Sultanate Of Oman
Ministry Of Education

Studying the effectiveness of fertilization with fruit waste (banana peels) in reducing carbon emissions

Prepared by student:

Aisha Ahmed Ali Al-Alawi

Supervision by teachers:

Teacher / Naeema Saeed Ali AL-Ghaithi

Hafsah Bint Sirin basic School (5-9)

Table of Contents

Studying the effectiveness of fertilization with fruit waste (banana peels) in reducing carbon emissions

Prepared by student:
Aisha Ahmed Ali Al-Alawi
Supervision by teachers: Naeema Saeed Ali Al-Ghaithi
Hafsah Bint Sirin basic School (5-9)

Summary:

Food waste is a major component of landfills around the world, and a major global source of greenhouse gases. However, this waste can be converted into fertilizer used in agriculture, so this study was conducted with the aim of highlighting the effectiveness of fertilization with fruit waste in reducing carbon emissions from the soil. Fertilizer soaked in banana peels with yeast added to the Ruelia plant. Food waste is a major component of landfills around the world, and a major global source of greenhouse gases. However, this waste can be converted into fertilizer used in agriculture, so this study was conducted with the aim of highlighting the effectiveness of fertilization with fruit waste in reducing carbon emissions from the soil. Fertilizer soaked in banana peels with yeast added to the Ruelia plant. The research questions are: What is the effect of fertilization with fruit waste on soil properties? What is the effect of fertilizing with fruit waste (banana peels) on plant growth? How effective is fertilization with fruit waste in reducing carbon emissions from the soil? The water, soil and land cover protocol were applied. The results showed that adding the solution contributed to improving the pH and increasing the concentration of solutes and salinity. These are good results for the plant, as the leaves were more numerous and widespread than the control plant. The percentage of organic carbon in the experimental soil was (0.21%) compared to the control soil (0.18%), which indicates an improvement in the plant's ability to store carbon. Based on the results, we recommend spreading awareness among community members to benefit from fruit and vegetable peels by recycling them and using them for fertilization to improve soil quality, reduce gas emissions resulting from burning waste, and reduce dependence on chemical fertilizers in gardens and farms.

Basic terms:

1- Ruellia, its scientific name is Ruellia tuberosa, and it is a shrub that reaches approximately 80 cm in growth with purple flowers.

2- Bromothymol is a blue liquid when exposed to air. It takes this form when it is nourished with oxygen and changes to a yellowish green color in the presence of carbon dioxide (CO_2).

Research questions:

1- What is the effect of fertilization with fruit waste (banana peels) on soil properties?

2- What is the effect of fertilizing with fruit waste on plant growth?

3- How effective is fertilization with fruit waste in reducing carbon emissions from the soil?

Introduction:

Wasted food - if it were a country - would be the third largest source of greenhouse gas emissions in the world, and reducing food waste can help reduce these emissions, and a study conducted by the journal Nature in 2023 found that converting food waste into fertilizer has a lower environmental impact, which leads to reduce emissions by 38-84% compared to landfills.

Farmers are increasingly using sustainable agricultural methods to enhance productivity and reduce greenhouse gas emissions at the same time. News has been spreading for some time about the benefits of using ground coffee for plants and eggshells, and recently the use of banana water for fertilization has increased. It is rich in potassium, calcium, phosphorus, and magnesium, and this combination can stimulate plant growth (Awad, 2023). According to FAO 2014, about 118 million tons of bananas are produced annually globally, and therefore the waste from this production will be enormous and it is best to exploit them to fertilize the soil and improve plant growth. Studies (Naseer, 2021) (Al-Dulaimi and Rashid, 2020) have shown that making banana fertilizer with boiled peels may be a more effective way to increase potassium levels. A study (Omar, 2003) proved the effectiveness of yeast extract in increasing the growth rate of tomato plants because the extract increases the rates of assimilation of carbohydrates and amino acids, which leads to improved vegetative growth.

Due to the lack of previous studies on the role of fruit waste in reducing carbon emission, the idea of this study came to evaluate the effectiveness of fertilization with fruit waste in increasing carbon storage in the soil, thus increasing plant growth, and reducing excessive consumption of chemical fertilizers to reduce the emission of greenhouse gases.

Research methods:

First: the research plan:

1 .Choose the research problem.

2 .Determine the study site.

