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BLUE-GREEN ALGAE ERADICATOR

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Abstract: Previous endeavors to boost fish farming has been retarded by invasion of fish ponds and lakes by harmful cyanobacteria. The Kenya vision 2030 launched in the year 2008 is aimed at transforming the country into a middle income earning country, right from the current third world state, it is currently in. However, studies that have been conducted previously indicate that practicing prudent control of harmful cyanobacteria has led to the increase of fish production from fish ponds. However, these studies used chemical methods to control the harmful cyanobacteria. Therefore this study sought to investigate the effect of the algae eradicator, which produces ultrasound, on harmful cyanobacteria. The specific objectives of this study were to provide a non-chemical method of controlling cyanobacteria found in fishponds; to save the dwindling aquaculture sector in Kenya because of effects caused by cyanobacteria and to boost food security, since fish is consumed by more than 70% of Kenyans. The data was collected from Kegati Aquaculture Research center, in Kisii town, Kisii County, Kenya. This study analyzed data using descriptive and regression analysis. Where the work of other authors was used, due acknowledgement was done. Where the work of other authors was used, due acknowledgement was done. The researcher obtained a research permit from St Angela Sengera Girls' High school in order to enable collection of data. It was concluded that cyanobacteria is a major threat to ponds, which is a habitat of fish. The study also concluded that ultrasound is the fastest method of eradicating cyanobacteria in fish ponds. The study finally concluded that ultrasound is the most efficient method of eradicating cyanobacteria in fish ponds. This study recommends that the government implement this gadget on a large scale basis so as to achieve vision 2030 goals.

Index Terms – Cyanobacteria, Food Security, Kenya Vision 2030
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CHAPTER ONE

INTRODUCTION

1.1 Background of the study

The Kenya vision 2030 launched in the year 2008 is aimed at transforming the country into a middle income earning country, right from the current third world state, it is currently in. Algae are natural and significant components of a healthy aquatic ecosystem. They are organisms that are responsible for releasing oxygen into the environment thought their photosynthesis activity (Downing, 2013). Cyanobacteria algae are classified into the following species: the blue green algae and the red brown algae. They are used in sewage treatment (Barrington, Ghadouani & Ivey, 2018). According to Kay, Quimby and Ouzts (1982), fishing is the largest economic activity in Asia after agriculture. Fish is an important protein for small scale farmers who have ponds.

Cyanobacteria has invaded American ponds making the color of water to change and prevent penetration of oxygen into the pond for fish to survive .This leads to death of fish making the farmers to suffer huge losses (Rajendran, & Wilson, 2018).The cyanobacteria (cynophcota) is an algae that first appeared as a fossil 3.5 billion years ago. The fossils were referred to as ‘stromatolites’. They were the first organism that were responsible for releasing oxygen into the environment through their photosynthetic activity (Sinha, Eggleton, & Lochmann, 2018). However, harmful cyanobacteria affect the Australian environment by blocking the sunlight that organisms need to survive .The cyanobacteria starts to multiply quickly. You might not be able to see Cyanobacteria blooms. Some of them bloom like scum or foam especially when the wind blows towards the side of the pond. They may make the water smell like rotting plants (Downing, 2013).

Cyanobacteria, sometimes referred to as blue-green algae, share characteristics with both algae and bacteria. Cyanobacteria are closely related to true bacteria, but perform photosynthesis like algae to gain or fix energy, and in turn, produce oxygen (Hansen, Welsh, Lipton & Cacela, 2002). Cyanobacteria are among the oldest organisms on earth and occur in diverse habitats, including both in soil and water. In water, cyanobacteria are naturally present in small numbers in slow-moving fresh or blackish water bodies (Sinha, Eggleton, & Lochmann, 2018). However, when waterways become enriched with nutrients, naturally or due to human-related activities, this is called eutrophication. This increased concentration of nitrates and phosphates can lead to rapid and explosive growth of cyanobacteria. This rapid growth is called a bloom. Cyanobacteria blooms will typically occur on the surface of a water body and vary in color, often looking bright green to blue-green, and may be dense enough to resemble paint on the water’s surface (Kay, Quimby & Ouzts, 1982).

