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The Shelf Life of Wet Noodle Added by Gendarussa (*Justicia gendarussa* Burm. F.) Leaves Extract

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Abstract. Gendarussa (*Justicia gendarussa*) is a herbaceous plant with a height of 1-1.5 m. Its stem and leaves extract show antimicrobial and antioxidant activities and have potent cytotoxic activity on the human cancer cell. Gendarussa has a better flavor than stem. Its aqueous extract shows higher extract than ethanol extract. The present study evaluated the preservative effect of aqueous extract of gendarussa leaves (GL) in prolonging the shelf life of wet noodles. The single-factor experiment (GL of 0, 50, 100, 150, and 200 g was extracted in hot water of 100 mL) arranged in a completely randomized design was applied in this research. Total bacterial and mold were observed as well as sensory hedonic characteristics during storage. Data were analyzed using SPSS ver.25. The microbial quality data were analyzed by the Kruskal-Wallis test followed by pair comparison with Bonferroni correction, while the sensory data analyzed by Friedman test continued by Wilcoxon Sign Rank Test. The results showed that the addition of GL aqueous extract (200 g in 100 mL hot water) could prolong the shelf life of wet noodles. The microbial quality of the wet noodle, which preserved at room temperature for 24 h still meet the Indonesian standard of wet noodle (SNI: 2987-2015) for total bacteria and 36 h for total molds. The wet noodles have log cfu/g of 5.35 and 1.58 for total bacterial and mold, respectively. The panelists preferred the color, aroma, texture, and taste of wet noodles produced with the GL aqueous extracts. The most preferred one was wet noodle with the addition of GL aqueous extract at a concentration of 200 g per 100 mL with the characteristic of greenish-white color, not scented with GL, chewy texture, and slightly flavored GL.

Keywords: antimicrobial, antioxidant, Gendarussa, noodles

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1. Introduction

Wet noodle is a food product, which is made from the primary raw material of wheat flour with or without the addition of other food ingredients and allowable food additives. It is processed by mixing, stirring, sheeting, slitting and cutting with the typical form of noodles with or without cooking process. Uncooked wet noodle is called raw wet noodles, while the cooked wet noodle is the noodle, which has been cooked by boiling or steaming [1].

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As a fresh food product, the water content of the cooked wet noodles is quite high at 54-58% [2], which caused of its short shelf life, i.e., ranging between 28 hours [3] to 3 days [4] at room temperature and about six days [4] [5] at 4°C. The shelf-life of food is very critical in the food security system. In the case of wet noodles, it was reported that synthetic preservatives of a mixture of calcium propionate, sodium acetate monolaurin, and paraben [6] or activated calcium [7] could prolong the shelf life. Some natural agents have been reported to be able to extend the shelf-life of a wet noodle, i.e., coconut coir ash extract [3], dragon fruit peel [2] [8] , chitosan and its Maillard reactions products [5], maesli (*Prunus mume*) juice [9], *Morus alba* and *Curcuma aromatica* extract [10], Indonesia bay leaves (*Syzigium polyanthum* Wight Walp.), galangal (*Alpina galanga* L. Swartz) and garlic (*Allium sativum*) [11].

Indonesia is rich in herbs diversity those have antimicrobial and antioxidant activity. One of these herbs is gendarussa (*J. gendarussa*), which shows as a medicinal activity for breathless [12], antinociceptive and antidiarrheal activities [13], antimicrobial activity [14], anti-inflammatory [15], anti-cancer activity [16], anti-HIV [17] and antioxidant activity [18]. This report is the first report of gendarussa leaves (GL) extract, which is used as a potential natural preservative for wet noodle produce. The use of GL extract in food production will lead to functional food caused by its antioxidant and anti-cancer activity.

2. Materials and Methods

2.1. Raw Material

The primary raw materials in the processing of wet noodles are wheat flour (medium protein), water, and additives in the form of eggs and salt. The water used was replaced with a dark green fresh GL aqueous extract, which was obtained from a community home environment in Palaran District, Samarinda City, East Kalimantan Province, Indonesia. Aqueous extract of GL was prepared by blendering the drained washed fresh GL. The blendered fresh GL was then macerated in 100 mL warm water at 70°C for 5 minutes. The aqueous fresh GL extract was collected by filtering the maceration of GL, while the macerated leaves are removed.

