

Design and Development of an Automated Fry Counter

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Abstract: Fry counting is part of the aquaculture industry that starts with stocking and counting fry. But the future growth of aquaculture industry in different areas are affected by lack of technology. Economic cost caused most fish farmers to use manual counting of fry even if automatic fry counting already existed. Thus, researchers come up to the idea of constructing an affordable and portable fry counter. The researchers designed, constructed, and evaluated the performance of automated fry counter in terms of accuracy, capacity and mortality rate of the fry. In testing and data gathering, fifty (50) pieces of fry sample were used. The initial number of fry weighed is the treatment of the study since it can affect the accuracy of the fry. The result shows that as the initial number of fry weighed is increased, the more accurate the fry count is. The machine's mean capacity is 52 fry per minute with a counting accuracy of 98% and mortality rate of 0%. It can be concluded that the constructed automated fry counter is advantageous and profitable for economic analysis resulted to 0.284 years of the payback period.

Index Terms— Automated fry counter, counting accuracy, microcontroller, mortality rate, tilapia fry

1 INTRODUCTION

The aquaculture industry is the main source of livelihood and food, especially in emerging economies. Species usually raised in aquaculture include milkfish, tilapia, shrimp, seaweed, oyster, mussel, and carp [1]. Aquatic products are becoming increasingly popular because of their high nutritional value [2]. Many newly developed advances in the technology of aquaculture have made significant improvements in aquaculture practices which have resulted in the development of new techniques, particularly in the intensive forms of aquaculture and the aquaculture systems in natural waters. However, lack of technologies will affect the future growth of Philippine aquaculture in the different areas. Fish farming as part of aquaculture starts in the stocking of fry. Fry in Figure 1 is the stage of fish development after alevin or larvae that may be applied to any small fish and fish slightly larger than this are usually termed fingerlings.



Figure 1. Tilapia Fish Fry

After following the required procedures for the fry to be released for marketability, their numbers have to be counted of. In the selling process fish farmers often face problems on the accuracy of the calculation of fish fry [3]. There are manual methods of counting fish fry, the individual counting in figure 2 and the counting by weight. These methods are in a way stressful and hassle because, to get a more precise and accurate result, a longer time is needed when counting fry [4].



Figure 2. Individual Counting

This paper presented an electronic fry counter by weight that reduces the consumption and minimizes the exposure of the fish to an unhealthy situation. The machine will help the fish farmers hasten time and effort in counting, aids human effort and reduce the cost of labor. The automated fry counter by weight will have a good economic value and will be more efficient compared to the manual method of individual counting. This study could also help researchers in the production sector related to aquaculture.

Methods and results are discussed on how we constructed the automated fry counter. Our methodology consists of (i.) Design and construction of the automated fry counter; (ii.) Preliminary and final testing and adjustment; and (iii.) Performance evaluation of the constructed automated frycounter.

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2 METHODOLOGY

2.1 Design of Fry Counter

The automated fry counter is a digital weighing scale like, and will be constructed based on the availability and accessibility of the materials needed. The materials that are to be used for this design are being identified with the help of electrical system. We used the idea in wirings connections from [5,6,7] online tutorials.

2.1.1 Mechanism

The automated fry counter is aimed to count the weighed fry automatically. As the whole number of fry is being weighed in the machine, aside from its weight, it will also display the total count of the fry.

The automated fry counter is composed of two system components, electrical system, and the framing system components. The electrical system is composed of wirings and electrical modules. While the framing system is composed of materials that hold the machine together. It is the entire construction of the machine.

2.2 Construction

The counter will be constructed after getting the average individual weight of the fry relative to its sizes where they are usually disposed. The automated fry counter will function using the electrical system materials. The electrical system materials are then connected to the readily prepared digital weighing machine. The microcontroller will serve as the brain of the automated fry counter. It is where the program will be saved using Arduino application. The construction was finished using some soldering and constructing tools. The machine was being operated with only one person. It was being powered by 9 volts Direct Current all throughout its operation.

