Fabrication of the mini multi-function pepper machine

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Abstract. Pepper is one of the most significant agricultural products in Sarawak, Malaysia currently in the fifth largest pepper producer in the world after Vietnam, India, Brazil and Indonesia. Black pepper and white pepper both come from the same plant, but they are prepared differently. Black pepper is made by cooking dried unripe fruit, meanwhile white pepper is made by cooking and drying the ripe seeds. The production contributes to the aspects of economy and plantation rate of the state. However, the process of pepper through manual work is time consuming and a tough process which requires commitment and hard labor from the farmers. Therefore, the objective of this research is to fabricate the Mini Multi-Function Pepper Machine for small or medium enterprise by reducing the time of drying process. This fabrication machine consists of all the procedures involved in the production of white pepper, which are soaking, heating, drying and grinding process. Through the operation observed, this machine was able to undergo production in 208 to 300 minutes for 300g of white pepper, in comparison to the traditional way that needs approximately 1 to 4 weeks to undergo one production batch of white pepper.

1 Introduction

Pepper, or its scientific name, Piper nigrum, originated from Southwest India. The production of pepper leads to two types of pepper which are black and white pepper [1]. Pepper is one of the most significant agricultural products in Sarawak, Malaysia. They contribute a lot from the aspects of economy and plantation rate of the state. However, the production of pepper through manual work is time consuming and a tough process which requires commitment and hard labour from the farmers.

Generally, post-harvested pepper proceeds into two types which are black and white peppers. The dissimilarities between both products are the maturity level of pepper berries and the processing method. White pepper is produced by removing the outer ripe

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berry skin (retting method), meanwhile black pepper processed by drying the unripe berries until the wrinkled skin is formed [2]. White pepper is a type of spice that is full of health benefits. There are four major steps on how to produce and process white peppers, which involve process of soaking, heating, drying and crushing. First step, soaking is where the method fully ripe the red pepper berries and soaked in water for about a week or two. This process where lead the flesh of the peppercorn softens and decomposes. The second step of the process is referring to a heating the pepper. The heating process is done to warm, heat and dry the peppers that had just been soaked. The third step of this process would be the drying process. When the labour done manually in the traditional way, the process of heating and drying occurs at the same time. The final step of the process is the crushing process [2,3]. For this process, the traditional and modern ways are completely different but they have only one purpose, which is to turn the berries into certain types of size as example such as whole and ground/fine size pepper. Accordingly, there has been a gigantic requirement for an elective technique in the market. While steaming and mechanical decortication is different techniques considered decently process-viable, fragrance and flavour are compromised. Subsequently, the sensible option of utilizing microbial methods for the production of white pepper has been recently advocated in the literature [3].

The main project’s objective is to fabricate a multi-function pepper machine for small or medium enterprise. The purpose of our Mini Multi-Function Pepper Machine is to reduce the production time by at least 10% from the usual average time that usually takes 2 to 4 weeks, while also maintaining the quality and taste of the pepper itself. This idea is to make sure that all the processes involved in the production of white pepper are able to be done in just one place. For instance, the process of soaking, heating, drying and crushing is usually done in separated processes and places [2]. In order to solve this issue, this project can help to improve the time delay issue that exist in the production of white pepper, while also reducing the manpower that is required in the entire process. It will archive much lesser energy from farmer but at the same time able to produce more end products.

The limitation of the project is it focusing for the use of Small-Medium Enterprise (SME). This machine will make a great benefit and be of advantages especially for farmers with smaller aims of business or those who are new to the business world. Another significance to point out is that this machine is completely portable, meaning it can be brought everywhere you go. This will be an ease especially those who need to move from one place to another. Because of its mini size and average weight, this makes a perfect portable machine and suitable for learning purpose to anyone that wishes to use it or first timers that are curious to know what is the machine about and how it works.

2 Methodology

In fabricate the mini multi-function of pepper machine, there are a lot of process that need to face includes a conceptual design, fabrication technique, process flow and finalized design to make sure this project become reality.
2.1 Conceptual design and finalized design

The first step is the design process using Autodesk Inventor Software. There are various sketching that have been developed based on the literature review conducted and the final design is chosen based on the morphology chart with criteria such as mobility, effectiveness, cost and technical aspect are taken into consideration. There are three types of conceptual design as shown in Table 1. Traditionally, the process of soaking, heating, drying and crushing are done on separate occasions and the event can take weeks to finally complete just to finish producing one batch of pepper. With this invention, it is ensured that all these processes can be done in one place at the same time in order to reduce the time of production. The process of heating takes place right after the process of soaking and separating is done, and this process is done by turning on the heating element in the chamber, which will be initiated by the heating element. When the heating process is done, the peppers will then be sent to the second chamber where the crushing process will take place by grinding using a blade. In Figure 1 show the finalized design and part list that involved with this project.

