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Sifat Mikrobiologi dan Fisikokimia Beef Patty yang Ditambahkan Bubuk Daun Senduduk (Melastoma malabathricum) dengan Level yang Berbeda

(Microbiological and Physicochemical Properties of Beef Patties Added with Senduduk (*Melastoma malabathricum* L.) Leaf Powder at Different Levels)

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ABSTRACT
This study investigates the effect of adding different concentrations of senduduk (Melastoma malabathricum L.) leaf powder (SLP) on the microbiological and physicochemical properties of beef patties. Senduduk leaf is known for its antimicrobial and antioxidant activities, which may help improve the shelf life and quality of meat products. Beef patties were prepared with varying levels of SLP (0%, 0.5%, 0.75%, and 1%) and evaluated at 0 and 5 hours of storage for total plate count (TPC), moisture content, water holding capacity (WHC), and pH. The results showed that the addition of SLP did not significantly affect the TPC or WHC at both time points. However, the moisture content of the patties with 0.75% SLP was significantly higher at 0 hours, while no significant differences were observed after 5 hours of storage. Similarly, the pH values remained stable across all treatments. These findings suggest that while SLP can initially influence moisture retention, its antimicrobial and physicochemical effects are limited, particularly after cooking, which likely degrades the bioactive compounds. Future research should explore the use of SLP in low-temperature cooking or cold storage to maximize its potential as a natural preservative.

Key words: Beef Patty, Melastoma Malabathricum, Microbiology, Physicochemical.

ABSTRAK
Penelitian ini menyelidiki pengaruh penambahan berbagai konsentrasi serbuk daun senduduk *(Melastoma malabathricum L.)* terhadap sifat mikrobiologi dan fisikokimia roti daging sapi. Daun senduduk dikenal memiliki aktivitas antimikroba dan antioksidan yang dapat membantu meningkatkan umur simpan dan kualitas produk daging. Roti daging sapi dibuat dengan berbagai tingkat SLP (0%, 0,5%, 0,75%, dan 1%) dan dievaluasi pada 0 dan 5 jam penyimpanan untuk total plate count (TPC), kadar air, kapasitas menahan air (WHC), dan pH. Hasil penelitian menunjukkan bahwa penambahan SLP tidak berpengaruh secara signifikan terhadap TPC atau WHC pada kedua titik waktu tersebut. Namun, kadar air roti dengan 0,75% SLP secara signifikan lebih tinggi pada 0 jam, sementara tidak ada perbedaan signifikan yang diamati setelah 5 jam penyimpanan. Demikian pula, nilai pH tetap stabil di semua perlakuan. Temuan ini menunjukkan bahwa meskipun SLP pada awalnya dapat mempengaruhi retensi kelembapan, efek antimikroba dan fisikokimianya terbatas, terutama setelah pemasakan, yang kemungkinan besar menurunkan senyawa bioaktif. Penelitian di masa depan harus mengeksplorasi penggunaan SLP dalam memasak dengan suhu rendah atau penyimpanan dingin untuk memaksimalkan potensinya sebagai pengawet alami.

Kata kunci: Patty Daging Sapi, Melastoma Malabathricum, Mikrobiologi, Fisikokimia

INTRODUCTION

Beef is a significant source of high-quality animal protein, playing a critical role in fulfilling human nutritional needs due to its rich nutritional profile. Recent years have witnessed an increase in consumer demand for beef, driven by growing awareness of the importance of nutrient-rich and protein-dense foods. Unlike plant-based protein, beef offers a complete amino acid profile and superior bioavailability, making it an indispensable source of essential nutrients (van Vliet et al., 2021). Among the most popular processed beef products is the beef patty, commonly used in fast food items like burgers.

Beef patties are typically produced using ground beef as the main ingredient, often combined with breadcrumbs, eggs, garlic, salt, pepper, and binding agents like starch to improve the texture and stability of the product (Noumo et al., 2016; Eshag Osman et al., 2021). Owing to their dense nutritional content—comprising proteins, fats, vitamins, and minerals—beef patties are considered a balanced processed food. However, the perishable nature of beef renders beef patties vulnerable to microbial spoilage, raising concerns over food safety and shelf-life extension (Babolanimogadam et al., 2024). Pathogens such as Salmonella spp., Escherichia coli, and Listeria monocytogenes are common contaminants in meat products, particularly when proper handling and storage conditions are not maintained (Alexa et al., 2024, Dos Reis et al., 2024).

