Monitoring System Development of Milkfish Salinity on Aquaponic at Green House

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Abstract. Water quality in milkfish cultivation requires great attention. Factors such as salt content in water, temperature, and pH become parameters to determine water quality. Salinity levels determine growth in pond aquatic ecosystems. This change is due to the biological processes in these waters and the interaction between the waters where milkfish are cultivated and the surrounding environment. This condition can be minimized, one of which is using regular observations of water quality in the cultivation area so that a monitoring tool is needed that can continuously maintain water salinity levels in the milkfish culture. Monitoring can use a salinity sensor to indicate the salinity level of the water used in milkfish cultivation. The results of the calibration of the salinity sensor of the first test, namely on 100mL of Aquades water, obtained an error of 0%, the second test was on 100mL of seawater with an error of 4.17%, and finally, the third test was a test of mixing 50mL of Aquades water and 50mL of seawater with an error of 4.04%. According to the calculation, the freshwater content required for comparing sea water and freshwater is 3.3 L. The testing is for 15 min and is carried out from 09.00 to 10.00, from noon 13.00 to 14.00, and in the afternoon from 16.00 to 17.00. The test results in the morning of 18.92 ppt. During the day, the salinity value is 15.78 ppt. In the afternoon, the salinity value was 15.57 ppt, but the salinity value obtained had not yet reached the set point of 15 ppt.

Keywords: sensory · aquaponics · salinity · monitoring

1 Introduction

Water quality in milkfish cultivation requires great attention. Factors such as salt content in water, temperature, and pH become parameters to determine the water quality needed to minimize the chance of death in milkfish [1]. Milkfish is often cultivated because, at an affordable price, milkfish has a high protein content and a taste favored by the community [2]. The basic principle beneficial for aquaponic cultivation is using nutrient waste from aquaculture waste in fish manure which can potentially worsen water quality and be reused as fertilizer for plants [3].

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Salinity is one of the environmental parameters that widely affect the growth of fish. Fish constantly adapt to their environment and maintain a balance of salt solutions in their bodies concerning the environment [4]. Salinity levels determine growth in pond aquatic ecosystems. Salinity needs to be considered in the growth of milkfish. Salinity has units of parts per thousand (ppt) or partial solid units (PSU). The salinity value of milkfish suitable for optimum growth ranges from 10–30 parts per thousand [5]. Fish metabolism will decrease when the temperature is not optimum or the change is too optimum. The ideal temperature for milkfish growth ranges from 18 °C to 30 °C [6].

Monitoring cultivators is carried out by direct monitoring to see water quality. If dead fish are floating, the cultivators will replace the water with new water. This will have an impact on fish production, which will decrease. Salinity levels can change from season to season, from month to month, and maybe even from hour to hour. This change is due to the biological processes in these waters and the interaction between the waters where milkfish are cultivated and the surrounding environment. This condition can be minimized, one of which is using regular observations of water quality in the cultivation area so that a monitoring tool is needed that can continuously maintain water salinity levels in the milkfish culture. The salinity value can change every time. This happens because of evaporation caused by hot weather, so the water evaporates quite drastically and causes the salinity value of the water to rise [7]. Based on the above study, it is necessary to test the salinity of the water in order to know the development of milkfish cultivation.

2 Method

The method stages are following:

1. The first stage is to identify the problems around the community, which will later be used as the research title. In this study, the problem is the lack of vacant land for cultivation, especially in big cities, and the lack of public interest in cultivating brackish water fish in aquaponics.
2. The second stage is to look for literature studies as a theoretical basis to be discussed in the research. The literature study used in this study is about the basis of aquaponics, especially in milkfish cultivation, and how milkfish cultivation can be carried out according to salinity.
3. The fourth stage is hardware design. The hardware design is carried out by installing an aerator pump to control salinity, a heater as a water heater, and a fan as a water cooler in aquaponics as a system controller using an Arduino microcontroller.
4. The fifth stage is testing hardware components. Hardware testing is serial testing whether the microcontroller can read the sensor, then the salinity sensor test serves to monitor each factor as programmed

The overall circuit in this control system uses an Arduino mega 2560 microcontroller; four relays are used to drive the actuators, namely salt water pumps, fresh water pumps, fans, and heaters. Then four indicator lights are used as indicators of the actuator that is working, there is one LCD and I2C module to display the sensor readings, and finally,

