" Economic and biological feasibility of the Farfar tree: its effects and uses "

:Prepared by students

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Hafsa Bint Sirin School for Basic Education (5-8)

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Sultanate of Oman - Al Buraimi Governorate

Abstract:

This research aims to study the economic and biological feasibility of Tecomella undulata (Farfar) tree by analyzing its antibacterial properties, the effect of its aqueous extract on seed germination, and its traditional uses in the local community. The research questions are summarized in: What are the suitable environmental conditions for the growth of Tecomella undulata tree in Al Buraimi Governorate? What is the effect of the aqueous extract of Farfar tree leaves on seed germination? How effective is the extract as an antibacterial agent? What are the traditional uses of Farfar tree? GLOBE (Global Atmosphere, Water, Soil, and Land Cover) program protocols were applied to collect data, in addition to conducting simple laboratory experiments. The experiments included preparing an aqueous extract of the tree leaves and testing it on different types of bacteria, where it showed an inhibitory effect on E. coli at a concentration of (1:80). The effect of the extract on the germination of bean seeds was also tested using Petri dishes, where a concentration of 150 mm proved to be ideal for seed growth. The results indicate that the Farfar tree has promising biological properties, especially in resisting E. coli bacteria, and has a positive effect on seed germination at specific concentrations. In addition, its traditional uses as organic fertilizer, fuel, and building materials have been documented. Based on the results, we recommend that the concerned authorities work on planting the Farfar tree to protect it from extinction. We also recommend conducting further studies to explore its economic and environmental benefits, such as improving soil and as a natural source of antibacterial materials. Community awareness should also be raised on the importance of preserving this tree and benefiting from it in a sustainable manner.

Basic Terms:

- Farfar: (scientific name: Tecomella undulata), is a type of tree, known as Rohida, found in the Thar Desert regions of India and Pakistan, as well as the Arabian Peninsula and in the mountainous regions of the Sultanate of Oman. It is a medium-sized evergreen tree.

Research Questions:

1. What are the environmental conditions suitable for the growth of the Farfar tree in Al Buraimi Governorate?
2. What is the effect of the aqueous extract of the Farfar tree leaves on the germination of the plant seeds?
3. How effective is the aqueous extract as an antibacterial agent?
4. What are the traditional uses of the Farfar tree?

Introduction:

The Sultanate of Oman is characterized by a unique plant diversity, as it includes many wild plants that play a vital role in maintaining the ecological balance and supporting the local economy. Among these plants is the Tecomella undulata (Farfar), a perennial tree known for its ability to withstand harsh climatic conditions, making it a symbol of endurance in arid and semi-arid regions. Farfar trees are widely spread in Oman, especially near valleys, mountain slopes in the northern regions, near aflaj (traditional irrigation systems), and in abandoned agricultural lands in governorates such as North and South Al Sharqiyah, Ad Dakhiliyah, Ad Dhahirah, and North and South Al Batinah (Encyclopedia of Oman, Volume 8).

The Farfar tree has great environmental and economic value, as it contributes to soil stabilization and combating desertification. In addition, it has been used in countries such as India as a medicinal plant to treat various human diseases (Al Wahaibi, 2019). Despite its importance, the Farfar tree is facing the risk of extinction due to climate change and overexploitation, which puts biodiversity and the benefits it provides to local communities at risk.

Since there are no previous studies in our region on the benefits of the Farfar tree, we sought to explore its economic and therapeutic potential. Our aim is to investigate whether its aqueous extract has antibacterial properties and affects seed germination, as well as document its traditional uses. This will enable us to suggest ways to sustainably utilize the tree while raising awareness of its environmental and economic importance.

Research Methods:

First: Research Plan:

1. The team visited the Environment Department in Al Buraimi Governorate and held a meeting with Ms. Fatima Al Jabri to learn about the wild plants in the governorate.

2. Choosing the research topic.

3. Collecting information:

- Searching scientific sources to learn about the Farfar tree.
- Field observation: Visiting areas where the tree grows to observe its characteristics.
- Interviews: Conducting an interview with Ms. Fatima Al Jabri from the Environment Department in Al Buraimi Governorate to learn about the locations of the Farfar tree. An interview was also conducted with the grandfather (Salem Al Saadi) to learn about the traditional uses of the tree.

4. Practical experiments:

- An experiment to plant seedlings of the Farfar tree in three types of soil.
- **Preparing the aqueous extract:** Collecting samples of the Farfar tree leaves and sending them to the central laboratory at the College of Agricultural and Marine Sciences at Sultan Qaboos University to extract the aqueous extract and analyze it in cooperation with Dr. Jamal Al Sabahi from the central laboratory.
- **Antibacterial properties experiment:** Testing the effect of the aqueous extract on different types of bacteria (using Petri dishes) in collaboration with Dr. Aida Al-Badi from the Laboratory Department at Al Buraimi Hospital, and Amna Al-Mandhari from the Central Laboratory at Sultan Qaboos University.

