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Antioxidant capacity of snack cookies made from mango and pineapple fermentation

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Abstract

Mango (*Mangifera indica*) and pineapple (*Ananas Comosus*) are tropical fruits that contain many nutrients, one of which is antioxidants and polyphenols. Lots of studies have shown that fermented fruit is higher in antioxidants and health benefits. Antioxidants have been reported to be an alternative to enhance body immunity and possibly become an Anti -SARS-CoV-2. One of the antioxidants that are easily found in vitamin C. This study is to process the fermented mango and pineapple fruits into cookies and to test the antioxidant content (especially Vitamin C) *in vitro*. There were three variations of the formulation, mango: pineapple: CO_2 free water. Sample 1 (1: 0.5: 0.5), sample 2 (2: 1: 1) and sample 3 (3: 2: 2). Then, all product samples were inoculated with *Lactobacillus paracasei* 5% b/v for 14 days under anaerobic conditions to get simpler mangoes and pineapple food fibre. The fermented products were made into flour with a freeze dryer. Sample variation is done to determine the average significance of the antioxidant content in it. The next step was Vitamin C analysis from 3 samples of cookies sample using Titration Iodometric Method, to determine the amount of Vitamin C (mg/100 g) and also the antioxidant activity with 2,2-diphenyl-1-picrylhydrazyl (DPPH). The amount of vitamin C obtained in Sample 1 was 100.20 mg/100 g respectively with antioxidant activity is 35.33%. Sample 2 was 95.75 mg/100 g respectively with antioxidant activity is 30.60%. Sample 3 was 107.90 mg/100 g respectively with antioxidant activity is 44.70%. The formulation with the highest amount of cookies sample containing vitamin C is S3. There was a significant difference ($P<0.05$) that determined vitamin C levels between sample formulations. The mean ash content of the three samples was 2.02±0.04% and water content were 1.60± 0.15%. The average vitamin C levels in the three sample cookies were 101.28±6.14 mg/100 g. Sample 3 indicated the best antioxidant activity towards 2,2-diphenyl-1-picrylhydrazyl (DPPH) in the amount of 44.70%. Therefore, fermented mango and pineapple have a great potential to be developed into healthy snack cookies. The vitamin C and antioxidants content in cookies from the fermentation of mango and pineapple may be a great substitute for snacks since antioxidants has the ability to improve immunity and anti-inflammatory response. These cookies are also good prebiotics for the gut microbiome which plays a good role in the immune system.

1. Introduction

Mango (*Mangifera indica*) is a tropical fruit plant that contains high levels of nutrients, fibre, macronutrients, micronutrients and minerals as well as abundant bioactive compounds (Maldonado-Celis *et al*., 2019). The well-known high content in mangoes, including vitamin C, beta-carotene, polyphenol types of quercetin and kaempferol (Nurkolis *et al.,* 2020; Mantik *et al*., 2021). Likewise, pineapple fruit (*Ananas comosus*) which is included in tropical fruit, is rich in nutrients and minerals, such as vitamin C, dietary fibre especially the bromelain enzyme (Arampath and Dekker, 2019). Both of these fruits contain a lot of dietary fibre which can be processed into functional foods such as fermentation drinks or probiotic drinks. The fermentation process is known to increase the levels of antioxidants or vitamin C in processed food products (Selibata *et al*., 2017). Lots of

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studies have shown that fermented fruit is higher in antioxidants and health benefits (Gagnon *et al*., 2015). Recent research has shown that increasing the intake of foods high in antioxidants and polyphenols such as Vitamin C, beta-carotene, quercetin and kaempferol can increase the body immunity against viral infection (Levy *et al*., 2020; Pitsillou *et al*., 2020; Suhail *et al*., 2020). The addition of pineapple in previous studies has shown that it can increase antioxidant levels in yogurt products (Kusumawati *et al*., 2020). By looking at the potential based on the basis of previous research, mangoes and pineapples can be used as fermentation drinks and other processed products, which has the potential to increase body immunity. In this study, researchers made processed products based on pineapple and mango fruit which were fermented with the *Lactobacillus paracasei* to get simpler mangoes and pineapples food fibre.

2. Material and methods

There were 3 variations of the formulation, mango: pineapple: CO_2 free water. Sample 1 (S1), 1: 0.5: 0.5, sample 2 (S2), 2: 1: 1 and sample 3 (S3), 3: 2: 2. Then, all product samples were inoculated with *Lactobacillus paracasei* 5% b/v for 14 days under anaerobic conditions. The part of mangoes and pineapples used were pure ripe flesh. The fermented products were made into flour with a freeze dryer, then the powder was mixed and stirred with the addition of 5% water using a mixer with a power of 102-189 rpm for 30 mins and then put in the oven for 15 mins with a temperature of 70 – 90 °C so that it became cookies. Sample variation was done to determine the average significance of the antioxidant content in it.

