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An Analysis of Acceptability and shelf life for Bilimbi Leaves Tea Product (*Averrhoa Bilimbi* L.) as Alternative Antihypertension

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Bilimbi leaves as a functional food can be used as a non-pharmacological anti-hypertensive. This plant is processed into herbal tea as herbal beverage. This study aimed to investigate the acceptability and shelf life for Bilimbi leaves tea product. This study was an experimental study using 4 wet leaves formulas which were dried into tea. Tests were carried out towards 15 semi-trained panelists and 30 consumer panelists. bilimbi leaves tea were stored for 14 days at 25°C, 35°C and 45°C by measuring the water content parameter and total microbes. Data were calculated and analyzed by using Kruskal Wallis test and Arrhenius equation. The analysis results of Arrhenius equation in the hedonic quality test of semi-trained panelists as whole highest score in formula 4, but the taste parameter score was lower. Meanwhile, in the hedonic test of consumer panelist, the highest score was in formula 2 with better taste parameter score overall. The results of Kruskal Wallis test showed that there was a significant difference ($p<0.05$). The highest water content of Bilimbi leaves tea product was stored at 45oC, while the total microbes of product met the standard. Tea Stored at 25°C has a longer shelf life for 112 days. It concluded that formula 2 (7 grams/150 ml of water) has better acceptability with the best shelf life store at 25°C.

Keywords: Acceptability; Bilimbi Leaves; Hypertension; Herbal Tea; Shelf Life.

One of Non-communicable diseases (NCDs) which become very serious health problem is hypertension which can affect anyone either young or old, it is also known as silent killer [1]. In America, it is estimated that 1 in 4 adults suffer from hypertension. Several studies have reported that uncontrolled hypertension can cause 7 times greater chance of having stroke, 6 times greater chance of having congestive heart failure and 3 times greater chance of having heart attack [2].Hypertension is also a degenerative disease. Generally, blood pressure increases slowly with age [3].High blood pressure (hypertension) is a condition in which the blood pressure is e"140 mmHg (systolic) or e" 90 mmHg [4]. Data from the World Health Organization (WHO) in 2015 showed that around 1.13 billion people suffer from hypertension in the world. It is also estimated that there are 9.4% million people who die from hypertension and complication every year [5]. The Baseline Health Research in 2018 stated that the prevalence of hypertension based on measurement

results in people aged 18 years was 34.1% and it was 32% in South Sulawesi. There was an increase of Baseline Health Research report in 2013 to 2018 by 8.3% [6].

Non-pharmacological therapy is therapy with healthy lifestyle strategy in patients with stage 1 hypertension without cardiovascular risk factors, While pharmacological therapy uses medicines such as beta-blockers, Angiotensin Converting Enzyme (ACE) inhibitors, anxiety receptor blockers, calcium channel blockers, diuretics, nitrates[7]. bilimbi leaves contain flavonoids, potassium and saponins which have function as diuretic so that fluid sodium outcome increases, and blood pressure decreases. One of methods to use bilimbi leaves is by brewing or boiling them [8]. bilimbi leaves are processed in the form of tea powder which is more practical and easier to consume. Tea is the most consumed beverage by Indonesians because it tastes fresh [9].In 2018, global tea consumption increased to 13.9% from 2014. Indonesia is in 10th place as the largest tea consumption in the world [10]. The practitioners of medicine and herbal industry usually choose leaves on sheets 4-6 from the tea shoot because they are considered to have greater active substance. Leaves that are too old have lower active substance as well as those which are too young[11].

In the manufacturer of product, shelf life is one of the parameters that should exist in food product packaging. The shelf life test describes how long the product can survive at the same quality during the storage process [12]. One of estimating methods to test shelf life for product is using ASLT (Accelerated Shelf Life Test) method. Before using ASLT method, it is necessary to determine the assumption and parameter that support the model [13].

Based on the high level of public preference for tea and potential utilization of the local plant namely bilimbi leaves for the incidence of hypertension also the importance of the shelf life score for various parties so that researchers are interested in conducting research on the acceptability test of bilimbi herbal tea leaves and determining the shelf life for tea product from Bilimbi leaves (*Averrhoa Bilimbi L.*) as an alternative antihypertensive.

