

Organic Waste Crushing Machine Automation in an Eco Enzyme Production

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ABSTRACT

In 2025, Indonesia has launched a zero-waste program. Towards a zero-waste program, of course, the community is given awareness in sorting and processing waste. Waste management is a common problem in urban or rural areas, along with the increase in population and people's lifestyles. Waste problems that are not handled properly can cause environmental problems (pollution of air, soil, and water) and public health. Based on the origin, waste is divided into organic and inorganic waste; organic waste is produced from biological materials that can be degraded by microbes or are biodegradable, or waste from fruit, vegetable, and leaf residues. This organic waste is the majority of the waste generated from households, so it is necessary to think about how to process it that is beneficial and efficient. One of these organic waste processing is processed into Eco enzymes, namely processing organic waste with molasses and water in a ratio of 1:3:10. The organic waste processing process is first chopped to become a small part to facilitate the fermentation process. The automation of this chopping machine uses Arduino as a microcontroller, a load cell as a measure of the weight of organic waste, an electric motor as a driving force, a solenoid door lock as a lock for the organic waste load before grinding, and a knife as an organic waste count. The purpose of making this tool is to help chop organic waste in the process of processing eco enzymes. The research results on the automation of this organic waste chopper machine loadcell with a load of 1 Kg runs well; the solenoid door lock can hold organic waste to work well. The research results on the motor for upper milling are given a large torque equipped with a downward knife position and a pillow block so that the motor does not shake.

Keywords: Arduino, chopper machine, eco enzyme, loadcell, organic waste

INTRODUCTION

The problem of waste in Indonesia seems to be endless to discuss and discuss because the amount of waste increases along with the increase in population and people's lifestyles. In 2025, Indonesia will declare Zero Waste for waste problems. This waste problem is urgent and must be resolved immediately because it must be sorted and processed properly and correctly [1]. Improper waste management can have an impact on the environment, which can cause air, soil, water, and environmental health pollution [2][3]. This is partly because of the accumulation of organic and inorganic waste. Organic waste is generated from biological materials that can be degraded by microbes or biodegradable. Organic waste can easily be decomposed through natural processes. In 2021 the composition of waste based on the source of household waste was

41.1%. The design of waste is based on its type, food waste is 27.8%, and leaf/wood/twig waste is 12.4%. Household waste, food waste, and leaves are organic waste. Organic waste is from the kitchen, food scraps, wrapping (other than paper, rubber, and plastic), flour, vegetables, fruit peels, leaves, and twigs. In addition, traditional markets also donate much organic waste such as vegetables, fruit, and other waste [4].

Organic waste that is allowed to accumulate can produce methane gas (CH₄), and this methane gas can cause global warming. To reduce global warming, it is necessary to process organic waste that brings usability back to the community by becoming eco-enzymes. Processing of organic waste in eco enzyme with a particle size of waste is very influential in the fermentation process of organic waste using a 1:3:10 ratio formula, namely one part molasses/gula jawa/palm sugar: three parts

organic waste (fruit and vegetable peels): ten parts water is placed in a container with a capacity of 60% of the power of the container, fermented for 90 days anaerobically [5]. The smaller the size of the organic waste, the decomposer bacteria contained in the organic waste will be more activated in the fermentation process because of the smaller field area. For this reason, it is necessary to have an automatic organic waste chopper machine in eco-enzyme processing [6].

Research on automation of organic waste chopping machines in eco-enzyme processing using Arduino UNO microcontroller, electric motor, load cell, solenoid door lock, and chopper knife [7][8][9]. This research is applied in eco enzyme processing to reduce organic waste particles [10][11].

METHODS

This study uses the R&D (Research and Development) method, which is the research method used to produce automation products for organic waste shredders and test the effectiveness of the automation of organic waste shredders. The research begins with designing software and hardware from the automation of organic waste chopping machines. The design of the software starts with the preparation of the program that is used to run and operate the organic waste counting device automatically using Arduino Nano as the microcontroller. The motor activates the grinding process by adding organic waste to be weighed according to the desired weight; the milling is complete, and the motor stops. Figure 1 describes the flowchart of the system used.

The tool's design uses several components: loadcell, 16x12c LCD, solenoid door lock, 2 AC motors, Arduino nano, HX711 driver, relay, gear, fan belt, iron meat grinder, and elbow iron. The automation design of the organic waste chopping machine is shown in Figure 2.

