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Detection of Salak Chips readiness on vacuum frying machines based on vacuum pipe temperature and frying time

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Abstract. Fruits are one of the horticultural commodities that have high economic value and have the opportunity to be exported. Fruit products in Indonesia are generally consumed in the condition of fresh fruit and very little processed into processed food. Because fruits are seasonal and perishable after being harvested, the selling price of the product has decreased significantly during the harvest season. One alternative to increase save time and fruit utilization is by processing fruits into chips. Fruit chips are a healthy snack because contains high fiber. Processing of fruit chips can be done using ordinary frying with dyeing on cooking oil at atmospheric pressure (deep frying) or with a frying pan at low pressure (vacuum frying). The purpose of this study is to examine the relationship between the temperature of the frying pan and the temperature of the flow of the pipe on the vacuum frying machine from the first time frying process until the chips are cooked. This research is limited to the following matters: the type of vacuum frying machine used is a water jet pump model 2 HP, a vacuum pressure 65 cmHg, the frying setting temperature is 90^{o}C, and the main ingredient of salak chips with a capacity of 5 kg. The results of the salak chip frying experiment results are as follows: Whatever the temperature of the frying pan before dipping the oil chips, the water vapor suction channel will remain at 27^{0}C, and after the chips have been oiled, the temperature changes slowly to the highest value (same as the frying temperature) and the longer it goes down until it reaches room temperature again (27^{0}C) this is due to the water content depleted from the fruit chips that have run out and the fruit chips have been fried in about 90 minutes.

1. Introduction

Fruits are one of the horticultural commodities that have high economic value and have the opportunity to be exported. Fruit products in Indonesia are generally consumed in the form of fresh fruits and still little is processed into processed foods. Because fruits are seasonal and perishable after harvesting, the selling price of products has decreased very significantly during the main harvest season and the high yield loss rate reaches 25-40% [1].

One alternative to increase lifetime and fruit utilization and provide added value the fruit products is by processing fruits into chips. Fruit chips processing can be done using ordinary frying by dipping in cooking oil at atmospheric pressure (deep frying) or by frying at low pressure (vacuum frying) [2].

Compared to conventional frying, the vacuum system produces a much better product in terms of appearance of color, aroma, and taste because it is relatively like the original fruit [3,4].

Vacuum Frying Machine according to Suyitno is a food processing that is commonly done to prepare food by heating the food in a pan filled with oil [5]. This process aims to produce a product that expands and is crispy. It also enhances flavor, color, nutrition and durability of the final product.

Frying can change the eating quality of a meal and provide a preservation effect due to the thermal decomposition of microorganisms and enzymes and reduce water content so that its shelf life is better [6]. According to Lastriyanto, vacuum frying is done in a closed room with a low pressure condition of around 65 cmHg [7].

Research conducted by Shamroz Afrozi and his colleagues on the relationship of temperature optimization and frying time on the 2 kg vacuum frying machine stated the temperature and frying time to get the best way to make banana chips is temperature of 90oC for 50 minutes and research conducted by Nicolas Tumble on the same topic but using pineapple objects obtained the best results at a temperature of 90oC and a time of 50 minutes [2,8].

2. Methods

The research method used in this study is the real experimental method (true experimental research). This type of research has the aim to determine the relationship that occurs between the temperature of the frying pan and the temperature of the suction channel water vapor when the first process to completion. This experiment was carried out 3 times with the same parameters.

2.1. Vacuum frying machine

The specification of the tools used in this study are as follows:

Table 1. The specifications of the tools.

System	Vacuum Frying Water Jet Pump
Dimension Machine	180cmx180cmx120cm
Material	Stainless Steel food Grade
Pan Capacity	5 Kg
Fitur Temperature Control	Automatic Thermostat Control
Source Thermal Energy	LPG (Liquid Petroleum Gas)
Capacity of Oil	35 Lt
Colling System	Water Circulation
Water Capacity	± 288 Liter
Cooling Water Capacity	
Input Voltage source, Power	220 V, 2HP
System Vacuum	Single Ventury Pipe