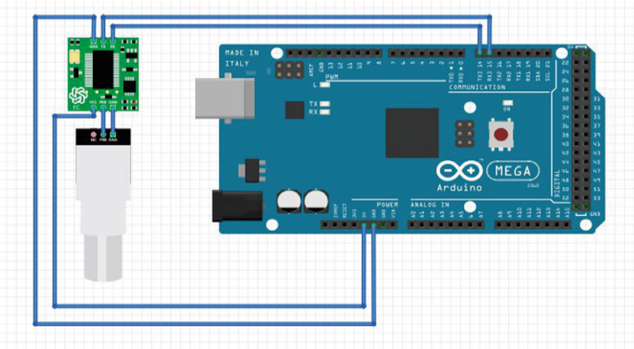

Fig. 1. Salinity sensor

there are two sensors that are used to read the parameter values in control, namely the salinity sensor. A conductivity sensor with signal conditioning or ADC connected to a microcontroller is used to read the salinity value in water. This sensor has 2 pin ports, namely TX and RX, and 2 other pins connected to the BNC conductivity sensor. Signal conditioning is given a 5V voltage obtained from the microcontroller and ground connected to the ground on the microcontroller. The TX pin in signal conditioning is connected to the RX 13 pin on the microcontroller, and the RX pin in signal conditioning is connected to the TX 13 pin on the microcontroller. The other pin on signal conditioning is connected to the BNC sensor. BNC is a cable that connects the sensor with signal conditioning, as shown in Fig. 1.

The salinity sensor in this study was designed by placing the signal conditioning close to the microcontroller inside the device so that if the tool is installed in aquaponics, this signal conditioning is not exposed to water. The salinity sensor used can read salinity values in the range from 0 to 42 ppt or PSU.

3 Result and Discussion

3.1 Salinity Sensor Test

The salinity sensor test in this study was carried out by calibration, namely comparing the Atlas Scientific salinity sensor with a refractometer, a measuring instrument to determine the salinity value commonly used to measure salinity in seawater contained in the Fisheries Laboratory of Sultan Ageng Tirtayasa University. Figure 2 shows the tests that have been performed on the sensor. The first sensor test was carried out by providing distilled water stored in a measuring cup of 100 ml. This test was performed 10 times with water changes every time to obtain accurate measurement results. Then prepare a salinity sensor that has been programmed to measure the salinity value, after which the measurement of the salinity value of the prepared distilled water uses a sensor with a refractometer so that the error value is obtained from the measurement results between the sensor and the measuring instrument which can be seen in Table 1.

The first test on the salinity sensor was carried out on 100 ml of distilled water. The results were obtained after testing with an error of 0% from the test results that had been

Table 1. Comparison of Salinity Sensors and Refractometers with Aquades

Time (minute)	Salinity Sensor (ppt)	Refractometer (ppt)	Error (%)
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
Error Average			0

Table 2. Comparison of Salinity Sensor and Refractor with Seawater

Time (minute)	Salinity Sensor (ppt)	Refractometer (ppt)	Error (%)
1	32,20	31	3,87
2	32,22	31	3,94
3	32,22	31	3,94
4	32,25	31	4,03
5	32,25	31	4,03
6	32,42	31	4,58
7	32,40	31	4,52
8	32,10	31	3,55
9	32,42	31	4,58
10	32,45	31	4,68
Error Average			4,17

carried out. Because distilled water is pure water that does not contain solids, the sensor and refractometer readings are 0.

The second test was carried out using 100 ml of seawater, which was carried out 10 times on the refractometer and salinity sensor with air changes every time to get an accurate measurement value. Table 2 is the result of tests carried out using seawater (Table 3).

Tabel 3. COMPARISON OF SALINITY SENSORS AND REFRACTOMETERS WITH AQUADES AND SEAWATER MIXING

Time (minute)	Salinity Sensor (ppt)	Refractometer (ppt)	Time (minute)
1	16,36	16	2,250
2	16,39	16	2,438
3	16,39	16	2,438
4	16,38	16	2,375
5	16,91	16	5,688
6	16,91	16	5,688
7	16,78	16	4,875
8	16,87	16	5,438
9	16,60	16	3,750
10	16,87	16	5,438
Error Average			4,04

After testing 10 times on seawater, the error result from the salinity sensor test was 4.17%. The result of calculating the error presentation of this error can prove that the Atlas Scientific salinity sensor can be used for research. Furthermore, the third test was carried out on mixing aquades with seawater. This mixing consisted of 50 ml of distilled water and 50 ml of seawater.

