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Ai-Based pH Level Detector and Neutralizer of Fish Ponds

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ABSTRACT: Because of its marketability and nutritional worth, tilapia is a popular and easily bred species, and the Philippines' fisheries industry makes a substantial economic contribution. Nevertheless, a lot of fish business owners view aquaculture as a supplemental source of revenue, which leads to inconsistent feeding and insufficient water quality monitoring. Water's pH, which should be neutral at 7.0, can change for a number of reasons, such as pollution and environmental variables, which can have a negative impact on fish productivity and health. Reduced yields can result from fish stress and injury caused by low pH levels. This study emphasizes how important it is to keep an eye on water quality, especially pH levels, in order to maximize the results of fish farming. Between 2019 and 2020, aquaculture production in Region 2 grew by 4.1%, however commercial fishing saw a decrease. Because they are straightforward, traditional monitoring techniques are still widely used; among fish producers, visual observation is the most popular method. This project created an Arduino-based pH level detector and neutralizer to overcome the difficulties in keeping an eye on the pH levels in fish ponds. This device provides real-time feedback for any necessary modifications while automating the measurement of water's acidity and alkalinity. The results showed notable variations in acidity and demonstrated that the developed model successfully assesses pH values across a range of samples, including distilled water, tap water, soft drinks, and alcohol. The results highlight how crucial it is to combine contemporary technology with conventional methods in order to enhance aquaculture water quality monitoring and management and guarantee the best possible conditions for fish sustainability and health. In order to improve aquaculture practices in the Philippines and strike a balance between ecological stability and economic growth, this research promotes regular monitoring and resource provision.

KEYWORDS: tilapia aquaculture, water quality, pH level control, fish pond management, acid-neutralizing solutions

1. INTRODUCTION

The fisheries sector in the Philippines plays an important role, various types of fish can be breed in any type of fishponds. One fish that is widely bred and it is common that are easily breed and produce is called as tilapia. Tilapia is a type of consumption fish that lives in fresh water, ocean, lakes, fish ponds. The said fish tends to be very easy to breed and is very easy to market because it is one of the most commonly consumed types of fish due to the price or its impact in the economic growth. Base on operational reasons, such as facilitating feeding, supervision and security, pest and disease control and harvesting processes [1], In order to maximize the yield of cultivated of any type of fish in the fishponds, proper monitoring of water is needed in terms of acidity.

However, at this time most fish entrepreneurs only make fisheries as a side to support the main economic income. Because the time taken up by the main work makes the fish farming side business not get enough time to take care of it. Irregular food supply due to lack of time is a factor that makes the results of fish farming will decrease [4],

The pH of water is 7.0, and the concentrations of hydrogen and hydroxide ions are equal. However, the dissolved minerals and chemicals in the water have the ability to change those ions into basic or acidic water. Two instances of this that significantly affect the alkalinity and acidity of the water are rain and clean deposition.

Fish can suffer from the acidity and alkalinity of water, aquaculture, which includes fish ponds, considers these factors. Furthermore, fish that are exposed to very alkaline or acidic water may have persistent stress and skin burns. Moreover, this can clog their gills, which would make breathing difficult for them. The bad news for aqua farmers is that there's a chance that these effects could result in death, which would lower fish yield.

Region 2's production related to aquaculture increased by 4.1 percent, from 3,198 metric tons in 2019 to 3,314 metric tons in 2020. However, commercial fishing in the Cagayan Valley reached its lowest point ever in 2020, with 1,052 metric tons, down 8.2 percent from 1,147 metric tons in 2019. Compared to 2019, fewer of the sixteen species that were discovered were harvested by commercial fishermen in 2020.

It is a laborious process to monitor the pH of fish waters because they are so sensitive that the simple act of adding or removing fish can change it. Fish waters can vary in pH at any time of day; if these differences are not recognized and quickly neutralized, fish productivity can be negatively impacted and fisheries could go bankrupt.