All algal blooms have the potential to negatively affect the health of a waterway through the depletion of available oxygen in water for aquatic and marine life. Low dissolved oxygen levels can lead to fish kills; when this condition persists, the result is "dead zones," where oxygen in water is so low that aquatic life is suffocated and very little life exists (Lynch, 2009). Cyanobacteria blooms have been labeled "harmful algal blooms" because they can release toxins into waterways as cyanobacteria cells die and breakdown (Rajendran, & Wilson, 2018).

Of the 2,000 species of cyanobacteria that have been identified, more than forty of these have the potential to release toxins, called cyan toxins, into the African environment (Sallenave, 2017). These cyan toxins can impact human and animal nervous systems and liver, irritate skin, cause gastrointestinal issues and contribute to the development of tumors. Documented cases of cyan toxin poisonings and illness in animals and humans date back to the mid-1800s, with the frequency of occurrence increasing in Kenya (Carmichael, 2008). The increased incidence of harmful algal blooms not only impacts human and animal health, but can also impact recreation, access to clean drinking water as seen in Toledo, Ohio, fishing and shell fishing, our economy, and ultimately our quality of life (Lynch, 2009).

Blooms may occur under low flow, warm temperature, and adequate light and sufficient nutrient conditions. Our community can play a significant role in introducing nutrients to our ponds, lakes, streams, and rivers. (Kay, Quimby & Ouzts, 1982). If not managed, nutrients carried in runoff from residential and agricultural activities can be transported to the nearest waterway, contributing to cyanobacteria growth. Runoff from landscaping and lawn care activities may have been the cause of eutrophication in a series of South Carolina coastal storm water ponds that resulted in over 200 harmful algal blooms between 2001-2005, with cyanobacteria being the most abundant species present in the ponds studied (Hansen, Welsh, Lipton & Cacela, 2002). Blooms like these are not limited to our South Carolina storm water ponds, and can occur on agricultural ponds, in rivers and streams, reservoirs, and elsewhere. Farmers have lost valuable livestock to harmful algal blooms in agricultural ponds (Downing, 2013).

Fig 1.1: Cyanobacteria growth in South Carolina, USA water ponds

1.2 Statement of the problem

Previous endeavors to boost fish farming has been retarded by invasion of fish ponds and lakes by harmful cyanobacteria. The Kenya vision 2030 launched in the year 2008 is aimed at transforming the country into a middle income earning country, right from the current third world state, it is currently in. However, studies that have been conducted previously indicate that practicing prudent control of harmful cyanobacteria has led to the increase of fish production from fish ponds. However, these studies never constructed a device that is put in fish ponds to produce ultrasonic sound waves to terminate the harmful cyanobacteria. Therefore this study sought to investigate the effect of the Blue-green algae eradicator on harmful cyanobacteria. Filamentous algae are one of the most common aquatic plant problems faced by pond owners now (Lynch, 2009).When the ponds are overgrown with algae the pond becomes unattractive for fishing and has foul taste and also restricting use of the water for drinking supply and fishing in ponds (Downing, 2013).They cause an adverse effects called harmful algae blooms .A report of livestock and pet sickness and deaths due to drinking of toxic water .Although documented illness (Carmichael, 2008) .It blocks penetration of light from reaching the bottom .They have led to reduction of fish leading to low income to farmers. Therefore, this study sought to eliminate the harmful cyanobacteria by constructing an algae eradicator.

1.3 Objectives of the study

1.3.1 General Objective of the study

To construct a Blue-green algae eradicator that will eliminate harmful cyanobacteria found in fish ponds using ultrasound.

1.3.2 Specific Objectives of the study

i. To provide a non-chemical method of controlling cyanobacteria found in fishponds.

ii. To save the dwindling aquaculture sector in Kenya because of effects caused by cyanobacteria.

iii. To boost food security, since fish is consumed by more than 70% of Kenyans.