MATERIAL AND METHOD

Design, Location, and Time of Study

This study was an experimental study to assess the acceptability by using the hedonic/ preference test and assess the shelf life for product. The place for making Bilimbi leaves herbal tea was in the Food Technology Laboratory, Department of Nutrition, Makassar Health Polytechnic and the place for determining the shelf life for Bilimbi leaves tea for water content test was in the Integrated Forestry and Environment Laboratory, Faculty of Forestry, Hasanuddin University. The Time of this study was carried out in April to August 2022.

Participants

Trained Panelists

Fifteen semi-trained panelists were students at Faculty of Public Health, Hasanuddin University, Makassar.

Consumer Panelists

Consumer panelists were 30 people with purposive sampling which was carried out in the work area of Paccerakang Public Health Center, Makassar City.

Instrument dan Procedure

Material, tools and work procedure for making bilimbi leaves herbal tea

The raw material for this study was bilimbi leaves which were neither too old nor too young. The leaves used were the fourth leaves from the shoot to the fourth from the bottom of stalk.

The tools used in making Bilimbi leaves tea were digital scale, basin, filter basket, spoon, tea bag and oven. The process of making Bilimbi leaves tea begins by picking the leaves from the stem, washing the leaves until clean and draining the leaves from the water, then placing them in the oven pan to dry, then crushing them into the preferred tea powder.

Acceptability

This study determined the hedonic quality test towards semi-trained panelists which was carried out to determine the quality of product or did not involve the preferred or non-preferred product and the hedonic test towards consumer panelists which was carried out to determine the level of preference for the product. This study used

an assessment questionnaire that had been adapted to the Indonesian National Standard for sensory testing guideline provided by laboratory staff (SNI 2346:2015: Guidelines for Product Sensory Testing). The reliability of this questionnaire was tested by using Cronbach's Alpha (á> 0.70) with a score of á = 0.843.

Water content

Water content was measured by drying the empty clean cups in the oven at ± 105 – 110oC for one hour, then cooling them on desiccator for 15 minutes and weighing (W1). Five grams of sample (W2) that mashed put into the cup and baked at 105 – 110oC for three hours until it reaches constant weight. Further, cool on desiccator and then weigh (W0). The water content is calculated by the formula:

$$\% \text{ water} = (WI - W2)/(W0) \times 100\%$$

Total Microbes

Measurement of total microbes used the TPC (Total Plate Count) method. According to the regulation of The National Agency of Drug and Food Control (BPOM) of Indonesia regarding microbial contamination in processed food in 2019, the number of total microbes allowed in the herbal tea category is 1x104 colonies/ml[14] and it can be calculated by the formula:

$$N = \Sigma C/([(1 \times n1) + (0{,}1 \times n2)] \times (d))$$

Description
N = Number of sample colonies (Col/ml)
ÓC = Number of colonies counted in all plates
n1 = Number of plates calculated in the first dilution
n2 = Number of plates calculated in the second dilution
d = the first dilution counted

Shelf of Life

The samples were stored in incubator with 3 different temperatures which were 25°C, 35°C and 45°C and the samples were measured for their water content for 14 days every day 0, day 4, day 7, day 11 and day 14, determination of temperature and storage time based on the Guidelines to estimate the shelf life for Food product [12]. The results of water content were analyzed to determine the selected reaction order which has the largest R2 score. The prediction of shelf life was seen from the score of reaction rate K at certain temperature and it was determined by putting the temperature score of 1/T (°K) into the Arrhenius equation:

$$t = (Q - Qo)/k$$

Description:
T : Time (Shelf Life)
Q : Parameter of final storage quality
Qo : Parameter of first storage quality
K : The reaction rate at certain temperature

This method was first carried out by making data plot on the relation among the quality scores (Qt) for each temperature to the observation time (t day) according to the reaction ordo 0 and 1. Furthermore, based on these equations, the score of reaction rate constant/degradation (kt) can be obtained and compare with the correlation score. Then the most suitable reaction order can also be determined. Afterwards, the determination of the shelf life can be obtained by extrapolating the storage temperature to the Arrhenius equation.

Data Analysis

The data obtained were analyzed by Kruskal Wallis test. Shelf life analysis used the Accelerated Shelf Life Test (ASLT) method with the Arrhenius model. All data were analyzed using SPSS version 23.