2.1 Vitamin C analysis

The next step was Vitamin C analysis from 3 samples of cookies sample using Titration Iodometric Method, to determine the amount of Vitamin C (mg/100 g) and also the antioxidant activity with 2,2-diphenyl-1-picrylhydrazyl (DPPH).

$$\text{Vitamin C}\left(\frac{\text{mg}}{100\text{g}}\right) = \frac{\text{V I2} \times 0.88 \times \text{Fp} \times 100}{\text{Ws gram}}$$

Where V I2 = Iodine Volume (mL), Fp = Dilution Factor, Ws = Sample weight (grams) and 0.88 = 0.88 mg of ascorbic acid is equivalent to 1 mL of I2 0.01 N solution

2.2 Water content analysis

The determination of water content used was the AOAC drying method (Thermogravimetry). The principle of this method is based on the evaporation of water in the material by heating, then weighing it to a constant weight. The weight reduction that occurs is the water content contained in the material. The way these method works is an empty plate heated in an oven at 105°C for 30 mins, cooled down in a desiccator for 15 mins, then weighed (W0). Approximately 2 g sample was then put in a plate with known weight, weighed (W1), then dried in an oven at 105°C for 3 hrs, cooled in a desiccator for 15-30 mins, then the plates and contents were weighed and dried again for another one hour, cooled in the exicator, and weighed again (W2). The water content was calculated using the following formula:

$$\text{Water content (\%)} = \frac{\text{W1} - \text{W2}}{\text{W1} - \text{W0}} \times 100$$

Where W0 = sample weight before drying (grams), W1 = weight of sample and dry cup (grams) and W2 = empty cup weight (grams)

2.3 Ash content analysis

The procedure for determining the ash content was carried out using the AOAC (2005) method. Meanwhile, the procedure is as follows: the cup was dried in an oven at 105°C for 1 hr. Then, it was cooled in the cup for 15 mins in a desiccator and weighed. Approximately, 2 g of the sample was put into a furnace where the temperature was 550°C for 3 hrs. It was then cooled outside the furnace to a temperature of 120°C and put in a desiccator. The plates and ashes were weighed so that a constant weight was obtained. Calculation of the ash content was carried out using the following formula:

$$\text{Ash content (\%)} = \frac{\text{Weight of bowl after heated} - \text{constant weight of empty bowl}}{\text{Sample Weight}} \times 100$$

3. Results and discussion

The results of vitamin C and antioxidant activity in each sample of fermentation before the cookies processing; S1 was 107.63 mg/100 g with 38.52% antioxidant activity, S2 was 98.21 mg/100 g with 34.83% of antioxidant activity and S3 was 111.16 mg/100 g with 48.12% antioxidant activity. And after the cookies processing, the amount of vitamin C obtained in S1 was 100.20 mg/100 g with 35.33% antioxidant activity, S2 was 95.75 mg/100 g with 30.60% of antioxidant activity and S3 was 107.90 mg/100 g with 44.70% antioxidant activity (Table 1). The formulation for the number of cookies samples containing the highest vitamin C was S3. There was a significant difference ($P<0.05$) which determined the vitamin C level between the sample formulations. The higher the antioxidant activity, the higher the antioxidant levels, and the less food needed to reduce free radicals (Lisdawati and Kardono, 2012). This shows that the formulation of a blend of fermented pineapple and mango which was made into cookies contain vitamin C and has antioxidant activity. Foods that are high in antioxidants and vitamin C can act as immunomodulators and even help the

Table 1. Vitamin C content, anti-oxidant activity, water and ash content in cookies sample.

Sample	Vitamin C Content (mg/100 g)	Anti-oxidant activity (% DPPH)	Ash Content (%)	Water Content (%)
S1	100.20	35.33	1.97	1.77
S2	95.75	30.60	2.05	1.55
S3	107.90	44.70	2.04	1.48
Mean	101.28±6.14	18.43±7.17	2.02±0.04	1.60±0.15

process of T-cell maturation (Manning *et al*., 2013). This makes formulated cookies a potential healthy snack that is high in vitamin C and antioxidants during the COVID-19 pandemic. The average vitamin C level in the three cookie samples was 101.28 mg/100 g. S3 showed the best activity, namely antioxidant activity against 2,2-diphenyl-1-picrylhydrazyl (DPPH) of 44.70% (Table 1).

The average ash content of the three samples was 2.02% and water content was 1.60% which is in accordance with the Indonesian National Standard (SNI) 01-2973-1992. In accordance with research (Andarwulan *et al*., 2014) which stated that the higher the ash content in cookies indicates the higher mineral contents in cookies such as calcium, potassium, and iron. It is clinically known that mineral intake can improve the respiratory system, especially in tuberculosis sufferers (Taslim *et al*., 2020).

Fermented mango and pineapple have a great potential to be developed into healthy snack cookies. The vitamin C and antioxidants content in cookies from the fermentation of mango and pineapple may be a great substitute for snacks during the pandemic since antioxidants and vitamin C have the ability to improve immunity and anti-inflammatory response. These cookies are also good prebiotics for the gut microbiome which plays a good role in the immune system. It needs clinical trials in humans to find out more about its effects on human health and the authors are very open to joint research collaborations.

Conflict of interest

The authors declare no conflicts of interest.

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