1.4 Research Hypothesis

Ultrasound is the best method of controlling cyanobacteria bloom in the fishpond ecosystem.

1.5 Research question

What is the best and safest method of controlling cyanobacteria in fishponds?

1.6 Variables of the study

In the study, the independent variable is the rising blooms of cyanobacteria in fishponds, which affects fish farming and has been a challenge to control. The dependent variable is the effect posed by cyanobacteria on fish which have led to loss of fish stock due to death.

1.7 Scope of the Study

This study investigated the effect of the Blue-green algae eradicator on harmful cyanobacteria. The study was carried out from the month of November to December, 2022 a period of two months. The study concentrated on the fish ponds available in Kegati Aquaculture Research center, in Kisii town, Kisii County, Kenya.

1.8 Limitations of the study

This study experienced the problem of unpredictable weather patterns during data collection. However, this study addressed this problem by collecting data during the dry season to avoid disturbing of the fish ponds.

1.9 Organization of the study

The study is divided into five chapters. Chapter one brings out the introduction to this study. This chapter will include the background of the study, the statement of the problem, the research objectives, the hypothesis, the significance, the scope and the limitations of the study. Chapter two will entail the Literature review of the study

Chapter three of the study will have the research methodology of this study. Chapter 4 will include the Data analysis and discussion while chapter 5 will entail the conclusions and recommendations.

CHAPTER TWO
LITERATURE REVIEW

2.1 Introduction

This chapter is divided into three parts which include the introduction, the empirical literature review, and a summary of the empirical literature review. A critical review of previous literature contributions by other scholars is also presented through the empirical literature review. A summary of the empirical literature reviewed is presented in tabular form in order for the research gaps to be unfolded, hence providing a knowledge gap for the current study.

2.2 Empirical Literature Review

Yang, Buley, Fernandez-Figueroa, Barros, Rajendran and Wilson (2018) experimented an increase in extracellular microorganism after treatment with 7mg/liter of hydrogen peroxide (H_2O_2).The observation method was used and data recorded using tables .The experiment obtained the result that microcystin concentration reduced after 7 day period. However hydrogen and other factors should be taken in account before applying hydrogen peroxide to active production pond moreover as hydrogen peroxide breaks down to water and hydrogen leaving behind the chemical residuals. The study suggested that the current study was to use a 7 mg/litre dose of hydrogen peroxide and high ambient sunlight to treat highly productive aquaculture ponds experiencing blooms of blue green algae. The current study constructed a Blue-green algae eradicator to eliminate harmful cyanobacteria.

Rajendran and Wilson (2018) investigated a system of ultrasonic sound that they installed in the canoe brook reservoir on a cliff to assess the impact of the system on controlling cyanobacteria in ponds .The four buoys worked for five months in the summer of 2014. During the initial part of the study the system seemed to control the algae well. In the sixth month, an economic assessment showed that buoys saved approximately 87,800 dollars in operational cost. The study concluded that the buoys were effective at treating algae. It is imperative to shift to correct ultrasonic programme before it occurs .Due to increased emphasis on harmful algal blooms the use of ultrasonic treatment in reservoir provides an additional tool for preventing the potential release of algal toxins into ponds. However, the study was conducted in United States of America with differing social and economic structure compared to Kenya. The current study constructed a Blue-green algae eradicator to eliminate harmful cyanobacteria using ultra sound waves in Kenya.

Sallenave (2017) researched about the filamentous algae and problems associated with them. The study concluded that there was a high percentage of nitrogen and phosphorus in water. Another common source of nutrients enrichment in ponds is poor functioning of septic system. The study also focused on ways on which excessive filamentous algae can be controlled. The author noted that the only way to ensure effective long-term control is to treat the cause of the problem by reducing nutrients in ponds and repairing septic system. However the current study noted that reducing nutrients in fish ponds would also affect fish, because they also needed the nutrients for their survival. The current study constructed a Blue-green algae eradicator to eliminate harmful cyanobacteria.

