Advances in Biological Sciences Research, volume 17
International Conference on Tropical Agrifood, Feed and Fuel (ICTAFF 2021)

Effect of Baking Temperature and Duration Towards Proximate, Crude Fiber Content and Antioxidant of Sweet Potato Snackbar Coated with Soursop Yoghurt

Maghfirotin Marta Banin, Uzair Nur Aziz, Maulida Rachmawati, Marwati Marwati, and Aswita Emmawati[1*]

Department of Agricultural Product Technology, Faculty of Agriculture, Mulawarman University
[*]*Corresponding author. Email: aswita_emmawati@faperta.unmul.ac.id*

ABSTRACT
Snack bars are defined as snack products in the form of stems and are a mixture of various ingredients such as cereals, fruits, nuts, which are bound to each other with the help of a binder agent. Utilization of purple sweet potato and soursop fruit to diversify food and improve its quality and nutritional value. This study was conducted to determine the chemical characteristics of the purple sweet potato snack bar coated with soursop yogurt in the form of water content, ash content, fat content, protein content, carbohydrate content, total energy, crude fiber, and antioxidant activity (IC). This study used two factors and two replications. The first factor is the roasting temperature (120°C, 130°C, 140°C, 150°C, 160°C), and the second factor is the roasting time (50 minutes, 70 minutes, 90 minutes). The results showed that the temperature and baking time had a significant effect on the chemical characteristics of the resulting snack bar. From the results of chemical analysis of purple sweet potato snack bar with the addition of soursop yogurt, the best treatment was at a temperature of 120°C and a roasting time of 50 minutes with a water content of 11.12%, ash content of 1.74%, fat content of 11.39%, protein 3.85%, carbohydrates 72.23 %, calories 340.79 Kcal, crude fiber 3.88%, and antioxidants 129.86 ppm.

***Keywords**: Purple Sweet Potato, Soursop, Yogurt, Coated Snack Bar*

1. INTRODUCTION

As time goes by, in today's modern lifestyle, especially in urban areas, most people tend to choose functional foods to meet their nutritional needs. Practical in the sense that it is easy to obtain and fast food so that it is ready to be consumed. One of the food products that can be directly consumed with a functional value developed in various countries is the snack bar. The snack bar is defined as a snack product with a stem shape and is a mixture of various ingredients such as cereals, fruits, and nuts tied to each other with the help of a binder. In this study, a snack bar made with local raw materials, namely purple sweet potato, as a source of carbohydrates rich in fiber to replace rice. cashews which are a source of protein in snack bars and coated with fruit yogurt to increase the fiber content to help human digestion.

Sweet potato (*Ipomoea batatas* L.) is an agricultural product that is cheap, easy to obtain, and has high production. Sweet potato productivity in Indonesia in 2014 was 152.00 ku/ha, an increase of 5.61% in 2015 by 160.53 ku/ha [1]. Sweet potatoes contain oligosaccharides such as raffinose and verbascose, which function as prebiotics and can be used as a substitute for wheat [2, 3]. The most significant content of sweet potatoes is carbohydrates, where the main carbohydrate content of sweet potatoes is starch, which consists of 30-40% [4]. In addition, purple sweet potato contains anthocyanin 110.5 mg/100g, which causes a purple color and functions as an antioxidant and radical scavenger [5, 6].

Yogurt is a health drink made from fermented milk. There are very beneficial bacteria in yogurt, namely *Lactobacillus acidophilus, Lactobacillus bulgaricus,* and *Streptococcus thermophilus.* These bacteria can break down milk sugar into lactic acid, which causes yogurt to taste sour. The fermentation process causes the lactose content in yogurt to decrease, so it is safe for

consumption by people with milk allergies and the elderly [7]. As time goes on, yogurt has several variants, one of which is fruit yogurt. This fruit yogurt is yogurt with fruit juice added. The addition of fruit juice to yogurt can add nutrients. The fruit used in this yogurt is soursop fruit. The aim is to increase antioxidant compounds and inhibit the growth rate of lactic acid bacteria.

In this study, a snack bar will be made from the basic ingredients of purple sweet potato and coated with soursop fruit yogurt. The snack bar will be studied for its nutritional content and chemical properties. This study aims to determine the effect of baking temperature and duration towards proximate, crude fiber content and antioxidant of sweet potato snackbar coated with soursop yoghurt.

2. MATERIAL AND METHODS

2.1. Material

The materials used in this study were purple sweet potato and soursop fruit obtained from the Traditional Market in Samarinda. Cashews, powdered skim milk, coarse granulated sugar, margarine, and white chocolate bars. The chemicals used for the analysis were aquadest, NaOH, HCl, H_2SO_4, K_2SO_4, H_3BO_3, boiling chips, benzene, and 95% alcohol.