Ethical Consideration

This study has received approval from the Health Research Ethics Committee (KEPK) of Faculty of Public Health, Hasanuddin University Makassar with number 3343/UN4.14.1/TP.01.02/2022.

RESULTS AND DISCUSSION

Acceptability of Bilimbi Leaves Tea

Based on table 2, it showed that the results of the hedonic quality test analysis towards semi-trained panelists on the color parameter, the highest score was formula 4, then the smell parameter score was the highest in formula 4 and the taste parameter score was the highest in formula 1, but the highest score was in formula 4 overall and the parameter score of taste was lower. The results of Kruskal Wallis analysis test showed that there was significant difference in the hedonic quality test in all aspects of parameters.

Based on table 2, it showed that the results of the analysis from the consumer panelist hedonic test on the color parameter with the highest score was formula 2, then the smell parameter had the highest score in formula 1 and the taste parameter had the highest score in formula 1, but overall the highest score is in formula 2. The results of Kruskal Wallis test analysis showed that there was significant difference in the hedonic test in all aspects of parameter.

Analysis of Shelf-life of Bilimbi Leaves Tea

Based on table 4, the water content of Bilimbi leaves tea showed a decrease after storing for 14 days. The highest water content reduction was at 45^{0}C (1.2%). Meanwhile, the percentage water content reduction at 35^{0}C and 25^{0}C was 0.9 and 0.5 for each.

Based on table 5, there was a decrease in total microbes in Bilimbi leaves tea stored from 0 days to 14 days with temperatures of 25^{0}C, 35^{0}C, and 45^{0}C. The highest reduction was at 45oC as 1.1x103. Meanwhile, at 35^{0}C and 25^{0}C were 0.8x103 and 0.2x103 for each.

Based on table 6, the results of Arrhenius equation calculation showed that at 250C, it had shelf life for 112 days, while it had a shelf life for 60 days at 35^{o}C and product stored at 45^{o}C had shelf life for 39 days. The shelf life test will describe how long the product can survive at the same quality during the storage process.

Table 1. Bilimbi Leaves Tea Formula After Drying Process

Category	F1	F2	F3	F4
Wet Weight	15 grams	20 grams	25 grams	30 grams
Dry Weight	5 grams	7 grams	8 grams	10 grams
Water	150 ml	150 ml	150 ml	150 ml
Temperature	55°C	55°C	55°C	55°C
Drying Duration	2 Hours	2 Hours	2 Hours	2 Hours

Tabel 2. Hedonic Acceptance Test Analysis of Bilimbi Leaves Tea on Likert Scale and Cruskal Wallis towards Semi-Trained Panelists

Parameter	Score of Bilimbi leaves herbal tea				
	F1	F2	F3	F4	*p-value**
Color	29%	69.3%	69.3%	84%	<0.001
Smell	34.6%	53.3%	60%	65.3%	0.002
Taste	70.6%	48%	32%	34.6%	<0.001
Overall	44.7%	54.2%	53.7%	61.7%	<0.001

* Kruskal Wallis Test

Table 3. Hedonic Acceptance Test Analysis of Bilimbi Leaves Tea on Likert Scale and Kruskal Wallis in Consumer Panelists

Parameter	Score of Bilimbi leaves herbal tea				
	F1	F2	F3	F4	*p-value*
*					
Color	62.6%	74.1%	70.6%	56.6%	0.022
Smell	66.6%	62.6%	58.1%	51.3%	0.003
Taste	64%	56.6%	42%	42%	<0.001
Overall	64.4%	64.5%	56.9%	49.9%	<0.001

* Kruskal Wallis Test

DISCUSSION

Acceptability

Based on the results of acceptability using the Likert scale as a whole, formula 2 (7 dry grams/150 ml) is the product with selected formulation, but in the hedonic quality test formula 4 also has a high overall score but it has more bitter taste so that the quality of formula decreases. The taste of food is one of important parameters that influence acceptance of consumer on food product.