• **Seed germination experiment:** Irrigating bean seeds (in Petri dishes) with the aqueous extract compared to irrigation water at a concentration of (150 mm) and monitoring the seed growth.

5. Apply appropriate protocols (atmosphere, soil, land cover, water).

Application mechanism	Protocol
Application of the atmosphere protocol in the study areas	Atmosphere
Studying the properties of the aqueous extract of the leaves of the farfar tree in terms of (salinity, conductivity, pH) and comparing it with the properties of irrigation water	Water Protocol
Studying the properties of the soil in the areas where the farfar tree grows in terms of (temperature, conductivity, salinity, pH, texture, consistency, number of roots, number of rocks, amount of carbonates) and comparing it with the properties of the soil in the Hamasa area (where the farfar tree does not grow).	Soil Protocol
Monitoring the growth of bean seeds in petri dishes by dividing them into two parts, experimental samples watered with the aqueous extract of the tree leaves, and control samples watered with irrigation water.	Land Cover Protocol

6. Compare results and write recommendations.
7. Enter data into the program website (www.globe.gov).

Research plan timeline:

Action plan	Month
Formulating the research problem and determining the tools	October/2024
Collecting and analyzing data	October-November/2024
Reaching conclusions	December-January/2024
Writing the research and preparing to participate in the student research competition	February-March/2024

Distribution of work roles on the research team:

Implementing students	Work
Lesson - Shahd	Formulating the research problem
Lesson - Shahd	Collecting and analyzing data
Lesson - Shahd	Reaching conclusions, formulating the summary and writing the research

Second: Study site:

Sultanate of Oman, Al Buraimi Governorate, Al Nafhat District (Al Uqdah Al Shamaliya), longitude 24°14'29.1"N, latitude 55°55'57.1"E, and Al Khadra District, longitude N 55°48'30.7, latitude 24°17'00.6 E, months (October - February), fall and winter, the atmosphere, soil, land cover protocol was applied.

Al Khadra District

Al Nafhat District
(Al Uqdah Al Shamaliya)

Third: Data collection and analysis:

To answer the first question, the study areas were identified in cooperation with the Environment Department in Al Buraimi Governorate and a visit was organized on October 3, 2024 to the Nafhat and Al Khadra areas, where the Farfar tree was observed and the protocols (atmosphere, soil, and land cover) were applied. We collected soil samples to study their properties and compare them with the properties of the soil in the Hamasa area, where the Farfar tree was not observed. We repeated the visit on February 18, 2025.

We also conducted an experiment to plant Farfar seedlings in different types of soil from the areas (Nafhat, Al Khadra, and Hamasa) in a pot in the school yard. The aim of this experiment was to determine the type of soil suitable for its growth and to try to plant it in areas where it did not appear, such as Hamasa.

