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The Design of Vacuum Frying for Making Rambutan Chips

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ABSTRACT

Vacuum Frying is a tool used to process raw materials into chips using a vacuum system. Basically, food ingredients will be fried at a temperature below the boiling temperature of the oil, so that the water content in the food ingredients will evaporate. The aim of research is to create design and development of vacuum frying with thermo control. Vacuum functions to reduce the pressure in the frying chamber, so that the oil will boil below the boiling temperature of the oil, namely below 300^0 to avoid burning by evaporating the water content (vacuumed) and minimizing the content lost by the heat of the oil. The design of the research consists of collecting data, design process, manufacturing process, machine testing, and evaluation. The oil tank capacity is 80 liters while the frying capacity reaches 10 kg. The vacuum frying process begins by putting oil into the drum and then heating the oil. Next, the raw materials are put into the chamber, after the oil boils, the vacuum faucet is turned on by turning it. Then the pump is turned on and the chamber is rotated to process the raw material into chips. According to the machine testing 1.5 kg of rambutan chips were produced from 3.1 kg of raw materials and 1.3 kg of banana chips were produced from 3.9 kg of raw materials. Both trials were carried out for 1 hour 20 minutes. For the temperature from the test results, the initial temperature was 60°C and during testing the highest temperature reached 80°C.

Keywords: Vacuum Frying, Rambutan Chips, Automatic Drying

INTRODUCTION

Rambutan is a fruit belonging to the Spidaceae family, is a plant native to the tropics of Southeast Asia. This plant grows flourishing in tropical climates and in some subtropical regions [1]. Subang Regency is one of the areas in West Java which is the largest producer of rambutan fruit in West Java, Indonesia. Rambutan (*Nephelium lappaceum L*) is a fruit with a skin shaped like a hair. There are various varieties of rambutan with different color variations [2]. The rambutan harvest season usually lasts from December to March. During this period, rambutan trees produce abundant amounts of fruit [3]. The selling price of rambutan fruit during harvest is relatively low and even cannot be sold at all, resulting in the rambutan fruit being wasted [4]. So a solution is needed for the post-harvest utilization [5].

Rambutan fruit farming products from Subang Regency are usually sold to areas of Java such as Brebes, Bumiayu and areas around Subang. Subang Regency can produce 62,068.98 tons of rambutan fruit in 2022, with the largest rambutan producing area being Kalijati District, namely 22,772.25 tons [6].

Most of the rambutan fruit produced by farmers in the village is the Lebak Bulus type of rambutan fruit and the remaining 30% is the Binjai type of rambutan fruit. The enormous potential for producing rambutan fruit possessed by West Tanggulun village should be balanced with the use of technology so that it has an impact on the added value of the product so that it can improve community welfare. Some examples of processed rambutan products include drinks, rambutan chips, sweets, chips and so on [7]. The results of this processing make rambutan fruit have a longer shelf life, are more practical, and still optimize the content in rambutan fruit so that it can be consumed even though it is not during the harvest period [8].

Processing fruit into chips is one of the effective ways to increase the shelf life, utilization, and added value of fruit products [9]. Rambutan chips have beneficial and functional value for health [10]. Rambutan provides a variety of significant health benefits for humans. This fruit is a source of energy thanks to its carbohydrate content, as well as providing proteins that contribute to cell regeneration. In addition, rambutan is rich in dietary fiber that promotes digestive system health, and contains vitamin C as a water-soluble antioxidant, supporting overall body health [11]. Rambutan has been shown to have medicinal properties, such as anthelmintic and antidiarrheal [12]. Chips are snacks made from thin slices of tubers, fruits, or vegetables that are fried in vegetable oil. As a processed product, chips have a low water content so they are more durable than fresh raw materials [13]. Processed fruit in the form of chips is more durable than unprocessed, because the moisture content is low [14][15].

One of the best ways to produce is to use vacuum frying technology [16]. The frying process aims to form color, aroma, and taste

characteristics, maintain product quality, and improve digestibility [17][18]. Fruit chips made by frying with a vacuum system maintain the taste, aroma, and crispy texture of the original fruit and maintain nutritional value [19].

