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Original Research Paper

Effects of Mangosteen Peel Extract Encapsulated By Maltodextrin On Antibacterial Activities of Escherichia coli

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Abtract: Mangosteen peel extract contains good antibacterial compounds and is thought to be better when microencapsulated is formed. This study aimed to determine the effects of formulation of mangosteen peel ethanol extract associated to maltodextrin on activities of *Escherichia coli*. It was conducted by disk diffusion method according to Kirby-Bauer test in Mueller Hinton Agar (MHA) using three different concentrations namely: 100, 75, and 50 (%). Each formulation was tested as many as 10 µL disk $^{-1}$ consisted of each treatment. The employed maltodextrin was obtained by enzymatic processing of arenga starch. Nine formulations were tested by measuring their bacterial inhibition activity in a Mueller Hinton Agar (MHA) medium. The results showed that the effects of formulation between mangosteen peel ethanol extract and maltodextrin had the significant effect ($P<0.05$) on the antibacterial activities of *Escherichia coli*. It had been shown the ability to actively inhibit the bacterial growth at medium levels.

Keywords: *E. coli*, maltodextrin, mangosteen peel, microencapsulation

Introduction

Antibacterial is a compound derived from synthetic chemicals or natural ingredients that inhibits or kills certain microorganisms (Astuti and Sasongko, 2014). Currently, researches are more focused on producing antibacterial compounds derived from natural ingredients, such as mangosteen peel, because it is proven to be safer (Narasimhan et al., 2017). In addition, mangosteen peel have a pharmacological role which is very beneficial for health because it contains xanthones that have very strong antioxidant activity (Francik et al., 2016). There are minimum of 40 xanthones present in the mangosteen peel and the most abundant xanthones found are mangostins (α-mangostin, β-mangostin, and γ-mangostin) as the most frequently studied (Rohman et al., 2019).

Bioactive compounds in mangosteen peel can be obtained by extraction using various methods. One of them is the maceration method by dissolving the mangosteen peel in certain solvents with different soaking times (Hasan et al., 2016). The mangosteen peel extract that was extracted using 96% ethanol had high antibacterial activity with an effective and efficient extraction time of 24 hours (Kusmayadi, 2018). The herbal extracts contains chemical compounds such as acetic acid, propanoic acid, benzene acetic acid, eicosanoic acid, oxalic acid, sitosterol, phenol, and phytol which are responsible for antimicrobial activity to inhibit clinical bacteria (Wei et al., 2014).

The bioactive compound contained in the mangosteen peel which acts as an antibacterial is known as xanthone with its various types of derivatives. In addition, ethanol extract 96% of mangosteen peel contains other bioactive antibacterial compounds such as flavonoids, saponins, tannins, alkaloids, triterpenoids, glycosides, and polyphenols (Astuti and Sasongko, 2014). Protect the bioactive compounds on the mangosteen peel extract, microencapsulation can be performed to keep it safe and stable when the product is going to use (Kusmayadi et al., 2019).

Microencapsulation is the protection process of the core material (mangosteen peel extract) which is encapsulated by encapsulant

material (maltodextrin derived from sugar palm starch). Maltodextrin is an additional food ingredient which is used to stabilize various food products such as margarine, yogurt, bread, and ice cream, which are produced using the enzyme of amylase (Arfah et al., 2018). Maltodextrin can protect probiotic bacteria which could be used as the sources that stimulates the growth of probiotic bacteria (Shokri et al., 2015) and reduce the number of pathogenic microbial populations in the digestive tract (Bomba et al., 2002).

Mangosteen peel extract has been reported to have a broad spectrum of antibacterial activity againsts several gram-positive and gram-negative bacteria (Vishnu et al., 2010). The α-mangosteen compound and its derivatives in mangosteen peel extract has been shown to have excellent ability to inhibit gram-positive bacteria such as *B. subtilis* and *S. aureus* which are then followed by inhibition of gram-negative bacteria such as *P. aeruginosa* (Narasimhan et al., 2017). This study examines the effects of formulation of mangosteen peel extract encapsulated by maltodextrin in various levels (70:30, 60:40, 50:50, 40:60, 30:70) on the antibacterial activities of *Escherichia coli*.