A pH meter is an electrical device used to measure the hydrogenion activity of a solution. It establishes a solution's acidity and alkalinity. Higher concentrations of hydrogen ions indicate acidic solutions; on the other hand, higher activity of hydrogen ions indicates alkaline solutions, which are more accurately measured with the Potentiometric method. Fish ponds need an immediate neutralizer in addition to the detector. Since sodium bicarbonate dissolves in water to generate an alkaline solution, it can be used for severely acidic foods. This is also the reason why heartburn and other similar issues are frequently treated with sodium bicarbonate.

The Talisay tree (Terminalia Catappa) is a popular tropical tree in the Philippines. Its leaves have the power to either maintain or reduce pH to zero. According to Aya (2019), tannins included in talisay leaf extract lower pH and TAN levels in water to ensure its quality. It can neutralize an alkaline solution without harming the fish because it possesses antibacterial and antifungal properties.

The goal of this project is to develop a novel research method that uses fish-safe variables to monitor and neutralize the pH level of fish water. The wire-connected opener will be preprogrammed by Arduino for the study, utilizing a spectrum of hazardous alkaline and acidic levels as the foundation for the opener's operation.

2. MATERIALS AND METHODS

2.1 System Architecture

The develop model used microcontroller as the central processing or the heart of the model as shown in figure 1. It shows a pH control system that uses a microcontroller to regulate a solution's pH level.

The microcontroller serves as the system's decision-making component. It determines if the solution is too basic or too acidic based on the pH level data from the pH detector and determines the appropriate course of action. pH sensor detector determines the solution's pH level. When it ascertain whether the pH needs to be adjusted, it transmits this data to the microcontroller. In Acid releasing, the microcontroller initiates a mechanism to release acid, bringing the pH down or lower, if the solution is too basic (pH is too high). Lastly, in adding the neutralizer the microcontroller uses a different method to add a neutralizing soltion, most likely a base, to raise the pH if the solution is too acidic (pH is too low).

The pH detector continuously checks the solution, and the microcontroller modifies the pH by releasing acid or neutralizer as necessary, the model operates in a feedback loop.

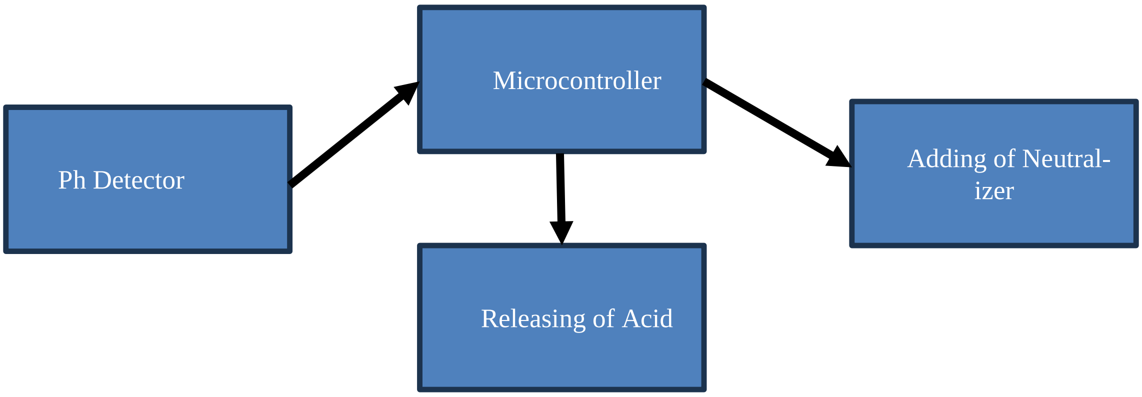


Figure 1. System architecture of the AI Based PH Level Detector and Neutralizer of Fis Ponds

2.2 Experimental method

The design model used the different variables to determine and detect the amount of pH level and acid amount that will serve as the basis for releasing for acid or neutralize.

Five distinct samples in labeled containers are seen in the supplied image as shown in figure 2. Most likely being prepped for an experiment assessing the acid content and pH level. With this technique, the acidity (pH) of these common chemicals might be measured because each container contains a unique liquid that may show varying pH levels. The following are utilized in the development of the study.