2.3 Testing and Adjustment

The machine was calibrated using materials which weight was determined and weighed in the counter to compare the weights. The machines counting capability was also tested and the program code was adjusted. In testing the fry count, we used fifty (50) pieces of Red and 50 pcs. Giant tilapia fry samples. We first weigh an initial fry number to determine the average individual weight of the fry where the machine was able to compute and save the average weight. Then we add the whole fifty fry samples and the counter displays the total weight and the total count. The display code was adjusted when the error was found out. It was determined that the accuracy in counting was affected by the average individual weight which we get from weighing initial number of fry out of the total sample.

2.5 Performance Evaluation

To evaluate the machine, we used formulas to calculate its counting accuracy, capacity, mortality rate. We also done eco-

nomonic analysis of the machine. We used materials such as stop watch, hand nets, pen and papers, and calculators to test and record datas. Below are the formulas that we used.

Capacity

$$capacity = \frac{Number\ of\ fry}{total\ counting\ time}$$

Accuracy

$$accuracy = 100 - \% \ error$$

Where;

$$\% \ error = \frac{|No.\ of\ Fry - Actual\ No.\ of\ Fry|}{Actual\ No.\ of\ Fry} \times 100$$

Mortality rate

$$Mortality\ rate = \frac{AC - Na}{AC} \times 100$$

Where: AC = Actual number of fry

Na= number of fry alive after 5 days

3 RESULT AND DISCUSSION

3.1 Design and Specification of the Automated Fry Counter

The constructed automated fry counter as shown below has a total length of 18 cm, total width of 18 cm, and total height of 10 cm. The fry holder diameter is 13.5 cm. Its load cell capacity is 5000 grams. It has a counting capacity of 52 fry/min. It is powered by a 9 volts DC battery, and can be operated by a single person.



Figure 3. Pictorial view of the Automated Fry counter

3.2 Machine Testing Results

It was observed that the accuracy of the counter was affected by the average individual weight. To know what initial fry number is to be weighed to get average individual weight, we undergone trials and accuracy calculations. Results showed that as we increase the initial fry weighed, the accuracy of the counter will also increase. In figure 4, the accuracy of the counter was higher at 20 and 25 pcs initial fry sample out of 50 individually counted fry weighed in the counter.

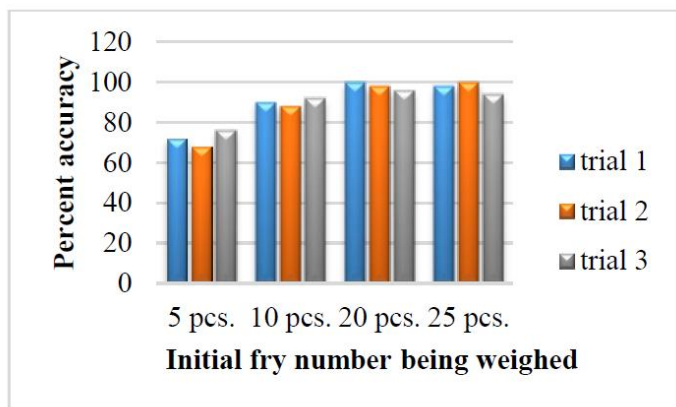


Figure 4. Percent accuracy for the different initial sample

Statistical analysis using STAR will show that means with the same alphabet are not significantly different. Table 1 indicates that for a 50 fry total sample, at 20 pieces and above, it has no significant difference in accuracy. Therefore 20 pcs fry could be an initial number for average individual weight.

Initial fry number (pcs)	Mean(% accuracy)	N group
5	71.67	3 c
10	89.33	3 b
20	98	3 a
25	97.67	3 a

Table 1. Summary of statistical analysis using STAR

3.2.1 Accuracy of the counter

The accuracy of the automated fry counter was compared to the manual method of counting. In individual counting, we get 100 % accuracy since there is 0%error. In real world individual counting done by the skilled laborers would be in estimation. A one scoop of fry has estimated corresponding total [8]. In this paper, we just used the data we get from our experiment to compare the results.

Counting by weight manually has an accuracy of 93%. And our constructed automated fry counter got 98% accuracy. This result was calculated from the data that we get from counting red and giant tilapia fry. Both had %error of 2. We get the

mean and used it in calculating the accuracy of the constructed counter. The result means that the constructed fry counter has an accuracy same with the existing mechanized counter which has 95-98% [9,10] accuracy.