2.2. Experimental Design and Data Analysis

The experiment was carried out using a completely randomized design with a single factor, e.i., the concentration of the GL extract consisting of 5 levels of treatment (0, 50, 100, 150, and 200 g of GL were macerated in 100 mL hot water of 70°C for 5 min). Each treatment level was repeated three times.

Microbiological quality, i.e., total bacteria [1] and molds [19] of the wet noodle, were observed as a parameter of the shelf-life of the wet noodle during storage at room temperature at 0, 12, 24 and 36 h. Hedonic and quality hedonic sensory test on cooked wet noodles at day 0 was performed by 25 semi-trained panelists for color, aroma, texture, and taste [20]. As the microbiological

quality was not distributed normally, a non-parametric statistic test, e.g., Kruskal-Wallis test followed by pair comparison test corrected by Bonferroni correction at $p<0.05$ was applied. The sensory data were analyzed by Friedman test continued by the Wilcoxon Sign Rank test at $p<0.05$. Both data analyses were performed under SPPS ver.25.

2.3. Wet noodles processing

Gendarussa wet noodle was prepared following the method suggested by Oktiarni [2] with a small modification. The gendarussa wet noodle processing was initiated by mixing 100 g of wheat flour, 4 g of eggs, 2 g of table salt, and 28 mL of GL extract. The mixture of the ingredients was stirred to form a smooth dough. The dough was then thinned to form a slab and put into a manual noodle mill repeatedly until it reaches a thickness of 2 mm. Next, the noodles are cut using slitter into lengths with a width of 0.5 mm and a length of 25 cm.

2.4. Assay procedure

The cooked wet noodle was prepared by boiling in boiled water for 2 minutes, then drained and cooled at room temperature for 5 min. The cooked wet noodles were assayed for the sensory properties and for microbial quality (total microbes and molds). The microbial quality test was performed during storage at 12, 24, and 36 h.

Total bacteria and molds were performed using Buffered Peptone Water media (peptone 10 g, NaCl 5 g, Na_2HPO4 3.5 g, KH_2PO_4 1.5 g in 1 L of pH 7.0) [1] and PDA [19], respectively. Twenty and ten grams of cooked wet noodle was crushed and diluted with 0.85% NaCl solution to 10^{-1} until 10^{-4} for total bacteria and molds assays, respectively. Pour plate and spread methods were applied for total bacteria and molds assay, respectively. The plates then incubated at 30^{o}C, 72 h, and 32^{o}C, 48 h for total bacteria and molds, respectively.

The sensory test was performed in the sensory analysis booth. Each panelist was tested the cooked wet noodle. The panelists were students who have already passed the Sensory Analysis Lecture and like to consume wet noodle. The panelists were given direction on conducted the sensory test prior to starting the test.

3. Results and Discussion

3.1. Total Bacteria and Total Molds

The use of GL aqueous extract affected significantly ($p<0.05$) the microbial quality of gendarussa wet noodles (GWN). It could suppress the microbial growth of the GWN at the beginning. However, the GL aqueous extract could not inhibit microbial growth (Table 1.).

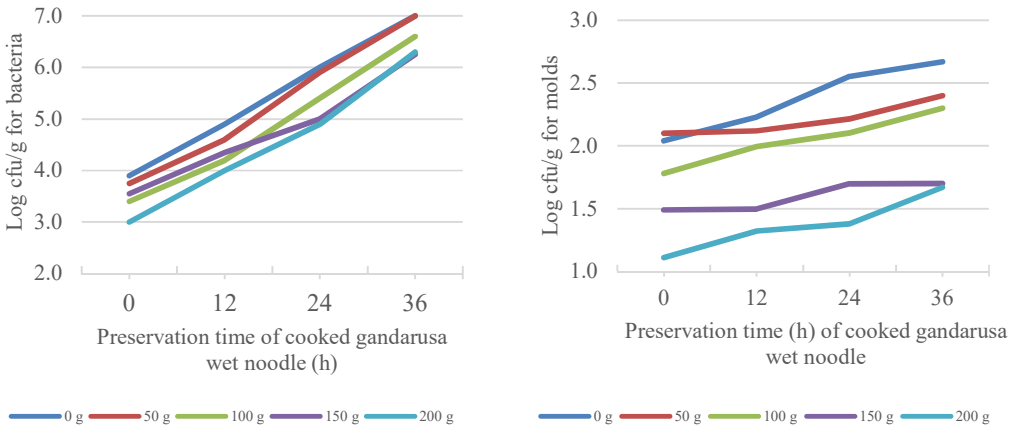
The shelf life of the cooked GWN at room temperature was prolonged due to the suppressing of microbial growth at the beginning. At the condition, the shelf life of the cooked GWN produces