2.2. Data Experiment and Analysis Design

This study used a completely randomized design (CRD) with two factorials and two replications. The first factor is temperature with 5 different levels (S1 = 120°C; S2 = 130°C; S3 = 140°C; S4 = 150°C; S5 = 160°C) and the second factor is time with 3 different levels (W1 = 50 minutes; W2= 70 minutes; W3 = 90 minutes). The data that has been processed is then analyzed using a variance. For the variance results that showed a significant difference at α-5%, the Least Significant Difference (BNT) was further tested.

2.3. Research Procedures

This research was carried out in four stages, namely the process of making soursop yogurt, crushing purple sweet potatoes into smooth and dry, making snack bars, and chemical analysis including water content, ash content, fat content, protein content, carbohydrate content, fiber content, calorie content, and antioxidants.

2.3.1. Soursop Yogurt Making

The fruit used in making yogurt is ripe soursop fruit, and the flesh is taken, then the flesh is mashed using a blender with the addition of 100 mL of water to make fruit pulp. Then 100 g of the slurry was pasteurized at 90°C for 10 minutes, and 10 g of skim milk powder and 10 g of granulated sugar were added, then cooled to 40°C. Inoculation of plain yogurt starter was 5% v/v and fermented at room temperature for 24 hours.

2.3.2. Making Purple Sweet Potato Flour

Purple sweet potatoes were sorted and then cut into small pieces and washed thoroughly. The purple sweet potato was then steamed at ±100°C for 30 minutes. After ripe, the purple sweet potato skin was peeled and separated and then mashed using a spoon, then dried in an oven at 60°C for 3 hours.

2.3.3. Making Snack Bar

100 g of dried purple sweet potato added 10 g of coarse sugar, 10 g of margarine, and 10 g of cashews, stirred and made a dough until well mixed. Then the dough is put into the pan and baked according to different temperature and time treatments. Cut and turn the snack bar after half the time according to the treatment level. Then cool at room temperature ± 15 minutes. Then cut according to taste.

Next is the coating process with soursop fruit yogurt, namely soursop fruit yogurt mixed with solid white chocolate that has been melted, to glue the yogurt with the snack bar. The chocolate is melted by heating it over boiling water over a glass or stainless steel bowl until the chocolate melts. Then cooled to 40°C then, mixed with soursop fruit yogurt in a ratio of 70:30, then layered on the snack bar until evenly distributed.

2.4. Analysis Procedure

Chemical analysis on purple sweet potato snack bar coated with soursop yogurt included water content analysis, ash content analysis, crude fat content (Soxhlet extraction), crude protein, and crude fiber (acid-base extraction) using the method of Sudarmadji et al. [8]. Carbohydrate analysis (by difference) followed the Winarno method [9], and the total energy analysis used the AOAC method [7].

Purple sweet potato snack bar coated with soursop yogurt was also tested for its antioxidant activity using the spectrophotometric method with DPPH (2,2-diphenyl-l-picrylhydrazyl) [10]. 1 mL of the extract which had been diluted in ethanol was added to 1 mL of DPPH (0.15 mM in ethanol), and at the same time, a control consisting of 1 mL DPPH with 1 mL ethanol was prepared. The reaction mixture was mixed well and then incubated in the dark at room temperature for 30 minutes. The absorbance was measured at 517 nm. Vitamin C was used as a positive control, and ethanol was used as a blank. The DPPH scavenging ability of plant extracts was calculated using the following equation:

$$\% \text{ scavenging activity} = [(\text{Abs control} - \text{Abs sample})]/ (\text{Abs control})] \times 100$$

The parameter to interpret the results of the DPPH test is to calculate the IC_{50} value. The IC_{50} value was obtained from the linear equation of the percentage of DPPH radical inhibition against several sample concentrations

3. RESULT AND DISCUSSION

3.1. Moisture Content

The results of the water content test on the purple sweet potato snack bar coated with soursop yogurt can be seen in Table 1. The analysis of variance showed that temperature and time had a significant effect on the water content produced. In all treatments, the two factors had the highest moisture content value obtained from the S1W1 treatment (temperature 120 °C and roasting time of 50 minutes), which was 26.90±0.08%, while the lowest moisture content was obtained from the S5W3 treatment (temperature 160 °C and roasting time of 90 minutes) which is 11.12±0.08%. The further test of BNT level 5% showed that the treatment of S1W1 was significantly different from that of S5W3. This result indicated that the higher the roasting temperature and the longer the roasting time, the lower the water content.