3.2.2 Capacity of the counter

Performance evaluation of the machine was done using the same sample in each trial for each treatment. It was based on the total number of fry being counted by the machine per unit time. Figure 5 indicates that the performance capacity of the constructed automated fry counter is higher compared with the manual methods of counting.

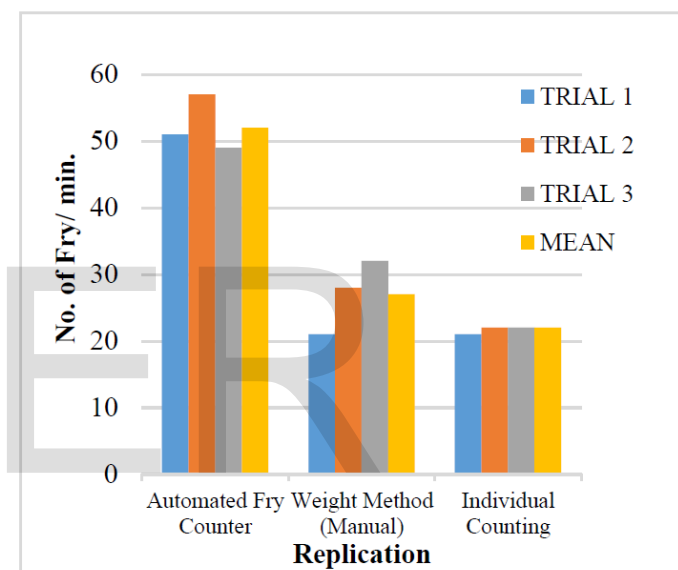


Figure 5. Performance capacity for each treatment

The N group result in table 12 shows that mean with the same letter are not significantly different. This means that treatment 1 or the automated fry counter is significantly different from the two methods. The two methods, counting by weight manually and individual counting, did not differ from its counting capacity. This capacity of 52 or 53 fry per minute was the calculated mean of capacity from testing giant tilapia fry sample.

Treatment	Means	N group
1 (Automated counter)	52.33 fry/min.	3a
2 (manual counting by weight)	27 fry/min.	3b
3 (individual counting)	21.67 fry/min.	3b

Table 2. Summary of the Statistical Result of Performance Capacity

3.2.3 Mortality rate

After the fry sample weighed and was counted, it was observed for five days to be able to calculate the mortality rate of the fry sample. This determines whether the machine affects the survival rate of the fry when they will be counted through the machine. Using the given equation, the mortality rate was calculated. After five days of fry observation, the theoretical number of fry matched the actual number of fry alive which tells that the machine does not affect the survival rate of the fry given that it has 0% mortality rate and as other factors were controlled.



Figure 6. Counting fry using Constructed counter showing fish fry freely moving in the fry holder



Figure 7. Example of individual counting method showing the risk of the fry from a surrounding with less oxygen and high temperature

4 SUMMARY AND CONCLUSIONS

An automated fry counter using weight method was designed, constructed, and evaluated. The machine was functional and had counted the number of fry that was weighed in it. The machine displayed the total weight of fry and the total count of fry.

The result in performance of the machine in terms of capacity is 52.33 or 53 fry per min., its accuracy is 98% shows that it is satisfactory. It is fast to count compared to the manual means but in terms of counting efficiency, individual counting is the most accurate of the three but it takes more time to count. The machine does not affect the survival rate of the fry since there is 0% mortality rate.

With the result of the performance evaluation of the automated fry counter, further improvements and modifications of the machine were necessary. It is recommended to further develop the machine's design especially the fry holder into a bigger one in order to weigh a large number of fry. Some adjustment on the counter's unit is also recommended, from gram to milligram since younger frylings have the weight of milligram. Also developing of the codes is recommended so that it will less read the noise made by wind speed and fishes moving. Also, more study should be done to know the minimum limit that the machine can handle. And additional experiments on calibrating the machine should be done and calibration curve should also have included in this paper.

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