3 .Collect soil samples from the study site and plant the Ruelia plant.

3 .Prepare the mixture by adding banana peels to a liter of water, leaving it for between 24 and 48 hours, then filtering it, adding a spoonful (5 grams) of yeast, and storing it at room temperature.

4 .Contact Dr. Jamal Al-Sabahi, head of the central laboratory, and Dr. Hamad Al Busaidi at the College of Agricultural and Marine Sciences at Sultan Qaboos University to analyze the chemical elements in the solution and in the study, soil samples and to measure the percentage of organic carbon.

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

6 .Record the growth data of the Ruelia plant every two weeks for three months and water it with equal amounts of water.

7 .Conduct an experiment to detect Co2 emission using the Bromothymol detector in the school laboratory.

8 .Contact agricultural engineer Nasser Al-Wahaibi, senior plant nutrition researcher - General Directorate of Agricultural and Animal Research in Barka to analyze the results.

.9 Compare results and write recommendations.

10 .Enter data into the program's website (www.globe.gov).

Schedule of research plan:

Activity	Month
Formulate the research problem and determine the tools	2023 September
Collect and analyze data	September - October - November
Reaching conclusions	December
Submit research	2024 February

Distribution of roles work on the research team:

Students	The work
Aisha Al-Alawi	Formulate the research problem
	Collect and analyze data by applying the soil and land cover protocol
	Drawing conclusions, drafting a summary, and writing the research

Second: Study Location:

Sultanate of Oman, Al-Buraimi Governorate, (Longitude 55.810224 East, Latitude 24.241612 North, October, Fair-weather, Soil, Water and land cover Protocol applied.

Third: Data collection and analysis:

The banana infusion was produced by adding banana peels to a liter of water, leaving it for between 24 and 48 hours, then filtering it, adding a spoonful (5 g) of yeast, and leaving it at room temperature. After watering the two plants with water, the test plant is watered with 50 ml of the infusion every two weeks, while the control plant is not watered with the solution.

To answer the first question, the soil was collected from the home garden and divided equally in plastic pots into two samples (the control without fertilization / the experimental one with fertilizer soaked in banana peels and yeast added to it), then I applied the soil protocol in terms of (texture, consistency, amount of rocks and roots, pH, Salinity, conductivity, color, amount of carbonate) and monitoring the characteristics of the experimental soil for three months and comparing it to the control soil.

Soak banana peels and yeast.

Image (1) Application of the soil protocol

To answer the second question, I planted the Ruelia plant and monitored its characteristics in the experimental and control soil for three months in terms of:

1- Plant length (cm): Measure the length of the plant using a ruler, starting from the surface of the soil in the pot to the top of the plant, then calculate the growth rate by dividing the sum of the length by the number of measurement times.

2- Number of leaves: Calculate the number of plant leaves in each sample.

Image (2) Application of the land cover protocol

To answer the third question, soil samples, banana solutions, and yeast were sent to the central laboratory at the College of Agricultural and Marine Sciences at Sultan Qaboos University to analyze the chemical elements and measure the amount of organic carbon in the soil in cooperation with Dr. Jamal Al-Sabahi and Dr. Hamad Al Busaidi. After three months of the experiment, the emission of Co_2 from the plant was detected using the Bromothymol detector in the school laboratory in cooperation with the laboratory technician, Professor Shamsa Al-Ghaithi, where I added a small amount of distilled water to the reagent solution in two glass laboratories and placed a leaf from the plant (control and experimental) and placed it on them. In a dark place and observe the change in the color of the detector depending on the amount of Co_2 gas emitted from the plant leaf.

Image (3) examining soil samples in the central laboratory
- Sultan Qaboos University