CHAPTER THREE
METHODOLOGY

3.1 Parts of the technology, apparatus and Procedure

3.1.1 Floater

This is a buoyant part of the technology which means that the gadget floats on water.

It is made from:

- Polystyrene materials
- Solar cells
- Silk cloth materials
- Transmitter materials
- Plastic material/ Timber
- Connecting wires
- Arduino Uno microcontroller
- Proximity sensor

Procedure of making the floater

- Cut the polystyrene and plastic material , the same shape and size (length 30cm, width 20cm)
- Make shallow depressions on the first polystyrene material and screw in the transmitter circuit. You can tape it to hold in position.
- Cover with the other polystyrene. Sandwich it with the two plastic material the screw on the corners.
- Cover with the two cloth material and stitch.
- Give in position the solar cells at the top and screw the transducer holder at the bottom.

3.2.2 Transducer

This is a frequency generator. It is held in position below the floater. It is made up of an Arduino Uno microcontroller that is the brain of the sensors. It has 2 proximity sensors that produce ultrasound. When the ultrasound hits the cyanobacteria, it produces an echo which is reflected back and hits the cyanobacteria. This process occurs continuously hence destroying the cyanobacteria.

How to install the gadget.

- One gadget is to operate in a pool size area of $100m^2$ effectively. If the pool is larger, install 2 or more gadgets.
- The gadget is placed in the fish pond and left to float. The transduced part submerges in water.
- As the wind blows, it moves the gadget around the pond.

3.2 Mechanism of the Technology

The solar cells produce energy which is stored in a small wet cell used by the gadget. The transducer. The transducer is an underwater speaker part of the gadget that produces ultrasonic vibration through the water. The ultrasound produced is 24 to 64 kHz, a frequency which is friendly to other aquatic organisms like fish, but destroyed cyanobacteria.

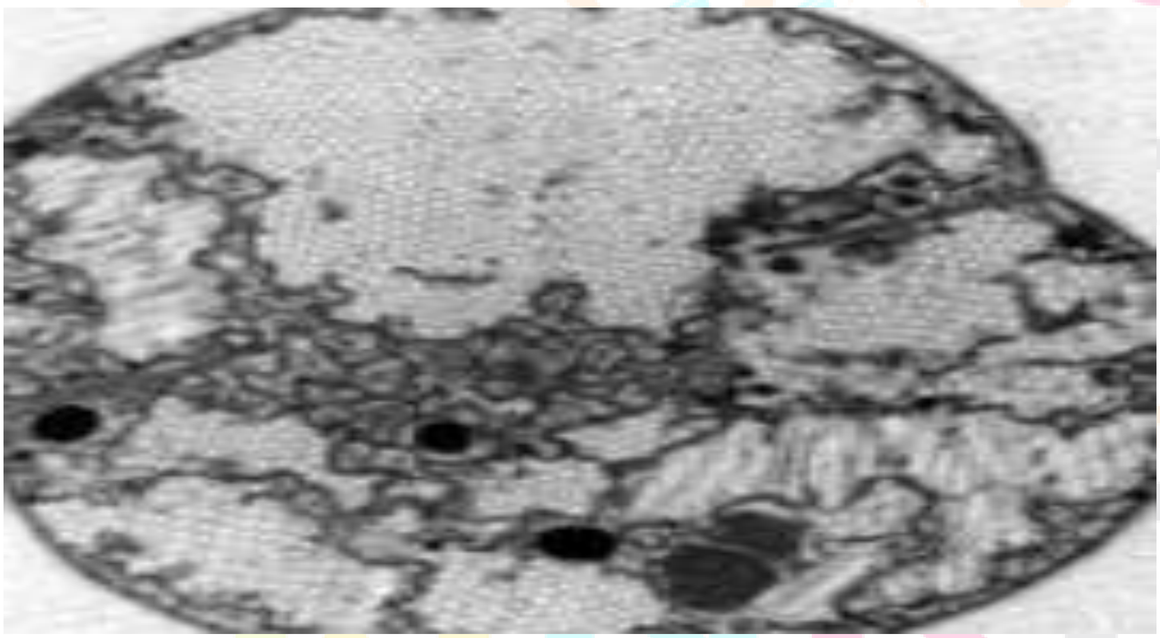
Cyanobacteria contains gas vacuoles whish help them in buoyancy, ultrasonic vibration damage these specialized part of the bacteria. The emitted ultrasound waves strike the algal cells to begin oscillating. The gas vacuoles also starts to resonate to such an extent that it continues to increase in size. It reaches a point where the vacuole becomes unstoppable and raptures making the cyanobacteria lose its buoyancy then sink to the bottom of the pond. In the absence of adequate light at the bottom of the pond, the cells are unable to restore their vesicles for buoyancy and cannot photosynthesize therefore, they starve to death.