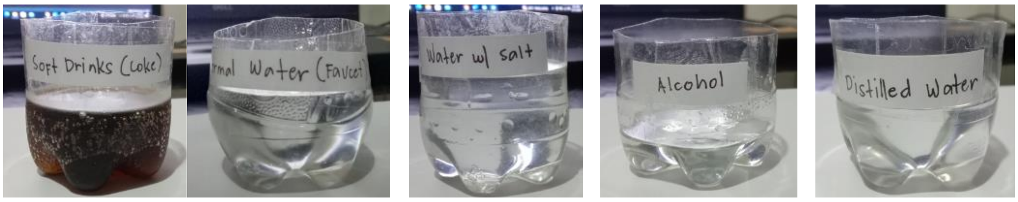


Figure 2. Sample variables used for experimental

First from the figure is the soft drinks (coke), due to carbonic acid (from dissolved CO_2) and phosphoric acid are frequently found in carbonated soft drinks, they are probably acidic. That the anticipated pH: Low, between 2.5 and 3.5, suggesting strong acidity. The tap water, or normal water, it may differ based on the source, tap water is typically neutral or slightly basic because of dissolved minerals and a little amount of alkalinity to stop pipe corrosion. Salty water or water with salt, due to the presence of dissolved sodium chloride (salt), which has no effect on pH at low quantities, the pH is neutral to mildly basic. Higher quantities, however, may cause a small pH shift. pH should be about 7 or a little higher. To consider that the value is norma the pH should be between 7 and 8. Another is the Alcohol, it may be neutral or somewhat acidic, depending on the type of alcohol. Although the pH of ethanol is neutral by nature, some alcoholic beverages may contain additional ingredients that cause the pH to drop. That the pH should be between 6 and 7, possibly a little acidic. Lastly, is the Water that has been distilled, the value should have a pH of about 7 and be neutral. Distilled water is perfect for pH testing control investigations since it is pure H_2O with no dissolved salts or contaminants anticipated pH: Near 7.

The purpose of this experimental method is, Using this arrangement, one may determine the acidity or basicity of a variety of common liquids by testing their pH levels. It is possible to compare the acidity levels of these liquids by using a pH monitor or indicator. For instance: Distilled water should stay neutral, but soft drinks (like Coke) should exhibit excessive acidity. The pH of water may somewhat vary when salt is added, although probably not significantly.

To automate the data gathering from these liquids, a pH sensor can be linked to the microcontroller as shown in the figure 1. In this manner, the system can continuously check each liquid's pH, which makes it beneficial for industrial pH monitoring systems or educational settings. In conclusion, this picture shows a pH testing experiment that uses common home liquids to compare the acidity or neutrality of each one using a pH sensor that are also applicable in any fish ponds.

2.3 pH Measurement

To measure a pH value, use reference electrodes that output different voltage values depending on the pH value. The pH value is thus not measured directly, but it must be calculated from the observed voltage. pH electrodes exhibit a nearly linear behavior in the range between 0 and 14. Therefore, to convert the voltage values to pH values, it need a linear equation in the form of $y = mx + b$ (linear equation). To calculate the slope m of the straight line, need the corresponding voltage values of at least two pH values. So, if already know the first pair of values from the calibration: pH = 7; U = 2.5 V then measure the voltage at another pH value, for example, at pH = 4.

We calculate m as follows:

$$m = \frac{\Delta \text{ voltage}}{\Delta \text{ pH value}} = \frac{\text{voltage (pH=7) - voltage (pH=4)}}{7 - 4} \qquad (1)$$

To improve accuracy, we can utilize two-point calibration, where we test the voltage for pH = 10 and compute the mean value of m appropriately. For example, we measured a voltage of 3.0 V for pH = 4.

```
pHvalue = (7 + ((2.5 - voltage)/0.167));
```

Here, the value of m that was just calculated reappears. It can be modified based on your own measured values. The formulas' accurate conversion promotes interdisciplinary collaboration with math peers.