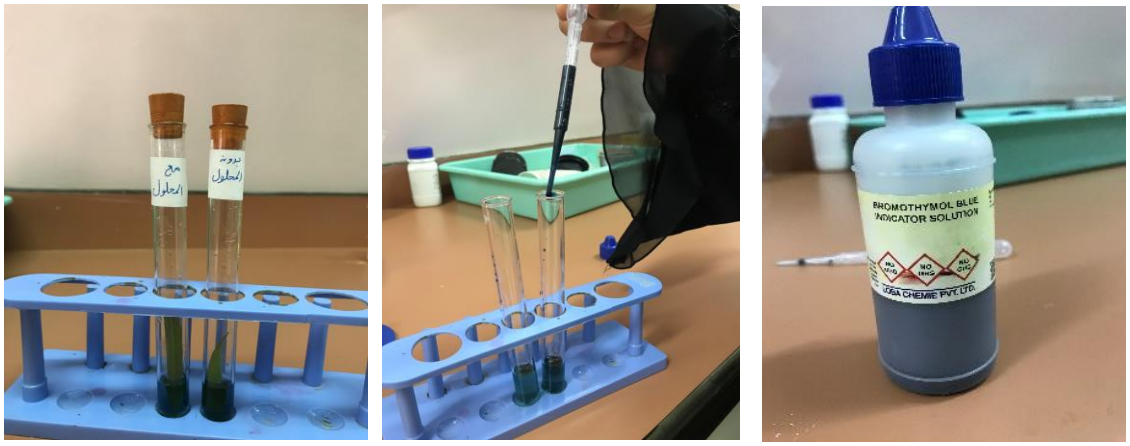


Image (4) Detection of Co_2 emission from plants using Bromothymol in the school laboratory.

Results:

1- The Water Protocol:

Salinity	Conductivity	PH	Temperature
237	473	7.8	25.8

Table (1) Data on the characteristics of water used in irrigation.

2- The soil protocols

Color	Conductivity	Salinity	PH	Carbonate	Roots	Rocks	Fabric	Consistency
10YR3/4	597.6	450.6	7.5	Little	Little	Little	Sandy Loam	Fragile

Table (2) Soil characteristics data (control) before adding banana peel fertilizer and yeast.

Soil moisture	Color	PH	Salinity	Conductivity	Temperature	Date
Moist	10YR 4\4	7.15	608	1192	30.9 ° C	2023\9\8
Moist	10YR 3\4	7.28	536	1115	29.1 ° C	2023\9\22
Moist	10YR 4\4	7.26	530	992	28.6 ° C	2023\10\13
Moist	10YR 4\4	7.10	708	1407	28.3 ° C	2023\10\27
Moist	10YR 3\4	7.11	688	1052	28.1 ° C	2023\11\12
Moist	10YR 3\4	7.10	516	940	28.6 ° C	2023/11/26

Table (3) Follow-up data on experimental soil properties after fertilization with banana peel waste and yeast

Carbonate	Roots	Rocks	النسيج	Consistency
a lot	a lot	Little	Sandy Loam	Fragile

Table (4) Experimental soil characteristics after fertilization with banana peel waste and yeast

Carbon percentage	Sample
0.18%	Control sample
0.21%	Experimental sample

Table (5): Percentage of organic carbon in control and experimental soil

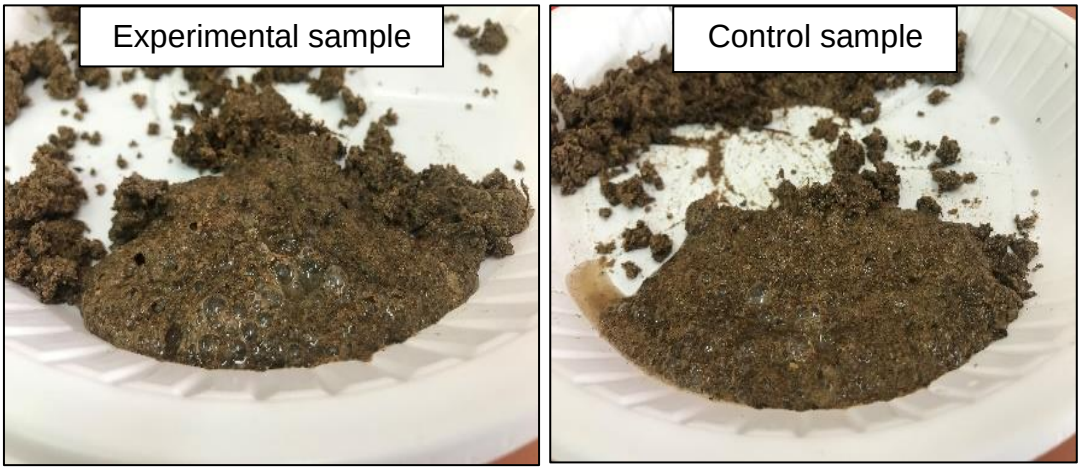


Image (5) comparison of the percentage of carbonates in the soil before and after fertilization using vinegar