Fig 3.1: The gadget and the gadget installed in water

Fig 3.2: Picture of the pond before treatment

Fig 3.3: Picture of the pond after treatment

Fig 3.4: Transverse section of a dividing cell of the cyanobacterium showing the cylindrical gas vesicles



3.3 Precautions

i. The tip of the transducer must be cleaned regularly to remove scum.

ii. The transducer must be leak proof to avoid water from leaving inside and damaging the electronic part.

3.4 Limitations and constraints

The limitation of this technology is that it is controlled by wind when there is no wind it remains in a static position. This gadget is in water so it is hard to know when it is faulty and not functioning.

3.5 Merits

100 % environmental friendly compared to the chemical methods currently used.

No generation of harmful by-products.

No genetic mutation of survivors like in the use of chemical methods.

Simple and to install and maintain.

3.6 Demerits

A "line of sight" is needed sometimes for the transducer output to be effective. If there is a lot of wind, the gadget becomes inefficient.

A lot of patience is required, it takes a long time depending on the volume of the water and the amount of cyanobacteria to function effectively.

3.7 Effect of changes in parameters

If lower frequency or higher frequency is produced, it may affect the fish and other aquatic organisms.

CHAPTER FOUR
DATA AND DATA DISCUSSION

4.1 Data collection

This involved a descriptive cross-sectional study of fishponds at the Kegati Aquaculture Research center. 6 respondents who work at the institution were sampled. Data was collected through questionnaires, interviews and by observing the state of the fish ponds at the institution. Data was also collected from laboratory experimentation where the efficiency of ultrasound and the chemical method of controlling cyanobacteria was compared. The same volume of water derived from the same pond, with 3 tilapia fingerlings in each experiment was used.

4.2 Data analysis

Table 4.1 Number of ponds highly invaded with cyanobacteria

Number of ponds in the institution	6
Number highly invaded by cyanobacteria	4
Number with low invasion of cyanobacteria	2

4/6x 100= 66.67%

Table 4.2 Number of days for color change for methods of controlling cyanobacteria

Method	**Number of fish at start**	**Number of days for color change**
Ultrasound (20kHz)	1000 cm^3	2
Copper (II) Sulphate	1000 cm^3	5
Hydrogen Peroxide	1000 cm^3	7

Table 4.3 Percentage efficiency of Methods of controlling cyanobacteria in fish ponds

Method	**Number of fish at start**	**Number of fish at end**	**Percentage efficiency**
Ultrasound	3	3	100
Copper (II) Sulphate	3	1	33.33
Hydrogen Peroxide	3	0	0

Table 4.4 Number of cells per colonies of cyanobacteria in fish ponds

Method	Number of cells at start	Number of cells at end
Ultrasound	5	0
Copper (II) Sulphate	5	1
Hydrogen Peroxide	5	2