Vegetative growth during February

Vegetative growth during October

Image (1) The Farfar tree in the Nafhat area

Vegetative growth during February

Vegetative growth during October

Picture (2) The Farfar tree in the Al-Khadhra area

Image (3) Application of the Atmospheric Protocol

Image (4) Application of the Land Cover

Image (5) Soil Protocol Application

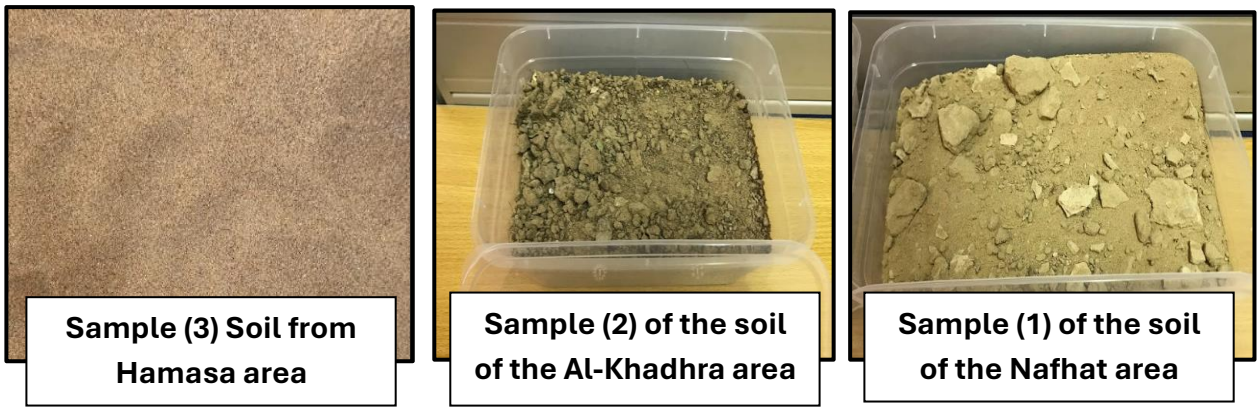


Image (6) Application of the soil protocol in the school

To answer the second question, we collected the leaves of the Farfar tree from the two study areas and sent them to the central laboratory at Sultan Qaboos University. We were provided with the aqueous extract of the leaves, where we tested its effect on the germination of bean seeds in Petri dishes and divided them into two parts: a control sample that was watered with irrigation water and an experimental sample that was watered with the aqueous extract of Farfar at a concentration of (50, 100, 150, 300 mm). Then the seeds that were watered at a concentration of (50, 100, 300) were excluded because they did not grow, and the seeds that grew at a concentration of 150 mm were followed up, where the length of the roots, the length of the stem, and the number of leaves were measured using a ruler for two weeks and the data was recorded.

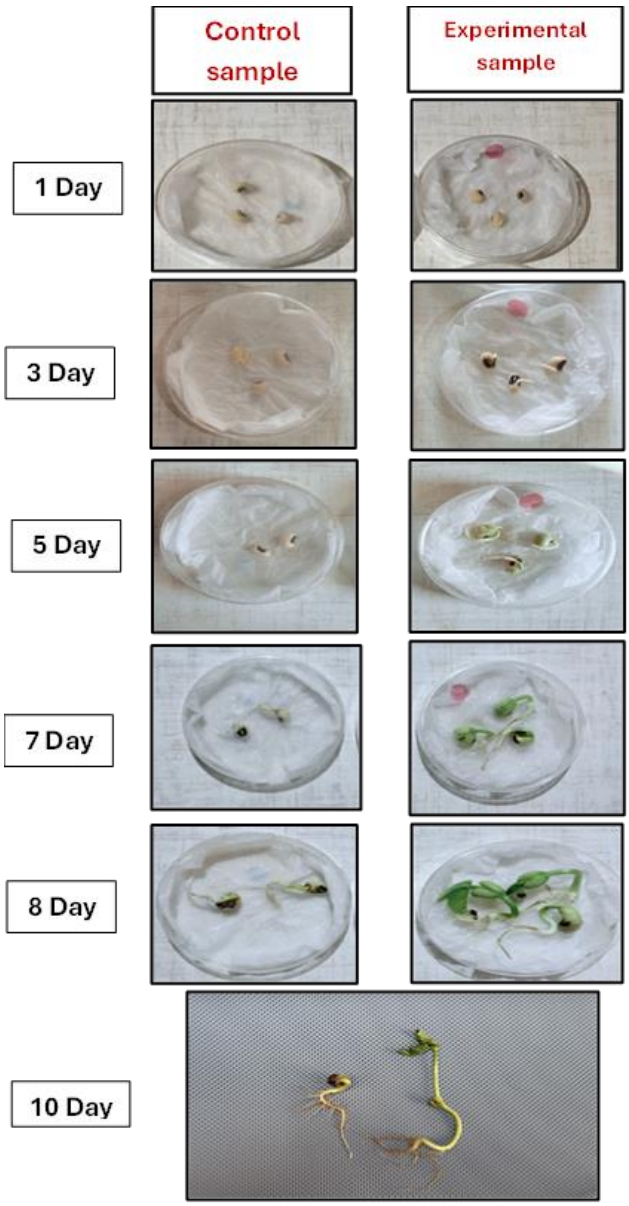


Image (7) Experiment of the aqueous extract of ferfar on the germination of bean seeds.

In response to the third question, we sent a sample of the extract to the Laboratory Department at Al Buraimi Hospital in collaboration with Dr. Aida Al Badi, and its effect was tested on different types of bacteria: Salmonella, Streptococcus, Staph. Aureus, Pseudomonas at concentrations of 150-200-250mm. Its effect as an antibacterial against E coli was also tested in collaboration with Amna Al Mandhari from the Central Laboratory at Sultan Qaboos University.

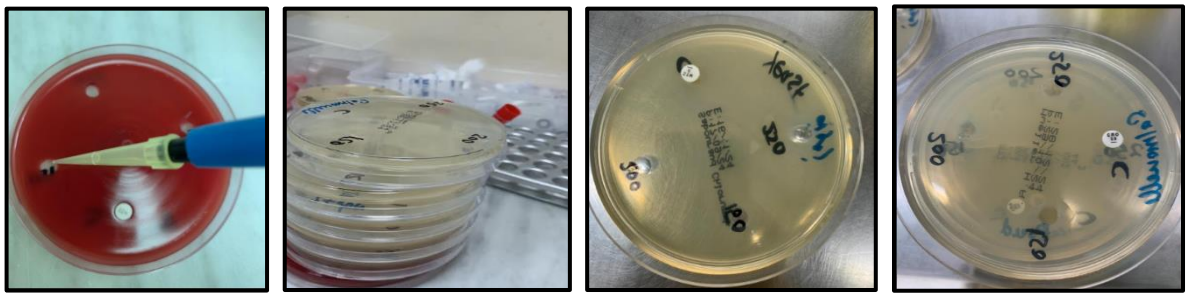


Image (8) Testing the effect of the aqueous extract of farfar as an antibacterial in the laboratory department of Al Buraimi Hospital