In recent years, the food industry has turned to natural preservatives with antimicrobial and antioxidant properties as an alternative to synthetic preservatives (Wen et al., 2024). One promising natural preservative is the leaf of Melastoma malabathricum L., commonly known as senduduk. The leaves of this plant are rich in bioactive compounds, such as tannins, flavonoids, saponins, and glycosides, which are known for their antimicrobial and antioxidant activities (Novelni et al., 2023, Suharyanto et al., 2023). Studies have demonstrated that extracts from senduduk leaves can inhibit the growth of pathogenic microorganisms and protect food products from oxidative deterioration (Novelni et al., 2023, Suharyanto et al., 2023, Yulion et al., 2023). Additionally, senduduk leaves have been widely used in traditional culinary practices, offering health benefits through their bioactive compounds (Suharyanto et al., 2022).

Recent research by Suharyanto et al., (2022) highlighted the effectiveness of incorporating senduduk leaf powder into processed meat products such as beef sausages. The study demonstrated that senduduk leaf powder reduced microbial growth and lipid oxidation while maintaining the physicochemical properties of the product. These findings indicate the potential of senduduk leaves as a natural preservative for other processed meat products. Therefore, this study aims to further explore the use of senduduk leaf powder in beef patties, examining its effects on microbiological safety and physicochemical quality.

This study investigates the microbiological and physicochemical properties of beef patties fortified with senduduk leaf (Melastoma malabathricum L.) powder. The findings provide deeper insights into the application of plant-based natural preservatives in meat processing, potentially extending the shelf life of beef patties while preserving their sensory and nutritional attributes. It was hypotesized that the addition of senduduk leaf powder could improve microbiological and phycochemical properties of beef patties.

MATERIALS AND METHODS

Powder preparation

Collecting Senduduk leaves from a single plot is the first step in the

Table 1. Formulation of beef patties based of the treatments fo a single batch

Ingredients	Treatments			
	T0	T1	T2	T3
Meat (g)	400	400	400	400
Cubic ice (g)	40	40	40	40
Skim milk powder (g)	20	20	20	20
Salt (g)	4.8	4.8	4.8	4.8
Vegetable oil (g)	4	4	4	4
Garlic powder (g)	2	2	2	2
White pepper powder (g)	1	1	1	1
Black pepper powder (g)	1	1	1	1
Senduduk leaf powder (%)*	0	0,5	0,75	1

*Percentage of senduduk leaf powder based on meat weight.

preparation process. After being air-dried for 72 hours, the leaves are further dried in an oven at 60°C for four to five hours or until they reach a consistent weight. The leaves are then blended into powder and sieved using a 35-mesh sieve.

Beef patties preparation

The preparation and formulation of beef patties were formulated with reference to Hajrawati et al. (2019) with slight modifications. The beef used in the patty preparation was top round beef. This cut is easy to grind and process into patties. Its solid consistency is ideal for creating uniform patties. After removing the fat from the meat (including subcutaneous and intramuscular fat), the meat was sliced thinly (4 x 5 cm) and processed in a meat grinder (with a hole diameter of 5 mm). After the meat was ground, several ingredients were added all ingredients (Table 1). All ingredients were hand-mixed for 10 minutes. A 75 g portion of the mixture was shaped into patties with a diameter of 90 mm and a thickness of 11 mm. The patties were then grilled for 15 minutes at 150°C and cooled to room temperature, approximately 27-29°C. Physicochemical and microbiological tests were conducted at 0 and 5 hours.

The formulations of the beef patties based on the treatments are as follows (Table 1).