Fig 4.1 CYANOBACTERIA INVASION OF PONDS

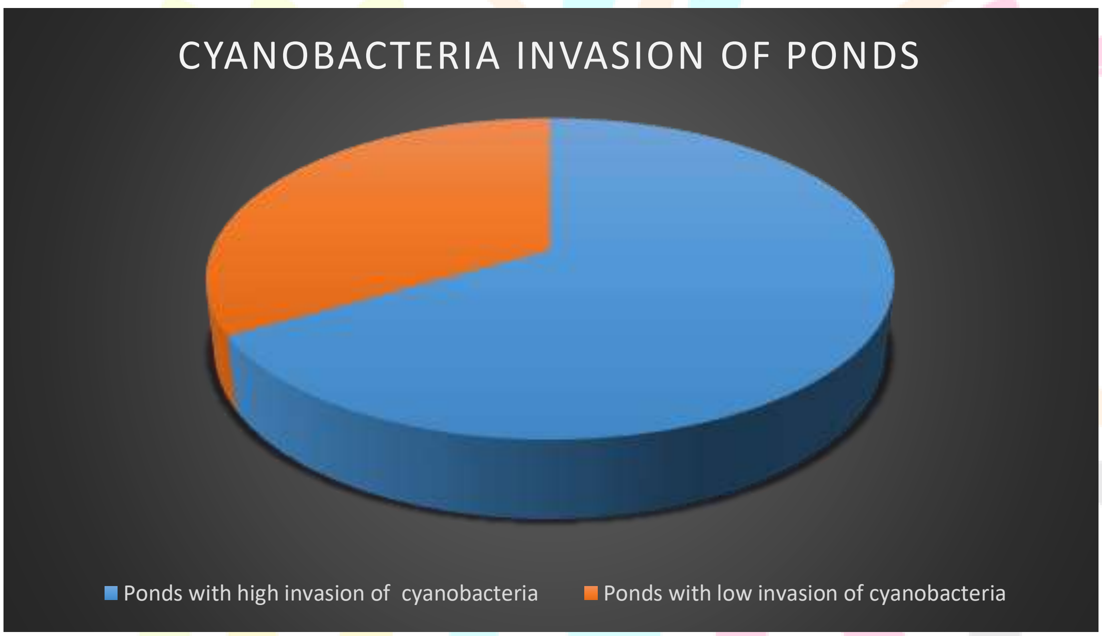


Fig 4.2 Number of Days for Colour Change