Material and Methods

Time and location of research

The research was carried out in November and December 2018 at the Central Laboratory, Universitas Padjadjaran, West Java, Indonesia.

Material

Mangosteen peel (*Garcinia mangostana* L.) was obtained from Puspahiang Subdistrict, Tasikmalaya regency, maltodextrin that was processed from palm starch (Kusmayadi *et al*., 2019), 96% ethanol, bacitracin, sterile aquadest, Mueller Hinton Agar (MHA) and bacterial isolates of *E. coli ATCC11229.*

The microencapsulation process and the preparation of samples

The mangosteen peel extract and maltodextrin which had been made in microparticle size were formulated on various ratios of mangosteen peel extract and maltodextrin as follows: 70:30, 60:40 50:50, 40:60, and 30:70. Each formulation was then homogenized for 15 minutes with a homogenizer (IKA T25, Germany) and then hydrated with thin layer hydration methods for 18 hours at 4°C. After being homogenized again for 1 minute, the formulation was spray dried using a spray dryer (Buchi-190) at a feed rate of 15 ml/minute with an inlet temperature of 170°C and a pressure of 1 atm (Kusmayadi et al., 2019).

The antibacterial activity test

The antibacterial activity test was carried out by using the method of Kirby-Bauer (Brooks et al., 2007). Each formulation was tested as many as 10 µL disk $^{-1}$ consisted of each treatment. The treatments of this study consist of: T1: 30% mangosteen peel extract (MPE) + 70% maltodextrin (MDX), T2: 40% MPE + 60% MDX, T3: 50% MPE + 50% MDX, T4: 60% MPE + 40% MDX, T5: 70% MPE + 30% MDX, T6: 100% MPE, T7: 100% MDX, T8: Positive control contains 100 ppm bacitracin, and T9: Sterile distilled water as negative control.

Data analysis

The data on the diameter of the inhibitory growth zone of *Escherichia coli* were analyzed using Kruskal Wallis Test with SPSS 25.0.

Result and Discussion

Result

Antibacterial activities were tested by disk diffusion method on *Eschericia coli*. The inhibitory zone diameter of antibacterial activity is presented in Table 1 and Figure 1.

Table 1. Inhibitory zone diameter of antibacterial activity

Treatments	Inhibitory zone diameter (mm)
	Escherichia coli
T1	6.61 ± 0.12^{b}
T2	6.68 ± 0.09^{b}
T3	6.75 ± 0.12^{b}
T4	6.93 ± 0.16^{b}
T5	7.70 ± 0.13^{c}
T6	6.75 ± 0.15^{b}
T7	6.69 ± 0.19^{b}
T8	11.5 ± 0.84^{d}
T9	0.00 ± 0.00^{a}

Description: *Superscript different within the same column shows a significant difference (P<0.05)

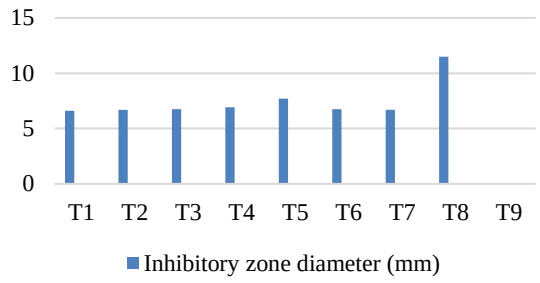

Figure 1. The inhibitory zone diameter of antibacterial activity

Discussion

The data in table 1 shows the significant effect ($P<0.05$) of treatments on antibacterial activities. This result demonstrated the treatments of mangosteen peel extract + maltodextrin at various ratios have an effect on the growth inhibitory of *Escherichia coli*. Antibacterial activity test results on the three bacterial species showed that the treatment of mangosteen peel extract encapsulated by maltodextrin (T1 - T5) was able to increase the antibacterial activity compared to mangosteen peel extract alone or maltodextrin alone. This condition shows that both of the ingredients, the association of mangosteen peel extract and maltodextrin contain antibacterial properties which when combined become stronger antibacterial activity as presented in Table 1.