Total Plate Count

The total plate count was conducted by following Indonesia National Standard (BSN, 2008). The total microbial count was determined using the plate count method. As a starting point for the dilution, 25 g of beef patty was aseptically homogenized and mixed with 225 ml of sterile Buffered Peptone Water (BPW). By pipetting 1 ml from each dilution into sterile BPW media, the initial dilution was further diluted in a series of 10^{-1}, 10^{-2}, 10^{-3}, 10^{-4}, 10^{-5}, and 10^{-6} increments. One ml from each dilution series was placed in sterile petri dishes, and 15-20 ml of sterile Plate Count Agar (PCA) was added to determine the total bacterial count. After the media solidified, the plates were incubated at 37ºC for 24-48 hours. At 0 and 5 hours of storage, the total microbial content in the beef patties was determined by counting the colonies. The preparation of BPW and PCA solutions followed the protocols specified by the brand used.

Moisture content

The oven drying method was used to determine the moisture content (AOAC, 2005). A stable weight was obtained after drying a 2 g sample of beef patty in an oven at 105°C for 3 hours. After 3 hours, the porcelain dish was removed and placed in a desiccator for approximately 15 minutes before being weighed. If the weight difference was less than or equal

Table 2. Tota plate count of beef patties added by senduduk leaf powder at different level

Variable	Hours	Treatments			
		T0	T1	T2	T3
Total plate count (log CFU/g)	0	4.26 ± 0.13	4.24 ± 0.07	4.24 ± 0.06	4.09 ± 0.11
	5	4.31 ± 0.03	4.28 ± 0.06	4.28 ± 0.02	4.24 ± 0.06

to 0.2 g, the weight was considered constant (AOAC, 2005). The formula to determine the moisture content is as follows:

Moisture Content (%) = ((BD+BS) initial - (BD+BS) after oven drying) / (BS initial) x 100

Where:
BD = Weight of the dish;
BS: Weight of the sample

Water holding capacity

One gram of crushed beef patty was added to a centrifuge tube along with 10 milliliters of distilled water. The sample and distilled water were mixed in the tube and stirred for five minutes. After that, the mixture was centrifuged at 3000 rpm for 30 minutes. The resulting supernatant was discarded, and the weight of the tube was recorded. Measurements were taken at 0 and 5 hours of storage. According to Jayasinghe et al. (2013), the following formula was used to determine water holding capacity (WHC):

WHC (%) = (b3 - b2 - b1) / b1 x 100

Where:
b1= weight of the sample;
b2: weight of the dry centrifuge tube;
b3 = final weight of the tube.

pH value

The pH value of the beef patty was measured by blending 2 grams of beef patty with 90 ml of distilled water until homogenized. A calibrated pH meter was used to measure the pH of the beef and water mixture. Data were collected at two different time points during storage: at zero and five hours.

RESULTS AND DISCUSSION

Total plate count

The addition of senduduk leaf powder (SLP) did not significantly affect the total microbial count in beef patties at both 0 and 5 hours of storage (P>0.05) (Table 2). Antimicrobial compounds such as flavonoids, tannins, and saponins in senduduk leaves are known to disrupt microbial cell membranes, inhibit essential enzymes, or interfere with DNA replication (Roy et al., 2023; Huang et al., 2024). However, in this study, increasing the concentration of SLP up to 1% did not significantly suppress microbial growth. The primary reason for SLP's ineffectiveness as an antimicrobial agent in this study is likely due to the high cooking temperature (150°C) used in the preparation of beef patties (Xiao, 2022). Typically, heating above 100°C can degrade phenolic structures that play a role in antimicrobial activity (Ginovyan, 2017). Additionally, certain microorganisms found in meat products, such as E. coli and Salmonella, are known to exhibit resistance to natural antimicrobial compounds, which may explain the lack of significant microbial reduction in the beef patties.

Another factor that could explain this result is the penetration level of antimicrobial compounds into the meat matrix (Aminzare et al., 2016). Heating

Table 3. Physicochemical properties of beef patties added with senduduk leaf powder at different level

