

# Constructing and Testing a Vacuum Frying for Salacca Fruit Using a Reused Vacuum Pump

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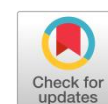
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## ABSTRACT

Fruit chips are the result of the processing of horticultural produce that does not use high temperatures. The abundance of agricultural products in Indonesia and still not many agricultural product processing technology make the fruit frying business a good prospect. On the one hand, processing fruit chips with high water content characteristics require a special frying technology called low temperature and pressure. On the other hand, this equipment is still not widely developed or even owned by small and medium enterprises. Therefore, this study aims to design and test a vacuum fryer for salacca. The vacuum method used is to use a vacuum pump recycled from the vacuum part of the cooling unit. The parameters observed were the effective capacity of the equipment, water content, and organoleptic test. The research results showed that the equipment's effective capacity was 0.26 kg/hr with 1.63% (w.b.) water content.



## KEYWORDS

Fruit Chips Fruit  
Frying  
Salacca  
Water Content



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## 1. Introduction

To meet food needs, agricultural products must have good post-harvest handling [1]. The handling that is carried out should pay attention to the level of quality standardization that is allowed. Poor handling will impact poor product quality, low selling prices and can cause losses for producers.

The processing of agricultural products, especially from the horticulture sector, is very promising given the vast agricultural land in Indonesia. According to [2] the prospects for agro-industrial development are quite bright. This is partly due to an increase in population, income, education, public nutrition awareness, processing industry, and tourism development. The market opportunities for fruit at home and abroad are still wide open so that it has the opportunity to be used as a source of foreign exchange.

The abundance of agricultural products at harvest time is still a hallmark of the agricultural system in Indonesia, which is highly dependent on the climate and traditional cultivation techniques. One of them is the salacca fruit which is very abundant at harvest time, and proper post-harvest handling has not been carried out so that the salacca can be processed before it rots. According to [3] salacca fruit is a very perishable fruit and cannot be stored for long. In addition, according to Sugianti and [4], salacca pondoh fruit can withstand fruit rot attacks for up to 10 days by immersing in water at a certain temperature. Therefore, one way to overcome the damage to agricultural products, especially salacca, can be done by using processing technology: making salacca candies or pickled salacca, making salacca lunkhead, making wine, and making barking chips. This technology is carried out to improve product quality, make variations of processed products with a distinctive salacca flavor, maintain durability, and increase the selling price. For this reason, it is deemed necessary to seek a form of technology that can efficiently process barking chips.

In order to produce processed products, it requires separate knowledge, expertise, and skills. Techniques in processing agricultural products also vary depending on the type. Some food processing techniques that are often used are removing unwanted outer layers, cutting [5], grating

[6], squeezing [7], emulsification [8] fermentation [9], cooking, boiling, boiling, frying [10]. Steaming, roasting, spray drying, pasteurization and packing. The community has several obstacles in carrying out several agricultural processing techniques, especially in frying. One of them is frying with vacuum technique. The advantage of using this method is that the temperature applied in the frying pan can be lower. This can be achieved as a result of using a lower pressure in the frying pan. The result is that the fried products still have relatively better nutritional content than the normal frying method.

There are two ways of vacuuming. Namely, using a water-jet vacuum pump and a vacuum pump. This water-jet vacuum pump uses a centrifugal water pump connected to the venturi so that the venturi generates suction power. The vacuum pump uses an electromotor as the driving force, and the speed of this pump can be adjusted so that the desired pressure can be adjusted without changing the pump.

The equipment available in the market for vacuum frying is a water-jet type where the vacuuming process uses a centrifugal water pump to rotate the venturi so that the venturi generates suction power. The greater the suction power we need to vacuum during the frying process, the greater the power of the centrifugal pump, water, and water tanks we need so that the vacuuming process will be limited. Thus the vacuum pump should be considered rather than the water-jet pump as a vacuuming device. Therefore, a vacuum frying method will be designed and tested using a recycled vacuum pump from a vacuum pump in the cooler in this study. This is expected to reduce the cost of the design of the tool without reducing the frying performance.

