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RESEARCH ARTICLES

Waktu Penggorengan terhadap Kandungan Gizi Keripik *Strawberry* Sebagai Alternatif Cemilan Sehat untuk Remaja

Frying Time on the Nutritional Content of Strawberry Chips as an Alternative Healthy Snack for Teenagers

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Abstract

Covid-19 is a disease that is transmitted through a virus that attacks the human respiratory system and appeared in early 2020. During the Covid-19 pandemic, people, especially teenagers, were required to increase their immune systems. This study aimed to determine the effect of frying time on the quality of strawberry chips as a healthy snack during the COVID-19 pandemic. The design used was a basic Completely Randomized Design (CRD), by analyzing the results of the organoleptic test using the kruskal-wallis test followed by the mann-whitney test. The content analysis was selected from the highest treatment value, namely P3 with 4,62 percent water content, 1,73 percent ash, 1,52 percent protein, 17,88 percent fat, 14,44 percent carbohydrates, 8,34 percent fiber, and vitamins C 62,8 mg/100g. The calorie contribution of selected strawberry chips per 40 grams was 223 kcal. In conclusion, the frying time has an effect on the quality of the strawberry chips which has a big effect on the organoleptic characteristics and vitamin C.

Keywords: *strawberry chips, covid-19, vacuum frying, proximate content, vitamin C*

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Abstrak

Covid-19 merupakan penyakit yang ditularkan melalui virus yang menyerang sistem pernapasan manusia dan muncul pada awal tahun 2020. Di masa pandemi Covid-19, masyarakat khususnya remaja dituntut untuk meningkatkan daya tahan tubuh. Penelitian ini bertujuan untuk mengetahui pengaruh lama penggorengan terhadap kualitas keripik stroberi sebagai jajanan sehat di masa pandemi Covid-19. Rancangan yang digunakan adalah Rancangan Acak Lengkap (RAL) dasar, dengan menganalisis hasil uji organoleptik menggunakan uji *kruskal-wallis* dilanjutkan dengan uji *mann-whitney*. Analisis kandungan dipilih dari nilai perlakuan tertinggi yaitu P3 dengan kadar air 4,62 persen, abu 1,73 persen, protein 1,52 persen, lemak 17,88 persen, karbohidrat 14,44 persen, serat 8,34 persen, dan vitamin C 62,8 mg/100g. Kontribusi kalori keripik stroberi pilihan per 40 gram adalah 223 kkal. Kesimpulannya, waktu penggorengan berpengaruh terhadap kualitas keripik stroberi yang berpengaruh besar terhadap karakteristik organoleptik dan vitamin C.

Kata Kunci: keripik strawberry, covid-19, *vacuum frying*, kadar proksimat, vitamin C

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INTRODUCTION

Covid-19 is an infection caused by a coronavirus that targets the respiratory system of humans (Amaliyah *et al.*, 2021). The WHO has labeled this disease a pandemic because it has infected nearly the entire global population as of the end of 2019. In an effort to reduce the propagation of the Covid-19 virus outbreak, one of these measures` entails altering the pattern of new habits about adherence to the health regimen. During the Covid-19 pandemic, it is vital to boost the immune system, particularly in adolescents who are still growing. Among the efforts that can be made, maintaining dietary intake is one.

One of the behavioral changes that occur in adolescents is eating behavior and adolescent consumption patterns that are frequently irregular, characterized by frequent snacking (fried, fruit syrup, pentol, seblak, and others), and a frequent absence of breakfast and lunch (Putri *et al.*, 2020). This results in dietary deficits and diminished immunity among adolescents. In order to maintain enough nutrition during the Covid-19 period, it is vital to consume meals that boost the body's immune system, such as vegetables and fruit.