Vacuum frying operates at lower pressur e and temperature, aiming to reduce oil conte nt and minimize browning reactions during p rocessing. Conversely, water frying uses hot a ir circulation instead of hot oil, resulting in a s horter processing time compared to tradition al air drying [20]. This technique works by lowering the air pressure inside the frying chamber, so that the boiling point of the water drops to about 50-60°C. This method allows frying at lower temperatures, preserving the nutritional quality and texture of the product [21]. The time and temperature of the frying are very important in determining the characteristics of fried products [22][23].

Making rambutan chips begins with pel the skin of the rambutan fruit. Then the peeled rambutan fruit is given freezing preprocessing treatment for a minimum of six o'clock. Next, pieces of rambutan fruit with a vacuum fryer at temperature 85°C, with a pressure of approximately 70 cmHg for 50 minutes [24]. Chips are a product produced through peeling and frying stages. The frying process works by evaporating water from raw materials through boiling steaming medium (cooking oil) at a certain temperature, which requires a certain amount of heat to take place [25][26].

The chips absorb a lot of oil while frying. Lots or lots of oil absorbed will affect taste, texture and condition physical chips. Frying technology with a vacuum fryer machine has several advantages over frying manually with a frying pan [27]. On a frying pan using a vacuum frying machine uses the temperature variable to determine the quality of the frying results, usually used for frying at standard temperature low. This quality includes in terms of color, texture, aroma and longer shelf life [28]. The selection of the frying temperature is very important to determine the quality of the fried product. The difference in temperature of the vacuum fryer has a very real effect on oil loss and moisture content so that it affects the organoleptic value, namely color, crispiness, taste, and overall acceptance [29]. Factors assessed include appearance, taste, amount of fat absorbed, storage stability, and economic considerations [30]. Fryers with the vacuum method maintain nutritional content such as protein, fat, and vitamins. The resulting product remains dry and crispy, without any damage to nutrition and taste, in contrast to a regular fryer [31].This invention concerns a vacuum fryer with automatic temperature control so that fried food remains crispy and retains its original color, taste and nutrition [32].

The purpose of this study is to create a vacuum frying machine design with automatic temperature control that is made to process rambutan fruit into crispy rambutan chips that have a delicious, natural taste and original

color [33]. Efforts to process food ingredients such as fruits and vegetables into chips have excellent prospects in meeting market needs. Fruit and vegetable chips can be a product that is in demand because of their unique taste and health benefits So that this rambutan chip product can be one of them [34].

RESEARCH METHOD

The vacuum frying machine design process begins with data collection through field observations, literature studies and interviews. Then continue with creation of vacuum frying design using Autodesk Inventor software 2015. This design is a design development. The research method can be seen from the following flow chart.

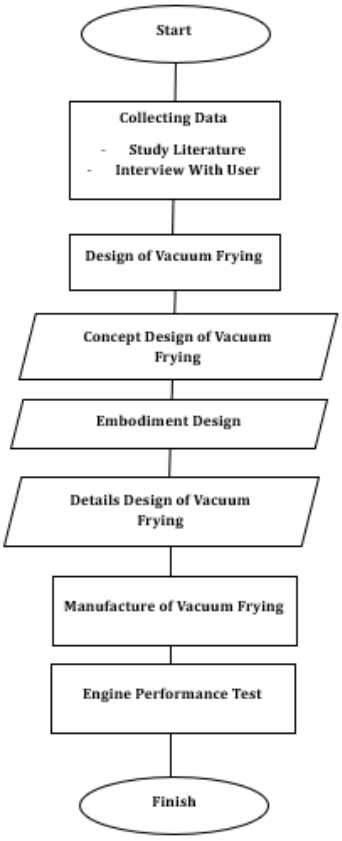

Figure 1. Flow chart of research methods

The step of research development consists of collecting data by literature study and interview with user to get need assessment of user about vacuum frying. After that, creating designs in to sketch and software design. Then the selection of material and cost of making the machine will be estimated too. The Developmental design or development design is design which takes existing concepts and seek improvements to performance gradually through refinement

Working Principles of a Product [29]. The design process has three stages, namely: design concept includes specifications and identification material, determine the function and working principle of the product. The second stage, namely embodiment of the design which includes development of layout, scale of forms, assembly analysis and optimization function. The third stage is detail design consists of inspection components, material selection, performance and cost optimization.

