Hong Kong Student Science Project Competition 2022

Team Number: SBBC263

Project Title: Algaeing the future

Project Type: Investigation

To our best knowledge and after thorough literature research, as at 12/6/2022 , there are / are no* similar works. If there are, the reference links are as below:

https://en.wikipedia.org/wiki/Aquaponics
PMID: 32194145 DOI: 10.1016/j.biotechadv.2020.107536
PMID: 31455102
DOI: 10.1080/07388551.2019.1654972
PMID: 33035988
DOI: 10.1016/j.scitotenv.2020.142532
PMID: 31128367
DOI: 10.1016/j.scitotenv.2019.05.123

The enhancement our project has made for the existing related products or research is summarized as below:

Aquaponics.
We replaced vegetables with microalgae to see if microalgae exerts similar effects as that of vegetables.
We would like to investigate deeper on how microalgae can enhance growth of vegetables and to what extent it is beneficial.

I. Background

Amidst the 21th century, the relatively affluent century, there are still around 690 million people in starvation and some in malnutrition. In 2030, it is expected to have a severe food shortage. Therefore, we urgently need to increase both food amount and rate of food production to support our swelling food demand. Now, we can have nutrient-rich microalgae to sustain our food supply and achieve 'zero hunger'.

II. Objectives

We hope to find out whether microalgae have the potential to provide sufficient food for the future, especially with increasing food demand. We apply microalgae into plants growing and fish living. We hope that this microalgae experiment can raise awareness of different countries and the public about putting microalgae to practical application. Urgent hunger and food shortage problems in the world can be fundamentally solved.

III. Hypothesis

The hypothesis can be tested by measuring the change in mass of three pots of lettuce. The predicted result is that lettuce with microalgae grows at a rate faster than lettuce with fertilizers so it can increase food supply and easily achieve 'zero hunger'.
Also, microalgae can be grown with fish. It maintains a good environment for fish, like oxygen production and maintaining water quality. It is self-sufficient and sustainable.

IV. Methodology

Experiment 1:
Materials used: 3 pots, 3 lettuce, 20 g fertilizer, 20mL 3.33 g dm^{-3} microalgae solution, Water, Lamp
We put equal amounts of soil into three pots separately, with pot 1 added water only (controlled set-up), pot 2 with 20g fertilizer and pot 3 with 20mL microalgae solution. We measure the fresh mass before watering the plants with 35mL water every day.
Experiment 2:
Materials used: 3 aquaponics tank, 12 fish, 3.33 g dm^{-3} micro algae solution, fish food
We set up 3 tanks of equal environment with 4 fish in each tank. We start the system and initially ran it for a few days with

regular feeding. Then we add algae solutions of different concentrations into tanks 2 and 3.

V. Results

Experiment 1:

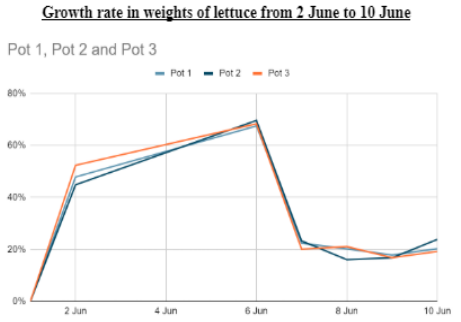

Figure 1 Graph about the growth rate of fresh mass of lettuce in three set-ups

The growth rate in weights of lettuce in Pot 3 is significant most of the time. It attained its peak at about 52% on 2 June. Despite the peak growth rate in weight of lettuce in Pot 2 is higher on 6 June, both of the growth rate in Pot 2 and 3 are at a higher level when compared with that of Pot 1. Furthermore, the average growth rate of lettuce throughout the experiment in Pot 3 is the greatest (32.973%).

From the experiment, microalgae serves as a plant growth promoter and biofertilizer. Microalgae can carry out photosynthesis to produce food and absorb compounds in air to produce minerals ions, which act as nutrients for growth and reproduction of plants. Therefore, adding microalgae can increase the productivity of the plants and the food supply.

Experiment 2

used			
Volume of water (cm^3)	4000	4000	4000
Amount of 3.33 g dm^{-3} green algae solution added at the beginning (cm^3)	0 (2 cm^3 of water is added)	2	5
Duration of Experiment (days)	14 (8 June - 22 June)	14 (8 June - 22 June)	14 (8 June - 22 June)
Time of survival (days)	12 (all died in 20 June)	14	12 (all died in 20 June)

Figure 4 Information about the three set-ups

	Set-up 1	Set-up 2	Set-up 3
Date of fish that died, amount of fish	16 June, 1 17 June, 1 20 June, 2	19 June , 1 20 June, 1	13 June, 1 15 June, 1 20 June, 2

Figure 5 Information about the death of fish

Set-up 2 shows the longest day of survival. For set-up 3, the fish only survives for 12 days because of excess microalgae. Fish in set-up 1 don't live as long as those in set-up 2. It shows the importance of microalgae in the fish tank.
The research has shown the importance of microalgae in the role of water. It can apply into the fish pond in real life. Microalgae can serve as food for fish and provide nutrients to fish. The pond can be self-sufficient. While microalgae can reproduce itself, the fish can obtain nutrients to grow rapidly.

VI. Conclusion

Both fertilizers and microalgae facilitate the growth of plants. The result shows that with microalgae, the lettuce grows at an average general rate more than the lettuce grown with fertilizers. However, the lettuce with microalgae solution added is kept with a more green color and wilts more slowly. Although the growth rate of lettuce with microalgae added is slightly less than that with fertilizers added, fertilizer is not sustainable as microalgae since fertilizers are non-living things while microalgae can continue to grow and reproduce. It is suggested that each farmland can prepare a tank under sufficient light for cultivating microalgae. Microalgae can be added periodically to replace fertilizers. With a rapid growth rate and guarantee of crop quality, more high-quality food can be produced to meet the hunger problems. In the future, we can find an appropriate amount of microalgae solution added to the plants so that the water potential will not be affected and maximize the amount of nutrients.

Also, microalgae maintains a better water environment with rich nutrients for fish. The result shows that with microalgae, the fish survives for the longest days, compared with that without microalgae. It is expected that the rate of consumption of algae by the fishes and the rate of growth and reproduction of microalgae can reach an equilibrium. However, too much microalgae causes algal bloom at night, which causes competition for oxygen between fishes and microalgae. Fishes die because of suffocation. From our experiment, we still have not found out the perfect ratio of fishes and microalgae. But one thing for sure in our experiment is that fishes eat microalgae.