Side note

$$m = \frac{\Delta \text{ voltage}}{\Delta \text{ pH}} = -0.167$$

$$-0.167 = \frac{2.5 - \text{voltage}}{7 - \text{pH}}$$

$$0.167 = \frac{\text{voltage} - 2.5}{\text{pH} - 7}$$

$$\text{pH} - 7 = \frac{\text{voltage} - 2.5}{0.167}$$

```
pHWert = (7 + ((2.5 - spannung) / 0.167));
```

For a linear function, the constant b is initially ignored in the equation, but if systematic deviations arise, you can manually set it to any value.

3. RESULTS AND DISCUSSION

3.1 water quality monitoring

Aquaculture has long employed manual and traditional techniques to monitor and control water quality, especially the pH and acidity of fish ponds. Even though precision and efficiency have greatly increased thanks to contemporary technology, many small-scale and traditional fisheries still use these outdated methods because they are easy to use, affordable, and accessible.

Some are using the method of one of the simplest traditional methods for maintaining water quality is regular partial water exchanges. Farmers drain a portion of the pond and replace it with fresh water to dilute acidic substances or harmful chemicals that may have accumulated. Usually the used water changes help remove dissolved wastes, balance the pH, and refresh the oxygen content. Farmers typically perform this task manually by opening sluices or drainage channels.

The table 1 shows the respondents that the usual practice in monitoring the water quality in terms of the pH level and acidity of the water for the safety of fish in aquariums that may relay in fish ponds. They are ten (10) respondents that represents the usual practice.

The most often used techniques are visual observation and water exchanges, most likely due to their simplicity, lack of specialized equipment, and historical dependability. The use of fish species as indicators is also rather widespread, suggesting that respondents believe this approach to be trustworthy in situations where there are no direct instruments for measuring pH. Surprisingly little manual pH strip testing is done, which may indicate limited access or a preference for alternative techniques. Because of its potential complexity and requirement for careful control, the use of organic materials is the least usual technique.

This distribution reveals a dependence on conventional, observation-based techniques for water quality monitoring, which is probably impacted by the respondents' degree of technological adoption and resource availability.

Table 1. The water quality monitoring utilized by the households/fisheries

Practice/Methods	No. of Respondents
visual observation	4
manual testing with pH strips	0
Fish Species as Indicators	2
water exchanges	3
Use of Organic Materials	1

3.2 The design model

The model utilized the Arduino Uno microcontroller linked to an LCD display for real-time monitoring and a sensor (perhaps a pH or gas sensor). The Arduino's 5V and GND pins provide the sensor's power (VCC and GND), and the signal output is linked to an analog input (A0) on the board. The LCD display can display sensor readings because it is connected to multiple digital pins on the Arduino (D4–D7 for data, RS, and E for control). The central processing unit, the Arduino Uno, provides feedback on environmental parameters such as pH or gas levels by collecting data from the sensor and presenting it on the LCD.

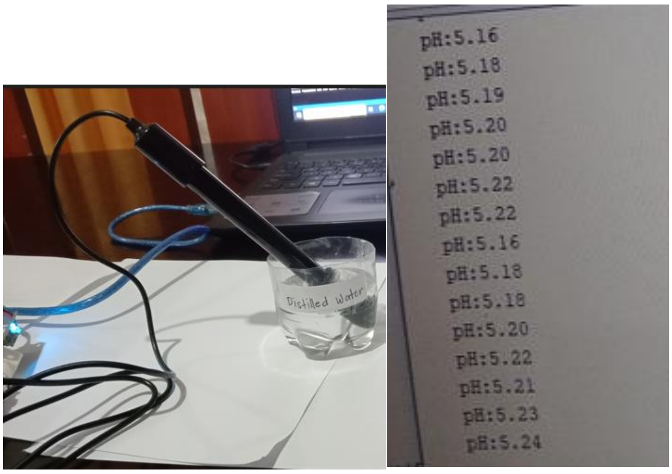
The system model is study and well-organized to the sensor and display being firmly placed and the wires being neatly connected to the Arduino's GPIO pins. This kind of setup is frequently utilized for environmental monitoring projects where real-time data is essential, like air quality control or aquaculture pH tracking. The enclosure makes the circuit a workable option for outdoor or industrial application by guaranteeing its resilience under a variety of circumstances. All things considered, the Arduino-based configuration is effective, simple to construct, and perfect for applications needing constant data gathering and visualization.

