1,000 to 1,800 meters) on steep slopes where rainfall is relatively high, and vegetation is diverse. Since the Arabian tahr has a limited geographic range due to water and nutritional requirements which makes them more susceptible to extinction [3].

Figure 1: Arabian Tahr,
Image source: Environment agency, Abu Dhabi

Native plants such as *Acacia tortilis* which Known as Samar and *Acacia ehrenbergiana* Known as Salam are important plants species that the country and its leaders have worked on to conserve it along with animals' species such as Arabian tahr. Acaciatortilis is small to medium sized slow growing tree found to survive in arid and semi-arid areas (Figure 2). It's one of commonly found trees in UAE with annual blooming period of three months from March to May. *Acacia tortilis* and its derivatives considered highly valuable[4]. It has medicinal benefits to treat number of diseases including dry cough, fungal infections, diarrhoea. Similarly, *Acacia ehrenbergiana* is native to the hot and dry environment (Figure 3). It's a tiny tree or tall shrub that seldom grows taller than 4 meters with blooming period similar to Acacia tortilis. Being modestly salt tolerant, Acacia ehrenbergiana and Acacia tortilis are suitable for the hot and dry weather of UAE, with water scarcity and high salinity which makes most of the land nonarable [5]. Both the *Acacia tortilis* and *Acacia ehrenbergiana* are important legume fodder tree for indigenous populations and used to feed animals, such as goats, sheep and camels.

In this study, we are investigating the nutritional and chemical values of Acacia tortilis and Acacia ehrenbergiana to understand the potential of these plants as native fodder plants for Arabian tahr. Moreover, the agriculture mapping has been shown in the land of Fujairah for the blooming period of these plants as a base of the project of blueprint mapping of native plants.

Figure 2: The tree of *Acacia tortilis.*

Figure 3: Flower and leaves of *Acacia ehrenbergiana* tree

Methods

Sample collection:

The leaves of *Acacia tortilis* and *Acacia ehrenbergiana* were collected from Wadi Wurayah and Al Taibah Farm, Fujairah, UAE, respectively. Each sample weigh about 500g and stored in sterile plastic Packaging.

Sample preparation for nutrient and chemical composition analysis:

The analytical grade, high quality chemicals has been used in this experiment to find nutrient, minerals, and

heavy metals. The Dry matter has been determined by Gravimetry, crude protein by Kjeldahl method, crude fat by Soxhlet, sugar using HPLC, crude fiber and TDN by standard method (Association of Official Agricultural Chemists) AOAC 962.09 and ash by AOAC 941.12 as mentioned in C. Naumann and R. Bassler, "Chemical Analyses of Animal Feed," VDLUFA-Verlag, Darmstadt, 2004. Mineral analysis for Calcium, Phosphorus, Sodium, Potassium, Zinc, Copper, Manganese, Selenium, Magnesium and heavy metal analysis has been done using standard methods in Inductively coupled plasma - optical emission spectrometry (ICP-OES) technique[6].Homogeneity is ensured while handling samples. Leaves samples were washed with sterile water to remove dirt. The <1g samples were weighed and grounded to make fine powder. The samples then transferred into Teflon vessel and washed with 5ml 69% HNO_3 (nitric acid) for 10 minutes on 200 °C. In the next step, the leaves were digested by adding 7ml of 69% HNO_3 and 1ml of 31 % H_2O_2.All the procedure has been done in rotor. After carefully removing the teflon vessel from rotor and washed with deionized water. The digested leaves were washed by deionized solution on filter paper three to 4 times and the master sample solution is to further run the analysis using above mentioned techniques and instruments. A reagent blank solution has also been prepared in parallel.

Vegetation Blueprint mapping

The high-resolution images of Fujairah region have been downloaded from Sentinel-2 satellite for the months of March, April and May 2022. The vegetation was marked on the map by NDVI(Normalized differences in vegetative index). The indexation values coming above 0.2 were marked green which shows the vegetation.

Area calculation

Downloading filtered satellite photos necessitates a pixel count estimate based on Fujairah's total area of 1,587.15 km2. Images were filtered using Python libraries into the 13 colors utilized in the NDVI range, with white serving as the backdrop color for the satellite picture. All 13 colors were analyzed and assigned to the image's pixels. All pixels with an NDVI value greater than 0.3 had their color intensity added together. The result was used to determine the pixel-by-pixel agricultural and non-agricultural regions in km2.