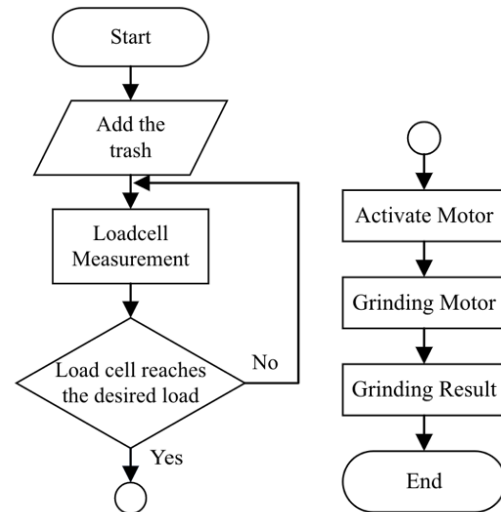


Figure 1. Flowchart System

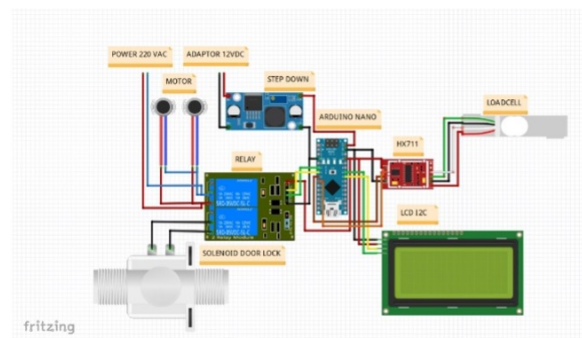


Figure 2. Organic Waste Crushing Machine Automatic Wiring Design

Hardware design of tool mechanics using SketchUp software for describing the method by describing the position of the tool seen from the right and left views; the invention is shown in Figure 3 and Figure 4. A single-phase capacitor motor is a motor whose users are only adding a component in the form of a capacitor, which functions for the initial start or starting torque, phase shift, and starting current of the capacitor motor, now when until the nominal limit is 75% then the centrifugal switch will cut off the auxiliary coil, and the rotor will only rotate in a magnetic field that generated by the main coil. The point is that the torque capacitor motor is stronger compared to no capacitor. The gearbox is one component of the main motor, referred to as the power transfer system; the transmission functions to transfer and convert the power of a rotating motor.

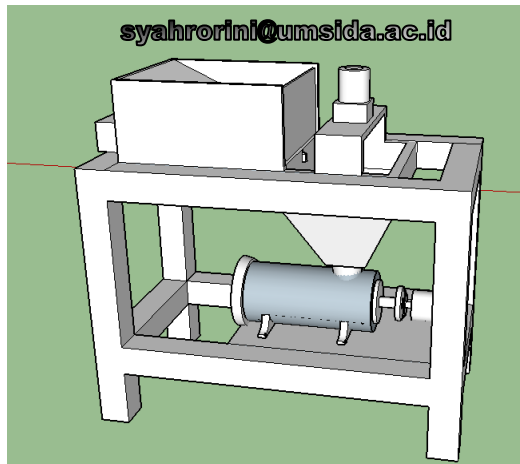


Figure 3. Hardware Design View Left

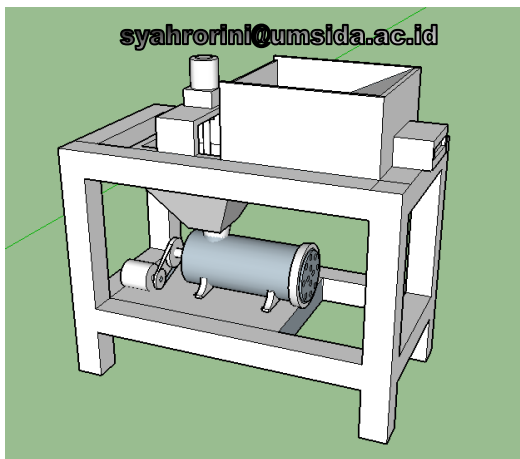


Figure 4. Right View Design

RESULT AND DISCUSSION

After the design is done, then the assembly of the tool is carried out, starting from the installation of the bottom mill as a rolling cutter so that the waste is chopped smaller, as shown in Figure 5. And the structure of the top mill is equipped with a downward pointing knife to chop organic waste more easily.



Figure 5. Bottom Mill Installation

The complete automation tool for organic waste chopping machines from the design and assembly results is shown in Figure 6.

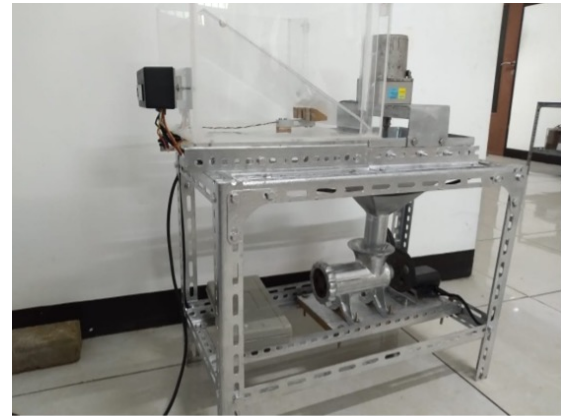


Figure 6. Automation of Organic Waste Shredder

The next stage is testing the automation of the organic waste hopper from testing software and hardware as a whole. The test begins by adding organic waste and measuring its weight; this test uses a weight of up to 2 kg of organic waste.