Strawberry fruit is one of the fruits that can help maintain intake since it contains numerous nutrients and bioactive substances, including phenolic compounds, vitamin C, flavonoids, and ellagic acid (Inggrid and Santoso, 2015). Strawberry antioxidants are effective against cancer, bad cholesterol, and heart disease; they assist in enhancing immunity and skin health; and they are beneficial for fetal health due to their high concentration (Sumarlan *et al.*, 2018). Strawberry is a subtropical fruit that is one of the plants that Binawan Agro cultivates. According to Central Statistics Agency BPS (2020) figures, Indonesia produced 8,350 tons of strawberries in 2020.

Strawberries can be categorized as fruits having a high economic worth and a large market share due to their vibrant red color, distinctive aroma, and flavor. Strawberries can be consumed fresh or as syrup, jam, stup (Sukasih and Setyadjit, 2019) and the newest culinary products that preserve the nutritional value of the strawberry fruit to extend the shelf life of the product. Fruit that will be made into chips has a longer shelf life than fresh fruit because it doesn't have as much water and doesn't go through the same physiological changes that fresh fruit does (Tumbel and Manurung, 2017).

Antioxidants, specifically vitamin A, vitamin C, vitamin E, and zinc, help boost the body's immune system (Nuriannisa and Yuliani, 2021). Antioxidants are chemicals that can counteract the activity of free radicals, such as smoke, pollution, and even unbalanced fast food consumption, thereby inhibiting or stopping the oxidation process (Aswani, 2019; Fakriah *et al.*, 2019). Vitamin C is an essential antioxidant since it protects against free radicals and fortifies the immune system (Siswanto *et al.*, 2013). In addition, fiber can aid in increasing the amount of feces, decreasing the transit time of food waste, lowering glycemic levels, and preventing the absorption of harmful chemicals (poisons) that enter with food (Dhingra *et al.*, 2012). Since fiber is a component of plant tissue that is resistant to the hydrolysis process by enzymes in the stomach and small intestine, fiber is an excellent source of nutrition (Fauziyah and Fajrianti., 2018). Vitamins and minerals in vegetables and fruits such as spinach, carrots, broccoli, strawberries, dragons, guava, mango, papaya, and almonds work as antioxidants (Kemenkes, 2020). Dietary fiber is found in fruits, vegetables, seeds, tubers, entire seeds, and plant parts with stems (Mustofa and Suhartatik, 2020).

Researchers are interested in doing a study on strawberry fruit that will be processed into fruit chips in order to identify the qualities of the resulting chips and the nutritional content that is maintained in strawberry chips during the vacuum-frying process. So, the researchers used time as a way to tell the difference between the treatments and see how they affected the quality of the strawberry chips.

METHODS

This study employed an experimental design using a straightforward, entirely random design (CRD). This research held in March-July 2022. There were three distinct fry-time treatments for strawberry chips: P1 (120 minutes), P2 (110 minutes), and P3 (100 minutes). The data collection instrument was an organoleptic test questionnaire administered to 35 semi-trained panelists, namely 6th and 8th semester students from Binawan University. KET-636/UN2.P1/ETIK/PPM.00.02/2022 has been granted ethical approval by the Ethics Commission of the University of Indonesia (UI). The tools used in this study were knives, cutting boards, digital scales, vacuum fryers, spinners, stopwatches, containers, frying pans, Erlenmeyer, hotplates, volume pipettes, stir bars, digital biuret, porcelain cups, filter paper, kjeldal tubes, microscopes. , camera, oven, desiccator, sandals, balance, and cup are the instruments used in this study. In this study, we used fresh strawberries, salt, oil, neutral alcohol, PP indicator (phenolphthalein), and NaOH solution.

This technique of making strawberry chips is done by slicing strawberries, soaking them in salt solution, then frying them for 120, 110, and 100 minutes. After that, an organoleptic test of strawberry chips will be carried out to find out the characteristics produced for each length of cooking time. Based on the processed data from the organoleptic test, proximate, fiber, and vitamin C tests will be carried out to

find out how healthy the selected treatment strawberry chips are. Data were analyzed with Microsoft Excel 2010 and statistical data processing. The normality of the organoleptic test data was checked using the kolmogorov-smirnov, kruskal-wallis was used to test the effect of the treatment on the organoleptic test, and for significant treatments, the mann-whitney test was used.

