Automation of Production of Raw Mokusaku Using Raspberry Pi

PUNO, John Carlo V., CATAPIA, Janine Joyce C., CHUA, Martin Christopher B., CORDERO, Pamela Jane A., NAGUIT, Angela Faye A., RAMIREZ, Jona May L., VALINO, Hannah Ruth M.*
*pamela.corder673@gmail.com

Abstract*— *Mokusaku, a type of organic fertilizer extracted from the condensed smoke produced by burning of woods, takes 3-6 months of production. In this paper, the proponents will discuss their project prototype. This prototype aims to lessen the time of production and increase the quantity of the product by introducing Raspberry Pi for automation. Traditionally, producers need to pour water on bamboo where the smoke goes through from time to time for condensation to occur. They then, need to wait for 3-6 months to be able to use the Mokusaku which was extracted from the condensate that was separated into three layers due to sedimentation. The whole traditional process makes it tedious for the producers. With this prototype, major parts will be programmed. The proponents made a cooling system that will automate the condensation part. The Mokusaku, which is the raw condensate, will then undergo an automated centrifugation system. This will result to a faster and more efficient production as well as better yield.

Keywords*— *centrifugation, automation, condensation, Mokusaku

I. INTRODUCTION

Agriculture is one of the many areas which particularly needs further advancement in technology [14], [15]. A good example for this is the industrial automation applied to fertilizer irrigation (shortened as fertigation) system. Based on the study, the user can wirelessly transmit data to the system with the use of mobile application for the reason that the system is connected on the internet through Wi-Fi [1].

To increase production and have better quality products, it is common for farmers to use fertilizer. Over the years, farmers have been continuously developing more and more traditional ways on creating the appropriate fertilizer types for their crops [10], [11]. Two of these methods are vermicomposting and bokashi. Vermicomposting involves the use of earthworms in the gathered compost while bokashi is basically, a food waste compost [2]. To this day, people are still finding ways on how they can produce their own organic fertilizer and the Japanese people have found a way to produce one, locally called as Mokusaku [16], [17]. Mokusaku is a type of organic fertilizer where the produced gas from burnt woods are condensated and turned into a liquid fertilizer. Different types of woods were used to create a variety of purposes for Mokusaku, a few to mention are Acacia Mangium as fertilizer [3] and Banana wastes as pesticide [4]. Mokusaku can also be used as fungicide [5] which have shown positive results on the plants.

Since Mokusaku has been proven as a good alternative for chemical fertilizers, pesticides, etc. [12], [13], Japan later introduced it to other countries. It was introduced in the Philippines, on 2011 at Benguet [6]. Production of Mokusaku has been giving good effects on agriculture and introducing it to a more farmers will be very beneficial not only to the farmers but also for our environment.

This study aims to develop an automated system that will produce Mokusaku with lesser time while increasing the quantity of production. Since Mokusaku chambers are usually built at a fixed placed, the researchers also aim to develop a portable chamber. As a result, this may be introduced to a wider audience as an alternative for fertilizers.

II. METHODOLOGY

The study is divided into two parts, the cooling system and the centrifugation system. The proponents developed a chamber for cooling system where condensation of smoke will occur. The produced liquid is placed into a developed centrifugation system. The liquid will be separated into three layers and Mokusaku, the middle layer, will be extracted.

a. Experimental Set-up

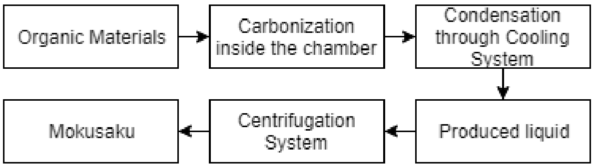

Figure 1. Process of producing Mokusaku

Figure 1 shows the flow of production of mokusaku. First, the organic materials that will become the main material for this project. Second, the burning of those materials inside the chamber to have smoke. Third, the condensation of the smoke that comes from the chamber will be done on the cooling system. Fourth, the condensed liquid will be put on a container and will undergo on the process of centrifugation. Lastly, the extracted mokusaku out of the produced mokusaku is the overall product of this project.

Hardware Design

The hardware setup for the automated Mokusaku chamber is composed of chamber for wood burning and cooling system, DS18B20, Raspberry Pi, and DC motor. The chamber for wood burning is oven sized to insert piles of tree or plant waste. As for the cooling system, it is made of out stainless steel to reduce oxidation. The DS18B20 is attached within the cooling system. A circuit is developed for the centrifugation system to control the speed of the motor. The DS18B20 and circuit for centrifugation system is connected to Raspberry Pi for monitoring and automation of each part.

Figures 2a to 2c show the proposed design for the chamber, cooling system and centrifuge. Figure 2d shows the actual prototype of the said design in figure 2a. Figure 2b show the whole system where it consists of the

Mokusaku chamber, cooling system and the centrifugation system.