The higher the baking temperature and heating time, the lower the moisture content of the snack food bars. The decrease in water content occurs because the heat channeled through the roaster will evaporate the water contained in the baked material [11]. The result is supported by Rahmaningsih et al. [12], that during roasting, much water is evaporated from the sample. One of the changes that occur after roasting is reducing the water content by 1 to 4%. During roasting results in loss of moisture content from the surface of the sample due to evaporation and continuous transfer of moisture to the oven environment.

The roasting process can reduce the water content in the snack bar due to the evaporation of water molecules during the process. The moisture content of less than 14-15% in foodstuffs can inhibit mold growth and fungi that cause spoilage [13]. However, the water content in the snack baris still relatively high at a heating temperature of 120°C150°C so that it can reduce the shelf life of the snack bar.

3.2. Ash Content

Table 1 shows that temperature and time have a significant effect on the ash content produced. In all treatments, the two factors had the highest ash content value obtained from the S1W1 treatment (temperature 120 °C and roasting time of 50 minutes) was 2.14%, while the lowest ash content was obtained from the S5W3 treatment (temperature 160 °C and roasting time of 90 minutes) was 1.74%. The further test of BNT level 5% results showed that the S1W1 treatment was significantly different from S5W3. Most foodstuffs (about 96%) consist of organic matter and water. The remainder consists of mineral elements known as organic matter or organic matter.

The results of the analysis of the ash content showed an average value of 1.76-1.99%. The existence of a combustion process causes organic matter to burn out, but inorganic or mineral materials are not burned. Ash is an unburned residue of combustion. The ash content in a food ingredient can indicate the mineral content [11]. Minerals have properties that are not easily damaged due to processing, but processing can cause a maximum mineral loss of 3% in some food sources so that the ash content can be reduced by more than 0.04%, which is very typical in the food processing process because there are mineral salts that shrink when boiling and blanching process [14].

3.3. Fat Content

The analysis of the fat content of the snack bar is shown in Table 1. The analysis of variance showed that temperature and time had a significant effect on the fat content of the purple sweet potato snack bar coated with soursop yogurt produced. In all treatments, the two factors had the highest fat content value obtained from the S5W3 treatment (temperature 160 °C and roasting time of 90 minutes) was 14.08%, while the lowest fat content was obtained from the S1W1 treatment (temperature 120 °C and roasting time of 50 minutes) was 11.39%. The further test of BNT level 5% showed that the treatment of S1W1 was significantly different from that of S5W3. The results show that the higher the temperature and the longer the roasting time, the higher the fat content and inversely proportional to the water content, which decreases at the high temperature and the length of time used during the roasting process. The results of this study are in line with Hidayat's research [15], the fat content of snack bars from various combinations of temperature and baking time shows the fat content in the range of 9.74%-17.08%. Sources of fat in snack bars are margarine (81g/100g), cashews (47g/100g), and yogurt (3.5g/100g) . According to Riansyah et al. [16], the longer the time and the higher the temperature used in the drying process, the more it causes an increase in fat content and is inversely proportional to the value of the water content, which increasingly shows a decrease along with the higher temperature and time used during the drying process. Yuniarti [17] states that the length of time and the high temperature used in the drying process will cause the fat content in the material to increase and the water content to decrease.

Table 1. Chemical analysis results of purple sweet potato snack bar coated with soursop yogurt