RESULTS AND DISCUSSIONS

Organoleptic test

The organoleptic test comprises of a hedonic test and a hedonic quality test, which will be administered by semi-trained panelists on strawberry chips fried at 70 ºC for 120 minutes (P1), 110 minutes (P2), and 100 minutes (P3) (P3). The results of the hedonic test or preference test on the selected treatment were examined to see whether strawberry chips had the highest average value. Table 1 displays the outcomes of the strawberry chip hedonic test.

Table 1. Strawberry chips hedonic test results

Treatments	Attribute			
	Color	Aroma	Taste	Texture
P1 (120)	3,03 ± 0,857[a]	2,08 ± 0,677[a]	2,34 ± 0,684[a]	2,40 ± 0,812[a]
P2 (110)	3,11 ± 0,758[a]	3,20 ± 0,759[b]	2,66 ± 0,968[ab]	3,03 ± 0,664[b]
P3 (100)	3,47 ± 0,741[b]	3,49 ± 0,781[b]	2,94 ± 0,873[b]	3,06 ± 0,684[b]

Notes: The attribute scale goes from 1 (very dislike) to 5 (very like), with different letters in the same column showing statistically significant differences (mann-whitney, p<0,05).

In addition, the findings of the hedonic quality test data processing on strawberry chips were used to express a product's positive or negative impression. Table 2 displays the results of the strawberry chip hedonic quality test.

Table 2. Strawberry chips hedonic quality test results

Treatments	Attribute			
	Color	Aroma	Taste	Texture
P1 (120)	2,71 ± 1,017[a]	2,23 ± 0,843[a]	3,09 ± 0,781[a]	1,83 ± 0,707[a]
P2 (110)	3,06 ± 1,056[ab]	2,23 ± 0,770[a]	3,20 ± 0,868[a]	2,09 ± 0,742[ab]
P3 (100)	3,37 ± 0,942[b]	2,77 ± 0,910[b]	3,69 ± 0,900[b]	2,40 ± 0,881[b]

Notes: Color scale 1 = brownish red (dark salmon) to 5 = dark red; aroma scale 1 = no strawberry aroma to 5 = strong strawberry aroma; taste scale, 1 = no sour taste to 5 = strong sour; texture scale, 1 = not crunchy to 5 = very crunchy; Different letters in the same column denote statistically significant differences (mann-whitney, p <0,05).

The organoleptic results of the hedonic test for color revealed that P3 had the highest preference value for color, 3,47 (ordinary/neutral), while P1 had the lowest

preference value, 3,03 (ordinary/neutral). According to the organoleptic results of the color aspect hedonic quality test, P1 was slightly red, followed by P2 and P3. The results of the kruskal-wallis test indicated that the treatment had an influence on the hedonic evaluation of the color aspect of strawberry chips. The Maillard reaction, also known as the reaction between reducing sugars and amino acids in the presence of heat, is responsible for the color shift (Hustiany, 2016).

Based on the aroma, the organoleptic results of the hedonic test showed that P3 had the highest preference for aroma, namely 3,49 (normal/neutral), while P1 had the lowest preference, namely 2,08 (hate). Based on the organoleptic results of the hedonic quality test, P1, P2, and P3 showed a faint strawberry taste. The results of the kruskal-wallis test showed that the treatment affected the hedonic evaluation of the aroma of strawberry chips. Changes in the aroma the longer the heating the weaker the aroma produced because it is influenced by the water-holding capacity contained in food which is getting smaller and will provide changes and form compounds with other ingredients, for example between amino acids resulting from changes in protein with reducing sugars that form aromas (Rahman *et al.*, 2014)

The organoleptic results of the hedonic taste test revealed that P3 had the highest preference for taste, with a preference value of 2,94 (disliked), while P1 had the lowest preference value of 2,34 (disliked). According to the organoleptic results of the hedonic quality test, P1, P2, and P3 tasted slightly sour. The findings of the kruskal-wallis test indicated that there was a treatment effect on the hedonic evaluation of strawberry chip flavor. Even though strawberry chips have been fried at low temperatures and for a long time, their taste is the same as that of fresh strawberries.

