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Saponins and Tannin Levels in Chayote, Mung Beans, and Biscuits from Chayote and Mung Beans

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Abstract

BACKGROUND: Saponins and tannins are active compounds of secondary metabolites which are known to have several health benefits, including antibacterial and antioxidant. Chayote and green beans are natural ingredients that contain saponins and tannins. Starch from these two ingredients is used as a basic ingredient for making biscuits.

AIM: The purpose of this study was to determine the levels of saponins and tannins in biscuits made from chayote and green beans.

METHODS: Saponins and tannins in the samples were extracted and analyzed using the Gravimetric method. The tannin content of flour and biscuits based on chayote and green beans was analyzed spectrophotometrically.

RESULTS: The results of the saponin analysis of biscuits made from chayote, flour, and chayote were 5.693%, 2.813%, and 2.574%. Meanwhile, the tannin levels were 1.143%, 4.308%, and 1.922%, respectively. The saponin levels in biscuits made from mung bean, flour, and mung bean obtained were 6.742%, 4.593%, and 4.315%, respectively, while the tannin levels were 4.464%, 3.250%, and 3.893%, respectively. From the sample of chayote and green bean flour biscuit formulation (1:1), the saponin content was 1.558%, while the tannin content was 3.436%.

CONCLUSION: In mung bean flour and mung bean biscuits, the saponin content was higher than that of chayote flour and chayote biscuits. The increase in tannin content in the formulation (1:1) was derived from mung bean flour, because the tannin content in mung bean was higher than that of chayote.

Introduction

The diversity of living plants such as vegetables and fruits needs to be researched, developed, and utilized for health improvement and economic purposes as well as sustainability. Medicinal plants can be utilized to overcome health problems due to the antioxidants, such as tannins, alkaloids, flavonoids, and saponins that they contain [1], [2]. Chayote, which is recognized as a medicinal plant, can lower blood pressure, produces a diuretic effect, relieves fever in children, and can be used to help treat gout and diabetes mellitus [3]. Chayote also protects the liver, prevents liver cell damage, destroys free radicals, and has anti-inflammatory properties. The saponin and tannin compounds in chayote produce antibacterial activity [3], [4], [5]. Mung beans (Vigna radiata), on the other hand, are a high vegetable protein food. In some parts of the world, they are a very important food source due to the high nutritional content of the seeds, which are eaten as a meat substitute.

Chayote and mung beans both contain active compounds of secondary metabolites that are known to have antibacterial and antioxidant properties. Saponins and tannins are some of the components of complex organic substances known as secondary metabolites [2], [6]. Saponins are compounds that produce antimicrobial and antibacterial activity, which can help to lower blood cholesterol. The content of saponins in chayote and mung beans has not been researched in any detail, both qualitatively or quantitatively [7], [8]. It should be noted that tannins may interfere with the absorption of nutrients needed by the body. Excess tannins in the body can have a negative impact on iron absorption as tannins easily bind to iron in the food we consume [9]. As a result, there is a risk of experiencing iron deficiency. Iron is needed by the body for the formation of red blood cells [10], [11].

Chayote and mung beans can be processed into health food biscuits that are diverse, nutritious, balanced, safe, and contain sufficient nutrients such as carbohydrates, fat, protein, fiber, and calories. Biscuits made from chayote flour and mung beans can eliminate hunger for a certain time and deliver a positive effect on health and nutrition. They are also safe and harmless to the body [12]. Chayote can be developed into various products to increase consumption and utilization. The processing of chayote and mung beans into biscuits is an innovative product, which could be developed as a

substitute or alternative food. A high percentage of people consume biscuits, which means that biscuit products are very much in demand. Biscuits are a type of food that is made by roasting and usually made from flour, mixed with other nutritional additives. Biscuits are very popular with all ages of people, from children to the elderly, and can be made with different textures [13], [14].

Biscuits are favored by consumers due to their delicious and varied taste, relatively cheap price, and good nutritional content. There are many types and shapes of biscuits on the market, such as rectangular, round, or even star-shaped. Presentation and use vary, some are eaten plain or combined with chocolate, cheese, etc. [15].

Several studies have shown that flour from chayote and green beans contains saponins and tannins. However, there have been no reports on the content of these compounds in biscuits made with flour from chayote and green beans. Therefore, it is necessary to test to prove whether there are still saponins and tannins in the flour from chayote and green beans after processing into biscuits.