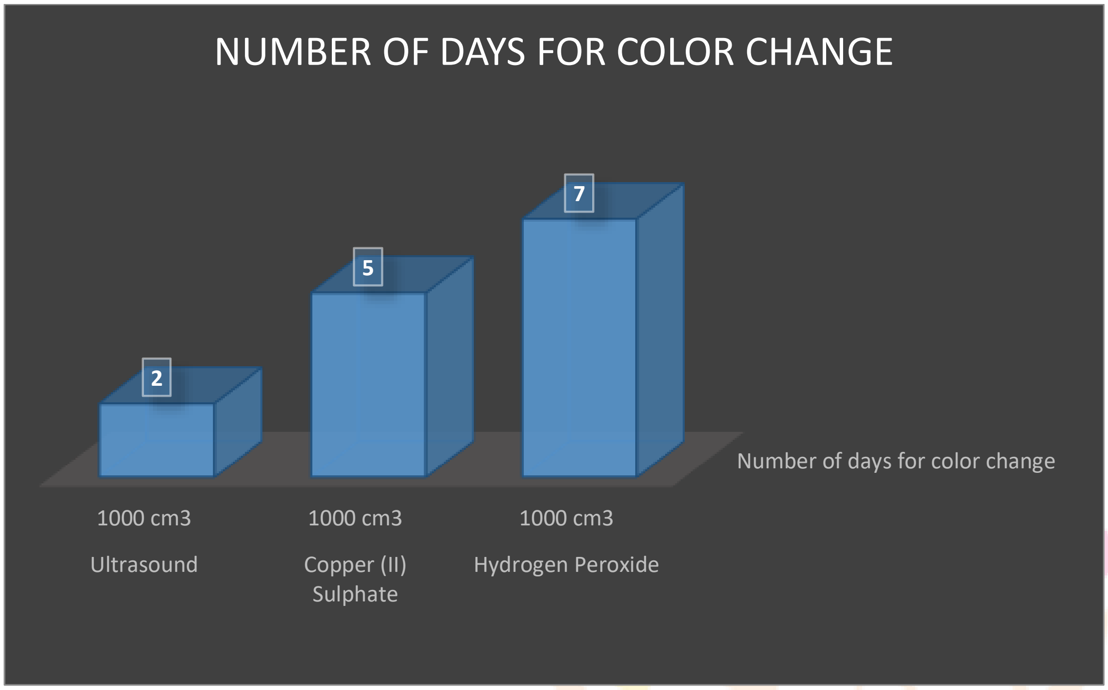


Fig 4.3 Percentage Efficiency

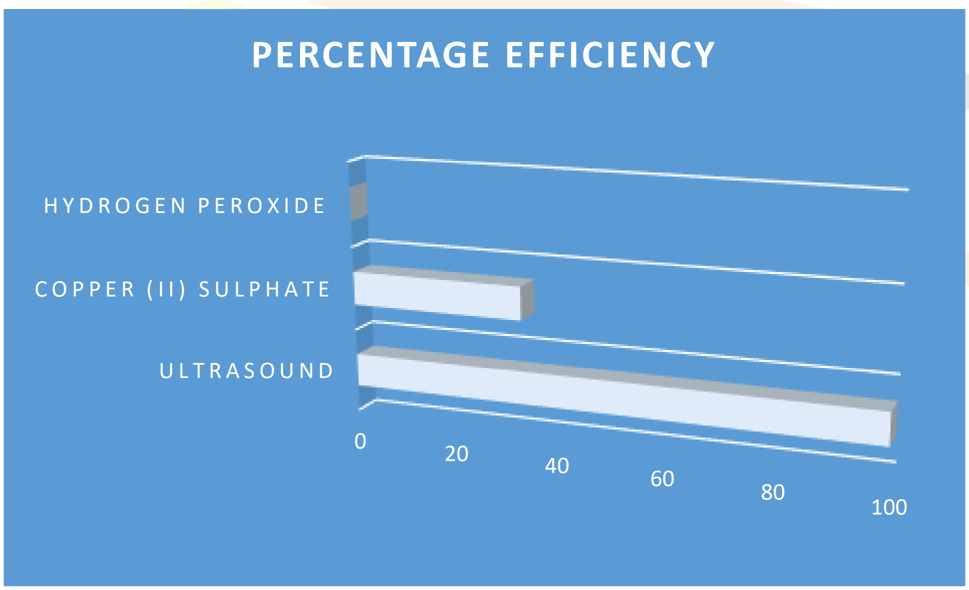
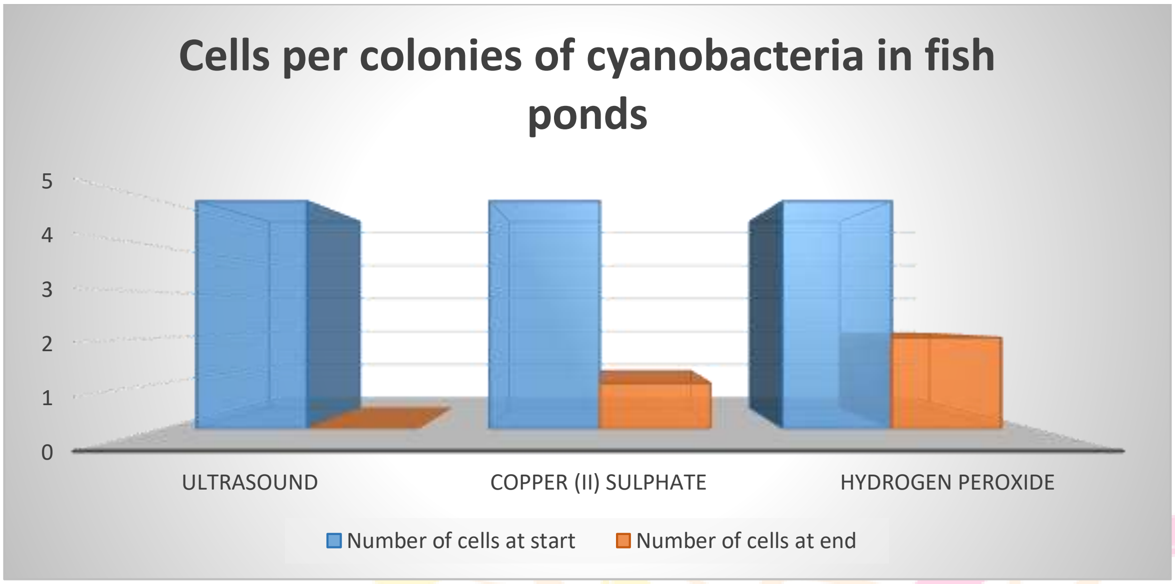