It could be identified in statistical tests of E. coli antibacterial activity, the T5 treatments were significantly different from T1, T2, T3, T4, T6, T7, and T9. This condition showed that T5 treatment has higher antibacterial activity than other treatments (except positive control) with an antibacterial inhibition zone diameter of 7.70 mm. The T5 treatment had an inhibitory zone diameter (7.70 mm) that was lower than the positive control (T8) which reached 11.50 mm. It was reached 11.50 mm. The result of T5 treatment result could be performed due to the treatment of T8 containing synthetic antibiotics, bacitracin which had been tested for its antibacterial ability belongs to bacteriocidal that could kill pathogenic microbes such as E. coli, so that it is widely used as a source of antibiotics. The T7 treatment which only contained maltodextrin had a high diameter to be apllied as a therapeutic of the E. coli inhibitory zone that was 6.69 mm, but it is still lower than mangosteen peel extract only (T6) because the E. coli bacteria utilizing complex sugars from maltodextrin as growth nutrients (Dippel and Boos, 2005).

The average inhibition zone diameter in all treatments (T1 - T7) is 6.61 - 7.25 mm, so it is categorized as an antibacterial at a moderate level. The average value of inhibitory zone diameter in the treatment of formulation of mangosteen peel extract microencapsulation ranged from 6.61 - 7.70 mm. These results indicate that the antibacterial activity of *E. coli* in mangosteen peel extract microencapsulation belongs to the medium category. This is in accordance with Ibrahim *et al*., (2016) who reported that α-Mangostin and its derivatives had an antibacterial effect on *S. aureus, P. aeruginosa, Salmonella typhimurium, Bacillus subtilis, Klebsiella sp.,* and *Escherichia coli* with inhibition at the medium level (Sundaram *et al*., 1983; Wei *et al*., 2014). Davis and Stout (1971) in (Budi and Sabriani, 2012) affirms that the diameter of the inhibitory zone below 5 mm showed inhibitory activity in the weak category, diameter 5 - 10 mm belongs to the medium category, diameter 10-20 mm was a strong category and a diameter above 20 mm was categorized as very strong. In this study, all the treatments which contained bacitracin as the positive control had the category strong level in E. *coli* bacteria.

Tannin compounds could act as an antibacterial by coagulating the protoplasm of bacteria so that a stable bond with bacterial proteins is formed (Poeloengan et al., 2010; Saputro, 2014). Flavonoid compounds will bind bacterial cell proteins, so it disrupts the bacteria metabolism process. These flavonoids compounds play the role as biogenesis and they have a close relationship with xanthone compounds. Xanthones contained in the ethanol extract of mangosteen peel is considered as the most important antimicrobial component. The mechanism of antimicrobial activity in xanthone is caused by dysfunction in bacterial cell proteins (Putra, 2010; Saputro, 2014). Meanwhile, the mechanism of terpenoid as an antibacterial is by reducing the permeability properties of bacterial cell walls that will make the bacterial cells experience nutritional deficiencies, so that the growth of *E. coli* bacteria are inhibited and eventually dies (Cowan, 1999; Saputro, 2014).

Conclusion

The antibacterial activity test on the formulation of mangosteen peel extract encapsulated by maltodextrin demonstrated the medium level of the inhibitory zone diameter in each test bacterium and it will be more evident when the dose of mangosteen peel extract is increased. The mangosteen peel extract encapsulated by maltodextrin increased the antibacterial activity compared to no-encapsulated mangosteen peel extract or maltodextrin alone.

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