RESULT AND DISCUSSION

The results of design a vacuum frying machine are as follows:

Figure 2. 3D Design of vacuum frying

Vacuum frying is a frying process carried out at a pressure below atmospheric. This method has been widely used for various types of food, especially fruits and vegetables. Based on recent reports, ingredients that are often processed with this method include apples, apricots, bananas, jackfruit, green kiwi and golden kiwi, carrots, mushrooms, potatoes, onions, sweet potatoes, and purple sweet potatoes. Vacuum frying offers a better alternative in improving the quality of fried products compared to conventional frying methods at atmospheric pressure. The quality of the final product is influenced by several key factors, such as the combination of frying time and temperature. The right combination is required to produce food products with suitable physical properties and optimal quality [35].

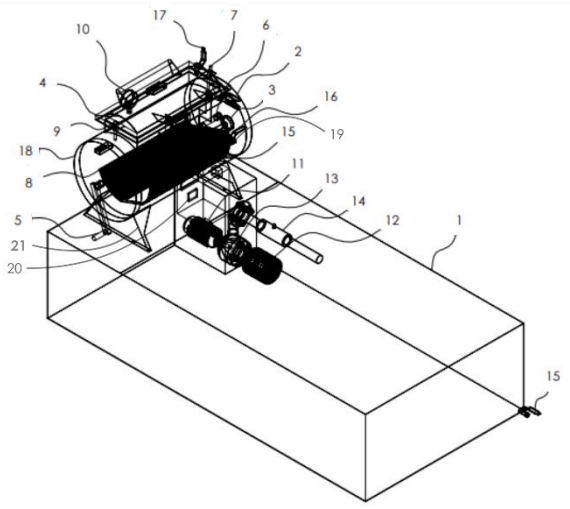

Figure 3. Design of vacuum frying

The description of the vacuum frying design can be seen in Table 1, below:

Table 1. Description of vacuum frying design

Item	Quantity	Name of Part
1	1	Water tub
2	1	Air Inlet Valve
3	1	Thermometer
4	1	Fryer tube cover
5	1	Frying crank
6	1	Fryer shaft
7	1	Cover shaft
8	2	Fried
9	1	Lock
10	1	Pressure gauge
11	1	Electric motor
12	1	Pump filter
13	1	Pump
14	1	Water Drain Pipe
15	1	Tub Water Drain Faucet
16	1	Oil drain faucet
17	1	Air drain faucet
18	1	Frying tube
19	1	Thermocouple
20	1	Thermocontroller
21	1	Frying tube legs

Deep frying is one of the longest-used food processing methods, where fat or oil serves as the heat-conducting medium in direct contact with the food. There are various types of frying methods, such as pan frying, sautéing, and deep frying. Today, deep frying has evolved into an industrial-scale operation, such as in the production of potato chips. During the frying process, fat or oil is used as the heating medium at high temperatures, usually between 160-180°C, or even more, depending on the needs of the fryer [36][37].

The working principle of a vacuum fryer starts with the oil being fed into a drum and then the oil is heated to a temperature of 85°C.

Next, the raw materials are put into the chamber, after the oil boils, the vacuum tap is turned on by rotating it. The pressure is set at 70 cmHg. Then the pump is turned on, the electric motor drives this 280-watt pump which functions to pump the air that enters the frying tube and then the chamber is rotated to process the rambutan fruit material until it becomes chips.

In addition, there is a thermocouple located on the bottom right side of the frying tube that functions as a temperature sensor in the frying chamber and a thermo controller for the temperature controller in the frying chamber so that the temperature in the frying chamber remains stable.

CONCLUSION

The design of vacuum frying can be implemented into a vacuum frying machine with automatic temperature control so that it can be used for the processing process of rambutan in West Tanggulun Village into crispy and delicious rambutan fruit chips, and the product can increase the income of rambutan fruit farmers there

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