**Effect of Vacuum Frying on Quality Attributes of Fruits** Vacuum searing of natural products empowers singing at lower temperatures compared to air broiling, in this manner progressing quality traits of the browned item, such as oil substance, surface, maintenance of supplements, and color. Creating high-quality vacuum-fried natural product may be a challenge, particularly since of the tall introductory water substance of natural products that requires long broiling times. Components affecting vacuum-fried natural product quality qualities are the sort of gear, pre-treatments, preparing conditions, natural product sort, and natural product lattice. Pre-treatments such as hot discuss, osmotic drying, whitening, solidifying, impregnation, anti-browning agents, and hydrocolloid application unequivocally impact the ultimate quality qualities of the items. The vacuum-frying processing parameters, to be specific searing time, temperature, and vacuum weight, have to be balanced to the natural product characteristics. Tropical natural products have distinctive network properties, counting physical and chemical, which changed amid aging and impacted vac[11]

**Mass transfer and texture characteristics of fish skin during deep-fat frying**, electrostatic frying, air frying and vacuum fryinBrowned angle skins are snacks with wealthy flavor in Asian. In any case, the tall fat substance approximately 50% isn't great for wellbeing. It is conceivable to diminish the oil substance whereas keep up its browned taste and surface by optimized searing strategies. The impacts of distinctive singing approaches such as discuss singing, vacuum broiling, electrostatic searing and conventional deep-fat searing on the oil take-up, dampness misfortune, breaking constrain, color, and microstructure properties of fricasseed angle skins were examined. Discuss and oil searing were performed at 180 °C for 2–12 min. Vacuum broiling was conducted at lower temperature 120 °C for 4–24 min. Comes about appeared that discuss fricasseed and vacuum fricasseed angle skins had the least fat substance (9.8% and 27.7%, separately) and appeared smooth, uniform microstructures. On the opposite, sacred, unpredictable and non-uniform microstructures were gotten by conventional deep-fat singing and electrostatic broiling due to tall warm and quick mass exchange happened. The oil take-up (47.6% and 46.3% fat conte.[12]

**., Effect of vacuum frying conditions on quality of french fries and frying oil** Vacuum searing conditions were examined with regard to physical, chemical and sensorial properties of French fries and searing oil, other than deciding the impact of singing conditions in terms of searing temperature and time. In arrange to decide the ideal searing conditions of the French fries optimization ponder was carried out concurring to Central Composite Rotatable Plan. The comes about were assessed to decide ideal vacuum singing conditions focusing on least oil substance, 30–45 N in extend of hardness, least acrylamide substance and greatest generally inclination. The ideal vacuum broiling condition was chosen as 124.39 °C of searing temperature and 8.36 min of searing

time for French fries. The French fries gotten at ideal conditions for vacuum singing protected the specified color, textural properties and flavor and it has moo oil substance and diminished acrylamide arrangement. In expansion, the broiling oil quality was protected with vacuum broiling.[13]

**Optimization of vacuum frying condition for producing silver carp surimi** In this ponder, we investigated the achievability of vacuum broiling to create fresh silver carp surimi chips. The impact of three prepare parameters (singing temperature, singing time, and cut thickness) on the quality parameters of vacuum-fried surimi chips (oil take-up, freshness, and optical properties) was examined. The exploratory comes about appeared the ideal conditions were chosen as 2-mm surimi cut being vacuum-fried at 118°C for 2.5 min. Beneath these conditions, the oil substance, breaking drive, and color distinction to commercial potato chips were 24.33%, 15.21 N, and 14.03, separately. Furthermore, we moreover measured the water misfortune amid vacuum searing and the oil quality changes amid capacity of surimi chips. Comes about illustrated the quick misfortune of water substance of surimi chips amid vacuum searing and oil disintegration was kept at satisfactory moo level up to 100 days. Taken together, our ponder upheld the pertinence of vacuum broiling innovation to create high-quality silv.[14]

**Impact of vacuum frying on quality of potato crisps and frying oil** This investigate was centered on a basic evaluation of vacuum singing as a innovation empowering minimization of acrylamide arrangement in potato crisps and decreasing undesirable chemical changes that happen in searing oil at tall temperatures. The potato cuts were fricasseed in rapeseed oil beneath vacuum at 125 °C and air weight at 165 °C. The tests were performed on two potato assortments, Saturna and Impala. Vacuum searing decreased the arrangement of acrylamide by 98% additionally other Maillard response items, particularly alkylpyrazines. Concurrently a lower degree of oxidative changes was watched within the searing oil, whereas 3-MCPD esters diminished reasonably rapidly amid routine broiling. Tactile characteristics of the vacuum and expectedly browned potato crisps were assessed by a 23-member board. The larger part of specialists favored the flavour of ‘conventional crisps’, whereas as it were a couple of of them acknowledged potato-like new enhance of ‘vacuum crisps’ and classified this item as.[15]