Results

The proximal nutritional analysis estimate that the percentage of dry matter in *Acacia tortilis* is higher than the percentage of dry matter in *Acacia ehrenbergiana* by 5.7%(Table 1; Figure 4).While crude protein is higher in *Acacia ehrenbergiana* than in *Acacia tortilis* by 0.34%which is not much different between both plants. Similarly, crude fats are similar in both plants. The total sugar and TDN in *Acacia ehrenbergiana* are higher than those in *Acacia tortilis* for a0.39% more total sugar, and a 4.53% more TDN. The macro-mineral composition analysis showed significantly higher amount of potassium (K) in *Acacia ehrenbergiana* than *Acacia tortilis*, where the values are 982.37mg/100g and 124.59mg/100g, respectively (Table 2; Figure 4).*Acacia tortilis* has less calcium valued 282.85mg/100g compared to *Acacia ehrenbergiana* which is 375.62 mg/100g. However, *Acacia tortilis* has comparatively more phosphorous quantity than *Acacia ehrenbergiana*. While the concentration of sodium is 11.63 mg higher in *Acacia ehrenbergiana* than in *Acacia tortilis*. Zinc and magnesium are more concentrated in *Acacia tortilis*, it has 0.15mg more zinc and 35.98 mg more magnesium and both improve bone density. While the element copper is most concentrated in *Acacia ehrenbergiana* by a total difference of 0.22mg. The element selenium has a similar value in both plants. No heavy metals have been detected in our investigation for the sample collected from Fujairah origin, UAE. This confirms the non-toxicity and safety for Arabian tahr consumption (Table 3).

Nutrients	*Acacia tortilis*	*Acacia ehrenbergiana*
Dry Matter	86.99	81.29
Crude Protein	7.08	7.42
Crude Fat	<0.1	<0.1
Crude Fiber	30.92	23.97
Ash	3.99	3.65
Total Sugar (Glucose, Fructose, Sucrose, Lactose)	1.84	2.23
TDN	63.11	67.64

Table 1: Proximal composition of nutrients in of *Acacia tortilis* and *Acacia ehrenbergiana*. Values in percentage (%) are shown.

Minerals	*Acacia tortilis*	*Acacia ehrenbergiana*
Potassium	124.59	982.37
Calcium	282.85	375.62
Phosphorus	133.31	122.94
Magnesium	153.88	117.9
Sodium	5.48	17.11
Zinc	1.31	1.16
Copper	0.5	0.72
Manganese	0.79	1.3
Selenium	<0.1	> 0.1

Table 2: Macro-Mineral composition analysis of *Acacia tortilis* and *Acacia ehrenbergiana*. Values are in mg/100g.

Heavy Metals	*Acacia tortilis*	*Acacia ehrenbergiana*
Cadmium (Cd)	ND	ND
Nickel (Ni)	ND	ND
Lead (Pb)	ND	ND

Table 3: Heavy metal comparative analysis of *Acacia tortilis* and *Acacia ehrenbergiana*(mg/kg). ND = Not detected.

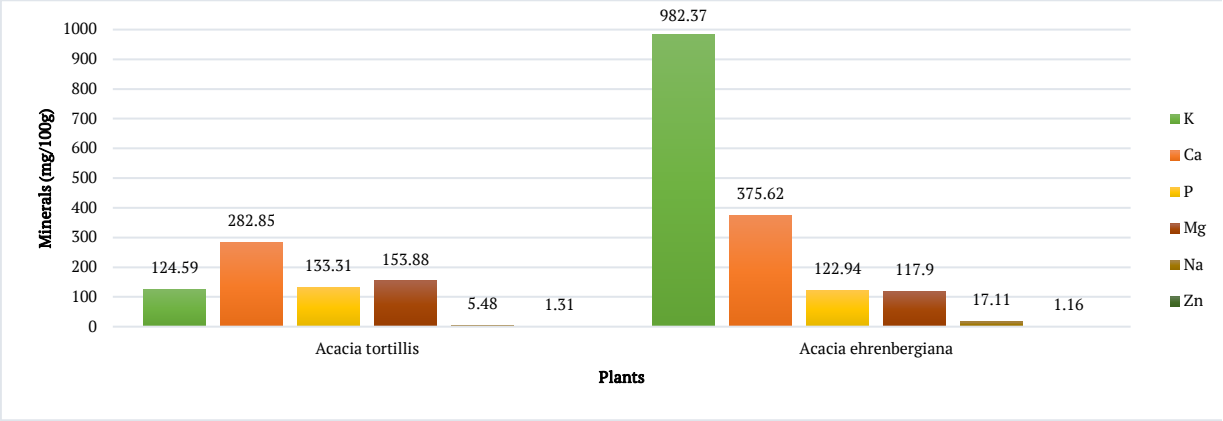

Figure 4: Comparison of Mineral content of *Acacia tortilis* with *Acacia ehrenbergiana*. The results demonstrate that the *Acacia tortilis*

The NDVI, which is well-known and often used, is a simple but efficient indicator for measuring vegetation. It correlates chlorophyll absorption at red wavelengths with near-infrared leaf scattering in green leaves. Using GIS satellite images, it is important to monitor the development of and spot changes in vegetation over time. The NDVI has a value range from -1 to 1 in general. (Table 4) below illustrates the differences between the index values. It functions well as a stand-in for actual real plants. In addition to (Figure 5), it shows the color legend of NDVI ranges. The vegetation blueprint mapping has been done for the blooming period of *Acacia tortilis* and *Acacia ehrenbergiana*. The blooming period lasts for three months (March to May). The yellow to green marking shows the intensity of the vegetation. Yellow shows low level of vegetation while the green coloured marking shows the high level of vegetation. Rest is the normal arid terrain of the land of Fujairah (Figure 6).

