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Analysis of Bay Leaf Tea Blend Made from Bay Leave (*Syzygium polyanthum*), Turmeric (*Curcuma Longa* L.), and Cinnamon (*Burmese cinnamon*) for Preventing Degenerative Diseases in the Community

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Abstract

Antioxidants act as free radical stabilizers to reduce oxidative stress, which in the long term can cause degenerative diseases. The development of functional drinks in the form of tea made from local ingredients such as bay leaves, turmeric, and cinnamon is expected to play a significant role in reducing the prevalence of degenerative diseases. This study aims to determine the best formulation of tea blend made from bay leaves, turmeric, and cinnamon based on physicochemical properties and consumer acceptance. It was conducted using an experimental method with a Completely Randomized Design (CRD). Three formulations with different ratios of bay leaves, turmeric, and cinnamon, namely F1 (50:25:25), F2 (37.5:25:37.5), and F3 (25:20:55), were tested for water content using the gravimetric method, pH using a pH meter, antioxidant activity using the DPPH method, and hedonic acceptance tests. The hedonic test was conducted with 100 untrained panelists. The best functional tea blend for the prevention of degenerative diseases was F3, which contained the highest content of cinnamon (55%) with moderate antioxidant activity.

INTRODUCTION

Degenerative diseases are conditions affecting organs or tissues that continue to deteriorate over time and may begin at a productive age without being recognized by the community. They can lead to the development of non-communicable diseases (NCDs), such as diabetes mellitus, hypertension, and cancer (di Renzo et al., 2021; Nediani and Giovannelli, 2020; Rukmini et al., 2021). Data from the Indonesian Basic Health Research (Riskesdas) indicated an increasing prevalence of degenerative diseases in Indonesia, including hypertension (from 25.8% to 34.11%), diabetes mellitus (from 1.5% to 2.0%), stroke (from 7.0% to 10.9%), chronic kidney failure (from 0.2% to 0.38%), cancer (from 1.4% to 1.79%), and obesity (from 15.4% to 21.8%) (Ministry of Health, 2018). Degenerative diseases are responsible for 72% of deaths worldwide, which is four times higher than the total number of deaths caused by infectious diseases, maternal issues, perinatal complications, and nutritional problems, especially in developing countries (Ministry of Health, 2023; IDF, 2021).

Degenerative diseases can develop over time, and one significant factor contributing to these conditions is the presence of free radicals. These molecules, which are unstable and highly

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reactive, possess one or more unpaired electrons in their outer shell (Halliwell & Gutteridge, 2015). Free radicals can originate from external sources, such as air pollution, radiation, ultraviolet rays, diet, and excessive exercise, as well as from internal sources, including immune cells, inflammation, psychological stress, aging, and cancer (Azeh et al., 2022; Halliwell & Gutteridge, 2015). The accumulation of free radicals in the body can trigger oxidative stress and cause damage (Peña-Oyarzun et al., 2018). Oxidative stress occurs due to an imbalance between the number of free radicals (prooxidants) and the number of antioxidants produced by the body (endogenous) (Demirci-Çekiç et al., 2022). This oxidative stress causes various degenerative diseases. Antioxidants play a key role in stabilizing free radicals by completing the missing electrons in free radicals so that oxidative reactions do not occur continuously (Sharifi-Rad et al., 2020). Understanding their role can facilitate the exploration of potential preventive measures and therapeutic approaches for combating such diseases.

Several in vivo studies have examined the effects of local herbs and spices, such as turmeric, cinnamon, and bay leaf, on non-communicable diseases, particularly in the context of diabetes and cardiovascular disease risk factors. These studies involved both animal models and human participants, investigating the spices individually and in combination (Oh, 2020; Syahfitri et al., 2023; Sivaranjani et al., 2021; Syahfitri et al., 2023). These studies indicate that turmeric, cinnamon, and bay leaf, both individually and in combination, exhibit potential therapeutic effects against non-communicable diseases such as diabetes and cardiovascular disease by reducing blood glucose levels, improving lipid profiles, and exerting anti-inflammatory effects (Oh, 2020; Syahfitri et al., 2023; Sivaranjani et al., 2021; Syahfitri et al., 2023).