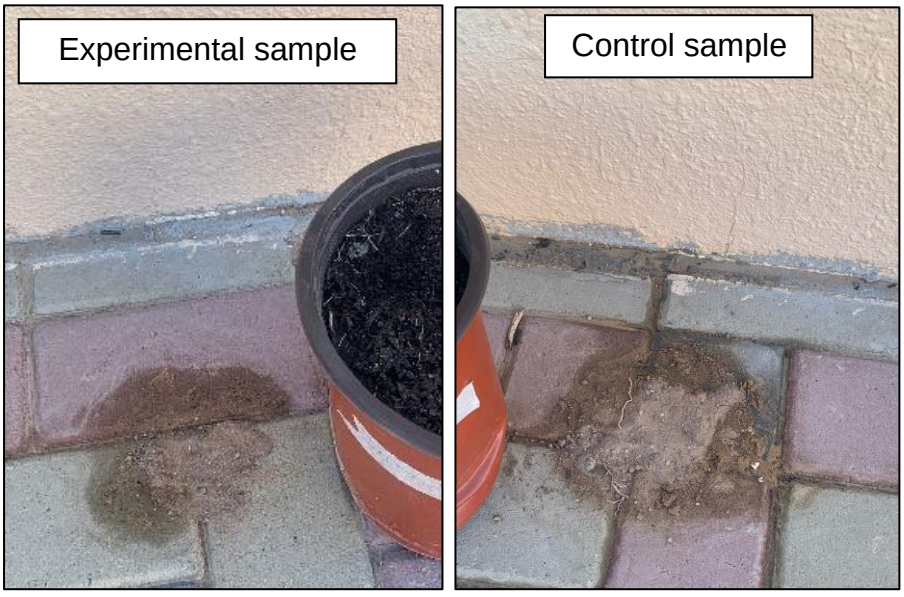


Image (6) comparing the effect of fertilization with banana waste in improving the efficiency and ability of the soil to conserve water after 3 months of fertilization.

3- The land cover Protocol:

Apply the ground cover protocol and monitor the growth of the Ruelia plant:

The formula for calculating the growth rate: by dividing the sum of the length by the number of measurement times:

1) **Measure the length of the plant (control sample):**

$$\frac{42 + 49 + 52 + 55 + 60}{5} = 43.2$$

2) **Measure the length of the plant (Experimental sample):**

$$\frac{40 + 47 + 50 + 54 + 59}{5} = 48.2$$

Characteristics of the ruellia plant (Experimental sample)				Characteristics of the ruellia plant (control sample)				Date
Number of flowers	Color of leaves	Number of leaves	Leg length / Cm	Number of flowers	Color of leaves	Number of leaves	Leg length / Cm	
0	Dark green	109	40	0	light green	96	42	2023\9\8
0	Dark green	136	47	0	light green	115	49	2023\9\29
2	Dark green	157	50	0	light green	107	52	2023\10\20
2	Dark green	245	54	0	light green	94	55	2023\11\10
0	Dark green	282	59	0	light green	103	60	2023\12\1
-	-	-	48.2	-	-	-	43.2	Average

Table (6): Follow-up of the growth stages of the Ruelia plant in the control soil and the experimental soil