**A novel vacuum frying technology of apple slices combined with ultrasound and microwave** The point of this work was to apply the ultrasound-assisted or ultrasound combined microwave vacuum broiling (UMVF) innovation in broiling of nourishments to diminish broiling time and make strides color and freshness. Apple cuts were utilized as demonstrate fabric for broiling. Two microwave control levels (800 W and 1000 W) were utilized at settled ultrasound control and recurrence of 600 W and 28 kHz, separately. Singing was carried out for 16 min. The impact of UMVF on leftover dampness substance, oil take-up, textural freshness and color parameters was measured and analyzed. The odor profile of the fricasseed cuts was measured and analyzed utilizing electronic nose (E-nose). The application of UMVF innovation essentially expanded the dampness dissipation rate, abbreviated the searing time, expanded the textural crispiness and delivered more alluring yellow color compared to microwave vacuum singing (MVF) innovation. The extreme oil take-up in UMVF items was comparable to that in MVF items. The UMVF created less Maillard respond [16]

**Enhancement of water removing and the quality of fried purple-fleshed sweet potato in the vacuum frying by combined power ultrasound and microwave technology**, The combination of ultrasound and microwave in vacuum searing framework was explored to attain higher drying effectiveness and quality qualities of fricasseed items. Purple-fleshed potato were utilized as test example and distinctive control levels of microwave (0 W, 600 W, 800 W) and ultrasound (0 W, 300 W, 600 W) amid vacuum singing. Drying energy, dielectric properties, dampness state variety and quality traits of browned tests were measured in a vacuum broiling (VF), and an imaginatively planned ultrasound and microwave helped vacuum searing (USMVF) hardware. The USMVF handle particularly expanded the dampness vanishing rate and successful dampness diffusivity compared to VF handle. The oil take-up was decreased by around 16–34%, the water action and the shrinkage was brought down, the surface (freshness) and the color of browned tests were incredibly progressed. The higher ultrasound and microwave control level in USMVF made a more prominent change.[17]

**Effect of ultrasonic on deterioration of oil in microwave vacuum frying and prediction of frying oil quality based on low field nuclear magnetic resonance (LF-NMR)** The ultrasound helped microwave vacuum searing framework was explored to realize higher physicochemical and quality properties of broiling oil. In this ponder, the impact of ultrasonic on peroxide esteem, corrosive esteem, carbonyl esteem, polar component, greasy corrosive, color, consistency, dielectric properties and moo field atomic attractive reverberation (LF-NMR) unwinding characteristics of searing oil beneath microwave vacuum broiling were analyzed; the vital component regression (PCR) analysis was utilized to set up a relationship show for anticipating physicochemical properties through LF-NMR unwinding characteristics. The comes about demonstrated that the corrosive esteem, carbonyl esteem, polar component, color, thickness, dielectric steady and soaked greasy acids of the oil tests expanded with the prolongation of frying time, and the peroxide esteem expanded to begin with and after that diminished with the expansion of searing time. Moreover the unwinding time of crest T21, T22 and T23 diminished slowly of broiling.[18]

**Effect of ultrasound and microwave assisted vacuum frying on mushroom (*Agaricus bisporus*) chips quality** The impact of ultrasound on broiling rate and item quality of browned mushroom chips (FMC) was examined utilizing microwave helped vacuum singing (MVF). To decide the viability of ultrasound amid broiling at diverse microwave control levels (800, 900 and 1000 W) and distinctive singing temperature (80, 85 and 90 °C), quality parameters (dampness misfortune rate, oil take-up rate, surface, color and microstructure) of the FMC gotten from vacuum singing (VF), MVF and ultrasound helped microwave vacuum singing (UMVF) were analyzed and compared. It was found that UMVF accounts for the most noteworthy dampness misfortune rate with the increment of microwave control and broiling temperature. Considering the oil take-up rate, UMVF may diminish oil substance by 16–20% compared to VF and MVF. UMVF chips moreover had way better surface and the foremost worthy color characteristics among the broiling strategies examined. The ideal condition of 1000 W and 90 °C accomplished a better dampness vanishing rate and lower oil substance. Mic[19]