4.3 Testing and evaluation of the model

The different variables were used for the testing and evaluation

4.3.a. Distilled water

Figure 2 most likely shows a configuration in which sensors and an Arduino-based monitoring system are used to measure the pH level and acidity of distilled water. When measuring the pH levels and acidity of other samples, the system's use of distilled water helps create a neutral pH reference, enabling more precise comparison and calibration. The values states that the pH level is normal.



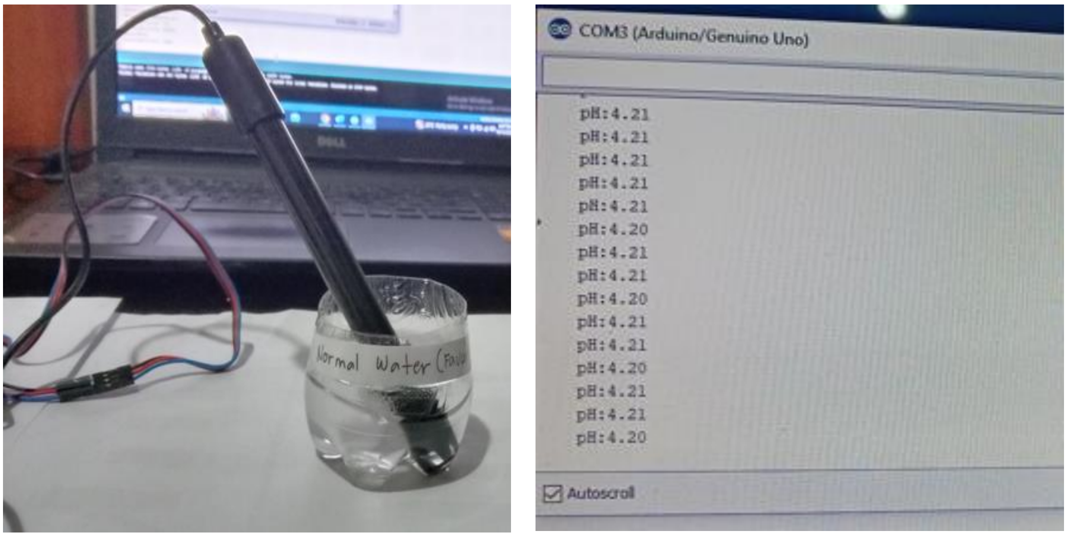
```
pH:5.16
pH:5.18
pH:5.19
pH:5.20
pH:5.20
pH:5.22
pH:5.22
pH:5.16
pH:5.18
pH:5.18
pH:5.20
pH:5.22
pH:5.21
pH:5.23
pH:5.24
```

Figure 2. Distilled water as sample data

4.3.b. Normal water

Figure 3, probably depicts a configuration in which an Arduino-based monitoring device is used to measure the pH level of ordinary water—possibly tap water or untreated pond water—as a sample.

This technique makes it possible to practically monitor the pH level in settings like aquariums and fish ponds by using regular water as a sample. The system makes sure the water is suitable for aquatic life by detecting and displaying the pH, which supports a healthy ecosystem.



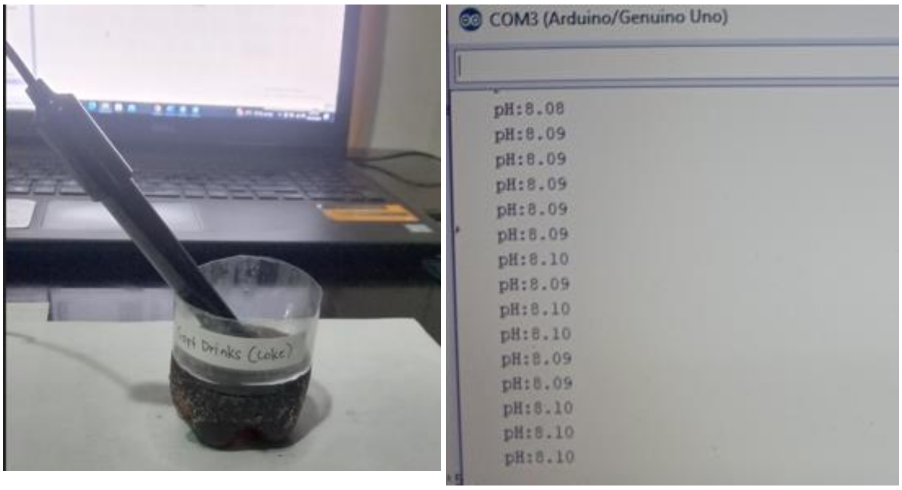
```
pH:4.21
pH:4.21
pH:4.21
pH:4.21
pH:4.21
pH:4.20
pH:4.21
pH:4.21
pH:4.20
pH:4.21
pH:4.21
pH:4.20
pH:4.21
pH:4.21
pH:4.20
```