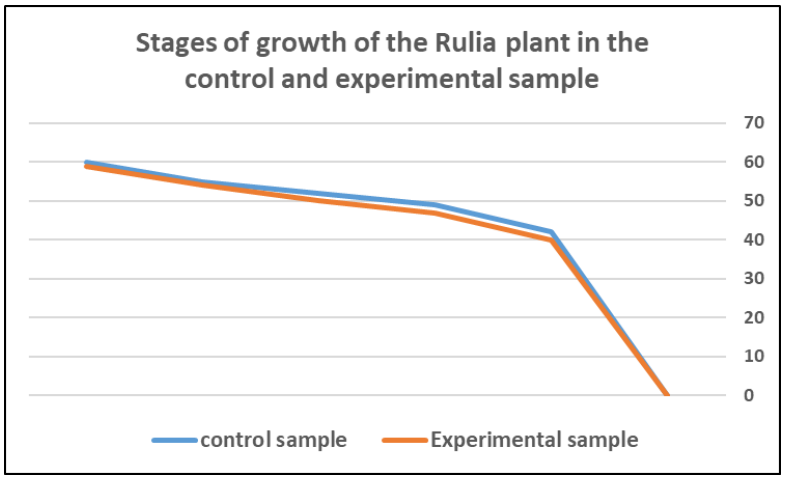


Diagram (1) results of the growth of the Ruelia plant for three months

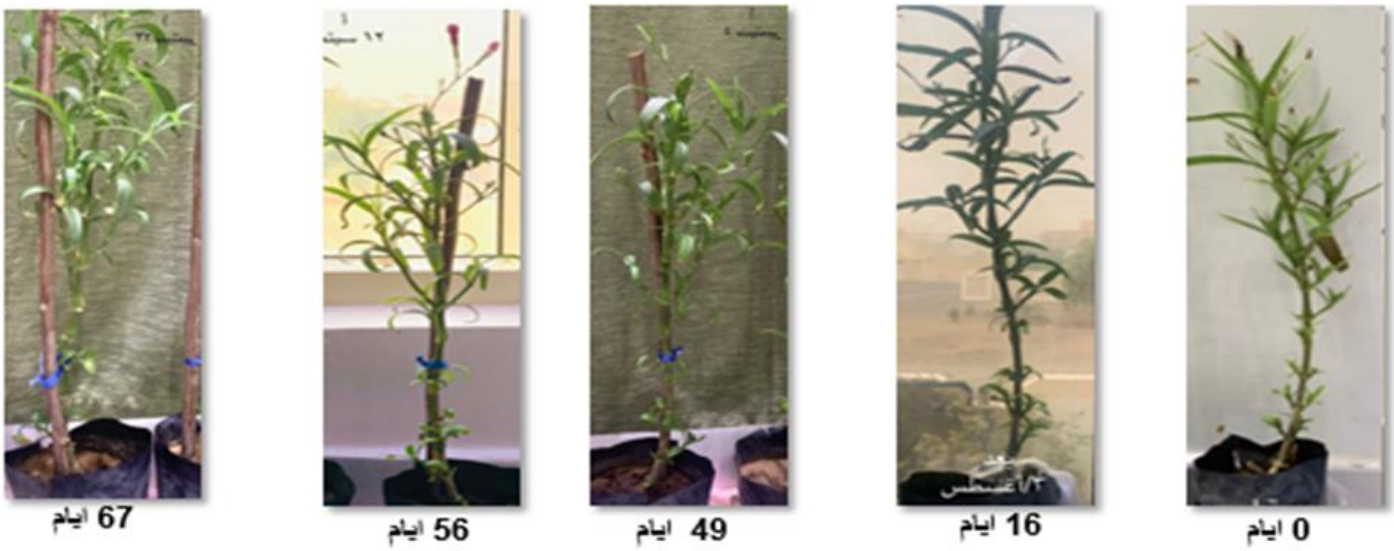


Image (6) The effect of fertilizing with banana peel infusion and yeast on the growth of the Ruelia plant