<table>
<thead>
<tr>
<th>No</th>
<th>Conceptual Design</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>![Conceptual Design 1 Image]</td>
<td><strong>Conceptual Design 1</strong>&lt;br&gt;The picture shown is the available design in the market for multi-function pepper machine. The design name Pepper Peel-O-Matic (White Pepper Decoticator) from UPM, is very well designed with water recycling system [4]. However in this conceptual design, by using this design it can be mini size of project.</td>
</tr>
<tr>
<td>2</td>
<td>![Conceptual Design 2 Image]</td>
<td><strong>Conceptual Design 2</strong>&lt;br&gt;Middle tunnel are a bit too large and Grinder are hard to remove to collect peppers.</td>
</tr>
<tr>
<td>3</td>
<td>![Conceptual Design 3 Image]</td>
<td><strong>Conceptual Design 3</strong>&lt;br&gt;Design of Mini Multi-Function Pepper Machine which consist of four types major step, which involve process of soaking, heating, drying and crushing.</td>
</tr>
</tbody>
</table>
2.2 Fabrication technique

2.2.1 Welding

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing fusion, which is distinct from lower temperature metal-joining techniques. In this project, the welding technique are used to join the rivet to the tank and to join the tank hole to the bottom tank.

2.2.2 Cutting process

Cutting process is a work by causing fracture of the material that is processed. We used the hydraulic cutting machine in the project workshop to cut a circular shape of the steel to be used as our cover.
2.2.3 Drilling

Drilling is a cutting process that uses a drill bit to cut a hole of circular cross section in solid material. The drill bit is usually a rotary cutting tool, often multi-point. The bit is pressed against the work-piece and rotated at rates from hundreds to thousands of revolutions per minute. As part of our progress, this project used the drill to create holes on the rivet.

2.2.4 Machining

Machining is a work involving the use of the lathe machine. It is used to grind or cut the metal into the desired length and shape. For this project, the lathe machine is used to grind the steel pipe, since it is much longer than our desired length.

2.3 Process flow

Process flow will divide into 4 parts which are Upper Body, Electrical Assembly, Grinder and Grater as in Figure 2.

Fig. 2. Mini multi-function pepper machine.

2.3.1 Upper body

2.3.1.1 List of part

List all part that related as draft in drawing and need to include the size, type and quantity of each part.

2.3.1.2 Measuring process

The measuring process is done using the measurement that is obtained from the design sketch in Inventor Autodesk Software. The correct tools and equipment such as L-square and measuring tape are to ensure to get the precise measurements.
2.3.1.3 Cutting process

Cutting processes are done carefully and safely. First, the Personnel Protective Equipment (PPE) clothing are worn properly such as gloves, coverall, mask, and safety glasses. Next, proceed to make the turning process to remove the top layer of metal to predetermined size. Then, continue to cut the metal completely by slowly and not in a rush to get more accurate results.

2.3.1.4 Body assembly process

In the assembly process, by using a TIG machine, it been weld every part of the stainless steel 304 plate cut. First, only use the tack welding method just to see the overview of the design of the top and bottom tank.

2.3.1.5 Lower body assembly process

130cm of stainless-steel pipe are cut using angle grinder with the length of 300mm each. Next, four 300mm of stainless-steel pipe are welded to a nat on each end of the pipe. Meanwhile 4 bolts are welded to each corner of the bottom tank with 45° angle, respectively.

2.3.1.6 Flow tunnel assembly process

Next, proceed to drill 2 holes to connect the end cap pipes as the flow tunnels of the machine. Drilled the holes using hole saw drill bits and coolant to reduce and remove the heat build-up in the cutting zone and workpiece.

2.3.1.7 Rolling bearing and metal tube assembly process

Rolling bearing that are used is ID 8mm x OD 22mm x W 8mm. The bearings are attached (welded) to each outer side of bottom tank. The bearing including shaft will be use to rotate the grinder in the machine. As bearing with smaller inside diameter cannot be found, a metal tube with outer diameter of 7mm and inside diameter 6mm are used to be attach to inner diameter of the bearing.

2.3.1.8 Polishing process

After every assembly process are done, continue the work with polishing the whole body by using angle grinder with flap disc and polishing soap to get smoother 30 and shinier surface as in Figure 3. Other than that, pickling liquid are used to get rid of the black welding residue.
2.3.2 Electrical assembly

The task for assembling electrical equipment is known as electrical assembly. Aside from that, reads and interprets instructions, puts parts and tools together, and connects electronic components. Most electrical assembly in this project refer to the planning and assembly of wires and components involved in this project. Like any other processes, this process has its own precautions and safety measure.

2.3.2.1 Wire stripping process

Wire stripping process is a process involving an electrical wire stripper to remove the electrical insulation from the wire in order to reveal the inner electrical wires which are needed to connect wires and components. In wire stripping, it is also necessary to follow the required safety measures in order to avoid injury.

2.3.2.2 Wiring process

Wiring is an electrical installation process of cable and associated devices in a structure. Wiring is subject to safety standards for design and during installation. In this project, all the wiring are mostly done to connect power supply to switch and then to components while also taking in mind the needed length of wire as the power supply is on the ground.