Table 1. Loadcell Test

No	Organic Waste	Loadcell (gram)	Digital Scale (gram)	Error
1	Watermelon Rind	638	522.70	18%
2	Chinese Cabbage	175.36	198	12,9 %
3	Cabbage	1070	1.203	12,4 %
4	Banana Stem	248.93	852	70%
5	Banana Leaf	364.50	555	52,2%

Based on the load cell test results in Table 1, there is a difference between the scales and the load cell; the smaller the error if it is closer to 1 kg. In the first experiment, the watermelon rind was the result that appeared in loadcell is 638 grams and the scales results are 522.70 grams here the error results from weight watermelon skin by 18%. Then in the second experiment. Entering chicory, the loadcell results get 175.36 grams, and on the scales 198 grams, here we get an error of 12.9%, the error value is smaller than the first experiment. In the

fourth experiment, it was done with banana leaves. Here the results that came out in the loadcell were 364.50 grams, and the results on the scales were 555 grams and got an error of 52.2%, which means the accuracy of the scales is still far away from the accurate word from the first and second try.



Figure 7. Trial of Chopping Organic Waste

Figure 7 shows the automation test of the organic waste chopper machine; in this test, the old milling process descends to the lower mill because there is movement from the motor, and the blade is less inclined. Due to insufficient motor drive, garbage counting with hard fruit skins (watermelon) results in less softness.

Table 2. Solenoid Door lock Test

No	Organic Waste	Loadcell (gram)	Solenoid Door lock
1	Watermelon Rind	638	0
2	Chinese Cabbage	175.36	0
3	Cabbage	1070	1
4	Banana Stem	248.93	0

Table 2 shows the readings of the door lock solenoid based on the test results. The solenoid door lock is set with the provisions of 1 kg to open. In the first experiment, with watermelon rind organic waste, loadcell showed 638 grams, and the result was that the solenoid was still closed. In the second experiment using chicory, the loadcell results were 175.36 grams, and the solenoid was still closed because it did not reach the specified limit. Furthermore, in the third experiment carried out using cabbage, the results from the load cell obtained 1070

grams, and the solenoid opened because it had reached the specified limit.

Testing the 16x i2c LCD display after the input voltage is given is shown in Figure 8, which displays the calibration program. At this stage, Loadcell will calibrate so that the results depicted can be accurate and then will be displayed on the 16x i2c LCD as a sign that during calibration, there is no load on the scales so that when weighing, there are no errors.

After being calibrated, the load cell results show the weight of organic waste. The first effect is 0 grams because there is still no load entered in the loadcell box shown in Figure 9. And at this stage, calibration is still repeated to get more accurate results.



Figure 8. LCD Readout When Load Cell is Calibrated



Figure 9. Load Cell No Load yet

The next testing stage is the same as the previous one, and the 16x2 i2c LCD is still being tested. Figure 10 shows that the LCDs weigh 1336.9 grams, meaning that the LCD can be connected to the load cell when the load has

been inserted. And the tool is already calibrated for accurate results.



Figure 10. Load Cell Testing There is a Load

The Doorlock Solenoid Test will detect the load received according to the program settings after being uploaded to the solenoid. At this stage, if garbage is detected, a 1000-gram garbage load is displayed on the LCD, the solenoid will light up, and the waste will go down to the top grinder. When the load is up or less than 1000 grams, the solenoid door lock will not open the door. The solenoid door lock will lock the boxes not to go directly to the grinder until a 1000-gram organic waste. The solenoid works if the signal from the load cell has already been reached, then the solenoid opens the door so that the load can go down to the grinder.



Figure 11. Solenoid Doorlock Condition When Load 1 kg

Furthermore, after the process of uploading the program to Arduino and also calibration. Then the test is carried out by inserting the garbage into the tool. The included

waste is organic waste such as fruit peels and vegetables, as shown in Figure 12.



Figure 12. Overall Testing of Organic Waste Shredder Machine

Based on the results of the Loadcell test as a measuring tool for scales to measure the predetermined waste load. If it has been reached, the loadcell will send a signal that the load has reached a predetermined point. A solenoid Doorlock is a lock/retainer of the load box door from the top organic waste so that it doesn't go directly to the top grinder. The solenoid works if there is a signal from the loadcell that the load has been reached, then the solenoid opens the door so that the load can go down to the top grinder, then to the bottom mill, and finish. The motor is used to drive the blade. Here we use two motor AC for the full mill and bottom mill so that the garbage can be easily chopped.

CONCLUSION

Loadcell will signal if the organic waste's weight is by the conditions set, namely a load of 1 kg. The signal from the load cell will be sent to the solenoid door lock to open the door so that the organic waste falls to the top mill. Solenoid Doorlock as a lock/retainer of the door to the top load box so as not to go directly to the grinder. The solenoid works if a signal from the loadcell already exists that the load has been reached, then the solenoid opens the door.

So that the load can go down to the grinder. Then to the bottom mill. So that the top milling can go down, the motor for the top milling is given a large torque, equipped with a downward blade position, and a pillow block is provided so that the engine doesn't shake. In the next research, it can be repaired for the chopping knife because even though there are two stages of grinding, the garbage is still not completely chopped, especially for top mill blades. On the other hand, the motor can be upgraded to be better.

Because for now, it is still very lacking in its torque and rpm. In the top mill, the torque is good, but the rpm is still small; on the other hand, for the lower mill motor, the rpm is good, but the torque is very small, even if it is used to chopping the hard fruit skin, the engine will heat up quickly.

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