Experimental sample | Control sample

Image (7) comparison of the growth of the Ruelia plant after 84 days

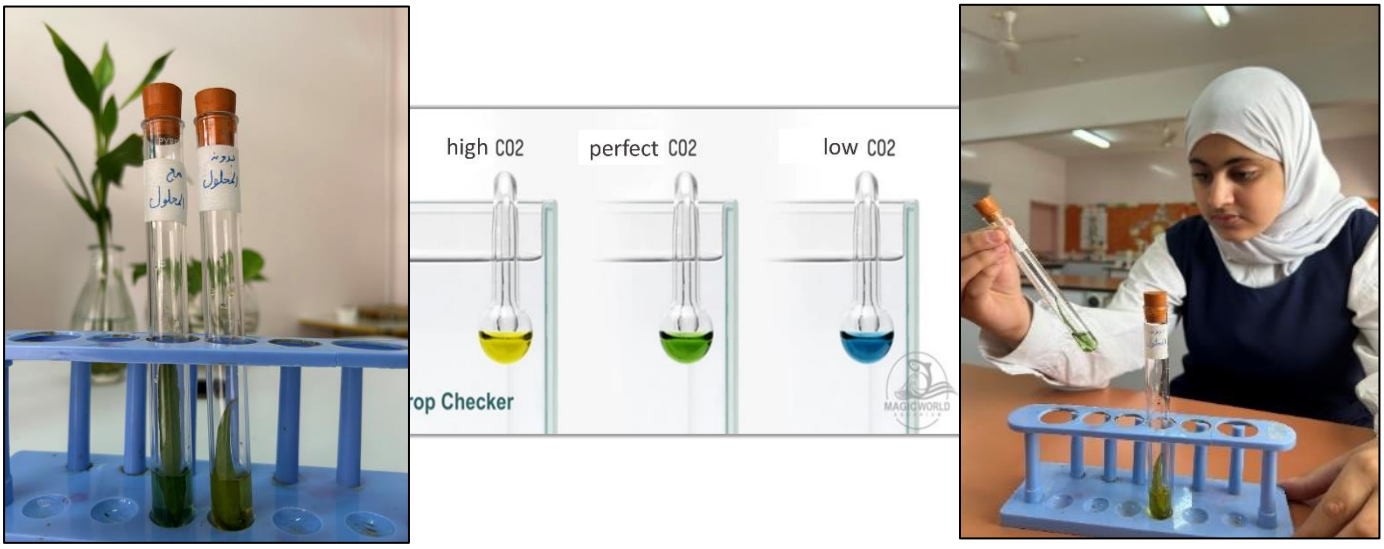


Image (8) comparison of the results of detecting Co2 emission from the plant in the control and experimental sample after three months using the Bromothymol detector.

The data has been entered in the program website (www.globe.gov) where the study site was added and enter data collected in research:

Discussion of the results:

The results in Table (1) showed that the water used for irrigation is suitable, as the PH value reached (7.8), and this result is suitable according to the Omani standards for water quality.

The results in Table (2) also indicated that the PH value of the control soil was (7.5), so it is a neutral soil. As for the consistency of the soil, the soil was sandy loamy, fragile, and easy to crumble. As for the amount of rocks and roots, it was small, and the amount of carbonates was small.

The results in Table (3) showed that fertilization with banana peel waste and yeast led to improved soil properties, as the PH value decreased and ranged between (7.10-7.28). The salinity value increased, ranging from (516-708ppm) in the experimental sample due to the increase in the soil content of dissolved nutrients, Appendix (2). Its ability to retain moisture also increased, unlike the control sample, which was exposed to drought because of the rapid descent of water to the bottom, as in the picture (6).

When conducting an experiment to detect the amount of carbonate in the soil, I noticed an increase in the amount of carbon in the experimental soil, and this is evident by the increase in the amount of vinegar reaction in it, as in Table (4) and Image (5).

The results in Table (6) showed an increase in the plant growth rate in the experimental sample, where the average growth of the plant stem length reached (48.2) compared to the control sample (43.2). I also noticed an increase in the number of leaves, a green color, and the appearance of some flowers in the plant. This is because the yeast present in the fertilizer increases the indicators of Vegetative growth (Omar, 2003), and banana peels contain magnesium and sulfur, which are elements that help in making chlorophyll, which gives plants the green color and contain phosphorus, which improves fruiting and flowering (Al-Dulaimi and Rasheed, 2020). As for the control sample, flowers did not appear throughout the study period and some leaves began to fall due to lack of water because the soil is unable to retain water due to the lack of soil cohesion.

The results of measuring the percentage of organic carbon in Table (5), which were conducted in the central laboratory at the College of Agricultural and Marine Sciences at Sultan Qaboos University, indicated that the percentage of organic carbon increased in the experimental soil (0.21%, while in the control soil (0.18%). This is due to the fruit residues It contains organic materials that are decomposed by organisms present in the soil, which leads to the slow secretion of carbon. Therefore, we conclude that this process reduces carbon emissions resulting from the decomposition of organic materials, according to what was stated by (Engineer Nasser Al-Wahaibi, General Directorate of Agricultural Research).

The results of the experiment to detect Co_2 emission using the Bromothymol detector in picture (8) also indicated that the color of the detector changed to yellow in the control plant leaf sample, which means that the percentage of Co_2 is high. However, in the experimental sample, the color of the detector was green, which means that the amount of Co_2 emission is ideal. (5), and this supports the idea of the ability of fertilization with fruit waste, such as banana peels and others, to enhance soil and plant health by storing organic carbon, reducing its emission into the atmosphere, and improving crop productivity.

