

1. INTRODUCTION

1.1. Background

Healthy eating has been widely acknowledged following a massive campaign and education about healthy lifestyle among society. Healthy eating could contribute to preventing chronic diseases like heart disease, diabetes, and cancer (Ridzuan *et al.*, 2018). Moreover, Ridzuan *et al.* (2018) mentioned that the most important thing in living a healthy life is by taking care of the food intake. One must eat a meal three times a day and control the portion of every meal they want to eat, should consume more fruits, vegetables, and fat-free or low-fat products. Consuming foods that have a low amount of saturated fats, trans fats, cholesterol, salt (sodium), and added sugar is also important.

In Asian countries, besides rice, tubers are also well known and contain mostly of carbohydrate. Purple Sweet Potato (PSP) is a tuber or root vegetable that has a good amount of carbohydrate, minerals, and vitamins. These comestibles are still underdeveloped; hence the probability of product diversification and prospect utilization is quite big (Firgianti and Sunyoto, 2018).



Research in 2006 (Mintel, 2006) showed that salty snack dominated more than half of the snack sales and became the majority of Americans' consumer diet. In 2018 the popularity of snacking has contributed to salty snack sales of 4.8%, and even though it's predicted that there'd still be market growth, the rate will be slower. Satisfaction brought by flavor is still the key of consumer demands, but two-thirds of the consumer wishes they had a more healthy option to choose from (Mintel, 2019). Additionally, the commercial snack producers still have to maintain desirable flavor and texture for the consumer (Garayo & Moreira, 2002; Mariscal & Bouchon, 2008; Esan *et al.*, 2015; Ahza *et al.*, 2015). In 2019 Mondelez International released a survey among global adults ages 18 and older. In the research was reported that 72% of Indonesians consume 3 snacks per day, which are consumed between mealtimes. And as many as 20% Indonesians are selective in choosing snacks and paying attention to the nutrition content (Mondelez International, 2019).

Despite all the benefits brought by PSP, the level of consumption is relatively low and tends to decrease. The processing is limited to traditional forms, and in the industrial section, PSP is usually only used as a mixed compound in sauce making (Ginting *et al.*, 2011). Hence the effort to process this comestible to increase the food value and diversification. Ginting *et al.* (2011) said that the effort to increase the diversification of PSP is a priority program of the Ministry of Agriculture. Processing PSP into chips aside from increasing its value, also aimed to reduce the public's high dependency rate of rice and wheat. In Indonesia, one can find processed tuber products everywhere either in supermarkets or retail stalls, from potato chips to cassava chips with lots of flavoring. However, fried chips are also known to contain significant amount of oil.

Gadiraju *et al.* (2015) mentioned that there is an association of oily food intake with a risk of developing chronic disease in adults. Ashakiran and Deepthi (2012) also said foods with high fat and cholesterol content have adverse effects on health like increasing blood pressure, stroke, and heart disease. That is why even though snacking is not prohibited, people should eat as healthy as possible. The most echoed advantage of vacuum frying is the food fried using this technique generally have lower oil uptake compared to atmospheric frying (Tagalpallewar *et al.*, 2015; Ayustaningwarno *et al.*, 2018). In article posted in Food Network, the author said that the lower temperature used by vacuum frying made the oil decompose slower so there are fewer carcinogens and retain more nutrients (Camillo, 2013).

There were some research on vacuum frying with different kinds of fruits and vegetables. Examples are vacuum frying of potato chips (Yagua & Moreira, 2011), apple chips (Mariscal & Bouchon, 2008), purple yam chips (Fang *et al.*, 2011), cassava chips (Oyedeji *et al.*, 2017), sweet potato chips, fried peas (Zhu *et al.*, 2014), and blue potato chips (Da Silva & Moreira, 2008). The previous research mainly focused on the effect of frying chips, however, there is no literature comparing the effect of vacuum and atmospheric deep-frying to quality parameters of PSP. Hence, the objective of this research is to compare the quality parameters of PSP with vacuum and atmospheric deep-frying methods. The quality attributes used were color, texture, oil and water content, monomeric anthocyanin content, and sensorial acceptance.

1.2. Literature Review

1.2.1. Purple Sweet Potato

Purple Sweet Potato (*Ipomoea batatas*) is originated from South America, and cultivated widely in China, Japan, India, also in South-East Asia and Africa. This comestible is one of the major crop foods with an annual production of 133 million tons. PSP contains complex carbohydrate with a little fat and protein content; however, it has lots of fibers, which is suitable for people suffering from constipation (Maria & Rodica, 2015). The purple color on the tubers' skin and flesh is caused by anthocyanin pigment. Anthocyanin is an antioxidant, which is reported to have more stability compared to other sources of this pigment (Dwiyanti *et al.*, 2018). Maria & Rodica (2015) mentioned that this variety could be used from roots to tops. Human could consume the young leaf and sprout, and the older ones could be used as animal feed. These tubers also could be used as decorative elements because of the various color and shape.

