Full Length Research Article
Advancements in Life Sciences – International Quarterly Journal of Biological Sciences

ARTICLE INFO

Date Received: 17/08/2022;
Date Revised: 23/09/2022;
Date Published Online: 31/12/2022;

Authors' Affiliation:
Fujairah Research Centre, Sakamkam Road, Fujairah, United Arab Emirates

***Corresponding Author:**
Shaher Bano Mirza
Email: shaher.bano@frc.ae

How to Cite:
Al Dahmani WSOF, Mirza SB*, Kalathingal MSU, Fouad FL (2022). Macro-mineral concentration analysis of *Acacia ehrenbergiana* (Salam) from the origin of Fujairah, UAE, with staple food items as a mineral rich dietary supplement for arid and semi-arid lands of the world. Adv. Life Sci. 9(4): 534-538.

Keywords:
Acacia ehrenbergiana; Priority plant; Native; Fujairah; High potassium; Calcium; Magnesium; Vegetation; Mapping; Sentinel2; NVDI

Open Access

Macro-mineral concentration analysis of *Acacia ehrenbergiana* (Salam) from the origin of Fujairah, UAE, with staple food items as a mineral rich dietary supplement for arid and semi-arid lands of the world

Wesayef Saeed Obaid Fares Al Dahmani, Shaher Bano Mirza*, Muhammed Sirajul Huda Kalathingal, Fouad Lamghari Ridouane

Abstract

Background: *Acacia ehrenbergiana* is native plant of the Emirates of Fujairah, UAE. It's qualities of being salt tolerant and coping up with harsh condition makes it prime focus and one of the priority plants for the Higher authorities in Fujairah.

Methods: The following study has assessed the nutritional values of *Acacia ehrenbergiana* and its comparison with staple foods used around the world. Proximate analyses were determined by international standard procedures (Association of Official Analytical Chemists, AOAC 2001.11, AOAC 920.39, AOAC 962.29, AOAC 942.05). Mineral ICP-OES vegetation mapping NVDI done using data from Sentinel2 satellite.

Results: The study highlighted the importance of this native plant as a potential source of potassium, calcium, and magnesium with higher values of these minerals as compared to the wheat, rice, soyabean and chickpeas. Expansion of vegetation has also been mapped which provide useful insight into the potential of Fujairah's landscape in mass production of *Acacia ehrenbergiana*.

Conclusion: Results shows that the *Acacia ehrenbergiana* is agro-economically favorable plant with nutritional values similar and mineral values higher than the widely used staple food crops. Moreover, the expansion of agriculture area in Fujairah provides more hope in expanding the production of *Acacia ehrenbergiana* and its use on industrial level to produce food items or dietary supplement as economically viable solution to malnutrition in world.

Introduction

Acacia ehrenbergiana, commonly known as salam is native to the hot and dry environment of the Arabian Peninsula. It's a tiny tree or tall shrub that seldom grows taller than 4 meters (13 feet) (Figure 1). It has many branches, a dark brown, hairy trunk, and green or brown stem with lustrous, peeling bark. Fujairah is the developing emirate of United Arab Emirates (UAE) with dry weather, rocky landscape, water scarcity and high salinity which makes most of the land nonarable. Being modestly salt tolerant, *Acacia ehrenbergiana* is suitable for the weather condition of Fujairah, hance is a native plant in UAE [1]. This plant can be found in abundance in desert area and in residential areas without external provision of water and mineral. It is an important legume fodder tree for indigenous populations and used to feed animals, such as goats, sheep, and camels. Its timber is used for charcoal and firewood. Acacia fiber's high concentration of soluble fiber is thought to provide several health advantages, including enhancing cardiovascular health, preventing diabetes, and reducing symptoms of irritable bowel syndrome (IBS). It has higher contents of minerals, vitamins, metals protein are useful carbohydrates.