Conclusion:

We conclude from this study:

1- Fruit waste, as an organic fertilizer, is important in increasing the concentration of nutrients and organic materials in the soil.

2- A solution of banana peels and yeast provides a rich source of nutrients that improve plant growth, as banana peels contain a high percentage of phosphorus and potassium, and yeast contains a high percentage of nitrogen, which are considered essential nutrients for plant growth and development.

3- Using organic fertilizer in agriculture helps sequester carbon in the soil and can replace chemical fertilizers that release high levels of greenhouse gases.

4- Fertilization with fruit waste contributes to improving the plant's ability to reduce Co_2 emissions.

The strengths of the study were obtaining important results through which I concluded that we, as individuals, can contribute to reducing the impact of climate change in the simplest ways, starting from home. In my research, I discovered that fruit waste is a hidden hero. Instead of sending it to landfills, it can be converted into fertilizer that can be used. It helps reduce emissions and significantly reduce our carbon footprint.

Competent authorities can benefit from the results of this research and work to provide special containers in restaurants and farms to collect fruit and vegetable waste and convert them into organic fertilizer at the lowest cost, which reduces our dependence on chemical fertilizers.

One of the challenges I faced in implementing the study was the lack of a device in the GLOBE program to measure the amount of Co_2 gas during plant respiration at night. The challenge was solved by using a Bromothymol detector, seeking the help of engineer Nasser Al-Wahaibi and searching the

Internet to analyze the result. The research can be applied again using fruit peels, comparing them to other fertilizers, and testing their effectiveness in reducing carbon emissions, thus using them as one of the successful means of reducing greenhouse gas emissions.

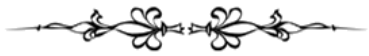
Thanks and appreciation:

We are pleased to extend our sincere thanks and appreciation to Mr. Ahmed Al Balushi, the National Coordinator of the GLOBE Environmental Program in the Sultanate of Oman, for his continuous support and encouragement, and to Ms. Amna Al Saadi, the Program Supervisor, for maintaining her continuous follow-up and helping in communicating with specialists and government agencies.

We would also like to thank the supervisor of the GLOBE program in the school, Ms. Naeema Al-Ghaithi, for motivating us to conduct the research and their continuous follow-up during the work steps. I thank Ms. Shamsa Al-Ghaithi, the school's science laboratory technician, for her cooperation in providing the necessary laboratory tools to collect research data.

I also extend my thanks to Dr. Hamad Al-Busaidi and Dr. Jamal Al-Sabahi, Head of the Central Laboratory at the College of Agricultural and Marine Sciences at Sultan Qaboos University, for their cooperation in conducting the analysis of soil samples. I also thank Engineer Nasser Al-Wahaibi, Senior Plant Nutrition Researcher at the General Directorate of Agricultural and Animal Research in the Wilayat of Barka, for the information he provided in the research and his cooperation in analyzing the results.

Badges:



❖ I AM A PROBLEM SOLVER

Qualifying for the “I'm a Problem Solver” badge is evident in several important aspects within research:

1- Study design: The research demonstrates my ability to design an integrated study that includes choosing the topic carefully and setting clear objectives for the research.

2- Research methodology: I can apply scientific methodologies accurately, as I, as a student in the Globe program, used the program’s tools to apply appropriate protocols (soil, land cover, and water) to collect and analyze data effectively.

3- Analyzing the results: I analyzed the results and provided scientific and logical explanations for the study results.

4- Creativity and critical thinking: Providing creative and appropriate solutions to contribute to achieving carbon neutrality, which reflects my ability to think critically, innovate, and find a sustainable environmental solution, which is converting fruit waste into organic fertilizers instead of throwing them in landfills.

Conclusions and recommendations: The research reflects my ability to deduce results logically and provide effective recommendations directed towards solving the problem of climate change, which is represented by recommending the competent government agencies to implement projects to recycle waste and convert them into fertilizers and recommending community members to contribute to reducing the emission of greenhouse gases by following policies. Suitable for environmental protection.