Analysis	Time (minutes)	Roasting temperature (°C)					average
		120	130	140	150	160	
Moisture Content (%)	50	26.90±0.08^{a}	25.73±0.28^{b}	23.18±0.08^{d}	20.13±0.31^{f}	17.31±0.34^{i}	22.65^{a}
	70	25.75±0.22^{b}	23.44±0.18^{d}	19.60±0.11^{g}	17.47±0.06^{i}	15.13±0.23^{k}	20.28^{b}
	90	24.42±0.14^{c}	21.73±0.06^{de}	18.54±0.32^{h}	16.08±0.01^{j}	11.12±0.08^{l}	18.38^{c}
	average	25.69^{a}	23.63^{b}	20.44^{c}	17.89^{d}	14.52^{e}	
Ash content (%)	50	2.14±0.06^{a}	1.92±0.00^{bc}	1.89±0.00^{c}	1.81±0.00^{de}	1.80±0.00^{ef}	1.91^{a}
	70	1.93±0.01^{b}	1.89±0.01^{c}	1.82±0.00^{de}	1.80±0.00^{ef}	1.75±0.01^{gh}	1.84^{b}
	90	1.90±0.00^{bc}	1.83±0.00^{d}	1.80±0.00^{def}	1.78±0.00^{fg}	1.74±0.07^{h}	1.81^{c}
	average	1.99^{a}	1.88^{b}	1.84^{c}	1.80^{d}	1.76^{e}	
Fat content (%)	50	11.39±0.00^{h}	11.47±0.12^{gh}	12.49±0.14^{e}	12.79±0.00^{d}	12.77±0.27^{d}	12.18^{e}
	70	11.68±0.14^{g}	11.98±0.02^{f}	12.79±0.01^{d}	12.97±0.03^{d}	13.69±0.14^{b}	12.62^{b}
	90	11.98±0.00^{f}	12.48±0.12^{e}	12.99±0.01^{d}	13.38±0.01^{c}	14.08±0.13^{a}	12.98^{a}
	average	11.68^{e}	11.98^{d}	12.76^{c}	13.05^{b}	13.51^{a}	
Protein content (%)	50	3.85±0.12^{a}	3.37±0.06^{b}	2.89±0.00^{d}	2.19±0.00^{f}	1.53±0.06^{i}	2.77^{a}
	70	3.41±0.00^{b}	2.89±0.00^{d}	2.23±0.06^{f}	1.71±0.06^{h}	1.14±0.00^{k}	2.28^{b}
	90	3.06±0.00^{c}	2.45±0.12^{e}	1.84±0.00^{g}	1.31±0.00^{j}	0.83±0.06^{l}	1.90^{c}
	average	3.44^{a}	2.90^{b}	2.32^{c}	1.74^{d}	1.17^{e}	
Carbohydrates (%)	50	55.72±0.27^{m}	57.51±0.22^{l}	59.55±0.06^{j}	63.08±0.32^{h}	66.60±0.01^{d}	60.49^{c}
	70	57.22±0.09^{l}	59.80±0.19^{j}	63.51±0.01^{g}	66.05±0.03^{e}	68.29±0.09^{b}	62.97^{b}
	90	58.63±0.14^{k}	61.51±0.06^{i}	64.83±0.31^{f}	67.46±0.01^{c}	72.23±0.01^{a}	64.93^{a}
	average	57.19^{e}	51.61^{d}	62.63^{c}	65.53^{b}	69.04^{a}	
Total Calories (Kcal)	50	340.79±0.54^{l}	346.77±1.70^{k}	362.20±1.02^{h}	376.18±1.24^{f}	387.44±2.73^{d}	362.68^{c}
	70	347.63±1.62^{k}	358.61±0.60^{i}	378.06±0.13^{f}	387.80±0.41^{d}	400.95±1.59^{b}	374.61^{b}
	90	354.61±0.59^{j}	368.17±0.36^{g}	383.58±1.31^{e}	395.47±0.02^{c}	418.97±0.96^{a}	384.16^{a}
	average	347.68^{e}	357.85^{d}	374.61^{c}	386.48^{b}	402.45^{a}	
Crude Fiber Content (%)	50	3.88±0.02^{a}	3.82±0.00^{bc}	3.79±0.00^{e}	3.75±0.00^{f}	3.69±0.01^{i}	3.78^{a}
	70	3.82±0.00^{b}	3.79±0.00^{de}	3.76±0.00^{f}	3.70±0.00^{h}	3.65±0.01^{j}	3.74^{b}
	90	3.80±0.00^{cd}	3.76±0.00^{f}	3.73±0.00^{g}	3.68±0.00^{i}	3.62±0.00^{k}	3.71^{c}
	average	3.83^{a}	3.79^{b}	3.76^{c}	3.71^{d}	3.65^{e}	
Antioxidant Activity (IC_{50}) (ppm)	50	129.86±0.77^{l}	327.77±0.04^{i}	411.01±0.43^{f}	435.51±0.37^{c}	ND*	326.04^{c}
	70	226.70±0.26^{k}	336.98±0.68^{h}	418.99±0.76^{e}	451.95±0.53^{b}	ND*	358.65^{b}
	90	316.34±0.22^{j}	348.20±1.05^{g}	427.65±0.47^{d}	511.31±1.27^{a}	ND*	400.88^{a}
	average	224.30^{d}	337.65^{c}	419.22^{b}	466.26^{a}		

Zuhra et al. [18], stated that the drying temperature of 100°C-200°C could increase the fat content caused by a decrease in the water content so that the percentage of fat content increases. However, at a drying temperature of 250°C, it can reduce the fat content due to fat breakdown due to the relatively high drying temperature. *Fat* is a compound formed as a result of the esterification reaction between glycerol and fatty acids. Giving high heat to the fat will result in breaking the double bonds in the fat so that the fat will be decomposed into glycerol and fatty acids.