Methods

This study used chayote, green beans, and biscuits made from chayote flour and mung beans, as observation samples. The sample was prepared as follows: the sample was ground and sieved with a size of 100 mesh, then 25 g were weighed using a digital scale. The weighing results were extracted by immersion using 96% ethanol solvent and allowed to stand in a beaker for 24 h, then stirred with the help of a shaker with a speed of 120 rpm for 2 h, and then filtered with a Buchner funnel, to separate the filtrate and residue. The residue obtained was macerated again with the same solvent until the filtrate was clear. The filtrate obtained was combined and concentrated with a rotary evaporator vaccum (RE) [15].

Analysis of saponin content gravimetrically, a total of 0.625 g of extract, was refluxed with 25 mL of petroleum ether at a temperature of 60–80°C for 30 min. After cooling, the petroleum ether solution was removed and the residue left was dissolved in 25 mL of ethyl acetate. The solution was transferred to a separatory funnel, and then, the ethyl acetate solution was separated. The residue left was dissolved with n-butanol 3 times each with 25 mL. The entire solution was mixed and evaporated using a rotary evaporator at a temperature of 60–70°C. The remaining evaporation was dissolved with 10 ml of methanol; then, this solution was dropped into 10 ml of diethyl ether while stirring. The precipitate formed in the mixture is poured on filter paper whose weight is known. The filter paper was dried and then weighed to a constant weight. The difference in the weight of the filter paper before and after filtering is determined as the weight of the saponins carried out 3 times with the results of the calculation of the average content and made in Table 1 [15a].

Table 1: Saponin and tannin levels chayote, mung beans, and flour

No	Sample	Saponin levels (mean ± SD) (g/100 g)	Tannin levels (mean ± SD) (g/100 g)
1.	Chayote	5.693 ± 0.1885	(1.143 ± 0.043)
2.	Chayote flour	2.813 ± 0.148	(4.308 ± 0.022)
3.	Mung beans	6.742 ± 0.0755	(4.464 ± 0.050)
4.	Mung beans flour	4.593 ± 0.1685	(3.250 ± 0.036)

Determination of tannin levels was done using the Folin Ciocalteu method, namely weighing 0.010 grams of sample (pumpkin, green beans, flour, and biscuits) then homogenized with ethanol solution, 1 mL of sample solution added 5 mL of distilled water. Folin Ciocalteu reagents and 20% Na2CO3 were added, allowed to stand for 2 hours, and the absorption was measured at a wavelength of 748.5 nm. The method weighed 0.010 g of sample (chayote, mung beans, flour, and biscuits) homogenized with an ethanol solution, 1 mL of sample solution added 5 mL of distilled water. The Folin Ciocalteu reagent and 20% Na_2CO_3 was added, allowed to stand for 2 h, and the absorption was measured at a wavelength of 748.5 nm.

Results and Discussions

This study has been carried out to analyze saponins in chayote, chayote flour, chayote biscuits, mung beans, mung bean flour, and mung bean biscuits using the gravimetrical method. The analysis of saponin levels showed that the highest composition was in mung beans, namely, 6.742 mg/100 g, and the lowest was in biscuit formulations of chayote and mung beans (1:1) which was 1.558 mg/100 g Table 1. The highest average yield of the saponin content was in the biscuits formulation (1:1), which is 4,315 g/100 g, and the lowest is on the mung beans-based biscuits which are 1,558 g/100 g Table 2.

Table 2: Saponin and tannin level of biscuits made from chayote and mung beans

No	Formula (Chayote flour: mung bean flour)	Saponin levels (mean ± SD) (g/100 g)	Tannin levels (mean ± SD) (g/100 g)
1.	100:0	2.574 ± 0.032	(1.922 ± 0.036)
2.	50:50	4.315 ± 0.315	(3.436 ± 0.050)
3.	0:100	1.558 ± 0.355	(3.893 ± 0.022)

Saponins are polar compounds, because they have a number of hydroxyl groups and glycosides, meaning they are easily soluble in the solvent n-butanol [10]. The entire n-butanol solution was mixed and evaporated with a rotary evaporator until a concentrated extract was obtained. This solution is dripped with ether solution which functions as a precipitate, because saponins are not soluble in ether. The precipitate formed in the mixture was poured onto filter paper to separate the

saponin precipitate from other impurities. The filter paper used must be known to facilitate the calculation of the saponin content. The precipitate on filter paper was dried and then weighed to a constant weight. The results Table 1 showed that the levels of chayote saponins were higher than those of the chayote which had been processed into flour. This is because chayote flour and mung bean flour have gone through various processes in the manufacture of flour, thus allowing the saponin levels to decrease. The use of 80° temperature causes a decrease in saponin levels [15b]. Saponin levels increase when green beans germinate. Saponins in green beans are triterpenoid-type saponins [14], [16]. Increasing temperature causes saponins to be oxidized to lanosterol which is the basic form of triterpenes [17].