NDVI range	HTLM color code	Color
NDVI < -0.2	#000000	
-.2 < NDVI ≤ 0	#a50026	
0 < NDVI ≤ .1	#d73027	
.1 < NDVI ≤ .2	#f46d43	
.2 < NDVI ≤ .3	#fdae61	
.3 < NDVI ≤ .4	#fee08b	
.4 < NDVI ≤ .5	#ffffbf	
.5 < NDVI ≤ .6	#d9ef8b	
.6 < NDVI ≤ .7	#a6d96a	
.7 < NDVI ≤ .8	#66bd63	
.8 < NDVI ≤ .9	#1a9850	
.9 < NDVI ≤ 1.0	#006837	

Figure 5: NDVI color legend based on its range.

Agricultural and Non-agriculture Areas

According to calculations, the statistics in (Table 5) show that in March 2022, 266.4 km2 of Fujairah was agricultural lands, with the remaining area being undisturbed by the NDVI and satellite images. However, by April of 2022, the agricultural area had shrunk to just 252.9 km2.Vegetation cover dropped substantially from May of the same year, to a mere 99.8 km2.These shifts are clearly depicted in (Figure 6).

NDVI values	Represent
Values close to -1 (low values)	Presence of water
Values close to zero (-0.1 to 0.1)	Simulate deserts with rocky, snowy terrain, or sand
Low, positive values (between 0.2 and 0.4)	Portray shrubs and grassland
High, positive values (approaching 1)	Temperate and tropical rainforests

Table 4: Explanation of NDVI range values and their representation in the filtered GIS image

Date	Total Area of Fujairah	Agriculture	Non-Agriculture
March 2022	1587.15 km²	266.4 km²	1320.7 km²
April 2022		252.9 km²	1334.3 km²
May 2022		99.8 km²	1487.3 km²

Table 5: Agriculture and Non-agriculture total area of the emirates of Fujairah

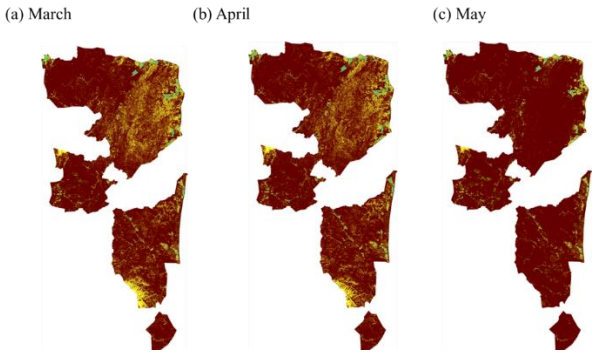

Figure 6: The figure shows the vegetation blueprint mapping for the blooming period of three months for the plants in Fujairah. (a) shows the vegetation in March, (b) shows the vegetation in April, (c) shows the vegetation May. The yellow-colored area showed low level of vegetation and greener colored shows the high level of vegetation. The rest of the brown colored showed the arid terrain of Fujairah.

Discussion

According to results, Acaciatortilis has higher in crude fibreby a percentage of 6.95 and in ash by percentage of 0.34 which mean that the leaves of *Acacia tortilis* could be a good diet for Arabian tahr to maintain healthy body mass.The value of potassium is much higher in Acaciaehrenbergiana than the *Acacia tortilis*. Potassium helps in proper muscle development and an important mineral for Tahr growth. The higher potassium contents have reported in *Acacia ehrenbergiana* from the origin of Sudan as well [7]. Similarly, the amount is calcium is higher in *Acacia ehrenbergiana* than the *Acacia tortilis*.Calcium is an important mineral for the bone strength and development.One of the previous studies has reported the higher nutritional values of *Acacia ehrenbergiana* as compared to widely used staple food crops including wheat, rice, soyabean and chickpea [6].

Overall key findings from our investigation suggest that the *Acaciae hrenbergiana* is comparatively healthier diet for Arabian tahr than *Acacia tortilis*. Arabian tahr can get on average 400 mg/100g of four important minerals including K, Ca, P and Mg while *Acacia tortilis* could provide 174 mg/100g. However, additional analysis is required to understand the absorption of potential minerals from this plant to finally conclude the exact benefits. Moreover, the native plant's blueprints have shown the vegetation that has covered Emirates of Fujairah for the blooming months of March to May in 2022. We will proceed further on vegetation blueprint mapping for native plants to benchmark the production of specific plant on the map. This will help in understanding geographical distribution of specific plants based on land conditions and assist in its expansion strategies.

Competing Interest

The authors declare that there is no conflict of interest.

Author Contributions

Aishah Saeed Sulaiman Jemei Al Dhanhani: involved in the experimental work and drafting the manuscript. Shaher Bano Mirza: carried out the design of the overall project and prepared final manuscript, Fatmah Rashed Mohamed Obaid Alhefeiti: carried out experiments work for vegetation blueprint marking and Fouad Lamghari Ridouane: participated in the overall design of the project and manuscript proofread.

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