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GREEN SUSTAINABLE "LEMANG" TOASTER MACHINE

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Abstract

Lemang is a favorite Malay cuisine in Malaysia especially during the festive season, or *Hari Raya.* Traditional *lemang* making process which uses firewoods as a source of heat and bamboo tree as a container contributes to an environmental problem due to the burning and cutting of wood and bamboo. It also causes health problems to humans due to air pollution and long exposure to direct heat. This innovation's objective is to design and fabricate a green sustainable lemang toaster. This innovation hopefully will help lemang sellers to save time and energy as well as save the environment from tree cutting and open burning. The novelty or uniqueness of the product are the heating source which uses natural gas to reduce environmental pollution and its cooking barrel/container that uses stainless steel tubes to reduce cutting and burning bamboo trees. The special feature of this product is it does not use bamboo, firewood, charcoal, and so on. The barrel can also rotate on its own with the help of a dc motor, performing the baking or toasting process without intensive care. Its impacts will reduce environmental problems, reduce cooking time, produce effective heat circulation, and need a minimum observation or maintenance making it a user friendly tool. The potential customers can be *lemang* business owners or producers, as well as personal users especially *lemang* lovers making it potential to be commercialised.

Keywords: *green, sustainable, environmental, lemang, user-friendly*

1.0 INTRODUCTION

Lemang is one of traditional foods that have been served not only during Hari Raya but also popular throughout the year (Adib, 2010). Traditional *lemang* making is very time consuming which requires about 4 to 5 hours cooking time and needs intensive care from time to time. It needs to be rotated regularly so that it can cook evenly. As shown in Figure 1, traditional *lemang* uses bamboo as a container and firewoods as its heat source. This gives many disadvantages not only to humans but also to the environment. Cutting bamboo and wood reduces the world's natural resources and burning wood pollutes the air. Among the other causes of environmental pollution is open burning. Open burning destroys the surrounding flora and fauna, increases the earth's temperature and the climate in the earth is getting hotter (Vallero, 2008). During the combustion process, combustion will emit pollutants into the air. The effects of air pollution are affecting human health. Humans will suffer from various illnesses when they inhale dirty air. The examples of diseases caused from air pollution are lung cancer, nasal cancer, and others (Kelly et al., 2011). Due to these problems, several researchers try to make lemang cooking process easier and safer to humans as well as to the environment.

Figure 1: Traditional ways of cooking "lemang"
Source : https://myagri.com.my/2017/04/pembuatan-lemang-tradisional-vs-lemang-moden/

2.0 LITERATURE REVIEW

To ease the lemang making process, several researchers invented new techniques. Several techniques have been applied by lemang producers such as baking in a drum, using a mechanism to rotate the bamboo and so on. However they still commonly use bamboo as a container and wood or charcoal as a heat source. In 2004, Azizol revolutionized the making of *lemang* which used a bamboo cylinder shaft and 13 bamboos can be cooked at a time (Haddy, 2004). This process requires 2 to 2.5 hours of cooking time and can cook approximately 4kg of rice depending on the size of bamboo. The procedure to prepare the bamboo cylinder is the same as the traditional method but the only difference is this *lemang* is cooked in a large oven-like container with fire at the bottom. The bamboo cylinder must be manually rotated occasionally to make sure the *lemang* is cooked thoroughly. It must also be taken out several times and pounded to make sure the *lemang* is compressed perfectly.

a) Close-up view b) Complete set

Figure 2: Azizol's invention of cooking "lemang"

Another invention of cooking *lemang* was invented by Malaysia Agriculture Research and Development Institute(MARDI) using a stainless steel hollow pipe to replace bamboo sticks. It consists of a two-halves hollow pipe that is pivoted at one end. It can be opened up to take out the *lemang*. This pivoted pipe is then inserted in a hollow container to contain the coconut milk. Both pipes are then inserted into the drum holes as shown in Figure 3. MARDI produced three different stoves with different numbers of pipes containing *lemang* and used different heat sources which are; a four lemang containers to be used with an electric stove for domestic use, and 13 and 25 pipes using LPG gas for commercial use. The price are RM1500 for the four pipes, RM3600 for 12 and Rm7000 for 25 *lemang* containers. The stove can bake *lemang* for 1.5 to 2 hours with a temperature of 160°C (Samsudin, 1998). These machines do not use wood or bamboo, therefore, it was the first green *lemang*-making tool. However, the container pipes still need to be rotated manually.

a) a 2-halves pivoted pipe b) a hollow container pipe c) complete Set

Figure 3: MARDI's invention of cooking "lemang"

3.0 PRODUCT DESIGN

Based on the strength and weakness of the invented *lemang* toaster as explained in literature review, we try to design a new "green sustainable" *lemang* toaster. Most of the ideas came from MARDI's invention by using stainless steel containers to replace bamboo containers. The main difference is we need to reduce the production cost and incorporate a rotating mechanism so that the *lemang* can be cooked evenly without manual operation.

From several conceptual designs, one design has been selected as shown in Figure 4. The machine was designed by using a lemang container of 50 mm in diameter and 500 mm in height. The number of *lemang* containers can be altered according to the customer's need. Only one layer of water tight container is needed compared to two layers in MARDI's design. This will substantially reduce the cost. The heat source will be the domestic LPG gas. The upper lid provided has an opening in the center for the burned flue gas to escape. The body is made from two layers of galvanized iron sheet and insulated with fiberglass foam in between. The purpose is to contain the heat to minimize heat loss. The *lemang* container is made from food grade stainless steel (SS 316) to prevent corrosion and pitting due to oxidization and salt reaction which often happens in food processing. The *lemang* containers are arranged in a circumference at a tilting position so that the heat can be distributed evenly from top to the bottom of the container. A rotating mechanism is driven by a Direct Current (D.C) motor which rotates the container occasionally to cook the *lemang* thoroughly.