with the addition of the GL aqueous extract of 200 g/100 mL has been extended to about ten hours. It fulfills the requirements of total bacteria number of the Indonesian National Standard of a wet noodle, SNI 2987-2015 [1]. Total bacteria number is a critical point in evaluating the shelf life of the GWN because of the bacterial growth faster than the molds' growth. Until 36 h of storage at room temperature, the number of total molds number of the GWN was still below the Indonesia National Standard of a wet noodle.

Table 1. The Changing of Microbiological Quality of Cooked Wet Noodles during Preservation at Room Temperature

Time of preservation (h)	Weight (g) of GL per 100 mL macerate					*p**
	0	**50**	**100**	**150**	**200**	
	Total Plate Count of Bacteria (Log cfu/g)					
0	3.900 b	3.750 ab	3.400 ab	3.550 ab	3.000 a	0.040
12	4.900 b	4.600 ab	4.200 ab	4.350 ab	4.000 a	0.040
24	6.000	5.900	5.400	5.000	4.9000	0.062
36	7.000	7.000	6.600	6.250	6.300	0.272
	Total Molds (Log cfu/g)					
0	2.040 ab	2.100 b	1.780 ab	1.490 ab	1.110 a	0.015
12	2.231 b	2.119 ab	1.996 ab	1.498 ab	1.322 a	0.011
24	2.553 b	2.215 b	2.103 ab	1.699 ab	1.380 a	0.024
36	2.670	2.400	2.300	1.700	1.670	0.070

Note: Data were median from three replications. Data were analyzed by the Kruskal-Wallis test (*) followed by pair comparison with Bonferroni correction ($p<0.05$) (SPSS ver.25). For each parameter, data within the same row (showing the same observation hours) followed by the different letter shows significantly different. GL = gendarussa leaves



(a) (b)

Figure 1. The Profile of Microbiological Quality Changing of the cooked Gendarussa Wet Noodle (Data were Calculated as the Median)

Subramanian et al. [14] showed that using 12 types of human pathogenic bacteria, aqueous extracts of GL showed significant antimicrobial activity only against *Staphylococcus aureus*.

However, the aqueous extract of gendarussa stem showed more effective. It inhibited significantly *Shigella flexneri*, *Proteus mirabilis*, *Escherichia coli* and *Bacillus subtilis*. The methanol extract of GL showed a potent inhibitor against both gram-negative and gram-positive organisms (*Staphylococcus aureus*, *Staphylococcus mutans*, *Bacillus subtilis*, *Micrococcus luteus*) and gram-negative microorganisms (*Proteus vulgaris*, *Klebsiella pneumoniae*, *Escherichia coli* and *Shigella flexneri* [15]. However, the methanol extract is undesirable to be used directly in the food product.

An experiment using the gendarussa stem extract, which has a broader spectrum of bacterial inhibition, is being developed to determine the more potent of gendarussa herbs. Lee et al. [9] showed that juice of maesli (*Prunus mume*), which has a broad spectrum of bacterial inhibition activity, could prolong the wet noodle until 20 days at 4ºC. The use of bacteriocin could also be considered as it inhibits the bacterial growth effectively [21]. The use of natural agents as the preservation of wet noodles has been reported; however, some of the reports only show based on organoleptic criteria [4] and antioxidant activity [8].

3.2. Organoleptic Properties

The use of gendarussa leaves (GL) aqueous extract affected significantly (p<0.05) on hedonic and quality hedonic sensory characteristics of gendarussa wet noodle (GWN) (Table 2.).