Figure 3. Normal water as sample data

4.3.c Soft drinks (coke)

The figure 4 shows that the presence of carbonic acid, which is created when carbon dioxide dissolves in water, as well as other acids like citric and phosphoric acid, makes soft drinks generally acidic. Because of this, soft drinks typically have a pH between 2.5 and 4.0, which indicates a significant amount of acidity. "Above normal" would be used here to describe pH values that are substantially lower than neutral (pH 7), indicating that soft drinks are far more acidic than ordinary drinking water.

Also, the data showing that soft drinks have "above normal" pH levels confirms their high acidity, which is attributed to the presence of various acids. This knowledge is essential for consumers and health professionals alike, emphasizing the need to be mindful of the potential health impacts associated with frequent consumption of these beverages.



```
pH:8.08
pH:8.09
pH:8.09
pH:8.09
pH:8.09
pH:8.09
pH:8.10
pH:8.09
pH:8.10
pH:8.10
pH:8.09
pH:8.09
pH:8.10
pH:8.10
pH:8.10
```

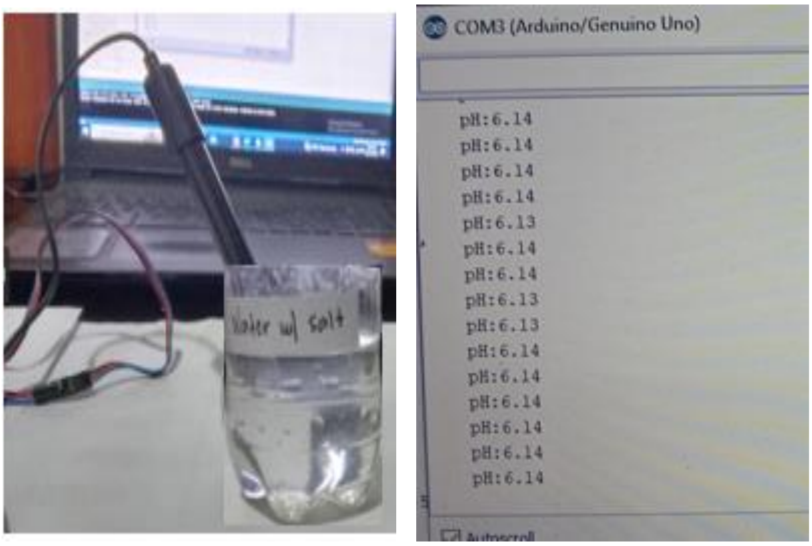
Figure 4. Soft drinks (coke) sample data

4.3.d water with salt

Figure 5 the data that shows lower-than-normal pH levels and acidity in fish ponds using water with salt involves understanding the implications of these measurements on aquatic life and water quality management.

Generally, freshwater fish ponds should have a pH of 6.5 to 8.0. The data suggests that the water is growing increasingly acidic if the pH values are less than 6.5. Although the permissible pH range may differ significantly in brackish or saltwater environments, lower levels might still have a negative impact on fish health.