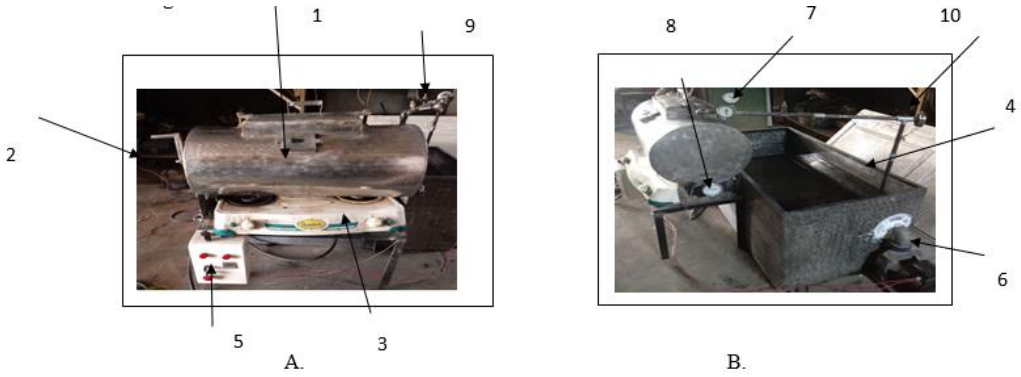

Figure 1. A) Vacuum frying machine capacity 5kg on front view, B) Vacuum frying machine capacity 5kg on side view.

Note:
1. Fryer Tube
2. Handle of vacuum frying bracket,
3. Heating Unit
4. Tube of water
5. Control box
6. Water jet Vacuum Pump
7. Manometer
8. Analog thermometer and thermocouple sensor
9. Air flow pipe
10. Analog thermometer

2.2. How vacuum frying machine works

The operating step of vacuum frying machine are:

- Fill the water tube with water until the surface of the tube.
- Put cooking oil in the fryer tube until the bottom of the fruit bracket.
- Turn on the temperature control on the position and the gas stove.
- Adjust the temperature adjustment to the desired temperature
- After achieve the setting temperature , put the fruits into the frying bracket then close the frying tube and lock tightly
- Close the vacuum release valve, start the pump by pressing the button in the on position on the control box while opening the water circulation on condenser, wait until the water comes out of the hose above the condenser.
- After the vacuum meter shows the number 65 mmHg, lower the bracket into the oil by turning the mixer lever half a turn (180 °). Shake the lever every 5 minutes to evenly warm up.
- Once cooked, the foam in the frying tube will disappear (look from the surveillance glass by pushing the light switch to the on position) lift the material onto the oil by turning the stirring lever 180 ° and lock it.
- Turn off the pump, stove and water circulation condenser, then open the vacuum frying air exhaust, slowly until the vacuum meter points to 0.
- Open the frying tube and bracket, remove contain the fruit chips and drain it on the spinner machine.

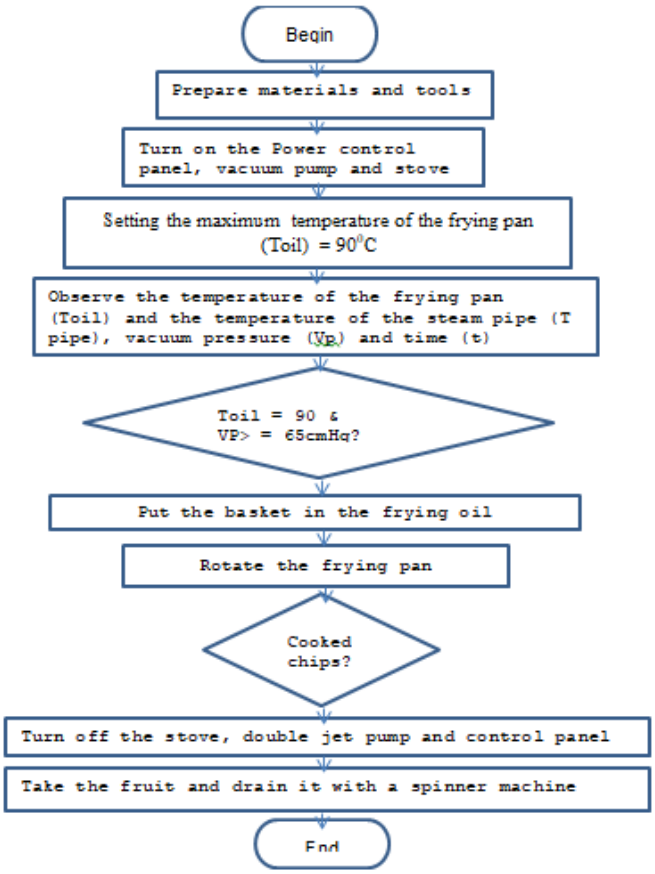

Figure 2. Flowchart process experimenting.