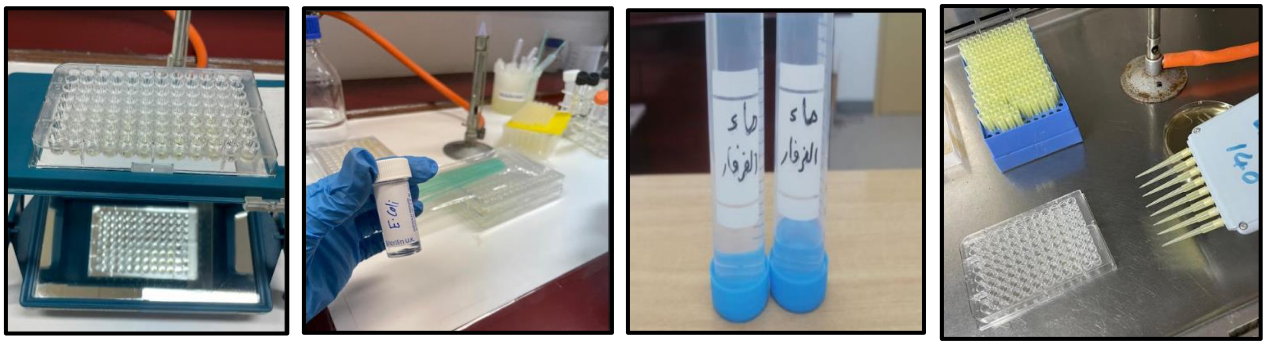


Image (9) Testing the effect of the aqueous extract of farfar as an anti-E. coli bacteria in the central laboratory at Sultan Qaboos University

To answer the fourth question, we interviewed Grandfather Salem Al-Saadi to learn about the traditional uses of the Farfar tree in the past.

Results:

To answer the first question, the atmosphere, soil and land cover protocol was applied.

First: Table (1) Atmospheric Protocol:

Clouds	Rainfall	Relative Humidity	Temperature	Date	Area
The sky is clear	0	55%	30˚C	3/10/2024	Al Nafhat
Cloudy (90-100) Stratus	rain drizzle	36%	22.8˚C	18/2/2025	
The sky is clear	0	48%	29.7˚C	3/10/2024	Al Khadra
Cloudy (90-100) Stratus	0	36%	24.2˚C	18/2/2025	

Second: Soil Protocol:

Table (2) Soil characteristics in the areas of Al Nafhat, Al-Khadhra and Hamasa:

Color	Consistency	Texture	Rocks	Roots	Carbonates	Conductivity	Salinity	PH	Area
7.5YR:5/4	fragile	Sandy clay	few	Low	Medium	134	135	8.2	Al Nafhat
10YR:5/4	fragile	Sandy	few	High	Low	334	167	7.4	Al-Khadhra
10YR:4/4	fragile	Sandy clay	none	None	High	135	69.6	8.6	Hamasa

- Results of the experiment of planting Farfar seedlings in Al Nafhat and Al Khadra soils and comparing them with Hamasa soil:

Soil of the Hamasa area | Soil of the Al Khadra area | Soil of the Al Nafhat area

Image (10) Results of the varicose veins after (10 days)

Soil of the Al Khadra area

Soil of the Al Nafhat area

Image (11) Results of the varicose veins transplant after (20 days)

Second: Land Cover Protocol:

Table (3) Land cover in the Nafhat area:

Canopy Observation	غطاء الشجر
Total (+) tree canopy	5
Total (-) sky or shrub	23
Canopy Type	**نوع غطاء الشجر**
Total (E)	5
Total (D)	0
Ground Observation	**غطاء الأرض**
Total (G)	8
Total (B)	20
Ground Vegetation Type	**نوع الغطاء النباتي للأرض**
Total (GD)	12
Total (SB)	10

Tree cover = ((+)Total)/(Total number of measurements) ×100
= (5)/(28) ×100= 17.8%

Evergreen cover = ((E)Total)/((D)Total+(E)Total) ×100
= (5)/5 ×100= 100%

Land cover = ((B)Total+(E)Total)/(Total number of measurements) ×100
= 25/(28) ×100= 89.2%

Grass cover percentage = ((GD)Total)/(Grass for total number of measurements) ×100
= (12)/(22) ×100= 54.5%

Table (4) Land cover in Al-Khadhra area:

Canopy Observation	غطاء الشجر
Total (+) tree canopy	١
Total (-) sky or shrub	23
Canopy Type	**نوع غطاء الشجر**
Total (E)	1
Total (D)	0
Ground Observation	**غطاء الأرض**
Total (G)	0
Total (B)	0
Ground Vegetation Type	**نوع الغطاء النباتي للأرض**
Total (GD)	0
Total (SB)	0

Tree cover = ((+)total)/(for total measurements number)×100
= (1)/(24)×100 = 4.1%
Evergreen cover = ((E)total)/((D)total+(E)total)×100
= (1)/1×100 = 100%
Land cover = ((B)total+(E)total)/(for total measurements number)×100
= 1 /(24)×100 =4.1%

- Table (5) Tree height data:

Tree Height (m)	Tree height at zero degrees of slope	Distance to tree (m)	The tangent of the angle for reading the slope meter	Slope scale (˚) reading	Sample
3.2 m	1.5 m	3 m	0.57	30	1- The Farfar tree in the Nafhat area
5 m	1.5 m	5 m	0.7	35	2- The Farfar tree in the Al-Khadhra area

- Tree height = tangent of angle (slope measure) × (distance to tree) + (tree height at zero degrees of slope measure)
- Tree height (1) = (0.57 × 3) + 1.5 = 3.2 m
- Tree height (2) = (0.7 × 5) + 1.5 = 5 m

To answer the second question, the water and ground cover protocol was applied to monitor the growth of bean seeds.

-Table (6) Characteristics of water used in irrigating bean seeds (control sample):

Conductivity	Salinity	PH	Temperature	Samples
521	254	7.7	21	**1**
519	266	7.6	21	**2**
523	265	7.3	21	**3**
521	261.6	7.5	21	**Rate**

-Table (7) Properties of the aqueous extract of the leaves of the Farfar used in the experimental sample:

Conductivity	Salinity	PH	Temperature
23.2	11.6	6.0	20

- Table (8) Comparison of bean seed growth between the control and experimental samples:

Experimental sample			Control sample			Date
Number of leaves	Stem length	Root length	Number of leaves	Stem length	Root length	
0	0	0	0	0	0	19/11/2024
0	0	0.5	0	0	0	21/11/2024
0	0	2	0	0	0	23/11/2024
0	1.5	2.5	0	0	0.5	25/11/2024
2	4.5	3	0	0	1.5	26/11/2024
2	7	3.5	0	1	2.5	28/11/2024

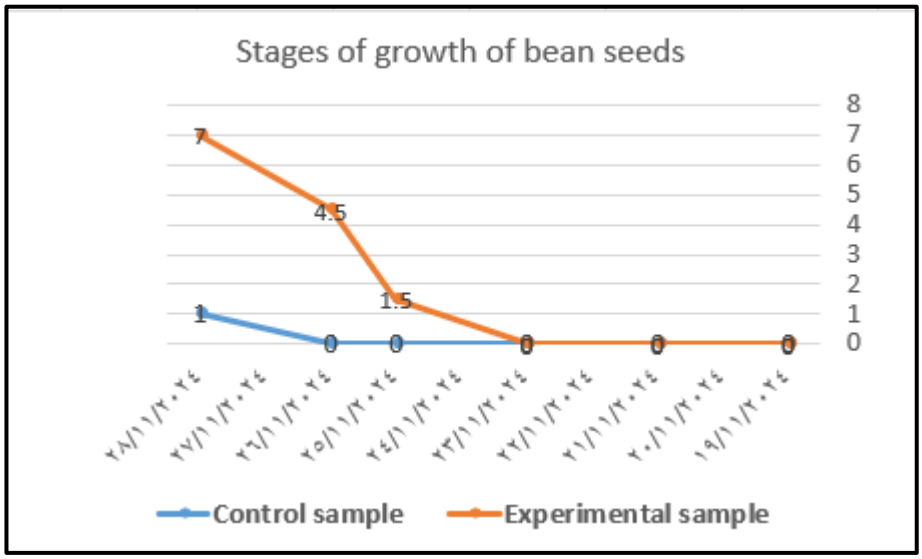


Figure (1) Results of bean seed growth (in Petri dishes) over 10 days

- To answer the third question, the effect of the aqueous extract of the leaves of the Farfar was tested on different types of bacteria:

1- Results of testing the effect of the aqueous extract of Farfar as an antibacterial (Staph. Aureus, Pseudomonas Salmonella, Streptococcus) in the laboratory department at Al Buraimi Hospital:

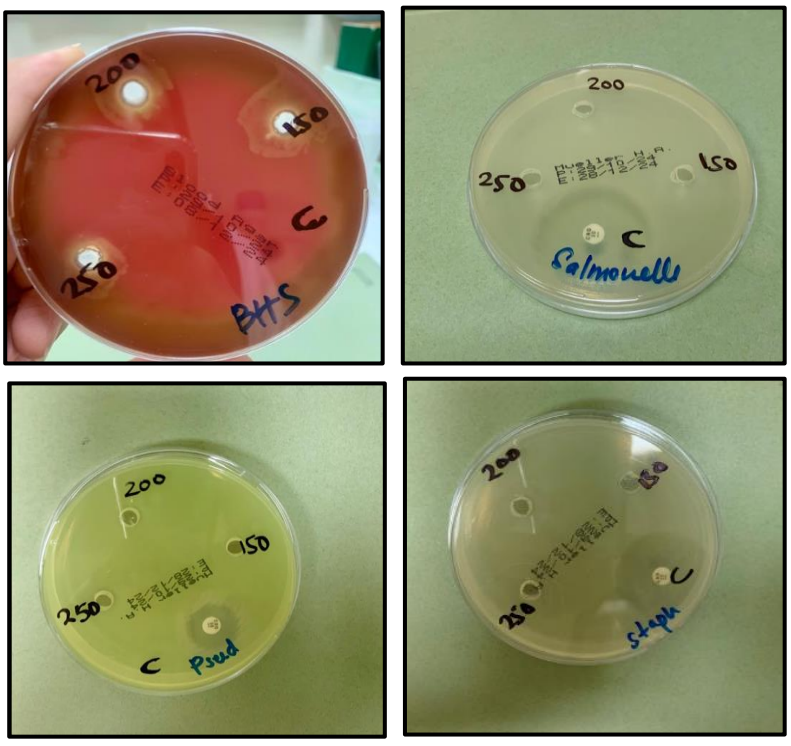


Image (12) Results of testing the effect of the aqueous extract of Farfar as an antibacterial in the laboratory department at Al Buraimi Hospital

2- Results of testing the effect of the aqueous extract of Farfar as an anti-E. coli bacteria in the central laboratory at Sultan Qaboos University.

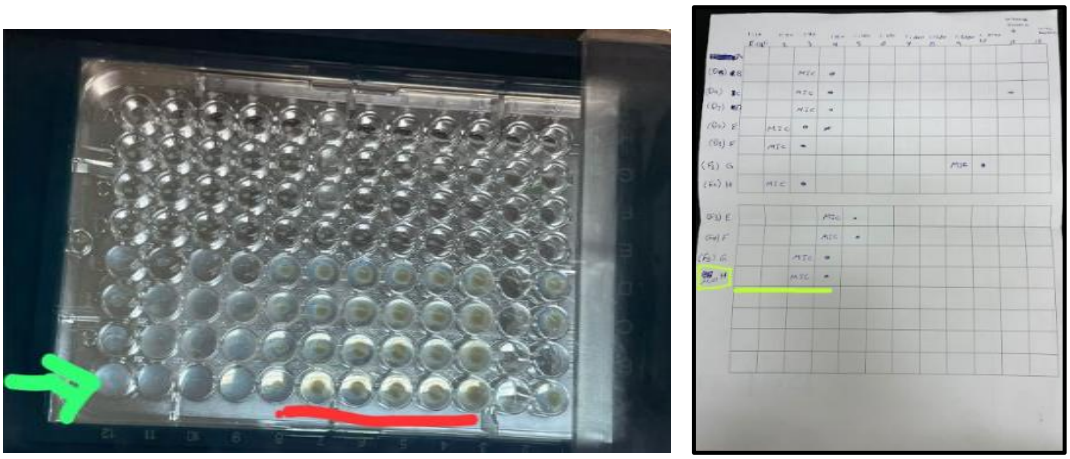
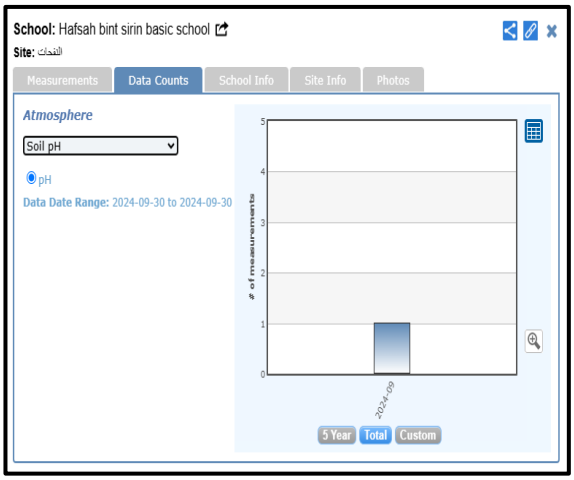
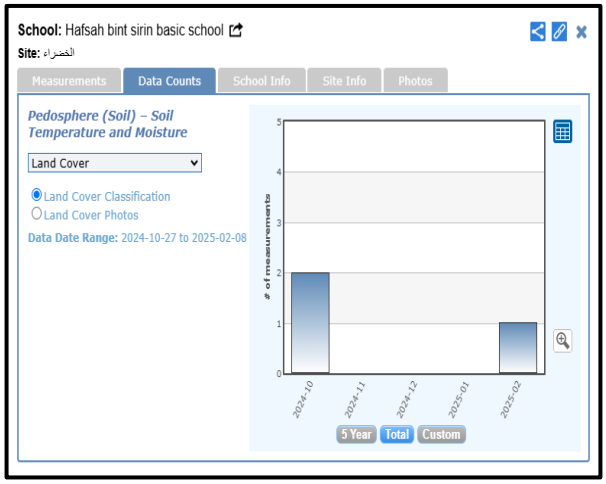


Image (13) Results of testing the effect of the aqueous extract of fermented wheat as an anti-E coli bacterium.