3.4. Protein Content

Table 1 shows the protein content of the snack bar where the temperature and time treatment significantly affected the protein content of the purple sweet potato snack bar coated with soursop yogurt. In all treatments, the two factors had the highest protein content value obtained from the S1W1 treatment (temperature 120 °C and roasting time of 50 minutes) was 3.85%, while the lowest protein content obtained from the S5W3 treatment (temperature 160 °C and roasting time of 90 minutes) was 0.83%. The further test of BNT level 5% showed that the treatment of S1W1 was significantly different from that of S5W3. The results indicated the occurrence of protein damage caused by the heating process. Where the more extended the roasting time, the lower the crude protein content [11].

The snack bar roasting process reduces protein content due to protein hydrolysis with the protein denaturation process at high temperatures where there is a change in the biological, chemical, and physical properties of the protein so that there is a change in the protein structure [19][13]. The heating process during

processing causes the Maillard reaction so that some of the protein is lost. Maillard reactions can occur in roasting with temperatures above 110^0C [20]. The Maillard reaction is also influenced by the use of purple sweet potatoes, which naturally contain reducing sugars such as glucose and fructose, which when combined with amino acids in cashews form cross-links that are not hydrolyzed, resulting in a decrease in protein content in the snack bar resulting in a decrease in protein content in the snack bar [21]. The quality of protein in food products is seen from the amount of protein and the content of essential amino acids. The addition of cashews can increase the essential amino acids of snack bars. The more complete the content of essential amino acids, the higher the biological value of the protein.

Temperatures that are too high can also cause changes to the structure of protein molecules so that their levels are reduced. The change in the structure of the protein molecule is known as denaturation [18]. Winarno [9], explained that protein denaturation could occur due to changes in heat, pH, and the addition of chemical substances. Product quality is something that determines whether or not the product is suitable for consumption by consumers.

3.5. Carbohydrates

The carbohydrate snack bar test was calculated by differential, as shown in Table 1. The analysis of variance showed that temperature and time had a significant effect on the carbohydrates produced. In all treatments, the two factors had the highest carbohydrate value of the purple sweet potato snack bar coated with soursop yogurt obtained from the S5W3 treatment (temperature 160 °C and roasting time of 90 minutes) was 72.23%, while the lowest carbohydrate was obtained from the S1W1 treatment (temperature 120 °C and 50 minutes of baking time) is 55.72%. The further test of BNT level 5% showed that the treatment of S1W1 was significantly different from that of S5W3.

The high carbohydrate content can be caused by the content in purple sweet potato of 27.90g/100g, cashew nuts 27g/100g, and sugar 94g/100g. The value of carbohydrates is also influenced by the fluctuation of other components such as water, ash, fat, and protein, so that the lower the value of the water, ash, and protein content of the resulting snack bar, the carbohydrate content will increase [22].

The analysis of carbohydrate content in this study used a by-difference calculation. Namely, the carbohydrate content was calculated using the residual value of the final calculation of the water, protein, fat, and ash content. The carbohydrate content in this snack bar is influenced by the large proportion of the water content, ash content, protein content, and fat content of this snack bar, but if the proportion given is small, the carbohydrate content will be even greater [16]. Muchtadi and Ayustaningwarno [23] stated that foodstuffs would contain compounds such as carbohydrates, proteins, and minerals in higher concentrations by reducing the water content, but vitamins and dyes are generally damaged or reduced. Therefore, the high-temperature treatment and long drying time have a significant effect on the carbohydrate content of the snack bar.

3.6. Total Calories

The total energy snack bar test was conducted to determine the calorie content in the purple sweet potato snack bar coated with soursop yogurt. The total energy is calculated based on converting the value of fat, protein, and carbohydrate snack bars. Table 1 shows the analysis of the variance of snack bars that temperature and time have a significant effect on the total calories produced. In all treatments, the two factors had the highest calorific value obtained from the S5W3 treatment (temperature 160 °C and roasting time of 90 minutes) was 418.97 Kcal, while the lowest total calorie obtained from the S1W1 treatment (temperature 120 °C and roasting time of 50 minutes) was 340.79 kcal. The further test of BNT level 5% showed that the treatment of S1W1 (temperature 120 °C and roasting time of 50 minutes) was significantly different from that of S5W3 (temperature of 160 °C and roasting time of 90 minutes).

The caloric value contained in the purple sweet potato snack bar covered with soursop yogurt ranges from 340.79 - 418.97 Kcal. These results are in line with the research of Hidayah et al.[15], the total calories of sweet potato snack bars produced from various combinations of temperature treatment and roasting time showed that the calories ranged from 325.54 Kcal - 451.28 Kcal, where the higher and longer heating increased total calories. The increase in total calories in the purple sweet potato snack bar coated with soursop yogurt during the baking time and temperature was in line with the increasing carbohydrate value at 160 °C and 90 minutes of roasting time. Where carbohydrates are nutrients whose primary function is as a producer of energy, each gram produces 4 kilocalories. Fat can produce higher energy than carbohydrates, but carbohydrates are consumed more every day as a staple food, especially in developing countries such as Indonesia [24].