Under certain conditions, the body requires exogenous antioxidants, which can be obtained through the consumption of functional beverages made from plant, animal, marine, or microbial materials (Gayathry and John, 2021). A wide variety of functional materials found in the environment can be utilized to develop innovative formulations for functional drinks. These drinks have considerable potential for preventing degenerative diseases and promoting healthier lifestyles and overall well-being (Handayani et al., 2020; Handayani et al., 2021a; Handayani et al., 2021b; Handayani et al., 2021c). In this study, the product formulated by combining bay leaves (*Syzygium polyanthum*), turmeric (*Curcuma Longa* L.), and cinnamon (*Burmese cinnamon*), is expected to improve the product's antioxidant content, flavor, and color appearance. Tea was selected as the product form because it is one of the most widely consumed beverages after water (Franks et al., 2019) and is among the most widely recognized beverages worldwide due to its flavor, aroma, and health benefits (Mondal and De, 2018).

Bay leaves contain various phytochemicals, namely alkaloids, flavonoids, saponins, betacyanins, tannins, steroids, terpenoids, phenols, cardio glycosides, and quinones (Alina et al., 2023; Ansari et al., 2024). The antioxidant activity of bay leaf ethanol extract is 64.93%, indicating very strong antioxidant activity (Negrão et al., 2023). Bay leaf tea has a brownish color and a fragrant aroma but a sour and bitter taste. Therefore, it should be combined with other herbal ingredients to improve its flavor (Ochanda et al., 2015). The formulation was developed by adding turmeric and cinnamon. Turmeric is commonly used as a food flavoring and traditional medicine. It contains curcumin, a diarylheptanoid and the principal active phenolic compound in turmeric, which has antioxidant and antibacterial properties. The curcumin content ranges from 3% to 15%, and its antioxidant activity is comparable to that of vitamins C and E (Riswanto and Rezaldi, 2021; Pratama and Yusmarini, 2015). Dried turmeric rhizome exhibits antioxidant activity of 48.7%, which is classified as moderate (Sandikapura and Noordin, 2018). Cinnamon powder demonstrates very strong antioxidant activity, with a value of 85.97% (Shoqairan et al., 2023). Cinnamon is added to enhance the flavor of the drink, with cinnamaldehyde as the main flavor component (de Silva et al., 2024; Kautsar et al., 2024). Previous studies have examined herbal tea formulation, such as Palupi and Widyaningsih (2015), who developed bay leaf tea with the addition of ginger and sappan wood filtrate; Srisuk et al. (2025), who formulated herbal tea from turmeric and pandan; and Indarto et al. (2020), who developed a tea formulation based on soursop leaf tea with the addition of cinnamon powder. Nevertheless, the combination of bay leaves, turmeric, and cinnamon in a single herbal tea formulation has not yet been reported. Therefore, this study aimed to determine the optimal blended tea formulation from three selected formulas (F1, F2, and F3) for the prevention of degenerative diseases, based on physicochemical tests, hedonic tests, and antioxidant activity assays.