The results of this study indicate that the levels of saponins in chayote and mung beans decrease due to the heating process. The high temperatures affect the levels of existing saponins. The higher the temperature, the greater the solubility of impurities (such as oil and phospholipids, proteins, sterols, and polyphenols) in the water solvent used. This means that the higher the temperature, the greater the possibility that the impurity components will be extracted, which causes the saponin levels to decrease [18], [19].

The data in Table 2 show that the saponin content of biscuits derived from chayote flour and mung bean flour in the same ratio is higher than biscuits from chayote flour or mung bean flour. This shows that the levels of saponins in chayote flour are higher than the levels of saponins in mung bean flour. The results of another study showed that the levels of saponins with the formulation of wheat flour and moringa flour were 0.46–8.41%. Another study showed that the production of biscuits from six mixtures of wheat flour, plantain, and sweet potato obtained saponin content of 0.06–1.14 mg/100 g. Biscuit products with various flour substitution formulations were significantly different ($p \leq 0.05$) with density levels ranging from 0.57 to 0.85g/cm^3 [20].

The highest average yield of tannin content in the mung bean sample was 4.464 g/100 g and the lowest tannin content in the chayote flour sample was 4.307 g/100 g Table 1. The highest average yield of tannin content was in the chayote-based biscuits, which was 3.893 g/100 g, and the lowest was in the chayote-based biscuits which were 1.922 g/100 g.

The tannin content of chayote was 1.736 g/100 g, chayote flour was 4.307 g/100 g, mung bean was 4.464 g/100 g, and mung bean flour was 3.25 g/100 g. This indicates that there is a decrease in tannin levels after the raw ingredients are processed into chayote and mung bean biscuits, due to fruit selection and heating. The higher the roasting temperature, the lower the tannin content in the chayote and mung bean biscuit products. The use of high temperatures in the roasting process results in lower tannin levels in the consumable product. The higher the temperature, the more the tannin compounds will be damaged. Thus, biscuit processing that is not properly controlled can cause low levels of tannins [21], [22], [23].

A study conducted by Arina (2019) found that tannin levels of 2233.82 ± 1.311 and antioxidant activity of around 93.422 ± 0.256% in manjakani plants decreased after heating at 75°C, meaning that heating significantly affects tannin levels and antioxidant activity. Extraction of methanol and hot water on raw fruit, leaves, and bark of D. mespiliformis (African Ebony) showed that hydrolyzed tannins in raw meat had the highest tannin content of 15.94 g, before it leaves that the tannin content was 12.35 g. Therefore, conservation of D. mespiliformis is very important as its leaves can be used as a substitute for fruit, due to regeneration [24], [25].

Processing chayote and mung beans into flour and biscuit products can reduce or eliminate secondary metabolites such as saponin and tannins. Soaking, peeling, and heating can reduce the levels of condensed tannins, lectins, and saponins. Paterson (2017) reported that some processes, including germination, affect the nutrient levels which can substantially reduce saponin and tannin levels. The effect of processing techniques on white sorghum seed tea (Liberty) has been reported as significantly decreasing ($p \leq 0.05$) condensed tannin levels, though the antioxidant activity did not change significantly [26], [27].

Conclusion

Saponin concentration in mung beans (6.742 mg/100 g) was higher than chayote (5.693 mg/100 g). Saponin levels in mung bean flour and mung bean-based biscuits were higher than chayote flour and chayote-based biscuit. The tannin levels in raw fruit, flour, and biscuits from chayote flour and mung bean with three different formulations were obtained, namely, 1.143 g/100 g in chayote, 4.464 g/100 g in peanuts, 4.307 g/100 g in chayote flour, 3.25 g/100 g in mung bean flour, 1.922 g/100 g in 100% chayote and 0% mung bean biscuit formula, 3.45 g/100 g in 50% chayote and 50% mung bean formula, and 3.893 g/100 g in chayote 0 % and 100% mung beans formula.

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