Fig 4.4 Cells per colonies of cyanobacteria in fish ponds



4.3 Data Discussion

From the results obtained in Table 4.1 and Fig 4.1, the number of ponds invaded with cyanobacteria is 66.67 percent while number of ponds invaded with cyanobacteria is 66.67 percent number of ponds invaded with cyanobacteria is 33.33 percent. These results indicate that cyanobacteria is a major threat to ponds, which is a habitat of fish.

From the results obtained in Table 4.2 and Fig 4.2, the color change of fish ponds when treated with ultrasound is 2 days. The color change of fish ponds when treated with copper (II) sulphate is 5 days while the color change of fish ponds when treated with hydrogen peroxide is 7 days. These results indicate that ultrasound is the fastest method of eradicating cyanobacteria in fish ponds.

From the results obtained in Table 4.3 and Fig 4.3, the percentage efficiency of eliminating cyanobacteria from fish ponds when treated with ultrasound is 100 percent. The percentage efficiency of eliminating cyanobacteria from fish ponds when treated with copper (II) sulphate is 33.33 percent while the percentage efficiency of eliminating cyanobacteria from fish ponds when treated with hydrogen peroxide is zero percent. These results indicate that ultrasound is the most efficient method of eradicating cyanobacteria in fish ponds.

From the results obtained in Table 4.4 and Fig 4.4, the number of cells per colony of cyanobacteria after treatment using ultrasound is zero. The number of cells per colony of cyanobacteria after treatment using copper (II) sulphate is one while the number of cells per colony of cyanobacteria after treatment using copper (II) sulphate is two. These results indicate that ultrasound is the most efficient method of eradicating cyanobacteria in fish ponds.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the results observed in chapter IV above, cyanobacteria is a major threat to ponds, which is a habitat of fish. The study also concludes that ultrasound is the fastest method of eradicating cyanobacteria in fish ponds. The study also concludes that ultrasound is the most efficient method of eradicating cyanobacteria in fish ponds. The study finally concludes that ultrasound is the most efficient method of eradicating cyanobacteria in fish ponds. With this data, the study has proved the hypothesis, answered all the research questions and achieved all the specific objectives.

5.2 Recommendations

This study recommends that the government supports us financially so as to enable us implement this gadget on a large scale basis so as to achieve vision 2030 goals.

5.3 Future Direction and Adjustments

This study in future will improve the Blue-green algae eradicator gadget by putting a GSM chip which will aid in locating the position of the gadget in the water.

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APPENDICES

APPENDIX I: LETTER TO THE RESPONDENT

Dear Respondent,

I am currently a teacher at St Angela Sengera Girls' High School, Kenya. My Science club students are currently carrying out a research study on a project whose topic is:

"BLUE-GREEN ALGAE ERADICATOR".

I therefore request for your information and cooperation in this exercise. All information will be treated with confidentiality.

Yours with regard

DR. DENNIS OSORO MARANGA

PhD (FINANCE)

KENYATTA UNIVERSITY