The total calories of the snack bar are taken into consideration in determining the serving size because it plays a role in providing sufficient energy for activities and maintaining ideal body weight. Energy value can be obtained from carbohydrates, fats, and proteins contained in the snack bar. Yuliani and Mardesci [25] states that energy can be obtained from carbohydrates, proteins, and fats contained in foodstuffs stored in the body, and energy for humans is used to grow and develop.

3.7. Crude Fiber Content

Table 1 shows the content and roughness of the snack bar, where temperature and time significantly affect the fiber content produced. In all treatments, the two factors had the highest crude fiber content obtained from the S1W1 treatment (temperature 120 °C and roasting time of 50 minutes) was 3.88%, while the lowest crude fiber content was obtained from the S5W3 treatment (temperature 160 °C and roasting time of 90 minutes) is 3.62%. The further test of BNT level 5% showed that the treatment of S1W1 (temperature 120 °C and roasting time of 50 minutes) was significantly different from that of S5W3 (temperature of 160°C and roasting time of 90 minutes).

Dietary fiber, also known as dietary fiber or dietary fiber, is part of plants that can be consumed and is composed of carbohydrates that are resistant to digestion and absorption in the human small intestine and undergo partial or complete fermentation in the large intestine [26]. Treatment of temperature and roasting time showed that the higher the temperature and the longer roasting time used, the lower the crude fiber content of the purple sweet potato snack bar. Baking in the manufacture of snack bars using high temperatures and a long time causes the structure of the crude fiber to be slightly damaged, where the use of high temperatures causes damage to the structure of the crude fiber, which will gradually be oxidized by oxygen [27]. Diana [26], also states that when food fiber is heated continuously, the food fiber contained in the material will be damaged.

3.8. Antioxidant Activity (IC_{50})

Antioxidant activity testing was carried out to determine the IC_{50} value of the sample. According to Tristantini (2016), the antioxidant IC_{50} value is powerful if the IC_{50} value is less than 50 ppm, strong antioxidant if the IC_{50} value is between 50-100 ppm, moderate antioxidant if the IC_{50} value is between 100-150 ppm, and weak antioxidant activity is between 150-200 ppm. Table 1 shows the antioxidant activity of snack bars through IC_{50} values. It is known that the antioxidant activity of the purple sweet potato snack bar coated with soursop yogurt is classified as moderate to weak, namely in the S1W1 treatment (temperature 120 °C and roasting time of 50 minutes), which is 129.86±0.77 ppm which is classified as moderate antioxidant activity. In contrast, the S4W3 treatment (temperature 150 °C and roasting time 90 minutes) was 511.31±1.27 ppm which had very weak antioxidant activity. The results show that the higher the temperature and the longer the roasting time, the weaker the antioxidant activity even until there are no more antioxidants, as in the 160°C roasting temperature treatment. The analysis of variance showed that temperature and time had a significant effect on the antioxidant activity of the purple sweet potato snack bar coated with soursop yogurt.

Purple sweet potato has the highest antioxidant component in anthocyanins, which are mono or diacetyl 3-(2glucosyl)glucosyl-5-glucosyl peonidin and cyanidin derivatives that cause purple color. The anthocyanin level in fresh purple sweet potato is 61.85 mg/100 g, while the anthocyanin content of processed purple sweet potato products ranges from 6.19 to 46.14 mg/100g [5][28]. The results of Salim's research [29] show that processing raw purple sweet potatoes yields antioxidant activity IC_{50} of 5.00 ppm, steamed IC_{50} of 47.82 ppm, and boiled IC_{50} of 86.22 ppm that the heating factor affects antioxidant activity.

The temperature and heating time can cause the anthocyanins contained in the material to be damaged [5]. According to Winarno [4], at high heating, the stability and resistance of anthocyanin dyes change and cause anthocyanin damage. In addition to anthocyanins, high-temperature thermal processes (>120ºC) can damage bioactive compounds and reduce their antioxidant activity because natural antioxidants are sensitive to heating temperatures [30].