METHOD

This study employed an experimental quantitative design using a completely randomized design (CRD). The design involved one factor: variations in the proportions of bay leaves, turmeric, and cinnamon. It comprised six formulations derived from previous research: P1 (2:1:1), P2 (1.5:1:1.5), P3 (1:1:2), P4 (75%:20%:5%), P5 (50%:20%:30%), and P6 (25%:20%:55%) (Yanti et al., 2022; Andriyani et al., 2024; Habi et al., 2021; Halim and Halim, 2023; Kaka et al., 2023; Palupi and Widyaningsih, 2015; Pura et al., 2015; Romadhoni et al., 2023; Tirtayani et al., 2022). Then, three formulations were selected through organoleptic testing and a focus group discussion (FGD) with trained panelists (P1, P2, and P6). The trained panelists had to: (1) possess a solid understanding of the fundamental principles of sensory evaluation, including descriptive analysis procedures, the use of intensity scales, and standardized objective assessment methods; (2) demonstrate strong cognitive and verbal abilities to identify, describe, and reach consensus on sensory attributes during FGD sessions and QDA evaluations; and (3) hold at least a bachelor's degree in a related field, ensuring adequate comprehension of technical instructions and scientific terminology used in sensory analysis. The three selected formulations were designated as F1, F2, and F3, as shown in Table 1. The formulations were continued in laboratory tests (water content, pH levels, and antioxidant activity) with two repetitions and hedonic tests with the target community (100 untrained panelists). The independent variable in this study was the tea formulation, consisting of combinations of bay leaves, turmeric, and cinnamon (F1, F2, and F3). The dependent variables included pH, water content, organoleptic properties, and antioxidant activity.

Table 1. Comparison of the Three Tea Formulations

Material	Comparison of Ingredients in Formulation (%)		
	F1	F2	F3
Bay leaf	50,0	37,5	25,0
Turmeric	25,0	25,0	20,0
Cinnamon	25,0	37,5	55,0
Total	100	100	100

The equipment used to produce the blended bay leaf, turmeric, and cinnamon tea included knives, baking trays, an oven, a blender, tea bags, analytical balances, measuring cups, and thermometers. The stages of tea preparation are presented in Figure 1. The blended tea was then packaged in tea bags (Figure 2). pH analysis (using a pH meter), moisture content determination (using the gravimetric method and expressed as a percentage), and antioxidant activity assessment (using the DPPH method and expressed as inhibition percentage) were conducted at the UNNES Nutrition Laboratory. Hedonic testing was performed to identify the preferred product using a 9-point hedonic scale questionnaire, which has been shown to be valid and reliable for assessing consumer preferences (Stone et al., 2021). The assessment was conducted with 100 consumer panelists aged 20–40 years who were healthy and willing to participate. The panelists were selected through purposive sampling, and acceptance testing was carried out using a 1–9 hedonic scale, in which 1 indicated "dislike extremely" and 9 indicated "like extremely" (Meilgaard et al., 2007; Setyaningsih et al., 2010). This study was approved by the Research Ethics Committee of Universitas Negeri Semarang (ethical approval number 750/KEPK/FK/KLE/2025). All data are presented as mean ± standard deviation (SD) from two replicates. One-way ANOVA was used to determine significant differences among groups, and post hoc tests were performed for further analysis of significant results at a 95% confidence level.

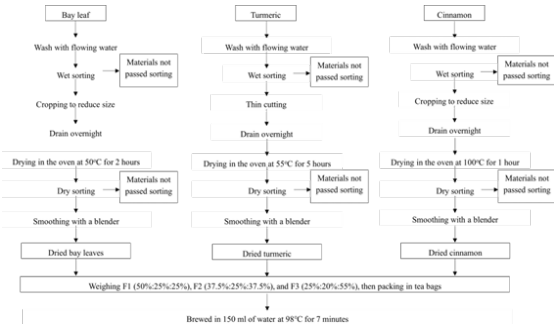

Figure 1. Flow chart processing of tea blend made from bay leaves, turmeric, and cinnamon (Modified from Anggraini et al.,2024; Haryani et al., 2021; Habi et al., 2021; Christina et al., 2018; Pérez-Burilloa et al., 2018)

RESULT AND DISCUSION

Six formulations were derived from previous studies for laboratory and hedonic testing. Organoleptic evaluation was then conducted by six trained panelists, followed by laboratory analyses of physicochemical properties and antioxidant activity. Subsequently, the three best formulations were selected through a focus