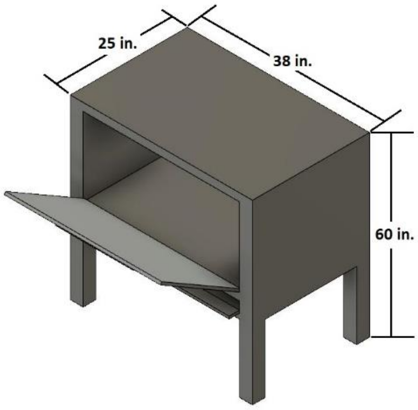

Figure 2a. Initial sketch of the chamber

Figure 2a shows the initial design of the chamber that will be using as the burning place of the organic materials to produced raw mokusaku.

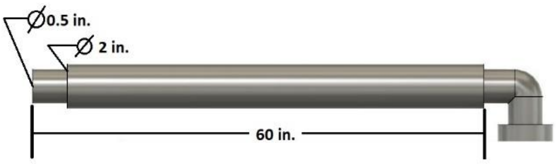

Figure 2b. Initial design for cooling system

Figure 2b shows the initial design for the cooling system that will be used to condensate the smoke from chamber.

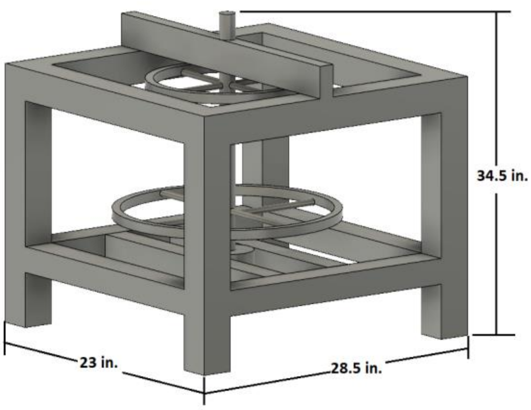

Figure 2c. Initial sketch of centrifuge system

Figure 2c shows the initial design for the centrifuge system. It has 3 slots where the user can place the containers that contains raw wood vinegar.

Figure 2d. Actual design of Mokusaku chamber

Figure 2d shows the actual design of the chamber to be used in the production of mokusaku.

Figure 2e. The Mokusaku chamber, cooling system and centrifugation system

Figure 2e shows the whole system of the project. It consists of the chamber, the cooling system and the centrifugation machine.

Circuit Diagram

The circuit diagram for the automated Mokusaku chamber mostly depends on DS1820 sensor and circuit for the centrifuge that are monitored and controlled through Raspberry Pi. As discussed earlier, the DS18B20 monitors the temperature at the cooling system which was made possible with Raspberry Pi.

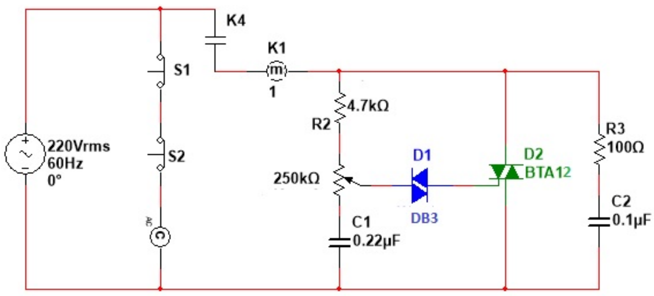

Figure 3. Schematic diagram for controlling centrifuge system

Figure 3 shows the circuit for centrifugation system that allows the proponents to turn the motor on and off and control the speed of the motor. The proponents connect the DC motor to Raspberry pi for time setup.

Flowchart

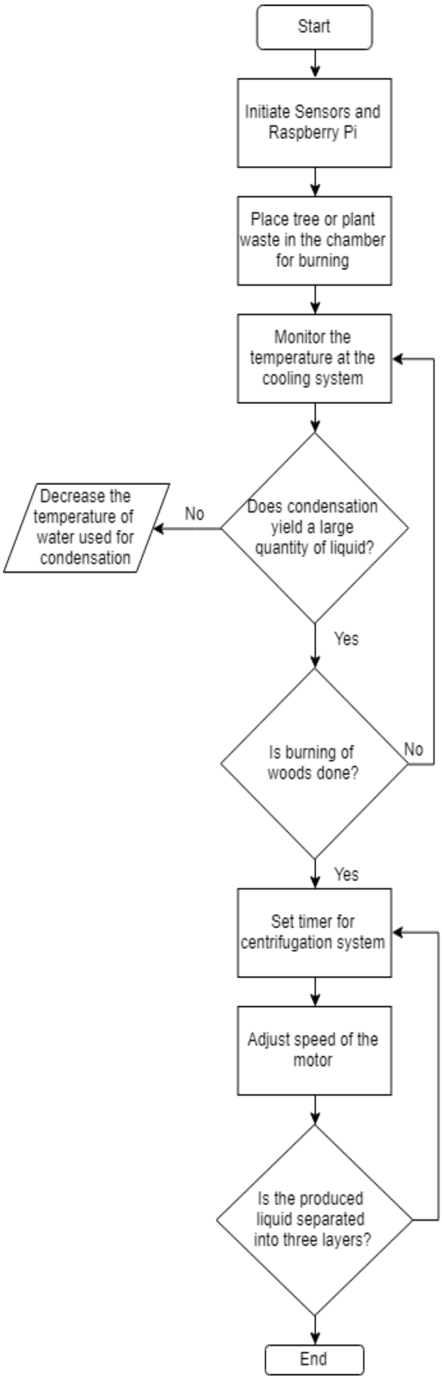

Figure 4. Flowchart of production of Mokusaku

Figure 4 shows the software setup of the system. The flow starts in initializing the sensor, circuits and Raspberry Pi. Place the tree or plant waste for burning. If no liquid was produced, consider decreasing temperature for the condensation to occur. If production of liquid is done, set the timer for the centrifuge to work. Repeat process until three-layers are separated.