Figure 1: The tree of *Acacia ehrenbergiana*

Wheat:

One of the most popular cereal grains consumed worldwide is wheat. It derives from (Triticum), a grass found in various variants all over the world. Wheat is the source of higher values of carbohydrate and ample amount of protein. Whole wheat is higher in fiber contents and minerals as compared to the refined one. Selenium, manganese, phosphorus, and copper are among the vitamins and minerals that may be found in reasonable amounts in whole wheat. There are varieties of wheat available in market including hard red wheat and hard white wheat. The hard red wheat contains high protein than hard white wheat, with values 12-15%, 10-14%, respectively. Along with nutritional benefits, wheat also promote gut health and reduce risk of colon cancer. Therefore, whole wheat, which contains wheat bran and wheat germ, offers defense against conditions like constipation, ischemia, heart disease, diverticulum disease of the colon, appendicitis, obesity, and diabetes [2].

Rice:

Rice (Oryza sativa L.) is one of the staple foods which fulfils the food requirements of more than half of the world's population [3]. The green resolution of the 1960s increase world rice production. Rice comes mainly in two varieties: white and brown. Whole grain rice that has had the inedible outer hull removed is known as brown rice. The bran and germ layer, which give rice its brown or tan color, remain on this type of rice even if the outer hull or husk is removed. Brown rice is rich in nutritional values than the white rice, however, later is consumed in more quantity than the brown rice. However, the Bran makes brown rice difficult to digest. Rice is a rich source of magnesium, phosphorus, manganese, iron, and selenium in addition to calories. However, the rice having a high glycemic index will lead to increased risk of diabetes as they digest quickly and can significantly raise blood sugar levels [4].

Soyabean:

Soybean (Glycine max) is a crop utilized for both human and animal nutrition. The seeds are high in concentration of isoflavones genistein and daidzein which is a source of important protein and energy contents, beneficial for human health. Soybean contains all eight essential amino acids, which are required for human nutrition and are not naturally generated in the body. Along with the nutritional benefits. Soybean also has medicinal benefits [5]. It contains healthy fat which is helps in to reduce blood cholesterol level. China is the biggest producer of soybean in the world with production of 1million tons per year. Soy milk is broadly used as alternate for dairy milk for lactose intolerant people.

Chickpea:

The chickpea (Cicer arietinum L.), along with other pulse crops, is a staple meal in many regions and is especially important as vegetarian diets around the world. The chickpea is a wonderful source of protein, fiber, minerals, vitamins, and energy [6]. It also includes phytochemicals that are useful for human health. The ingestion of chickpeas always needs some processing due to the numerous anti-nutritive components that prevent protein digestion in addition to their nutritional advantages. In 2020, India production of chickpeas was 11.1 million tons. Inadequate nutritional sources and the higher price of animal protein are the primary causes of malnutrition and undernourishment in the population because of the country's fast modernization and ongoing population growth. We are in dire need to

look for alternate food source or dietary supplements to fulfill the malnutrition in fast paced worldly habits [7].

In this study, we are investigating the nutrients and useful contents in Acacia from the region of emirates of Fujairah, UAE. This comparison analysis of Acacia with other staple food can be beneficial for the selection of Acacia as an alternate source of food and dietary supplement. Moreover, the expansion of agriculture land in the emirates of Fujairah has been mapped for past 5 (2017 to 2022) years to show the vegetation opportunity to exponentially grow this plant.

Methods

Sample collection:

Samples of fresh leaves of *Acacia ehrenbergiana* were collected from Fujairah near Al Taiba Farms weighing about 500 g. samples were stored inside sterile polythene bags until its used.

Chemical analysis:

The analytical grade, high quality chemicals has been used in this experiment to find nutrient, minerals, and heavy metals. Proximate analysis for chemical components; Dry Matter, crude protein, Crude Fat, crude fiber, ash, and TDN were determined by international standard procedures (Association of Official Analytical Chemists, AOAC 2001.11, AOAC 920.39, AOAC 962.29, AOAC 942.05) and others as mentioned in C. Naumann and R. Bassler, "Chemical Analyses of Animal Feed," VDLUFA-Verlag, Darmstadt, 2004. Total sugar was determined by HPLC.