Fish health and the balance of the ecosystem are at risk due to the higher acidity suggested by the figure data showing lower-than-normal pH levels and acidity in fish ponds employing salt water. In order to restore ideal pH levels and guarantee a healthy environment for aquatic life, it is imperative to identify the causes and put management techniques into place. Maintaining the health of fish ponds, especially those that use brackish or salty water conditions, requires routine monitoring and correction.



```
pH:6.14
pH:6.14
pH:6.14
pH:6.14
pH:6.13
pH:6.14
pH:6.14
pH:6.13
pH:6.13
pH:6.14
pH:6.14
pH:6.14
pH:6.14
pH:6.14
pH:6.14
```

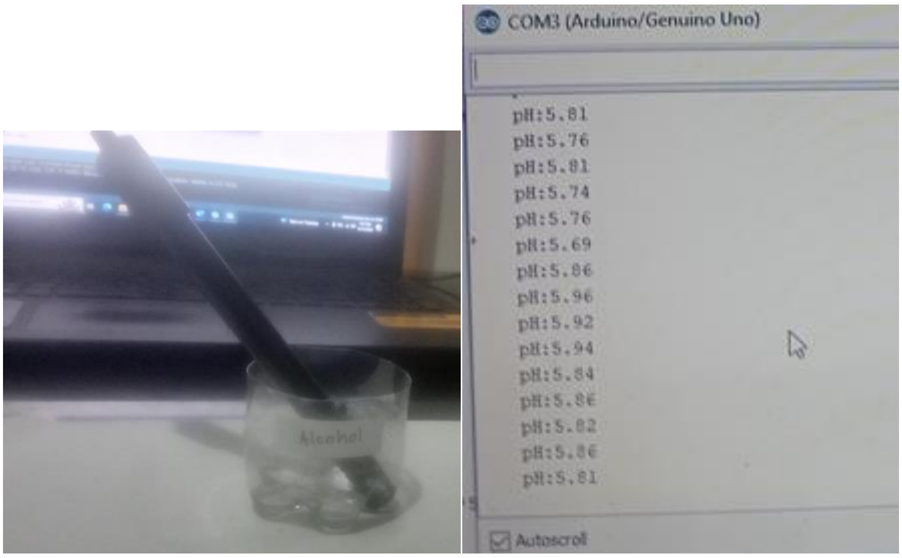
Figure 5. Water with salt sample data

4.3.e alcohol

Data that shows given in the figure 6 illustrates that the values are lower-than-normal pH levels and increased acidity in fish ponds using alcohol involves understanding the implications for aquatic life and the overall water quality.

The typical pH range for freshwater fish ponds is between 6.5 and 8.0. If the data read indicates that pH levels are below of the given range, it suggests that the water is more acidic than ideal for fish health. This could be particularly concerning in a scenario where alcohol is introduced.

The data indicating lower-than-normal pH levels and increased acidity in fish ponds using alcohol suggests significant risks to aquatic life. Increased acidity can lead to physiological stress, impaired respiratory function, and reproductive challenges for fish.



```
pH:5.81
pH:5.76
pH:5.81
pH:5.74
pH:5.76
pH:5.69
pH:5.86
pH:5.96
pH:5.92
pH:5.94
pH:5.84
pH:5.86
pH:5.82
pH:5.86
pH:5.81
```

Figure 6. Alcohol sample data

SUMMARY AND CONCLUSION

Summary

This study examines traditional and modern methods for monitoring water quality in aquaculture, particularly focusing on pH levels and acidity in fish ponds. Despite advancements in technology, many small-scale fisheries continue to rely on manual and traditional practices, such as visual observation and partial water exchanges, due to their affordability and ease of use. Data collected from ten respondents indicates that visual observation is the most commonly used method (4 respondents), followed by water exchanges (3), while methods like manual testing with pH strips were notably absent (0 respondents). The results reflect a reliance on conventional techniques likely influenced by the respondents' technological adoption and resource availability.

The study also introduces a design model utilizing an Arduino Uno microcontroller for real-time monitoring of water quality, demonstrating its practical application in aquaculture. Various samples were tested, including distilled water, normal water, soft drinks, water with salt, and alcohol. Distilled water served as a neutral reference for calibration, while normal water monitoring confirmed its suitability for aquatic life. In contrast, the tests revealed that soft drinks have significantly lower pH levels, indicating high acidity due to the presence of carbonic and other acids. Moreover, the data from water with salt showed increasingly acidic conditions detrimental to fish health, emphasizing the importance of management strategies for pH balance. Similarly, the introduction of alcohol into fish ponds posed substantial risks to aquatic life, leading to physiological stress and reproductive challenges.