Based on texture, the organoleptic results of the hedonic test revealed that P3 had the highest preference for texture, 3,06 (ordinary/neutral), whereas P1 had the lowest preference, 2,40 (unusual/strong) (dislike). The organoleptic results of the hedonic quality test revealed that P1 had the least crisp texture, followed by P2 and P3. The findings of the kruskal-wallis test indicated that the treatment influenced the hedonic evaluation of the texture of strawberry chips. This could be because the strawberry chips still have a lot of water after being fried, which doesn't meet the quality standards for chips and makes them not crisp.

Figure 1. Selected treatment of strawberry chips

Based on the findings of the hedonic test on strawberry chips, P3 was selected as the optimal treatment, as its average preference value for flavor is greater than that of P1 and P2. Then the selected treatment of strawberry chips, P3 with a mean value of 2,94, was utilized.

Proximate Analysis

After performing the organoleptic test and generating the chosen treatment on P3 strawberry chips, the amounts of proximate, fiber, and vitamin C in strawberry chips will be analyzed. Table 3 presents the results of the approximate analysis and dietary fiber in the chosen treatment, P3.

Table 3. Proximate analysis results, fiber and vitamin C P3 per 100 grams

Componen	Selected formula (%/b/b)	SNI* (%)
Water content	11,57 %	5
Ash content	4,33 %	0,1
Protein	3,81 %	-
Fat	44,71 %	2,5
Carbohydrate	36,10 %	-
Fibre	20,85 %	-
Vitamin C	62,8%	-

*) Indonesian National Standard, 2018

Based on the results of the analysis more or less presented in Table 2, P3 strawberry chips contain 11,57 percent water. This is due to the reduced water content of the strawberry chips during frying. However, the quality criteria for fruit chips are based on SNI 837:2018 which stipulates a maximum water content of 5% so that strawberry fruit chips do not meet the SNI quality requirements for water content. SNI 8370:2018 was created to replace several other SNI, namely starfruit chips, breadfruit chips, jackfruit chips, pineapple chips, and banana chips (BSN, 2018). The high water content of strawberry chips is due to the high water content of the strawberries (91%) and the lack of freezing before frying. When frying, the water content that evaporates during frying leaves residual steam that has not reduced in the glass frying pan, so that water remains in the strawberry chips after frying. Cutting or slicing the chips increases the surface area of the material, allowing it to come into contact with the heating medium, thereby facilitating the diffusion of water (Sugito *et al*., 2013).

The ash content of P3 strawberry chips of 4,33 percent does not meet the SNI limit of 0.1% ash content. High ash content occurs due to material contamination by friction devices during the vacuum frying process and the results are related to the mineral content of food ingredients (Kaderi, 2015). The high ash content produced by strawberry chips can affect the level of product cleanliness. This is in accordance with the findings of Iskandar (2018), which showed an increase in the ash content of potato chips along with an increase in organic and inorganic content along with an increase in the frying duration. This is because when the temperature rises, more water evaporates so that the amount of ash in the air increases (Tumbel and Manurung, 2017).

Strawberry chips from P3 have a protein content of 3,81 percent. Compared to commercial chips (salak chips), salak chips have a lower protein level (3%) than strawberry chips. Furthermore, strawberries have 0,67 percent less protein than strawberry chips (USDA, 2018). This occurs because the weight of fried fruit differs from the weight of 100 grams of fresh fruit, allowing the protein content to be maintained at a low temperature during frying. Irhamni *et al*. (2012) found that protein denaturation in fruit chips does not differ between treatments when using the vacuum frying method, as the processed fruit chips preserve their quality, particularly their protein content.