Table 2. Results of water content, pH and antioxidant activity tests of tea made from bay leaves, turmeric and cinnamon

Parameter	Formulation			P-value
	F1	F2	F3	
Water Content (%)	8.8 ± 0.00	8.48 ± 0.01	7.41 ± 0.00	0.111
pH	8.85 ± 0.13	8.83 ± 0.21	8.80 ± 0.24	0.939
Antioxidants (%)	21.05 ± 2.61	21.53 ± 3.64	26.39 ± 1.112	0.036*

Data were shown as mean ± standard deviation *ANOVA test, significant at p-value <0.05

group discussion (FGD) and used for large-scale hedonic testing among the target community. Based on the FGD results, the trained panelists selected three formulations, designated sample codes 430 (F1), 256 (F2), and 167 (F3) (Table 1), which were then subjected to further laboratory analysis and large-scale hedonic testing.

Figure 2. Tea formulation processing

Water Content, pH, and Antioxidant Activity

The results of the laboratory tests of water content, pH, and antioxidant activity in tea made from bay leaves, turmeric, and cinnamon are presented in Table 2. The lowest moisture content was found in formulation F3 (7.41%), whereas the highest pH value was observed in F1 (8.9), and the highest antioxidant activity was found in F3 (26.39%) (Table 2). Laboratory analysis of the moisture content and pH of tea products formulated with bay leaves, turmeric, and cinnamon yielded p-values > 0.05, indicating no significant differences among F1, F2, and F3.

The addition of varying proportions of bay leaf and turmeric to the blended tea did not result in significant differences in water content or pH. However, the highest moisture content (8.83%) and the highest pH value (8.9) were observed in F1, which contained the highest proportion of bay leaf (50%). The tested formulations complied with the Indonesian National Standard (SNI) for tea quality, namely a moisture content of <8% for packaged dry tea (SNI 3836:2013), a moisture content of <10% for simplicia (Indonesian Ministry of Health, 2017), and a pH range of 5–10 (BPOM RI, 2025; Ministry of Health, 2017).

The antioxidant activity analysis of the tea blended with bay leaves, turmeric, and cinnamon yielded a p-value < 0.05, indicating significant differences in antioxidant activity among all formulations (F1, F2, and F3). Accordingly, a post hoc test was performed to identify the specific differences between formulations (Table 3). The post hoc results showed a significant difference in antioxidant activity between F1 and F3 and between F2 and F3 (p < 0.05) (Table 3).

Table 3. Results of post hoc tests of antioxidant activity

Formulation		p-value
F1	F2	0.805
	F3	0.020*
F2	F1	0.805
	F3	0.030*

*Significant at p-value<0.05

The highest antioxidant activity (26.39%) was observed in formulation F3, which contained the highest proportion of cinnamon (55%), whereas the second-highest antioxidant activity (21.53%) was found in formulation F2, which contained the second-highest proportion of cinnamon (37.5%). The ANOVA results indicated significant differences in antioxidant activity among formulations F1, F2, and F3 (Table 2). Further post hoc tests showed significant differences, particularly between F1 and F3 and between F2 and F3. These findings indicate that one determinant of the antioxidant activity of the blended tea is the proportion of cinnamon in the formulation. The antioxidant activity of all formulations was classified as moderate. Moderate antioxidant activity ranges from 20% to 50%; high activity ranges from 50% to 100%; and low activity is defined as less than 20% (Asmediana et al., 2023; Setyaningtiyas et al., 2024 in Wulansari and Catur, 2011).