Data were entered into the program website (www.globe.gov) where the study site was added and the data collected in the research was entered:





Discussion of results:

Through interviews with Fatima Al-Jabri (Head of Environmental Protection Department) and field observations, we found that the Farfar tree is widespread on the banks of valleys in the Wilayat of Mahdha, as these areas provide suitable conditions for its growth. However, we noticed the presence of only one tree in the Al Nafhat area. We also found a tree planted in the Al-Khadhra area, while we did not find any trees in the Al-Hamasa area.

The results in Table (1) indicate that the Farfar tree prefers a dry climate and moderate humidity. Table (2) showed that the tree grows in loose, sandy soil with low salinity and good drainage, with a pH ranging between (7-8). The results of images (10-11) show that the seedlings planted in the Al-Nafhat and Al-Khadhra soil grew better compared to those planted in the Al-Hamasa soil. This indicates that the soil in Al-Hamasa is less suitable for the growth of the Farfar tree due to the high alkalinity of the soil and the lack of nutrients in it.

The results of Table (5) indicate that the height of the wild tree in Al Nafhat is 3.2 m, while the height of the tree in Al-Khadhra is 5 m. We also noticed that the leaves of the tree in Al Nafhat were small and green to gray in color during our first visit in October, while the leaves of the tree in Al-Khadhra were large and dark green. This difference is because the cultivated tree gets water regularly, while the wild tree depends on rain and groundwater. When we visited the tree in Al Nafhat in February, we found that the leaves were green and red flowers appeared, while we found the tree in Al-Khadhra with yellow flowers as in pictures (1-2). This is an important discovery as we were able to detect the red-flowered Farfar tree in our area. This result contradicts what Al-Wahaibi (2019) reached in his study, where he stated that this species does not exist anywhere in Oman. We conclude from this that this tree may have grown recently in Al Nafhat, and it is not known how it entered the country. We believe that it grew from a seed that was transported with the wadi water. The results of the experiment showed through Figure (7), Table (8) and Graph (1) that the aqueous extract at a concentration of 150 mm contributed to accelerating the germination of bean seeds compared to the control sample that

was irrigated with normal water. On the tenth day of the experiment, the plant length in the experimental sample reached 15 cm with the emergence of two leaves, while the plant length in the control sample did not exceed 3 cm and no leaves appeared. We also observed mold growth in the control sample, indicating that the aqueous extract provided a suitable environment for germination and protected the seeds from harmful microbes. These results are consistent with previous studies such as Diniz do Nascimento (2020), Machka (2022), and Lee, and its antimicrobial properties, which explains its enhancement of plant growth. When the aqueous extract was tested on some types of bacteria such as Staphylococcus aureus. A study conducted on Staphylococcus aureus, Pseudomonas aeruginosa, Salmonella and Streptococcus bacteria at different concentrations (150-250 mmol) showed that the aqueous extract did not show any antibacterial effect on these types of bacteria, but when the extract was tested on Escherichia coli bacteria, it showed an inhibitory effect at a concentration of 1:80, meaning that these bacteria were more sensitive to the extract. Amna Al Mandhari from the Central Laboratory stated that the strength of the extract increases with increasing concentration, indicating that it can be used as an antibacterial at higher concentrations.

Possible sources of error:

- The amount of aqueous extract used was not sufficient in the experiment to test its effect on bacteria. We believe that it may have needed higher concentrations to prove its effect.

Through our interview with Grandfather Salem Al Saadi, we learned about the many traditional uses of the Farfar tree, as women used to make necklaces from its flowers for decoration, and the leaves were used as animal feed, in addition to mixing the remains of dates and leaves with water to make natural fertilizer for agricultural crops. The hard trunk of the tree was also used to build huts and make knife handles, as well as fuel.

Conclusion:

At the end of this research, we concluded that the Farfar tree prefers areas with well-drained sandy soil and a dry to semi-arid climate, and the aqueous extract of its leaves enhances seed germination, and we concluded that it is useful as an antidote at specific concentrations for some types of bacteria such as E. coli. These results reflect the importance of the tree in agriculture and medicine, especially with its many traditional uses. Also, during our field visits, we found the Farfar tree with red flowers, which was not previously present in Oman, and this is an important result as it can be focused on studying it in the future to discover its properties and benefits. The research can be applied again by studying more areas to identify the conditions suitable for the growth of Farfar.