Strawberry chips at price point P3 have a fat level of 44,71%. The fat level of the chosen chips was greater than that of the Muli banana chips (16,44%), so the fat content of the chosen treatment of strawberry chips did not match the highest quality requirements of SNI chips. The high fat content of fruit chips is due to the absorption of cooking oil during frying and the duration of frying, which increases the fat content of fruit chips. In accordance with the findings of Iskandar (2018) the fat content of taro chips across all treatments was between 24,97% and 25,80%. In the frying process, there is an absorption of oil into the material. Therefore, the higher the temperature and the longer the frying time, the more water evaporates and the larger the empty space that may be filled with oil as a frying medium (Tumbel and Manurung, 2017).

Carbohydrate content is dependent on the reduction factor in water content, ash content, fat content, and protein content. Hence, carbohydrate content is dependent on the reduction factor. Compared to the carbohydrate content of fresh strawberries, the carbohydrate content of strawberry chips increased from 7,68% to 36,10%. This fits with the results of a study by Iskandar (2018), which show that a chip's carbohydrate level can go up when its water content evaporates, making the carbs in the chip thicken and increase in concentration.

The selected treatment of P3 strawberry chips included 20,88% dietary fiber. Due to the high fiber content of strawberries and the use of a low frying temperature with a steady temperature, the high fiber content of strawberry chips can be maintained and increased by increasing the presentation of strawberries that are introduced into the frying tube. When compared to the 2% fiber content of fresh strawberries, the fiber content of strawberry chips increases by 18,85% (USDA, 2018). However, the fiber content of commercial fruit chips such as apple chips is 3,96%, resulting in a fiber content of 3,96% for commercial fruit chips. The apple chip fiber content is lower than the strawberry chip fiber level.

The vitamin C content of fresh strawberries was 13,9%, while the vitamin C content of P3 strawberry chips was 62,8%. Due to the low water content and difference between 100 grams of strawberries and 100 grams of strawberry chips, the increase in vitamin C levels in 100 grams of strawberry chips was greater than in 100 grams of fresh strawberries. One kilogram of fresh strawberries is required to produce 100 grams of strawberry chips, resulting in an increase in the vitamin C content of strawberry chips. Vitamin C, often known as ascorbic acid, is a water-soluble vitamin that provides benefits to humans. Vitamin C possesses thermolabile qualities and is quickly oxidized by light, pH, dissolved oxygen, metal ions, sugar, and storage temperature. Nevertheless, vitamin C is stable in the absence of water and oxygen (Devianti and Amalia, 2019).

Serving size nutrient content

Using nutrient analysis, the serving size of strawberry chips has been determined to provide 40 g of energy, protein, fat, carbs, dietary fiber, and vitamin C. It is advised that 10% of the total daily dietary requirements be met through snacking. So, one serving of strawberry chips contains 40g of the selected treatment, which contains 10,36% of the whole daily requirement of 2150 kcal, 2,53% of the total daily requirement of 60 grams of protein, and 26,68% of the total daily requirement of fat. 67 grams, 4,44 percent of the total daily requirement of 325 grams of carbs, 27,8 percent of the total daily requirement of 30 grams of fiber, and 27,91 percent of the total daily requirement of 90 milligrams of vitamin C Since strawberry chips have fiber and

vitamin C, they can help with digestion, boost the immune system, and lower the risk of getting a chronic disease.

CONCLUSIONS

Hedonic Test and Hedonic Quality conducted on strawberry chips regarding color, aroma, taste, and texture can increase the level of product acceptance so that strawberry chips have distinctive characteristics that are produced. The duration of frying strawberry chips affects the hedonic and hedonistic qualities of strawberries. In this study, P3 was the optimal frying time in terms of organoleptic quality (100 minutes duration). During the frying process, strawberry chips lose some of their water, which makes them higher in vitamin C. Suggestions for further research are to add freezing treatment and the effect of packaging on the shelf life of strawberry chip products to find out whether the resulting strawberry chips are crunchy or not, and to find out how packaging can maintain product shelf life.

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