The study carried out was to use the original taste of tea or without other additions so that the bitter taste produced by the product was not covered and then affected the acceptability of panellists. A study conducted by [15] stated that taste is a very determining factor in the consumer's final decision to reject or accept a product, even though other assessment parameters are better, if the taste is not preferred then the product will be rejected. Flavonoids are colorless, soluble in water and it has bitter and astringent taste in steeped tea so that the higher the temperature and drying time, the less astringent and bitter tastes are due to reduced flavonoids [16]. The results of other studies showed that there is no significant difference between drying time and temperature on acceptance of Bilimbi leaves tea taste. This showed that the temperature (50 – 70°C) and time (120 – 240 minutes) for drying bilimbi leaves tea have no effect on the level of preference for taste, while the composition of the tea has an influence [17].

The higher the composition of the tea used, the higher the color, smell, and bitter/foreign taste, but the lower public acceptance [18]. The drying temperature has an effect on the natural color of the tea so that the higher the temperature, it can cause a decrease in the natural color of the tea because it destroys the color such as chlorophyll in the leaves [19]. Another study has shown that the level of color preference in Bilimbi Leaves tea is not significant based on the temperature and drying time. This showed that the temperature (50 – 70°C) and drying duration (120 – 240 minutes) have no effect on consumer acceptance of the color of Bilimbi leaves tea but have an effect on the composition on the tea used[20].

The smell of tea is related to the level of extract in water and the weight of tea contains where the more extract in the water and the heavier the tea used, the more the smell of tea will be smelled[21]. The smell in food materials can be generated by several volatile components. however, these volatile components can be lost during processing, especially heat [22]. Another study has shown that drying duration and temperature are not significant for acceptance of the smell on Bilimbi Leaves tea based on the composition, Duration (120 - 240 Minutes) and Drying Temperature (50 – 70°C). [23]

Table 4. Water Content Analysis of Bilimbi Leaves Tea

Days	Water content (%)		
	25°C	35°C	45°C
0	4.0	4.1	4.6
4	5.0	4.2	5.4
7	4.2	3.3	4.7
11	3.9	4.6	3.5
14	3.5	3.2	3.4

Table 5. Results of Total of Microbes Analysis in Bilimbi Leaves Tea

Days	Total microbes (CPU/gr or ml)		
	25°C	35°C	45°C
0	$1,3 \times 10^3$	$2,0 \times 10^3$	$2,4 \times 10^3$
14	$1,1 \times 10^3$	1.2×10^3	$1,3 \times 10^3$

Table 6. Shelf life for Bilimbi Leaves Tea Product Based on the Arrhenius Equation

Temperature (°C)	Q	Q_0	k	Shelf Life (Day) t
25	8.0	4.0	0.0357	112,0
35	8.0	4.1	0.0642	60,74
45	8.0	4.6	0.0857	39,67

Shelf Life

Shelf Life is defined as the length of time that product has from production to consumption before the product gets lower quality and become inappropriate for consumption and this relates to food quality. In general, the writing of shelf life on the packaging label uses 'best before' words. The shelf life test describes how long the product can survive at the same quality during the storage process[12]. The Shelf life Determination of herbal tea product from Bilimbi leaves uses the acceleration method or ASLT of the Arrhenius model in which the product is packaged using aluminium foil and stored in an incubator at 25°C, 35°C and 45°C for 14 days. With the Arrhenius equation obtained, it can be calculated that the score of Arrhenius constant with each storage temperature. Based on the calculated data obtained, it showed that it had the longest shelf life at 25°C which is 112 days. From these results it can be seen that the higher storage temperature, the shorter shelf life for Bilimbi Leaves herbal tea product. This showed that the increase in temperature causes a faster rate of reaction which causes the tea to spoil quickly so that the shelf life is shorter. The rate of chemical reactions is faster at higher temperatures, which means that the quality of the product decreases faster.[24,25,26]

CONCLUSION

The hedonic quality test towards semi-trained panellists of Bilimbi Leaves herbal tea based on the quality level, The respondents chose more formula 4 but there was weakness in the bitter taste aspect that was produced later in the hedonic test of consumer panellists of Bilimbi Leaves herbal tea based on the level of preference to choose formula 2. Bitter taste which is still strong so other additional ingredients are needed such as sugar or honey to cover it. The highest water content of Bilimbi leaves tea product was stored at 45°C while the total microbes of the product met the standard. Tea stored at 25°C had a longer shelf life for 112 days. Tea product stored at 25°C had the longest shelf life for 112 days.

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Conflict of Interest

There is no conflict of interest.

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