The bioactive compounds in cinnamon, including cinnamaldehyde, cinnamic acid, and proanthocyanidins, are believed to play a major role in its antidiabetic activity (Hayward et al., 2019). In addition, cinnamon contains phenolic and fla-

vonoid compounds, which act as antioxidants by neutralizing lipid free radicals and preventing the decomposition of hydroperoxides into free radicals (Antasionasti et al., 2020). Active compounds in cinnamon extract, such as tannins, flavonoids, triterpenoids, and saponins, have anti-erythrocyte agglutination and antihypercholesterolemic properties (Maslahah and Nurhayati, 2023). Antasionasti (2021) also reported that the antioxidant activity of cinnamon ethanol extract, measured using the DPPH method, yielded an IC50 value of 0.055 µg/mL, indicating strong activity. Nurminabari et al. (2019) also found that cinnamon powder exhibited very strong antioxidant activity, with a value of 6.43 ppm. Another study reported that cinnamon powder had very strong antioxidant activity, reaching 85.97% (Shoqairan et al., 2023). Previous studies have also shown that polyphenolic compounds in cinnamon extract, such as flavonoids and tannins, possess antihypertensive properties by inhibiting angiotensin-converting enzyme (ACE) activity, thereby promoting relaxation of the vascular endothelium, increasing blood flow to the heart, and reducing blood pressure (Fransiska et al., 2019).

The addition of bay leaves (Syzygium polyanthum) and turmeric (Curcuma longa L.) to the formulation was expected to enhance the tea's antioxidant activity. Previous studies have shown that bay leaves may be used as antihypertensive, antidiabetic, antihypercholesterolemic, antioxidant, antidiuretic, and antibacterial agents, as well as for managing gout (Mayasari et al., 2020). These benefits can be obtained from fresh leaves, simplicia, or extracts. The therapeutic effects of bay leaves are attributed to their bioactive compounds, or secondary metabolites. Qualitative tests have indicated that bay leaves contain flavonoids, alkaloids, terpenoids, saponins, and tannins (Wilappangga and Sari, 2018). Flavonoids are aromatic compounds with antioxidant capacity that inhibit oxidation by neutralizing free radicals and forming non-reactive compounds (Ekawati et al., 2017). Flavonoids also help prevent cardiovascular disease through their antioxidant activity, which protects cells from damage caused by reactive free radicals (Erwan and Parbuntari, 2023). In addition, bay leaves may reduce dyslipidemia by inhibiting fat absorption and lowering low-density lipoprotein (LDL) levels through their antioxidant role in inhibiting apoB-100 secretion into the intestine. They may also reduce uric acid levels due to their fluorescein content (Harismah, 2017).

Turmeric is also known to provide various health benefits, including antioxidant, anti-inflammatory, antitumor, antimicrobial, and anticancer effects, as well as the ability to lower blood lipids and cholesterol and purify the blood. Curcumin, the principal antioxidant compound in turmeric, helps protect healthy cells, particularly those at risk of becoming cancerous. This effect is also associated with its antioxidant properties, including the inhibition of carcinogenesis, suppression of estrogen-dependent cell proliferation, and anti-angiogenic activity (Kusbiantoro and Purwaningrum, 2018). Previous studies have shown that curcumin exhibits strong antioxidant activity, comparable to that of vitamins C and E (Shan and Iskandar, 2018). However, in this study, the combined composition of bay leaves, turmeric, and cinnamon, all of which are rich in antioxidants, did not enhance the antioxidant activity of the final tea product.

The moderate antioxidant activity observed in the tea blend of bay leaves, turmeric, and cinnamon is likely attributable to predominantly additive interactions among phenolic compounds with similar chemical characteristics, which tend to act independently without strong regeneration mechanisms or synergistic enhancement (Hossain et al., 2023). Although turmeric contains curcuminoids with potential synergistic properties, their contribution may be limited by instability under processing conditions such as heat, light, and the chemical environment, leading to reduced overall antioxidant capacity (El-Saadony et al., 2023; Ali et al., 2024). In addition, the ionization state and electron-donating reactivity of phenolic groups can influence radical-scavenging efficiency, while possible kinetic competition among antioxidants with similar mechanisms may further limit increases in total activity (Hossain et al., 2023; Soetan et al., 2023).