At the time of this experiment, a third-class salak was chosen which was cheap. The frying process is tried three times. Previously, salak is prepared and then peeled and cleaned from the skin and its contents. Next is the preparation of vacuum frying equipment and cooking oil. Put the ingredients to be fried in the frying bracket in the position above. Close the frying bracket and frying tube. Turn on the vacuum pump first until a pressure of 60-70 CmHg is obtained. The vacuum frying machine is set at a temperature of 80-100 ° C, then the gas stove is turned on. After the oil temperature has reached 90**º** C, the salted peel that has been in the bracket is turned downward. Salak is put into 5 kg. Furthermore, frying is done for 80-100 minutes. During the frying process the temperature values will be monitored on the thermocouple sensor and the LM 35 temperature sensor. After the time the frying time is reached then the lid is opened and salak chips are taken and drained.

3. Result

3.1. Pipe flow temperature experiment results

This experiment is carried out during the frying process by recording the measured tube pressure values using a Manometer measuring instrument and using an analog wipro thermometer on the air duct pipe between the frying tube and the water bath. The results of experimenting the tube temperature, pressure and temperature of the pipe are seen in Table 1 below.

Table 2. Results of pressure, temperature of the frying tube and air pipe.

No	Time (minute)	Pressure Tube **(mmHg)**	**Oil Temperature (oC)**	**Pipe Temperature (oC)**
1	5	300	36	27
4	10	550	70	27
3	15	620	72	27
	20	650	90	27
Start dipping salak fruit in cooking oil				
5	25	420	60	90
6	30	470	80	86
7	35	520	82	80
8	40	580	82	72
9	45	600	84	66
10	50	620	86	54
11	55	630	86	50
12	60	640	88	46
13	65	640	89	40
14	70	650	90	38
15	75	650	89	34
16	80	660	89	32
17	85	670	90	30
18	90	680	90	27

From Table 2 shows the relationship of time, oil temperature and air pipeline and vacuum pressure of the frying tube, the experiment shows that when the beginning of the process begins the oil temperature will gradually rise followed by vacuum pressure of the tube. The time needed to dip the chips (when the oil temperature approaches 90^0C and the vacuum pressure above 60 cmHg) is around 20 minutes and when it is finished about 90 minutes and the oil temperature is still stable at 90^0C and the temperature of the pipe will show the value 27ºC.

Table 3. Experiment results when dipping and cooking time of chips.

Process	Exp 1(minute)	Exp 2(minute)	Exp 3(minute)	Average
Time dipped	20	24	25	23
Cooking Time	90	92	88	90

From the result of three (3) times experiment the average time when the chips are dipped in oil is about 23 minutes and the time needed to finish cooking is 90 minutes.

Table 4. Experiment results when after dyeing and chips are cooked.

Process	Exp 1		Exp 2		Exp 3		Average	
	(ºC) Oil	(ºC)Pipe	(ºC) Oil	(ºC)Pipe	(ºC) Oil	(ºC)Pipe	(ºC) Oil	(ºC)Pipe
After dyeing	60	90	65	90	60	85	61,6	88,3
When chips are cooked	90	27	92	27	88	27	90	27

Table 4 shows that from three times experiment the average temperature experimenting after dyeing decreased by 32%, from 900C to 61.60C and also the decrease in pipeline temperature by 2%. While the time needed to fry 5 kg capacity zalacca chips for 90 minutes and the temperature of the pipe will show the room temperature (27ºC).

Fruit chips fried in a vacuum frying machine are undamaged and crunchy. This is because the temperature received by the fruit chips is pulled directly by the flow rate of the fluid in the venturi measured in vacuum pressure, according to the azaz Bernoulli equation where the faster flow rate in the venturi tube decrease pressure (vacuum pressure). The lower the air pressure is used in a vacuum frying machine.

4. Conclusions

In this study the following conclusions are obtained:

- The characteristics of the temperature of the air flow after salak is inserted there is an increase in temperature up to 90oC, along with the longer time the material enters the cooking oil also causes the temperature of the gas stream to gradually decrease to room temperature of 27 oC.
- From the experiment results obtained the temperature of the chips ready to be dipped in oil ie when the oil temperature is 90oC and the vacuum pressure above 65 cmHg takes 23 minutes.
- After experimenting using an analog thermometer on the air flow pipe and the frying tube the data obtained that the temperature of the pipe will rise still shows 27oC before the fruit is dipped in cooking oil and will rise until it reaches the same temperature value in the frying tube then slowly drops until it returns to temperature back room (27oC).

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