**Influence of ultrasound and microwave-assisted vacuum frying on quality parameters of fried product and the stability of frying oil** Vacuum frying (VF), which combines sonication, with microwave heating was used to evaluate the quality attributes of fried mushroom chips as well as the stability of the frying oil. Frying was performed at 90 °C, 0.015 MPa, 1000 W microwave power input at two ultrasound power levels. Mushroom (*Agaricus bisporus*) chips were fried using four frying conditions, namely: VF, microwave vacuum frying (MVF), 300 W ultrasound-assisted MVF (300UMVF), and 600 W ultrasound-assisted MVF (600UMVF). The fried samples were evaluated in terms of their moisture content, oil content, protein content, bioactive compounds (total phenolic compound, total flavonoid compound), and color characteristics. The 600UMVF sample required less processing time to reach at the same final moisture content. The oil content was also found to be lower in the high-power sonicated sample. The contents of protein, total phenolic compound, and total flavonoid compound in the fried mushroom chips (FMC) were preserved to a greater extent by the ultrasound treatment. All fried samples displayed natural color; the best result found for the 600UMVF sample. UMVF was found to delay oil deterioration by enhancing its oxidative stability. Microstructure observations revealed that the cell structure of the fried sample is preserved better by the ultrasound treatment. The findings of this work show that sonication-enhanced frying minimizes the loss of nutrients, bioactive compounds, and preserves the color of the original sample.[20]

**Ultrasonic microwave-assisted vacuum frying technique as a novel frying method for potato chips at low frying temperature** The ultrasonic microwave-assisted vacuum searing (USMVF) was legitimately planned and tried as a novel broiling procedure for potato chips at moo searing temperature in this work. The USMVF was carried out by the combination of ultrasound and microwave within the vacuum searing to abbreviate the searing time and progress the quality of items. Two singing temperatures (90 °C and 100 °C) were comparatively analyzed both in USMVF and microwave-assisted vacuum searing (MVF). Based on the examination of drying energy and quality appraisal, the USMVF extraordinarily expanded the dampness vanishing energy and compelling dampness diffusivity, decreasing 20–28% of the drying time compared with the MVF, particularly at lower searing temperature. The oil take-up of fricasseed potato chips was diminished within the USMVF with moo broiling temperature. The surface properties (freshness) and color of



browned potato chips were enormously moved forward by the combination of ultrasound in MVF. [21]

**Effect of microwave-assisted vacuum frying on the quality of banana chips** This article looks at the capability of microwave-assisted vacuum singing (MWVF) on sparing searing time and quality change of browned banana chips. The MWVF machine was planned to combine vacuum singing (VF) and microwave warming (MW) in which electromagnetic dissemination was mimicked by COMSOL Multiphysics application program. New banana chips were browned at 95 °C and 2 kPa, at different vacuum broiling times (25–75 min), and at microwave warming times of 5 and 10 min. The quality of the banana chips was considered in terms of dampness, oil substance, surface, color, and tangible qualities. The comes about appeared that MWVF might give a altogether shorter searing time than VF, from 75 min to 50 min (VF40MW10). The MWVF procedures were able to protect the quality of banana chips comparative to the VF strategy. The banana chips made by MWVF had distant better; a much better; a higher; a stronger; an improved" > a much better tactile assessment than the ones fricasseed as it were by vacuum. [22]

**Effects of vacuum frying on the preparation of ready-to-heat batter-fried and sauced chub mackerel** Chub mackerel (CM) could be a commercial angle in Korea, owing to its accessibility and dietary values. This ponder pointed to create a ready-to-heat (RTH) Korean arrangement of CM, known as Godeungo gangjeong. We utilized vacuum broiling innovation to sear the CM and assessed its quality. Routine singing with a profound fryer was performed in parallel to evaluate the predominance of the vacuum fryer. We optimized the broiling conditions of vacuum broiling (VBF) and profound broiling (DBF) utilizing reaction surface strategy. At ideal conditions of 95° C for 7 min 42 s, VBF delivered superior tactile, chemical, and microbial properties than DBF at 190° C for 5 min 30 s. The dietary values, counting amino corrosive and greasy corrosive substance, were examined and found to be higher in VBF than in DBF. Tangible properties too appeared way better scores on VBF than DBF, particularly in appearance, smell, taste, and generally worthiness. The VBF created lower unstable fundamental nitrogen (VBN). [23]