Table 2. Effect of Concentrated Level of GL Extract on the Sensory Response of Cooked Wet Noodle

Attributes	Weight (g) of GL per 100 mL macerate					p*
	0	50	100	150	200	
Hedonic						
Color	4 a	4 ab	4 a	4 a	4 b	0.0005
Aroma	3 a	4 d	4 ab	4 b	4 c	0.0005
Texture	4 a	4 b	4 ab	4 ab	4 ab	0.0005
Taste	4 a	4 b	4 ab	4 ab	4 ab	0.0005
Overall acceptability ǂ	4 a	4 c	4 b	4 b	4 c	0.0005
Hedonic quality						
Color	3 a	4 b	4 c	4 d	4 c	0.0005
Aroma	5 d	4 c	4 c	4 a	4 b	0.0005
Texture	5 a	5 a	5 a	5 a	5 b	0.0010
Taste	5 b	4 b	4 b	3 a	3 a	0.0005

Note: Data were median, calculated from 4 replications assessed by 25 semi-trained panelists. All performance data are calculated as the average of other attributes. The data were analyzed by Friedman test (*). Data within the same row followed by different letter were significantly different (Wilcoxon Sign Rank Test, p<0.05) (SPSS ver.25). Hedonic properties level (1-5): very dislike to like very much. Hedonic quality properties level (1-5) for **color**: white, greenish-white, slightly green, green, dark green; for **aroma**: highly GL scented, GL scented, slightly GL scented, unscented GL, unscented GL very much; for **texture**: hard, slightly hard, not chewy, slightly chewy, chewy; for **taste** are: highly tasty of GL, GL tasty, slightly tasty of GL, not tasty of GL, not tasty of GL very much. GL = gendarussa leaves.

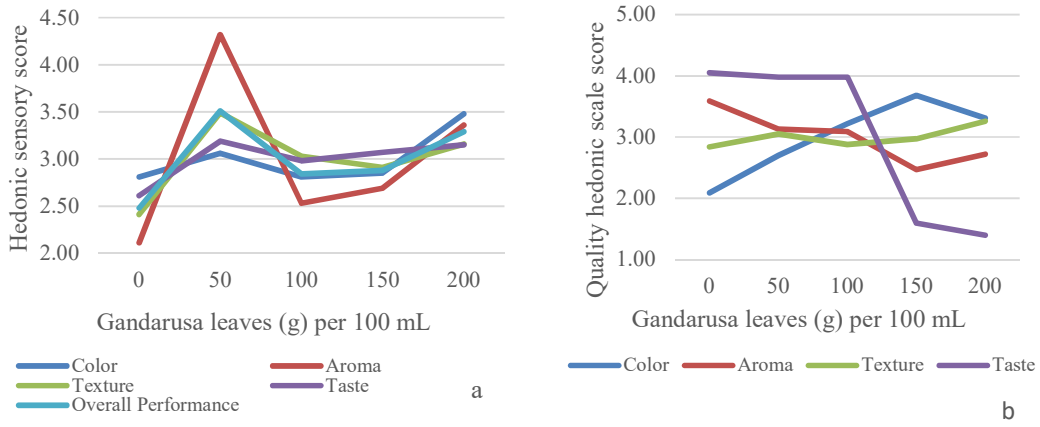


Figure 2. Sensory Response Profile of Effect of Gendarussa Cooked Wet Noodle (Data were Calculated as Mean Rank. The Detailed Note is the same as in Table 2)

The hedonic sensory characteristics, the GWN produced with the addition of aqueous extract of 200 g per 100 mL, are the most preferred in terms of color, aroma, texture, and taste. The GWN has hedonic quality sensory characteristics of green color, unscented GL aroma, chewy texture, and slightly tasty of GL. The addition of natural extract agents showed no or slight effects on the sensory hedonic of wet noodles [7, 10, 22–27].

4. Conclusion

Aqueous extract of gendarussa leave showed a preservation effect on wet noodles by suppressing the number of bacteria and molds. The aqueous extract of GL of 200 g in 100 mL is recommended to be applied in gendarussa wet noodle (GWN) produce. The microbiological quality of the cooked GWN still meets the Indonesian standard of wet noodles (SNI: 2987-2015) for total bacteria and molds after preserved for 24 and 36 h, which has a mean of log cfu/g of 5.35 and 1.58, respectively. The hedonic sensory of the cooked GWN was preferred by the panelists. The color, aroma, texture, and taste of the GWN showed a characteristic of green color, unscented GL aroma, chewy texture, slightly tasty of GL.

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