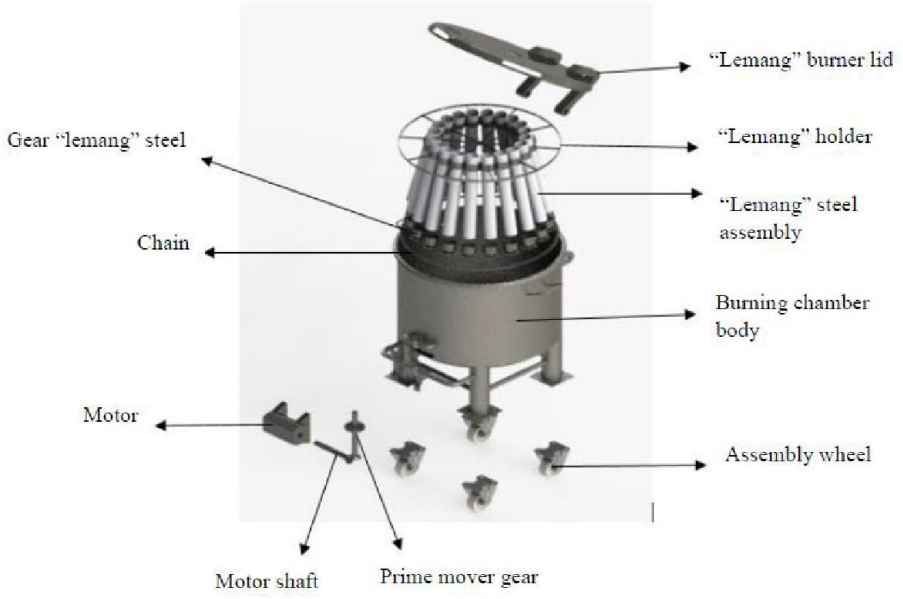
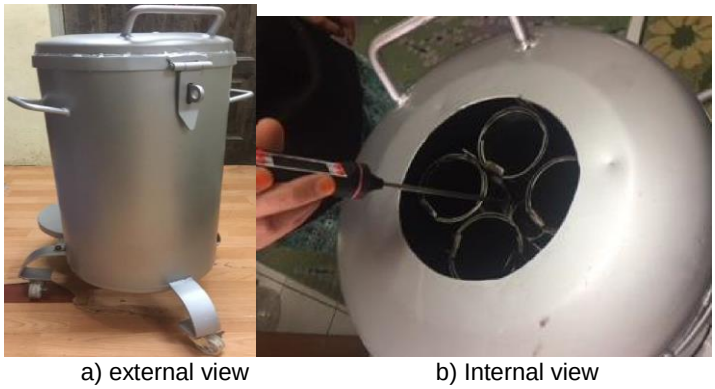


Figure 4: Exploded view of newly-invented green sustainable *lemang* toaster

4.0 VERIFICATION AND TESTING

A prototype consisting of four *lemang* containers was built. The complete set of prototypes is shown in Figure 5 with a total production cost of about RM 1000.00. For a mass production, this cost can be reduced by ordering the material in bulk quantity. To test the real performance of the machine, *lemang* was cooked using 1 kg glutinous rice and 1-liter coconut milk. Following the traditional recipe, the rice was cleaned and soaked for several hours in clean water, tossed and then soaked for one hour in a coconut milk mixture (salt, sugar and some water added to taste). A piece of banana leaf was rolled and put in the stainless steel container as a lining for easy removal of the *lemang* as well as to maintain the traditional flavor. The mixture of the rice and coconut milk was scooped into the container up to three quarters (¾) full to prevent overflow while cooking. Three containers can fill up to 1 kg of the rice. The containers were then inserted into the heating chamber and the gas burner was lit up as shown in Figure 6. For this testing a two-ring burner was used as the size is identical to the chamber.



a) external view b) Internal view

Figure 5: The fabricated prototype

a) Insert roll of banana leaf | b) Fill up with rice mixture | c) Insert container in cooking chamber

Figure 6: Lemang preparation

During the cooking process, the temperature at three places were taken at some time intervals as shown in Table 1 below.

Table 1. A record of temperature during cooking process

Time(min)	Temperature(□C)		
	Rice Mixture (in the container)	Inside of Burning Chamber	Outside of Burning Chamber
0	20	26.5	27.2
15	48	50	30
30	75	101	42
45	88	143	54
60	100	155	60
75	80	158	75
90	65	155	82

In Table 1 it is shown that the rice started to boil after 60 minutes at 100°C and was fully cooked after 90 minutes while the temperature reduced to 65°C when all the coconut milk was absorbed by the rice. The temperature in the chamber rose up to 143°C within 45 minutes and maintained between 155°C to 158°C until the burner was turned off. The temperature on the outside is maintained below 100°C. The time can be reduced if we use a bigger burner or fire. The rotational capability of the container made the lemang evenly cooked and prevented the lemang from over-burning.

5.0 DISCUSSION AND CONCLUSION

As shown in the experiment, the machine can maintain the temperature inside the chamber and only a small amount of heat is wasted due to convection and conduction. This will make an efficient use of energy or gas. The cooking time will also be reduced compared to those listed in literature review and can be further reduced by using a bigger burner. The cost is also cheaper compared to MARDI's four-containers version. Most importantly, without the use of bamboo and firewood, it can reduce open burning and tree cutting. As a conclusion, this green sustainable *lemang* machine fulfilled its duty to provide a modern mechanized *lemang* toaster machine for the betterment of the lemang industry as well as Malaysia's environment.

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