**Comparison between atmospheric and vacuum frying of apple slices** Vacuum deep-fat broiling may be a unused innovation that can be utilized to make strides quality traits of fricasseed nourishment since of the moo temperatures utilized and negligible presentation to oxygen. In this paper barometrical and vacuum searing of apple cuts were compared, in terms of oil take-up, dampness misfortune and color advancement. In expansion, a few apple cuts were pre-dried (up to 64% w.b.) some time recently vacuum searing to decide the generally impact. To carry out suitable comparisons between both advances proportionate warm driving strengths were utilized in both forms ( $\Delta T = 40, 50, 60$  °C), keeping a consistent distinction between the oil temperature and the bubbling point of water at the working weight. Vacuum singing was appeared to be a promising strategy that can be utilized to decrease oil substance in browned apple cuts whereas protecting the color of the item. Especially, drying earlier to hoover singing was shown to provide the most excellent comes about. For occurrence, when employing a driving constrain of  $\Delta T = 60$  °C, pre-dried vacuum. [24]

**Co-influence of ultrasound and microwave in vacuum frying on the frying kinetics and nutrient retention properties of mushroom chip** The searing energy (dampness misfortune rate and oil take-up rate) of an inventively outlined ultrasound and microwave-assisted vacuum singing (UMVF) framework was examined and the plausibility of UMVF for decreasing the supplement misfortunes amid broiling were assessed in this work. The white button mushroom was the tried test in this ponder. The chips were fricasseed into two singing temperatures (80 and 90 °C), three distinctive broiling forms, vacuum searing (VF), microwave vacuum searing (MVF), and UMVF at a settled vacuum weight ( $12 \pm 1$  kPa). The first-order dynamic demonstrate was utilized for the mass exchange (dampness misfortune and oil take-up). Concerning the fitting exhibitions, the logarithmic demonstrate and Pedrischi show appeared the best-fitted demonstrate for dampness misfortune rate and for oil take-up individually. Combining ultrasound and microwave in VF, the calculated dampness diffusivity rate was expanded from  $1.599 \times 10^{-10}$  to  $2.769 \times 10^{-10}$  m<sup>2</sup>/s and oil take-up rate was diminished from 0.0121 to 0.0059 s<sup>-1</sup>. [25]

## 2. Method

The materials used in the vacuum fryer's construction consist of a food-grade stainless steel plate, 400 mm x 400 mm angle iron, gas stove, stainless steel pipe, water faucet, vacuum pump recycled from cooling equipment, and a thermometer barometer, iron pipe, bolts, and nuts. Then the materials used for testing the vacuum fryer consist of water, cooking oil, salacca fruit, calcium chloride, sodium metabisulfite. In addition, the tools used as a whole in this study consisted of stationery, hacksaws, zinc scissors, scales, calculators, grinders, computers, hammers, welding machines, and drilling machines.

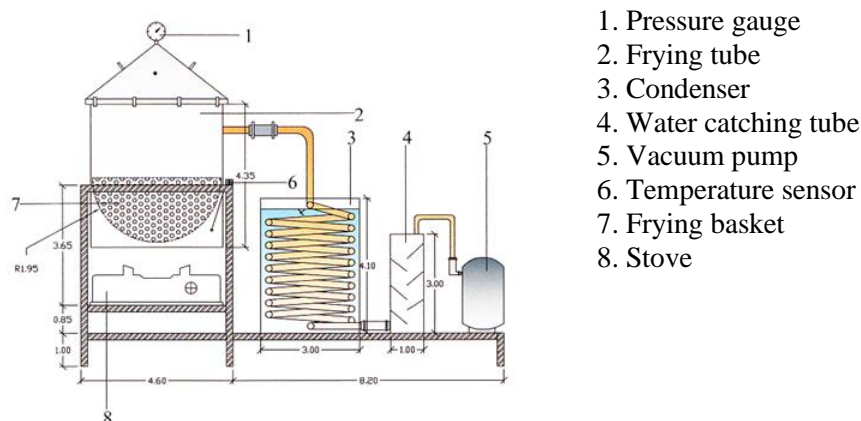
To test the vacuum fryer, the salacca pondoh type is taken. The salacca pulp is peeled first and soaked in the lime solution for 1 hour. Frying is carried out by deep frying in a vacuum condition of 635 mmHg and at a temperature of 85-95<sup>0</sup>C for 90 minutes. After the frying is done, the salacca fruit chips are then drained using a spinning machine. The faulty fruit chips that have been drained will then be tested for moisture and organoleptic content.