Hedonic Test

Table 4 presents the results of the hedonic test for tea blended with bay leaves, turmeric, and cinnamon, including color, aroma, flavor, and overall acceptability. The highest color score was obtained for F1 (7.1), the highest aroma score for F2 (5.9), the highest flavor scores for F2 and F3 (5.3), and the highest overall acceptability score for F2 and F3 (5.9) (Table 4).

Panelists' assessment of color obtained an F value of 5.770 with a p-value of 0.003, indicating significant differences among the tea formulations containing bay leaves, turmeric, and cinnamon (F1, F2, and F3) with respect to color. In contrast, aroma evaluation produced an F value of 1.023 with a p-value of 0.361, indicating no significant differences among F1, F2, and F3.

Similarly, flavor evaluation yielded an F value of 0.557 with a p-value of 0.574, also indicating no significant differences among the formulations. The overall acceptability assessment produced an F value of 0.166 with a p-value of 0.847, indicating no significant differences in panelists' overall preference among F1, F2, and F3.

Table 4. Results of the hedonic test of tea mixed with bay leaves, turmeric, and cinnamon

Parameter	Formulation			P-value
	F1	F2	F3	
Color	7.1	6.6	6.7	0.003*
Aroma	5.8	5.9	5.9	0.361
Flavor	5.1	5.3	5.3	0.574
Overall	5.8	5.9	5.9	0.847

*ANOVA test, significant at p-value <0.05

A post hoc test was conducted for the color parameter to determine more specific differences among the formulations. The results showed that the panelists' color preference scores differed significantly between F1 and F2, as well as between F1 and F3 ($p < 0.05$), indicating significant differences in color preference between F1 and the other two formulations. In contrast, no significant difference was observed between F2 and F3 ($p > 0.05$).

The ANOVA results of the hedonic test conducted with 100 target panelists (adults aged 20–40 years) showed no significant differences in panelists' preferences for aroma and flavor. However, a significant difference was observed in panelists' preference for the color of the tea blended with bay leaves, turmeric, and cinnamon. Marfungah et al. (2019) reported that cinnamon is added to beverages and foods to enhance flavor through its main flavor component, cinnamaldehyde, and that a 4% addition of cinnamon was preferred by panelists. In addition, Qur'ani (2023) found that a 15% cinnamon concentration produced a dark brown color that was preferred by panelists. Thus, cinnamon was included in this tea formulation to increase antioxidant activity, improve flavor, and enhance the color of the tea.

The best tea formulation from this study, in accordance with its preventive purpose for degenerative diseases, was F3 (25% bay leaves, 20% turmeric, and 55% cinnamon). This formulation was selected based on its highest antioxidant activity (26.39%), which was classified as moderate. Because the antioxidant analysis in this study was limited to inhibition percentage, further analyses, such as IC50 determination or in vivo testing, are needed to more specifically assess antioxidant strength and the mechanism of free radical scavenging. Further research is also needed to improve product availability for consumers, including packaging development and shelf-life analysis.

Further studies employing complementary assays and interaction modeling are needed to determine whether the combined effect is additive, synergistic, or antagonistic, as this study relied solely on the DPPH inhibition assay, which reflects only a single electron-transfer-based mechanism. The research design was limited to a single in vitro endpoint without dose-response or combination-index analysis, thereby restricting accurate characterization of interaction patterns. Moreover, the DPPH assay does not capture other antioxidant mechanisms or reflect activity in complex biological systems. Therefore, the results are limited to chemical antioxidant capacity and cannot be directly translated into physiological efficacy or used to substantiate health claims.

CONCLUSION

The findings indicate that the most suitable formulation for the prevention of degenerative diseases is F3, composed of 25% bay leaves, 20% turmeric, and 55% cinnamon. This formulation contains the highest proportion of cinnamon (55%) and exhibits moderate antioxidant activity. These results suggest that the tea blend can neutralize free radicals, although less effectively than products with high antioxidant activity. Further research is needed to improve its availability for a broader consumer base.

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