2.3.2.3 Handling of heating element

Heating element is a component of the machine that is used for the process of heating in the machine where it will dry the white pepper in the machine. This PTC Heating Element has a voltage of 12V and has optimum heating temperature of 220°C. There are lots of benefits of using this type of PTC Heating Element, which among them is its long-lasting durability, no oxidation and long service life of 6000 hours. The thermal efficiency of this PTC Heating Elements is up to 99%.
When handling the heating elements, make sure the tank has been fully closed before the switch is on. This is to prevent burns or injuries from the extreme heat emitted from the heating element. Also, make sure all 3 pieces of the heating elements have their wires not overlapping each other to prevent short circuit. After the process of heating is done, switch the heating elements off and wait for 5 minutes for the heating elements to cool down as a precaution to prevent burns.

2.3.3 Grinder

Grinder is a part after drying process goes, the white pepper will crush with difference type of size and will divide with a certain type as required.

2.3.3.1 Measuring process

The modification of the design has been made of the new body grinder that suit with upper body design. The downside of sticking with the previous design is that the grinder blade will not connect with the crushed pepper if the grinder body is vertical. Furthermore, the location of the motor’s attachment to the blade’s body are not suitable. As a result, the new design has been finalised. By using the proper tools and equipment, such as a L rectangle and a measuring tape, the exact measurements that match correctly with the measurements that have been specified on the fixed design.

2.3.3.2 Cutting process

Cutting is done with care and safety. The maker then proceeds to cut the metal gently and consistently to get more accurate results. Steel cutting is used in the cutting process to cut aluminium. Furthermore, the maker uses angle grinders and disc cutters to cut steel plates.

2.3.3.3 Assembly process

Assembly process such as pepper outlet, grinder blade, holder and connect DC motor to blade are those steps that need to fulfil in grinder area.

2.3.4 Grater

This grater may be found on the mini multi-function pepper machine’s body as in Figure 4. This grater is used during the soaking, heating, and separating processes. The diameter of this grater is 120mm. It measures 230.5mm in length. Each grater hole is 3mm in diameter, and the space between each little hole is 20mm. The iron on the grater is made of steel and is simple to weld. Designers used a TIG machine to weld the grater’s edges.
3 Result and analysis

Upper Body, Electrical Assembly, Grinder and Grater are those 4 differences part that have done thru the fabrication process. The grater is the easiest process to build because of the combination of two semi-circle cylinder and the hole are drill with intermittently place around the cylinder. Meanwhile, the grinder is the difficult process to assembly because of the blade itself is not in the exact centre location of the body. This is because the cable that connected is short and need near the main plug. This cause a waste that left behind at the large area because of the alignment between body and grinder space not in line. Therefore, this area is recommended to further discussed in the next step to improve the design.

The main reason in designing and fabricate this product is to conduct the experiment between comparing the freshly pick of pepper and after 3 months old in four types of process; soaking, heating, drying and grinding process. It shows in Table 2 that there is no significant differences between the age of peppers being pick in this project. Therefore, farmer can pick by their own time and the process to make the white pepper can up to three month old the age of fresh pepper to complete the production. Through the experiment result of Mini Multi-Function Pepper Machine, the production time taken takes around 208 ~ 300 minutes from the beginning of soaking process until grinding process.
Table 2. Comparison data between freshly pick and after 3 month old of pepper in four types of process.

<table>
<thead>
<tr>
<th>Process</th>
<th>Fresh</th>
<th>3 months</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soaking Process</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time taken</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soaking pepper 11 hours</td>
<td>11 hours</td>
<td>11 hours</td>
</tr>
<tr>
<td>Turn the grater</td>
<td>3 minutes</td>
<td>3 minutes</td>
</tr>
<tr>
<td><strong>Heating Process</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The inside chamber to reach optimum temperature (=120°C)</td>
<td>30 minutes</td>
<td>30 minutes</td>
</tr>
<tr>
<td>Process of heating to start taking place</td>
<td>30 minutes - 1 hour</td>
<td>30 minutes - 1 hour</td>
</tr>
<tr>
<td>Complete heating process</td>
<td>2 – 3 hours</td>
<td>2 – 3 hours</td>
</tr>
<tr>
<td><strong>Drying Process</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Turn the grater until the peppers are dried</td>
<td>20 minutes</td>
<td>20 minutes</td>
</tr>
<tr>
<td><strong>Grinding Process</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grind pepper into fine powder</td>
<td>5 – 7 minutes</td>
<td>5 – 7 minutes</td>
</tr>
</tbody>
</table>

4 Conclusion

The idea of a Mini Multi-Function Pepper Machine is inspired through the needs of local market in Sarawak, where pepper is one of the biggest contributions to the business and economic world especially in the state. A study was conducted, where it was found that white peppers take about 1 to 4 weeks to finish one batch of production. Through this study, it was decided that by using this invention, it be able to improve the issues faced among the farmers, which are time limitations and hard labour. All the procedures and steps included in the machine, from soaking to separating, heating and finally the final process, crushing, are essential parts of the machine. The process is done in such a way that when the pepper is completely being processed and has been turned into fine grains, the product is ready to be commercialised for market purposes. In conclusion, the Mini Multi-Function Pepper Machine is one of a way to simplify the process of work for farmers harvesting white pepper and reduce the production time in comparison to the traditional way of processing peppers.
References