The effective capacity of the tool is measured by counting the number of salacca chips produced per unit of time required during the frying process. This organoleptic test is usually carried out on chips which include taste, crunchiness, and color. This test was conducted using ten panelists. One panelist performed an organoleptic test for all samples. The test is carried out by sensory organoleptic, which is determined based on a numerical scale.

## 3. Results and Discussion

### 3.1. Part of components vacumm frying

The parts of a vacuum fryer are presented in full in Figure 1. In general, this vacuum pump type fryer consists of four main parts, namely the frying pan, the cooling container/condenser, the water trap container, and the vacuum pump. The framework of this tool serves as a support for other components, which are made of angle iron. This tool is 1280 mm long, 950 mm high, and 440 mm wide. This frying container is a part of the tool that functions to fry the fruit. This container is in the form of a cylindrical tube with a diameter of 400 mm and a height of 500 mm. At the top, it is a cone with a height of 50 mm, which is connected to the connecting pipe to the condenser. This frying basket is a basket where ingredients are placed before frying. This basket is shaped like a cylindrical tube with a diameter of 390 mm and a height of 200 mm, which is latticed. At the top of the basket, it can be opened when adding ingredients and closed when frying. This condenser consists of a spiral stainless-steel tube. At the bottom of the tube, a hole will be made for the outflow of water. This water will lower the steam temperature from the frying pan so that some of the steam will change phase to liquid and is not sucked in by the vacuum pump that it can see on fig 1 for the vacuum fryer design using recycled. This water catcher is a continuation tube from the condenser, which is a vacuum. This tube consists of a stainless-steel pipe coming from a condenser and an iron pipe with a diameter of 25.4 mm. This vacuum pump is a pump that functions to suck air from the frying container. In this tool, the vacuum pump used is 0.5 HP.



1. Pressure gauge
2. Frying tube
3. Condenser
4. Water catching tube
5. Vacuum pump
6. Temperature sensor
7. Frying basket
8. Stove

**Fig. 1.** Vacuum fryer design using recycled vacuum pump

In addition, this tool is equipped with a vacuum pressure gauge, digital temperature gauge, stainless steel connecting pipe, a frying basket connected to the crank out of the frying pan, and a heating device used in the form of a gas stove. This frying pan is 400 mm in diameter and 500 mm high. There is a frying basket in the shape of a half ball with a diameter of 390 mm where this basket is latticed in this container. A frying pan can be filled with cooking oil as much as 20 L.

A 12,7 mm diameter pipe connects the frying pan and the cooling container. The vacuum pump will suck the hot steam from the frying. Still, it will first pass through the condenser container so that the wet steam will condense into water and will be stuck in the water catcher/water trap so that the condensed water vapor will not be sucked into the vacuum pump. This cooling/condenser container is 300 mm in diameter and 410 mm high and is given a water tap at the bottom so that water can be removed more easily when the frying is finished. The water trap has a diameter of 100 mm and a height of 300 mm.

The process of frying the ingredients is carried out when the desired temperature and vacuum pressure have been reached by turning the crank upwards so that the frying basket will sink into the cooking oil. This crank must be rotated every 10 minutes so that the ingredients in the pan cook evenly into chips.

### 3.2. Frying Process

The material requirements for frying using this tool are presented in Table 1. One frying process takes 90 minutes with 500 g of gas as fuel. 29 L of cooling water is needed, and 2000 g of salacca fruit. During frying, the pressure in the frying pan must be maintained. This is because the leakage will cause the pressure to rise, so that the voiding process will take a very long time.

**Table 1.** Material requirements for one-time vacuum frying

Component	Value	Units
Fuel gas	500	g
Water	29	L
Sallaca fruits	2000	g
Cooking oil	20	L

### 3.3. Effective capacity of vacuum frying

The effective capacity of a tool shows the productivity of the tool during operation for each unit of time. In this case, the effective capacity of the tool is measured by dividing the weight of the resulting salacca chips against the time it takes to operate the tool. In the research that has been done, salacca chips were obtained in each replication as many as 420 g, 380 g, 380 g. The average weight of the salacca chips produced during the test is 390 g with a frying time of 90 minutes. Based on this, the effective capacity of this vacuum fryer is 0.26 kg/hr.