Based on the antioxidant activity test of the purple sweet potato snack bar coated with soursop yogurt with various temperatures and heating, it appears to have the best antioxidant activity with an IC_{50} value of 129.86 ppm with a treatment temperature of 120 °C and a roasting time of 50 minutes. The lower IC_{50} value indicates that the better the antioxidant activity of the test sample [31]

4. CONCLUSION

Roasting temperature and time significantly affected the moisture content, ash content, fat content, protein content, carbohydrates, total calories, crude fiber, and antioxidant activity (IC_{50}) of the purple sweet potato snack bar coated with soursop yogurt. The higher the roasting temperature and time, the lower the product's water content, ash, protein, crude fiber, and antioxidant activity. In contrast, the levels of fat, carbohydrates, and total calories are getting higher. Purple sweet potato snack bar coated with soursop yogurt with roasting treatment at 120°C and 50 minutes of roasting has the best chemical characteristics with water content 11.12%, ash content 1.74%, fat content 11.39%, protein 3.85%, carbohydrates 72.23%, calories 340.79 Kcal, crude fiber 3.88% and antioxidant activity (IC_{50}) 129.86 ppm.

CONFLICT OF INTEREST

The authors declare no conflict of interest

ACKNOWLEDGMENTS

This research was funded by the Faculty of Agriculture, The University of Mulawarman through the PNBP Lecturer Funding Research Grant scheme in 2020.

REFERENCES

[1] S. Aminah, S. Sulfiani, and A. Upe, "Uji Optimum Pertumbuhan Dan Produksi Ubi Jalar Ungu Melalui Aplikasi Zat Pengatur Tumbuh," *J. TABARO Agric. Sci.*, vol. 4, no. 2, pp. 490–595, 2020.

[2] Marlis, "Isolasi Oligosakarida Ubi Jalar (Ipomoea batatas L.) dan Pengaruh Pengolahan terhadap Potensi Prebiotiknya."

[3] N. Putra, "Sweet potato varieties sukuh potential as a prebiotic in tilapia feed (Oreochromis niloticus). ," *Int. Conf. Aquac. Indones.*, vol. 35, no. 1, pp. 254–258, 2014.

[4] F. G. Winarno, *Kimia Pangan dan Gizi*. 2004.

[5] N. El Husna, M. Novita, and S. Rohaya, "Kandungan Antosianin Dan Aktivitas Antioksidan Ubi Jalar Ungu Segar Dan Produk Olahannya," *AGRITECH*, vol. 33, no. 3, pp. 296–302, 2013, doi: 10.22146/agritech.9551.

[6] N. Sabuluntika, "Kadar B-Karoten, Antosianin, Isoflavon, Dan Aktivitas Antioksidan Pada Snack Bar Ubi Jalar

[7] Kedelai Hitam Sebagai Alternatif Makanan Selingan Penderita Diabetes Melitus Tipe 2," Universitas Diponegoro Semarang, 2013.

[8] AOAC, *Official Of Analysis Of The Association Of Analytical Chemistry*. 2005.

[9] S. Sudarmadji, B. Haryono, and Suhardi, *Prosedur Analisa Untuk Bahan Makanan dan pertanian*. 2010.

[10] F. G. Winarno, *Kimia Pangan dan Gizi*. 1986.

[11] H. Farhan *et al.*, "In vitro antioxidant activity of ethanolic and aqueous extracts from crude Malva parviflora L. grown in Lebanon," *Asian J. Pharm. Clin. Res.*, vol. 5, no. 3, pp. 234–238, 2012.

[12] R. Kasim, S. A. Liputo, M. Limonu, and F. P. Mohamad, "Pengaruh Suhu Dan Lama Pemanggangan Terhadap Tingkat Kesukaan Dan Kandungan Gizi Snack Food Bars Berbahan Dasar Tepung Pisang Goroho Dan Tepung Ampas Tahu," *J. Technopreneur*, vol. 6, no. 2, pp. 41–48, 2018, doi: 10.30869/jtech.v6i2.188.

[13] A. Rahmaningsih, T. Surti, and A. D. Anggo, "Pengaruh Penambahan Tepung Buah Lindur (*Bruguiera gymnorrhiza*) Terhadap Kualitas Biskuit Ikan Lele (*Clarias batrachus*)," *J. Peng. Biotek. Has. Pi.*, vol. 5, no. 3, pp. 52–59, 2016.

[14] R. Ummah, E. Probosari, G. Anjani, and D. N. Afifah, "Komposisi Proksimat, Kandungan Kalsium dan Karakteristik Organoleptik Snack Bar Pisang Raja dan Kacang Kedelai Sebagai Alternatif Makanan Selingan Balita," *War. Ind. Has. Pertan.*, vol. 37, no. 2, pp. 162–170, 2020, doi: 10.32765/wartaihp.v37i2.6159.

[15] R. Kesuma, "Pengaruh Pemanasan Terhadap Kandungan Proksimat, Mineral dan Vitamin C Selada Air (Nasturtium officinale)," 2019.

[16] N. Hidayah, R. A. Setia, S. Darniadi, and Suismono, "Optimasi Kondisi Proses Pemanggangan Snack Bars Berbasis Ubijalar Sebagai Alternatif Pangan Darurat," in *Prosiding Seminar Hasil Penelitian Tanaman Aneka Kacang Dan Umbi*, 2012, pp. 624–635.