The third test of mixing aquades with seawater was carried out by mixing 50 ml of distilled water and 50 ml of seawater, and this test was performed 10 times the same as the tests in the first and second tests. After testing, the results obtained from the test are known from the calculation of the error on the salinity sensor test with a refractometer using aquades and seawater mixing with an error percentage of 4.04%. The results of the presentation of errors obtained are almost similar to the results of the presentation of the second test conducted on seawater, thus proving that the Atlas Scientific salinity sensor can be used for research.

3.2 Testing Salinity Calculations with the Formula

Testing the salinity calculation with the formula is intended to determine the ratio of fresh water and seawater that must be given to the aquarium to match the specified set point, which is 15 ppt using Eq. (1).

$$S = \frac{S1.V1 + S2.V2}{V1 + V2} \tag{1}$$

$$15\,\text{ppt} = \frac{17,50\ \text{ppt}.20\,\text{L} + 0\,\text{ppt}\ .V2}{20\,\text{L} + V2}$$
$$= 3,3\ \text{Liters Fresh Water}$$

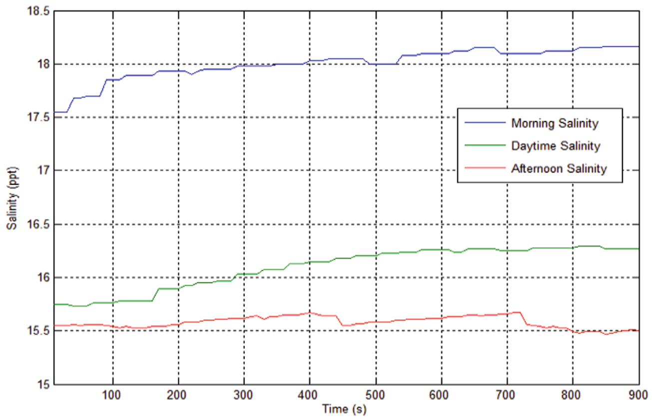

Fig. 2. Salinity monitoring graphic

Based on the results above, it can be concluded that the temperature and salinity control system testing is almost by the reference formula for calculating salinity, only that there is a time difference of 30 s in its implementation. This is because there is a delay when activating and turning off the actuator.

3.3 MonitoringTest

Monitoring tests on salinity and temperature were carried out to determine the initial conditions in the plant before controlling the salinity and temperature values using fuzzy logic control. The time of salinity and temperature monitoring test was carried out for 15 min with the distribution of collection time in the morning starting from 09.00 to 10.00, in the afternoon from 13.00 to 14.00, and in the afternoon from 16.00 to 17.00. The data taken during this salinity monitoring test was carried out for 15 min or 900 s which is displayed on the graph.

3.4 Salinity Monitoring Test

The monitoring test on salinity in aquaponics found that the main factor was that it caused instability which was not too significant because the research was conducted in a closed room, so the values obtained varied but were not too drastic. The salinity monitoring graph in Fig. 2 shows salinity conditions that experience instability in the morning, afternoon, and evening.

The results of the salinity monitoring test shown in Fig. 2 show that there was 18.92 ppt salinity instability in the morning. This was because, in the morning, the greenhouse temperature increased quite a lot. After all, in the morning, the sun shone on the greenhouse. During the day, the salinity value increased again due to the still hot greenhouse conditions, which was 15.78 ppt. In the afternoon, the salinity value is almost stable because in afternoon, the greenhouse temperature is not too hot with a salinity value of 15.57 ppt, but the salinity value obtained has not reached the set point of 15 ppt.

4 Conclusion

The monitoring system was successfully carried out using an electronic device, namely the salinity sensor was successful as expected. The test results in the morning of 18.92 ppt. During the day, the salinity value is 15.78 ppt. In the afternoon, the salinity value was 15.57 ppt, but the salinity value obtained had not yet reached the set point of 15 ppt.

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