**Table 2.** Results of the frying using vacuum frying are designed

Repeat	Salacca chips weight (g)	Frying time (minutes)
1	420	90
2	380	90
3	380	90
Average	390	90

The process of making salacca chips using a vacuum fryer requires a frying time of 90 minutes that the of the results of the frying using vacuum frying provides on table 2. The frying process is not immediately carried out initially because there will be a frying room-clearing process first. The frying basket is lowered by turning the crank when the desired pressure and temperature have been reached. The frying process is declared complete when the color of the salacca chips in the frying pan has turned brown (can be seen through the viewing glass), the sight glass is no longer condensed, and the cooking oil has calmed down because the fried ingredients have been cooked.

### 3.4. Salacca chips moisture content

Measurement of water content is carried out to determine the amount of water content in the salacca chips, which can indicate the level of the crispness of a salacca chip. In this study, the water content of the salacca chips in each test was 1.20% (w.b.), 0.8% (w.b.), 2.90% (w.b.), respectively. The average moisture content of the salacca chips in the vacuum fryer test is 1.63% (w.b.). These results indicate that for every 10 g of salacca chips, there are 0.163 g of water. The water content of the barking chips shows on table 3.

**Table 3.** Water content of the barking chips

Repeat	Chips weight before oven (g)	Chips weight after oven (g)	Moisture content (% w.b.)
1	10	9,88	1,20
2	10	9,92	0,80
3	10	9,71	2,90
Average	10	9,83	1,63

From the results of this study, it was obtained that the water content of the salacca chips was 1.63% (w.b.), where according to Jamaluddin, Rahardjo, Hastuti, and Rochmadi (2012) that the lower the water content in the solid, the smaller the strain value or vice versa so that in this condition the resulting solid texture becomes more and more crispy. In addition, Firdaus, Bambang, and Harijono (2001) also stated that the loss of some free water in solids causes the texture properties to change from soft to hard.

Organoleptic testing is a simple test of taste, aroma, crunchiness, and overall acceptance of food ingredients from organoleptic panelists. In the research that has been done, it was found that in the first test, the average level of crunchiness was obtained based on the panelists' assessment on a scale of 2.9 (crispy), taste on a scale of 3.1 (like), the aroma on a scale of 2.8 (like) and overall acceptance on a scale of 3.0 (like). In repeat II, the average level of crunchiness was obtained based on the panelists' assessment on a scale of 3.0 (crispy), taste on a scale of 3.1 (like), the aroma on a scale of 3.1 (like), and overall acceptance on a scale of 3.1 (like). In repeat III, the average level of crunchiness was obtained based on the panelists' assessment on a scale of 2.9 (crispy), taste on a scale of 3.1 (like), the aroma on a scale of 3.1 (like), and overall acceptance on a scale of 3.0 (like). Table 4 provides organoleptic test results of barking chips.

**Table 4.** Organoleptic test results of barking chips

Repeat	Crunchiness	Taste	Aroma	Overall acceptance
1	2,9	3,1	2,8	3,0
2	3,0	3,1	3,1	3,1
3	2,9	3,1	3,1	3,0
Average	2,9	3,1	3,0	3,0

Based on the above research, the overall average level of crispiness was obtained on a scale of 2.9 (crispy), taste on a scale of 3.1 (like), the aroma on a scale of 3.0 (like), and overall acceptance on a scale of 3.0 (like). In this case, the overall acceptance indicates color, taste, and aroma. [10]state that fruit chips do not experience taste, aroma, and color changes in vacuum frying because they use a frying temperature below the boiling point of the oil.

## 4. Conclusion

The vacuum fryer with a recycled vacuum pump has been successfully constructed and tested. The frying pan is made of stainless-steel food-grade plate. The frying pan is in the form of a cylindrical tube with a diameter of 400 mm and a height of 500 mm. The frying pan can hold up to 20 L of cooking oil. The effective capacity of this vacuum fryer is 0.26 kg/hr. The water content of the fried salacca chips is 1.63% (w.b.). Organoleptic tests on the average level of crispness, taste, aroma, and overall acceptance were 2.9 (crunchy), 3.0 (like), 3.0 (like), 3.0 (like), respectively.



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