PSP is a tuber with rich and concentrated carbohydrate and vitamin which makes it suitable to improve society's nutrition (Septianti & Fatah, 2013). The starch-filled roots provide nutrition and energy; the green tops are a source of concentrated essential vitamins and minerals (Padmadja *et al.*, 2011). But the 'tubers is a poverty food' sentiment makes this comestible hard to be popular in upper-middle-class Indonesian (Zuraida & Supriati, 2001), and the consumption level are limited to traditional forms and tend to be stagnant (Ginting *et al.*, 2014). Following is the nutritional fact of PSP:

Table 1. Nutritional Facts of Purple Sweet Potato

Nutrition	Purple Sweet Potato
Starch (%)	22,64
Fat (%)	0,94
Protein (%)	0,77
Water (%)	70,46
Ash (%)	0,84
Anthocyanin (mg/100g)	110,51

Sumber: Ginting *et al.* (2011)

1.2.2. Vacuum Frying

Vacuum frying is a new technology, which the frying process is done in a low pressure, which makes the water boiling point become lower; hence lowering the temperature needed (Da Silva & Moreira, 2008; Garayo & Moreira, 2002; Pedreschi, 2012; Moreira, 2014; Tagalpallewar *et al.*, 2015). This method is very suitable to process fruits and vegetables because it could give the same crispness and oil content level also dehydration level with atmospheric deep fat frying. Vacuum frying using lower temperature so it doesn't give excessive scorching or darkening (Da Silva & Moreira, 2008; Garayo & Moreira, 2002; Moreira, 2014).

Vacuum frying is a deep-frying method done under lowered pressure, lowering the boiling point of oil and moisture in the food, causing it possible to lower the frying temperature (Da Silva & Moreira, 2008; Mariscal & Bouchon, 2008). The frying oil will be heated into the required temperature, and then the raw food was placed into the frying tube in the frying chamber. After the chamber was closed, the pressure inside the chamber was reduced to the required pressure. Then the hot oil fulfilled the chamber for the required time, and then drained from the chamber. The tube then centrifuged for the required speed and time.

Starch gelatinization, protein denaturation, flavor development, crust formation are things that occur as a manifestation to structural changes on food. The condition required makes frying has a high transfer rate, hence the rapid cooking, browning, and development of texture and flavor on food. Lower frying temperature brings lots of positive effects, for example decreasing adverse effect to oil quality, maintaining natural color and flavor, decreasing acrylamide content, and maintaining the nutritional content (Da Silva & Moreira, 2008; Garayo & Moreira, 2002; Pedreschi 2012). Tagalpallewar (2012) mentioned that low oxygen level also decrease the rate of oxidation, including lipid oxidation, and enzymatic browning, so the nutrition and color of the sample could be maintained. However, Pedreschi (2012) stated that the information on vacuum frying is still scant because the scientist just started to research in this field; hence the

mechanism of oil uptake is not thoroughly understood. Yet it should be understood that the acrylamide level in food would lower along with the temperature used.

1.2.3. Atmospheric Frying

Frying is one of the oldest and preferred food processing processes. The process of frying in which the fried material is dipped entirely in oil heated above the boiling point of water is called deep fat frying. It was mentioned that this process could give a unique combination of flavor and texture (Moreira, 2014; Tagalpallewar, 2015). Oil plays a role as a heat medium; fat will go inside the food to provide nutrition and flavor (Tagalpallewar *et al.*, 2015). Normally this process is done with atmospheric pressure and in 165°C - 195°C temperature. This process will lead to the formation of preferred sensory attributes, including structural attributes such as density and porosity (Moreira, 2014).

Bhattacharya (2015) explained the high temperature induces reaction between compounds naturally found in food such as asparagine and reducing sugars, urging the formation of toxic substances (e.g. acrylamide & furan), affecting negatively the chemical safety of starchy products. Such is also supported by Tagalpallewar *et al.* (2015), it is said that acrylamide is commonly found in carbohydrate-rich food products that processed in high temperature. He also added that asparagine; a major amino acid in potatoes and cereal, is a crucial component in the Maillard reaction pathway, the sequence that produces acrylamide.

1.2.4. Quality Parameters

In this research, there are several quality parameters to be analyzed, namely colors, texture, monomeric anthocyanin levels, proximate analysis, and sensorial acceptance. Oyedeji *et al.* (2017) stated that texture is an important quality attribute in determining the level of product acceptance, because texture depends on raw product attributes such as starch content, starch granule size, and also process conditions which include frying time and temperature. Color is also a major quality attribute because it is important in consumers' perception of the product at the time of purchase. Lightness (L^*), redness (a^*), and yellowness (b^*) color parameters have been widely used to evaluate color

changes between raw and finished products. Anthocyanin contained in purple sweet potatoes generally exists in the form of acetylation, which means there are advantages in pH and heat resistance, sensitivity to light, and overall stability (Xu et al., 2015). Xu et al. (2015) stated that generally purple sweet potatoes are processed into additive products so that a process that involves heat and oxygen exposure is needed, resulting in the degradation of anthocyanin pigments. Therefore, anthocyanin stability was assessed as an attribute that had an impact on overall quality.

One of the mechanisms happening during frying is moisture evaporation and oil uptake. It was said that frying using a vacuum fryer would result in lower moisture content and oil content in the product (Tagalpallewar, 2015). Sharif et al. (2017) stated that the role of sensory analysis is to determine the level of consumer acceptance, and also ensure that inferior products won't circulate on the market. This analysis is also useful to ensure the target group of consumers, competitor products, and also get new ideas.

1.3. Objective

The objective of this study is to compare the quality characteristics of the purple sweet potato chips produced by vacuum frying and conventional frying.