CONCLUSION

The findings underscore the critical importance of monitoring water quality in aquaculture for sustaining fish health and ecosystem balance. While traditional methods remain prevalent, integrating modern technologies like Arduino-based systems can enhance monitoring accuracy and responsiveness. The study highlights the need for consistent management practices to mitigate the risks associated with low pH levels and increased acidity, particularly when using alternative water sources like saltwater and alcohol. For the future of aquaculture, adopting a combination of traditional wisdom and innovative technology will be essential for maintaining optimal water quality and ensuring the sustainability of fish farming practices. Regular training and resource provision for aquaculture practitioners can further facilitate the effective monitoring and management of water quality in fish ponds.

REFERENCES

1) *CAFE: pH – Acidity of Private Drinking Water Wells | Center for Agriculture, Food, and the Environment at UMass Amherst*. (n.d.). UMass Extension. Retrieved October 23, 2022, from https://ag.umass.edu/cafe/fact-sheets/ph-acidity-of-private-drinking-water-wells
2) Daly, J. (2019, October 2). *pH Neutralization Solutions for Industrial Wastewater*. South Fork Instruments. Retrieved October 23, 2022, from https://www.southforkinst.com/ph-neutralization-solutions-for-industrial-wastewater/
3) Dianala, R. D., & Villa, H. P. (2019, October 29). *Talisay leaves may 'revolutionize' PH aquaculture*. VERA Files. Retrieved October 23, 2022, from https://verafiles.org/articles/talisay-leaves-may-revolutionize-ph-aquaculture
4) *Effects of acids and alkalis on aquatic life*. (n.d.). Lenntech. Retrieved October 23, 2022, from https://www.lenntech.com/aquatic/acids-alkalis.htm
5) *Fish Pond Water Quality: As Simple as Chemistry 101*. (n.d.). Noble Research Institute. Retrieved October 23, 2022, from https://www.noble.org/news/publications/ag-news-and-views/2009/july/fish-pond-water-quality-as-simple-as-chemistry-101/
6) Higgins, P. (2014, October 14). *pH Measurement Methods - Advantages and Disadvantages*. YSI. Retrieved October 23, 2022
7) https:// www.ysi.com/ysi-blog/water-blogged-blog/2014/10/ph-measurement-methods-advantages-and-disadvantages
8) Home.(n.d) *YouTube. Retrieved October 23, 2022, from* https://www.fishing-advisor.com/how-to-control-ph-levels-in-fish-tank/
9) Home.(n.d) *YouTube. Retrieved October 23, 2022, from* https://projecthub.arduino.cc/
10) Khan.s(n.d.). *Automatic Door Opener Project using PIR Sensor and Arduino*. Circuit Digest. Retrieved October 23, 2022, from https://circuitdigest.com/microcontroller-projects/automatic-door-opener-project-using-arduino
11) *Managing high pH in freshwater ponds*. (2013, September 30). The Fish Site. Retrieved October 23, 2022, from https://thefishsite.com/articles/managing-high-ph-in-freshwater-ponds
12) *pH in Fish Farming*. (n.d.). Yokogawa. Retrieved October 23, 2022, from https://www.yokogawa.com/library/resources/application-notes/ph-in-fish-farming/
13) Ph Level and Neutralizer of Fish Ponds, March 2023, Research Project
14) *Sodium Bicarbonate: Health Benefits, Side Effects, Uses, Dose & Precautions*. (2021, June 11). RxList. Retrieved October 23, 2022, from https://www.rxlist.com/sodium_bicarbonate/supplements.html
15) Sterling, I. (n.d.). *Indian Almond Leaves: Keeping your fish happy, naturally.* FishLab.com. Retrieved October 23, 2022, from https://fishlab.com/indian-almond-leaves/