III.. DATA AND RESULTS

After gathering of data, table 5 shows the production of raw Mokusaku in chamber. The materials used for producing Mokusaku were Corn Leave, Banana Leaves and Coconut Husk. These materials were used due to the fact that Philippines produces a lot of banana, coconut and corn [7], [8], [9]. Table 6 shows the extracted tar after centrifugation in cubic centimeter and in liters.

Table 5. Produced Mokusaku of chamber

Trial	Material	Weight (kg)	Produced (cm^3)	Produced (L)
1	Corn Leaves	2.4	923.08	0.92
2	Corn Leaves	2.1	807.69	0.81
3	Corn Leaves with stem	1.75	673.08	0.67
4	Corn Leaves with stem	1.81	696.15	0.70
5	Corn Leaves with stem	1.95	750.00	0.75
6	Banana Leaves	2.25	865.38	0.87
7	Banana Leaves	2.65	1,019.23	1.02
8	Banana Leaves	2.15	826.92	0.83
9	Banana Leaves with stem	1.76	676.92	0.68
10	Banana Leaves with stem	1.8	692.31	0.69
11	Dried Coconut Husk	1.5	576.92	0.58
12	Dried Coconut Husk	1.65	634.62	0.63
13	Dried Coconut Husk	1.61	619.23	0.62
14	Dried Coconut Husk	1.9	730.77	0.73
15	Dried Coconut Husk	1.25	480.77	0.48

Table 6. Produced Tar after centrifugation for 15-20 minutes average time

Trial	Weight (kg)	Average Speed	Produced (cm^3)	Produced (L)
1	2.4	1503	205.4	0.21
2	2.1	1349	179.8	0.18
3	1.75	1524	149.8	0.15
4	1.81	1716	154.9	0.15
5	1.95	1562	166.9	0.17
6	2.25	1603	192.6	0.19
7	2.65	1512	226.8	0.23
8	2.15	1623	184.0	0.18
9	1.76	1500	150.6	0.15
10	1.8	1400	154.1	0.15
11	1.5	1359	128.4	0.13
12	1.65	1623	141.2	0.14
13	1.61	1756	137.8	0.14
14	1.9	1591	162.6	0.16
15	1.25	1371	107.0	0.11

Table 7 Growth of Pechay

Week	Width of Leaves (cm)		Height of Pechay (cm)	
	Water Application	Mokusaku Application	Water Application	Mokusaku Application
1	1.270	1.397	2.794	3.302
2	3.048	3.810	6.350	7.112
3	3.937	4.064	8.382	9.144
4	5.080	6.096	10.668	11.938

Table 7 shows the data for width of the leaves and height of the pechay which have an application of mokusaku and with no application for 4 weeks. Based on the data gathered, the plants that have applied mokusaku shows better growth as well as appearance compared to the pechay that has water only. This proves that mokusaku is effective organic fertilizer.

Figure 5 shows the measurement of the raw Mokusaku using ruler for measurement.

Figure 5. Actual measurement of extracted raw mokusaku

IV. CONCLUSION

In conclusion, the developed prototype has produced as much, if not more amount of Mokusaku. The traditional chamber uses 2.7kg of tree or plant waste to produce 1L of Mokusaku while for the developed automated chamber, the average production of 2.6kg to 1 L ratio.

For the automation, the monitoring of temperature for cooling system served its purpose. The cooling system made a slight difference by producing almost the same amount of Mokusaku in an easier way. The developed centrifugation system showed a positive result by separating the three-layered liquid from the sedimentation time of 3-6 months to an average of 20 minutes of centrifugation.

The design of the chamber have served its purpose to be portable compared to the traditional chamber where it can be built on a fixed place. The proponents were able to transfer the prototype from one place to another

The produced Mokusaku shows positive result for using it as a fertilizer in pechay plant as shown in data and results.

V. RECOMMENDATIONS

Since there is no available automated Mokusaku chamber in the market, no references for chamber design was considered. With this paper, the proponents advise to have a better chamber design. It is recommended to have it more portable due to difficulty of transferring the system from one place to another. By having a smaller chamber, the cost may also be cheaper which is also recommended. A different type of metal for the chamber can also be reconsidered due to oxidation because of outside environment.

Even though the chamber is automated, there are still some parts where human interaction is needed. Automating the setting of centrifuge speed is one of the seen suggestions. The proponents also suggest automating the ignition of woods after inserting it inside the chamber to have a less human interaction.

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