[17] Riansyah, A. Supriadi, and R. Nopianti, "Pengaruh Perbedaan Suhu Dan Waktu Pengeringan Terhadap Karakteristik Ikan Asin Sepat Siam (*Trichogaster pectoralis*) Dengan Menggunakan Oven," *Fishtech*, vol. 2, no. 1, pp. 53–68, 2013.

[18] N. Yuniarti, D. Syamsuwida, and A. Aminah, "Pengaruh Penurunan Kadar Air Terhadap Perubahan Fisiologi Dan Kandungan Biokimia Benih Eboni (*Diospyros celebica* Bakh.)," *Jurnal Penelitian Hutan Tanaman*, vol. 5, no. 3. pp. 191–198, 2008, doi: 10.20886/jpht.2008.5.3.191-198.

[19] Zuhra, Sofyana, and C. Erlina, "Pengaruh Kondisi Operasi Alat Pengering Semprot Terhadap Kualitas Susu Bubuk Jagung," *J. Rekayasa Kim. Lingkung.*, vol. 9, no. 1, pp. 36–44, 2012.

[20] P. D. Eckersall, "Proteins, Proteomics, and the Dysproteinemias," in *Clinical Biochemistry of Domestic Animals*, 2008, pp. 117–155.

[21] N. Yu and L. P. Tang, "Kinetics of non-enzymatic browning reaction from the l-ascorbic acid/l-cysteine model system," *Czech J. Food Sci.*, vol. 34, no. 6, pp. 503–510, 2016, doi: 10.17221/86/2016-CJFS.

[22] D. A. Kanaka and F. Ayustaningwarno, "Nilai Cerna Protein In-Vitro Biskuit Dengan Substitusi Kecambah Kedelai

[23] (*Glycine max* (L.) Merril) dan Pisang (*Musa paradisiaca* sp.) Sebagai Makanan Sehat Untuk Anak Sekolah Dasar," *J. Nutr. Coll.*, vol. 4, no. 2, pp. 141–146, 2015, doi: 10.14710/jnc.v4i2.10058.

[24] N. Erni, K. Kadirman, and R. Fadilah, "The influence of temperature and length of drying to the chemical characteristic and organoleptic of taro flour(Colocasia esculenta)," *J. Pendidik. Teknol. Pertan.*, vol. 4, pp. 95–105, 2018.

[25] F. Muchtadi, T. R. Ayustaningwarno, *Teknologi Proses Pengolahan Pangan*. 2010.

[26] G. S. Pandit, *Biokimia Hasil Perairan*. 2012.

[27] S. Yuliani and H. Mardesci, "Pengaruh Penambahan Tepung Ampas Tahu Terhadap Karakteristik Biskuit Yang Dihasilkan," *J. Teknol. Pertan.*, vol. 6, no. 1, pp. 1–11, 2017, doi: 10.32520/jtp.v6i1.96.

[28] N. E. Diana, "Pengaruh Waktu Perebusan Terhadap Kandungan Proksimat, Mineral Dan Kadar Gosipol Tepung Biji Kapas," *J. Penelit. Pascapanen Pertan.*, vol. 13, no. 1, pp. 99–107, 2016, doi: 10.21082/jpasca.v13n2.2016.99106.

[29] S. Cahyani, Tamrin, and Hermanto, "Pengaruh Lama Dan Suhu Pengeringan Terhadap Karakteristik Organoleptik

[30] Nadi M. Aktivitas Antioksidan Dan Kandungan Kimia Tepung Kulit," *Sains dan Teknol. Pangan*, vol. 4, no. 1, pp. 2003– 2016, 2019.

[31] "Дендримеры И Белки Д . Г . Щербин 1 , Б . Клайнерт 2 , М . Брышевска 2," pp. 1–14, 2008.

[32] M. Salim, A. Dharma, E. Mardiah, and G. Oktoriza, "Influence of Antosianin and Antioxidant Influences on Process of Processing Ubi Jalar Purpose," *J. Zarah*, vol. 5, no. 2, pp. 7–12, 2017.

[33] N. Hidayah, Rohadi, and B. Kunarto, "The Effects Of Oven Heating Time On The Antioxidant Stability Of Methanolic Extract Of Java Plum Seeds (Syzygium cumini Linn.)," *Univ. Semarang*, 2019.

[34] F. Alifyana, Rohadi, and E. Y. Sani, "Effect of Heating Temperature on the Stability of Antioxidant Properties of Tea Extract (Camellia sinensis Linn.) Type of White Tea," 2018.