❖ I AM A DATA SCIENTIST

In this study, I applied my skills in data analysis by highlighting my abilities to retrieve and process data using computer programs, creating tables and charts in Excel, and comparing them to previous research data. I was able to analyze the data and discover the changes that occurred in the soil properties after applying the infusion of banana

peels and yeast. As an organic fertilizer and to identify the reasons for this. I was also able to analyze the growth data of the Ruelia plant in the experimental sample and compare it to the control sample. I mentioned the reasons that helped improve the growth of the plant in the experimental sample and documented the interpretation of the results with the sources that I relied on in conducting the research.

❖ I MAKE AN IMPACT

In this study, I reached important and influential positive results for society, given the challenges we face in the field of climate change and environmental preservation. Every individual in society can contribute to reducing the carbon footprint, starting with his or her home garden, by changing the soil management policy, as I found in my experience that soaking banana peels and yeast contributed to improving the properties of the soil and storing organic carbon instead of emitting it from the soil, and this reflected positively on the health and growth of the plant. Therefore, I believe that fruit waste can be used effectively and sustainably instead of chemical fertilizers, which contributes to achieving environmental sustainability and reducing negative impacts on the climate.

.

References

1- 1. GLOBE Environmental Program Teacher's Guide, (2015).

2. Naseer, Mona Ibrahim, (2021). The effect of organic fertilizers derived from orange and banana peels on tomato plant quality, Department of Lands, Faculty of Agriculture, Ain Shams University.

3. Rashid, Iman Anwar, Al-Dulaimi, Ahmed Fatkhan Zabbar, (2020). The effect of whey and banana pulp extract on the growth of olive seedlings, Khastawi variety, College of Agriculture, Anbar University.

4. Awad, Nourhan Muhammad. (2023, April 23). Banana water is a natural fertilizer for plants. Retrieved on December 25, 2023 from https://icona.almasryalyoum.com/ /

5- Balancing carbon dioxide in plant beds. Retrieved on December 25, 2023 from

https://www.magicworldsy.com/sw-marine/plants/plant-index/co2/

6. Omer, Khalieda A (2003). Effect of spray with suspension of dry yeast on growth and productivity of tomato plant. Mesopotamia Journal of Agriculture, 2003, Volume 4, Issue 3, Pages 23-28

Appendices

Central Analytical and Applied Research Unit
Sultan Qaboos University
123, Al Khoudh, Muscat,
Sultanate of Oman
Tel: 24148801 Email: caaru@squ.edu.om

ISO 9001

TEST REPORT

Booking NO. : CAARU/E/23/811	Report NO: CAARU/SQU/E/23/200

SAMPLE SUBMITTED BY PARTY

Name of the Customer	: Ms. Aisha Ahmed
Name of the Company	: Hafsa bint Sirin School
Address	: Oman
Sample Described by the Customer	: -
Customer Reference No./Job No.	: -
NO. of samples given by the Customer	: 01
Quantity of the Sample Received	: -
Code No. / Batch No. of the Sample	: N/A
D.O.M	: N/A
D.O.E	: N/A
Manufactured by	: N/A
Date of Sample Receipt	: 17/09/2023
Date of Start of Analysis	: 18/09/2023
Date of Completion of Analysis	: 18/09/2023
Date of Final Report	: 18/09/2023

	Sample Id	Mg 285.213 (mg/L)	Na 589.592 (mg/L)	K 766.490 (mg/L)	P 213.617 (mg/L)	Ca 317.933 (mg/L)	Fe 238.204 (mg/L)
1	CAARU_23_I_811_Aisha	29.03	65.57	839.79	131.77	36.92	3.71

Note:

1. Sample were prepared by CAARU ICP specialist.

END OF REPORT

Analysed By:
Muna Al-Hosni

Reviewed By:
Dr Suad Al Burtamani
Dr Premkumar Samuel S D

Appendix (1) Results of analysis of banana and yeast

XRF RESULTS(Total) in mg/kg

Results in mg/k	Control sample	Results in mg/k	Experimental sample	Results in mg/k
483000	Mg	46200	Mg	41600
3120	K	3940	K	3760
110000	Ca	98800	Ca	130000
234	Mn	190	Mn	226
11000	Fe	10800	Fe	9680
371	Ni	431	Ni	382
29.1	Cu	8.64	Cu	23
54.3	Zn	13.7	Zn	20.7
3170	P	BDL	P	BDL
2520	S	1040	S	1140
27100	Al	25400	Al	25300

BDL-Below Instrument Detection Limit

Appendix (2) Results of analyzing the amount of nutrients in soil samples.