Variable	Hours	Treatments			
		T0	T1	T2	T3
Moisture content (%)	0	64.02 ± 0.27^{ab}	64.63 ± 0.52^{ab}	65.98 ± 0.55^{a}	63.26 ± 1.97^{b}
	5	62.99 ± 0.73	61.20 ± 3.24	65.10 ± 2.30	63.18 ± 1.48
Water holding capacity (%)	0	60.86 ± 6.70	57.80 ± 12.20	51.80 ± 6.87	48.11 ± 6.65
	5	58.82 ± 6.51	63.67 ± 4.90	57.84 ± 8.52	62.56 ± 5.85
pH	0	5.65 ± 0.09	5.63 ± 0.13	5.60 ± 0.10	5.60 ± 0.15
	5	5.66 ± 0.11	5.57 ± 0.13	5.61 ± 0.08	5.67 ± 0.01

Different superscripts in same row indicate significant different (P<0.05)

may cause an uneven distribution of bioactive compounds in the meat, reducing antimicrobial effectiveness. Thus, although senduduk leaf powder possesses antimicrobial potential, the high cooking temperature limits its effectiveness.

Moisture Content

In this study, the moisture content of the beef patties tended to decrease with increasing concentrations of SLP at 0 hours (P<0.05) but showed no significant difference at 5 hours of storage (P>0.05) (Table 3). At 0 hours, the addition of 0.75% SLP (P2) resulted in the highest moisture content compared to other treatments, while the 1% concentration (P3) showed a lower moisture content. The decrease in moisture content at higher SLP concentrations is likely due to the astringent effect of tannins. Tannins are known to interact with proteins, causing tissue contraction and reduced water-holding capacity in the meat (Zhong et al., 2021). The increase in concentration of additives with astringent properties can lower the moisture content of processed meat products (Xiong, 2012). However, after 5 hours of storage, the moisture content of the beef patties showed no significant difference between treatments (P>0.05). This could be due to the gradual evaporation of water during room temperature storage. Water in processed meat products gradually evaporates over time, and by this stage, the water-binding effect of SLP may not be strong enough to maintain significant differences between treatments, as environmental factors like temperature and humidity become more dominant.

Water Holding Capacity (WHC)

The addition of SLP to beef patties did not significantly affect water holding capacity (WHC) at both 0 and 5 hours of storage (P>0.05). WHC is highly influenced by pH, especially when the pH approaches the isoelectric point of meat proteins (around 5.1-5.5). At this pH range, the ability of the meat to retain water tends to decrease. In this study, the pH of the beef patties ranged from 5.57 to 5.69, which is close to the isoelectric point of meat proteins. Therefore, the addition of SLP did not significantly increase water-holding capacity. The reduction in WHC after cooking was also attributed to protein denaturation during high-temperature heating. Protein denaturation leads to the loss of protein structure that holds water, causing water to be more easily released from the meat matrix during cooking (Liu et al., 2024). Although SLP contains bioactive compounds that can influence water-holding capacity, their effect may be too small to counterbalance the structural

changes in the proteins caused by high-temperature cooking. A study by Sedlacek-Bassani et al. (2020) that added spice powder to beef burgers also found similar results, where no significant changes in water-holding capacity were observed despite the addition of natural ingredients. The strong muscle fibers and stable proteins in beef during cooking likely prevented significant changes in water-holding capacity.

pH value

The pH values of beef patties with the addition of SLP showed no significant difference, ranging from 5.57 to 5.69 across all treatments ($P>0.05$). This relatively stable pH indicates that the addition of SLP, despite containing acidic compounds such as polyphenols, was not sufficient to alter the acid-base balance in the beef patties. The lack of difference in pH in this study may be because the concentration of the additive was too low to have a substantial impact on the pH of the meat products. This is consistent with the findings of Munekata et al. (2020), who found that natural ingredients such as plant extracts do not always affect the pH of processed meat products unless used in sufficiently high quantities.

CONCLUSION

The addition of senduduk leaf powder (SLP) at higher concentrations did not significantly affect total microbial count, water holding capacity, or pH of beef patties at either 0 or 5 hours of storage. Although the addition of SLP influenced moisture content at 0 hours, this effect was not observed at 5 hours, indicating that the water-binding effect of SLP is temporary. The primary factor limiting the effectiveness of SLP is the high cooking temperature, which leads to the degradation of bioactive compounds such as polyphenols. Future research is recommended to explore the use of SLP in low-temperature cooking or cold storage conditions to optimize the bioactive potential of antimicrobial and water-binding compounds in senduduk leaves.

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