One of the challenges we faced in implementing the study was the difficulty of applying the atmospheric protocol on a daily and continuous basis due to the ruggedness of the road and visiting the study area daily, so we made two visits during two different seasons to monitor changes in its growth.

Recommendations:

* Conduct additional studies to explore the benefits of the Farfar tree in other areas, such as soil improvement and crop protection.

* Develop more effective extraction methods to benefit from its antioxidant and antimicrobial properties.

* Work on increasing the cultivation of red-flowered ferfar to protect it from extinction.

* Conduct studies to understand the unique characteristics that distinguish red-flowered ferfar from other species.

* Apply research in other areas and use advanced techniques to analyze chemical compounds.

* Study different parts of the plant and experiment with other extracts.

* Re-experiment with cultivating ferfar in Hamasa soil with the addition of nutrients.

Thanks, and appreciation

We are pleased to extend our sincere thanks and appreciation to Dr. Ahmed Al Balushi, the National Coordinator of the Globe Environmental Program, for all the information he provided and his continuous encouragement to prepare the research, and to Ms. Amna Al Saadi, the supervisor of the program team in the governorate, for her continuous follow-up and assistance in communicating with specialists and government agencies.

We also extend our thanks to the supervisor of the GLOBE program at the school, Ms. Naeema Al Ghaithi, for encouraging us to conduct the research and provide the necessary recommendations to implement the study. We thank Ms. Maryam Al Muqbali and Asila Al Saadi, the science laboratory technician at the school, for their cooperation in providing the necessary laboratory tools to collect the research data. We also thank Fatima Al Jabri, Head of the Environmental Conservation Department at the Environment Department in Al Buraimi Governorate, for helping us obtain data on the areas where the Farfar tree is found.

We also extend our sincere thanks to Dr. Jamal Al Sabahi and Engineer Amna Al Mandhari from the Central Laboratory at the College of Agricultural and Marine Sciences at Sultan Qaboos University for their cooperation in conducting the analysis of Farfar leaf samples and analyzing the results.

Badges:

❑ Be a Collaborator

Globe team students cooperated in choosing the research topic, distributing tasks and roles to collect data, reaching results, finding appropriate solutions, record the research, and conduct mathematical statistics and graphs attached to the research.

❑ Make an Impact

We studied the economic and biological feasibility of the tamarisk tree (Tecomella undulata) using GLOBE protocols, analyzing the effect of its aqueous extract on seed germination and its antibacterial efficacy. The results showed its ability to inhibit E. coli and promote bean germination at specific concentrations. We also documented its traditional uses and its role in agriculture and construction. We recommended its cultivation to preserve it from extinction and explore its environmental and economic benefits. The research contributed to **enhancing community awareness and supporting sustainability, making us eligible for this badge.

❑ I AM AN EARTH SYSTEM SCIENTIST

In our research on the Tecomella undulata tree, we wanted to understand how the parts of the Earth interact with each other, such as the atmosphere, soil, and vegetation. We used GLOBE protocols to collect and analyze data, which made us work as Earth systems scientists.

* Atmosphere protocol: We recorded weather data such as temperature, humidity, and rainfall in different areas such as Nafhat, Al-Akhdar, to see how climate affects the growth of the tree.

* Soil protocol: We analyzed soil samples to know their properties, and analyzed the pH and soil type, and found that well-drained sandy soil is the most suitable for the growth of the Tecomella.

* Land cover protocol: We studied the locations of the tree and how vegetation affects its growth.

After comparing the data, we discovered that the Tecomella tree grows best in sandy soil and dry climate. In this research, we applied GLOBE protocols to collect accurate data, studied how the parts of the Earth such as climate and soil interact with the tree, and analyzed and interpreted the results scientifically, which helps in understanding the environment and preserving it.

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Appendices

Appendix (1) Chemical composition table of the aqueous extract of the leaves of the Farfar tree:

	Farfar
Area %	Compound Name
1,37	2-Hexenal
0,74	.alpha.-Pinene
12,63	Eucalyptol
0,28	U.I
3,80	Linalool
0,59	.alpha.-Campholenal
1,39	L-Pinocarveol
0,26	(R)-cis-Verbenol
1,47	Camphor
1,29	cis-Verbenol
1,08	Verbenol
0,27	Pinocarvone
1,42	.alpha.-Phellandren-8-ol
2,64	4-Terpinenol
2,55	.alpha.-Terpineol
0,69	(1R)-(-)-Myrtenal
0,69	Verbenone
0,62	Bornyl acetate
0,58	U.I
1,89	U.I
63,13	Armid E
0,63	U.I