Sample preparation for nutrient and chemical composition analysis:

Mineral analysis for Phosphorus (P), Calcium (Ca), Zinc (Zn), Copper (Cu), Magnesium (Mg), Selenium (Se), Manganese (Mn) has been determined by using inductively coupled plasma optical emission spectroscopy (ICP-OES). Sample were carefully handled to ensure homogeneity. A minimum amount of 250 g of sample was required for testing. The samples (leaves) were washed with sterile water. Each sample weighed <1g by analytical balance was transferred into sterile mortar pestle and then grounded to make a clear fine solution. They are mixed thoroughly to ensure homogeneity before weighing. Weigh approximately 0.8 g leaf sample were transferred into the Teflon vessel which has been washed with 5 ml 69% nitric acid (HNO3) at 500 W, 200 C for 10 minutes. The weight was recorded up to 4 decimals. Leaves were dried at 105 C. added 7 ml 69% nitric acid and 1 ml 31% H2O2. closed the rotor and digest the samples using the leaf digestion program. After the digestion is complete, we waited for the vessels to cool down. Rotor was carefully removed from the microwave. Later, Opened the rotor and took out the Teflon vessels. Wash the Teflon vessels with deionized water using wash bottle and filter through a Whatman No. 41 filter paper. Rinse the vessel thoroughly and transferred washings through filter paper. Washed the filter paper 4 – 5 times with de-ionized water. Used small increments so that the total volume remains under 50 ml capacity of flask. Allowed the solution to cool to room temperature and then make up to the mark and mix. This is the master sample solution. Similarly prepare a reagent blank solution in parallel with samples.

For essential metals such as sodium (Na) and potassium (K) we used a Eppendorf flame photometer. Firstly, we prepared the standard solution. For that, we added one gram of a sample, water, and HCL and waited for system to heat-up for 15 – 20 min. After boiling, we filtered it by vacuum filtration. The instrument was given (flame photometry) five to ten minutes to warm up. Added distilled water to the instrument. Selected the element Na by turning the selector "Elementwahl". Turned the outer knob "Messbereich" into position "100". Pulled the "Kompensaton I" knob slightly out and adjust readout to 0. Pressed the "Kompensation I" knob back. Readjusted 0 reading with "Kompensation II" when necessary. Aspirate the most concentrated standard solution and adjusted readout to approximately 350 (on uppermost scale) using inner "Messbereich" knob. Aspirated distilled water. Aspirated the standard solution and test solution and recorded the results. Later on, Aspirate distilled water for at least 5 minutes to clean the system.

Mapping the vegetation:

NDVI (Normalized differences in vegetative index) Images are downloaded from Sentinel 2 satellite vegetation was marked white with every NDVI coming above 0.2 value which represents the vegetation. All in-house scripts are used to carry out this mapping. Area was calculated based on pixel size.

Results

The proximate analysis in current study elaborated the comparison of nutritional attributes of *Acacia ehrenbergiana* with the widely used staple food around the world including wheat, rice, soyabean and chickpea (Table 1). Results demonstrated that the studied plant is significantly higher in crude fiber then staple foods where *Acacia ehrenbergiana* has 23.97%, wheat 2.5, rice 12%, Soyabean 18.38% and chickpea8% (Table 1). Similarly, *Acacia ehrenbergiana* has comparable total digestible nutrients (TDN) with the studied staple food with TDN value of 67.64% which is higher than the rice with the TDN value of 60.07%. Mineral composition analysis showed the adequate Ca concentration in *Acacia ehrenbergiana* which is significantly higher than the wheat, rice, and chickpea, however, comparable to

the soybean with values, 375.62, 34, 11, 2.45 and 300.36, respectively (Table 2; Figure 2).

Interestingly, the amount of Potassium in *Acacia ehrenbergiana* surpassed all the other staple food items under this study with 982.37 g/100g. The higher potassium contents have reported in *Acacia ehrenbergiana* from the origin of Sudan as well (8). Similarly, the values of magnesium (117.9g/100g) are noteworthy as well. Our experiment doesn't show the heavy metals contamination including cadmium (Cd), Nickle (Ni), and Lead (Pb) in the sample form the origin of Fujairah, UAE which confirms its non-toxicity for human and cattle consumption. However, trace amount of these cadmium (Cd) has been found in the wheat, rice and soyabean (Table 3).

Nutrients	*Acacia ehrenbergiana*	Wheat	Rice	Soyabean	Chickpeas
Dry matter	81.29	89	90	90	89
Crude Protein	7.42	11	12	37.08	12.6
Crude Fat	> 0.1	02.5	15	99.7	6
Crude Fiber	23.97	2.5	12	18.38	8
Ash	3.65	2		-	3.3
Total Sugar	2.23	-	-	-	3.6
TDN	67.64	74	60.09	77	-

Table 1: Proximal (%) composition of Nutrients in *Acacia ehrenbergiana* and its comparison with Wheat, Rice, Soyabean and Chickpea.

Minerals	*Acacia ehrenbergiana*	Wheat	Rice	Soya	Chickpeas
Calcium	375.62	34	11	300.36	2.45
Phosphorus	122.94	357	71	0.2	0.152
Sodium	17.11	3	7	3	24
Potassium	982.37	363	35	0.05	0.05
Zinc	1.16	2.6	2.7	2.7	-
Copper	0.72	0.41	0.284	-	-
Manganese	1.30	4.07	3.743	2.52	21.3
Selenium	< 0.1	35.2		-	
Magnesium	117.9	137	23	258.24	0.03

Table 2: Mineral contents analysis of *Acacia ehrenbergiana* and its comparison with Wheat, Rice, Soyabean and Chickpea. Values are in mg/100g.

Heavy metal	*Acacia ehrenbergiana*	Wheat	Rice	Soya	Chickpeas
cadmium (Cd)	-	1.57	1.2	0.11	-
nickel (Ni)	-	-	-	-	-
lead (Pb)	-	-	-	-	-

Table 3: Heavy metal detection in *Acacia ehrenbergiana* and its comparison with Wheat, Rice, Soyabean and Chickpea, (mg/kg).

The increase in vegetation area of Fujairah is mapped for the past 5 years and it can be seen that agriculture has grown enormously from 2017 to 2022 with overall area 4.77643675 km^2 to 99.98363163 km^2, respectively (Figure 3). White area denotes the vegetation and blue area is the normal land.

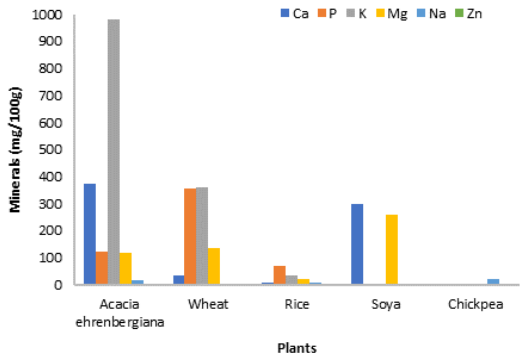

Figure 2: Mineral content analysis *Acacia ehrenbergiana* and its comparison with Wheat, Rice, Soyabean and Chickpea. The results demonstrate that the *Acacia ehrenbergiana* is high in potassium (K), calcium (Ca) and showed similar level of phosphorus (P) magnesium (Mg) sodium (Na) and zinc (Zn).

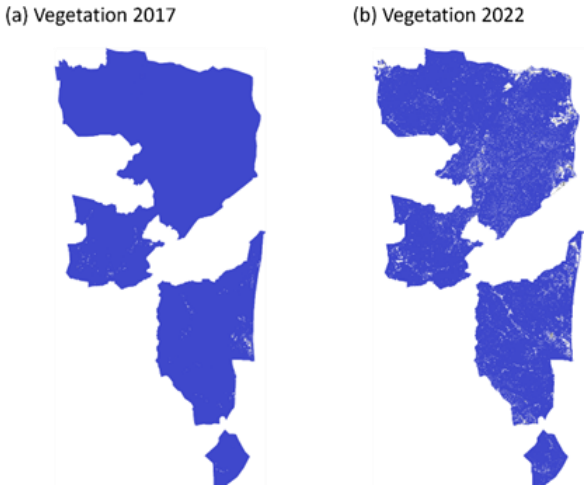

Figure 3: Mapping of vegetation in the emirates of Fujairah since past 5 years. (a) shows the area of 4.77643675 km^2 covered in vegetation in 2017 and (b) shows the area of 99.98363163 km^2 covered in vegetation. White area denotes the vegetation and blue area is the normal land.

Discussion

From the analysis above, the key finding emerged are *Acacia ehrenbergiana* is high in important minerals and it could potentially be used as a high potassium, calcium and magnesium diet or dietary supplement. The amount of Potassium in *Acacia ehrenbergiana* surpassed all the other staple food items under this study with 982.37 g/100g. The higher potassium contents have reported in *Acacia ehrenbergiana* from the origin of Sudan as well [8]. From the results, it's clear that the *Acacia ehrenbergiana* is agro-economically favorable plant with nutritional values similar and mineral values higher than the widely used staple food crops. Additional analysis is required to understand the absorption of potential minerals from raw form of this plant to get most of the benefits. Moreover, the expansion of agriculture area in Fujairah provides more hope in expanding the production of *Acacia*

ehrenbergiana and its use on industrial level to produce food items or dietary supplement as economically viable solution to malnutrition in world. Furthermore, we are working on mapping vegetation trend of Fujairah and the finding will be published as a separate research paper in future.

Competing Interest

The authors declare that there is no conflict of interest.

Author Contributions

Wesayef Saeed Obaid Fares Al Dahmani involved in the experimental work and drafting the manuscript. Shaher Bano Mirza carried out the design of the overall project and prepared final manuscript, Muhammed Sirajul Huda Kalathingal carried out experiments work for vegetation mapping and Fouad Lamghari Ridouane participated in the overall design of the project and manuscript proofread.

Acknowledgment

The authors thank the Fujairah Research Centre (FRC) for their financial and technical support.

References

1. KARIM FM, DAKHEEL AJ Salt-tolerant plants of the United Arab Emirates. Chapter: Book Name. 2006 of publication; International Center for Biosaline Agriculture, , Dubai, UAE.
2. Kumar P, Yadava R, Gollen B, Kumar S, Verma RK, et al. Nutritional contents and medicinal properties of wheat: a review. Life Sciences and Medicine Research, (2011); 22(1): 1-10.
3. Rehman H-u, Aziz T, Farooq M, Wakeel A, Rengel Z. Zinc nutrition in rice production systems: a review. Plant and soil, (2012); 361(1): 203-226.
4. Fukagawa NK, Ziska LH. Rice: Importance for global nutrition. Journal of nutritional science and vitaminology, (2019); 65(Supplement): S2-S3.
5. Burssens S, Pertry I, Ngudi DD, Kuo Y-H, Van Montagu M, et al. Soya, human nutrition and health. Soya bean meal and its extensive use in livestock feeding and nutrition InTech, (2011); 157-180.
6. Yadav SS, Chen W Chickpea breeding and management. Chapter: Book Name. 2007 of publication; CABI.
7. Raza H, Zaaboul F, Shoaib M, Zhang L. An overview of physicochemical composition and methods used for chickpeas processing. International Journal of Agriculture Innovations and Research, (2019); 7(5): 495-500.
8. Abdalla MS, Babiker IA, Elkalifa KF. Chemical analysis of *Acacia ehrenbergiana* (salam) tree fruits (seed and pods) as dry season supplement for livestock in arid and semi–arid lands of Sudan. Animal Review, (2015); 2(3): 76-80.