Formulation of Indonesian traditional functional drink wedang empon based on Zingiberaceae rhizomes mixed with fruits

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Abstract. Wedang empon is a rhizome-based drink, one of the most popular functional drinks in Indonesia. This drink is consumed as a drink that is believed to increase the body's immunity and maintain a healthy body. This is due to the potential content of secondary metabolites contained in it. The purpose of this study was to combine empon-based drinks with several types of fruit and flower extracts. The development of this empon-based drink was carried out to provide variations in taste, aroma, and color as well as its nutritional content. Therefore, in this study, wedang empon drink which has been combined with several fruits and flowers was analyzed for product quality with several parameters such as phenol content, vitamin C, and product hedonic tests to find out how consumers respond to the resulting product. In this study, an analysis of the moisture content of the dried product was also carried out to ensure that the water content was within the permissible limits. The research started from material preparation, formulation, characterization and product analysis. Based on the results of the analysis, it was found that in general the yield value of the water content was less than 10%. Overall, the total phenol content of all treatments ranged from 14.75-43.32 mg GAE 100 g⁻¹ and the highest total phenol content was detected in the combination of rosella with wedang empon ingredients. The amount of vitamin C ranged from 42.1013-107 mg/100 g and samples of wedang empon mixed with lakum were the highest. Hedonic test results ranged from 63.556 to 90.667, taste ranged from 63.556 to 79.556, then color ranged from 70.222 to 84,889. This means that there are differences in the effect of adding different ingredients to the taste of wedang empon. By mixing the rhizome drink with fruit and flower extract will help improve the sensory properties of the drink so that this drink can be more accepted by many consumers of all ages or for those who don't even like the unpleasant smell of wedang empon drinks.

1. Introduction
Functional drinks are a form of functional food. Functional drinks can be made from various natural raw materials. This type of food product is getting more and more attention nowadays. Moreover, with the increasing percentage of people with degenerative diseases and the spread of diseases that are not difficult to avoid that functional drinks are one of the alternative drinks that are ogled to be developed in order to better fulfill their function as functional foods that have good nutritional value, have good sensory properties and have health values. Functional drinks are processed with various natural ingredients such as leaves, fruits, seeds, flowers, stems, roots and tubers. One of the herbal drinks that have been known in Indonesia is wedang empon (empon = rhizome). As the name suggests, that this drink is made from a mixture of different types of rhizomes as the main ingredients including turmeric, ginger, curcuma, and kencur (aromatic ginger) with other additional ingredients that are often used such as lemongrass, secang, tamarind, betel and brown sugar [1][2][3]. As a functional drink, this type of drink is known for its compounds which are beneficial for the body because the rhizomes are known as natural ingredients that contain bioactive compounds with antioxidant activity such as phenol groups. [4] reported that the antioxidant activity of a mixed herbal drink of red ginger and curcuma was 86.97% RSA. [2] reported that the phenolic content of drinks based on rhizome with the addition of spices served in liquid form had a higher phenolic content of around 80 mg/g. [5] reported that the addition of ginger and curcuma up to 7.5% increased
the total phenolic value to 39.06 g/ml and antioxidants but at a certain concentration with the largest yield of 81.43%.

Combining various rhizomes with other herbal plant to form functional drinks is becoming increasingly popular, especially in almost all cities in Indonesia at this present. It is consumed as traditional beverages and good sources for health-promoting by its phenolic compounds. In addition, there are some people who think that mixing rhizome drinks with other ingredients such as lemongrass, cinnamon, sappan wood will make this functional drink richer in efficacy and nutritional content as well as changes in taste, aroma, and color attributes. Some of previous study report that the diversification of herbal drinks can be done by adding various ingredients that can increase the nutritional value and content of bioactive compounds. Various kinds of functional drinks from various combinations of rhizomes with other additives have been reported such as the combination of functional drink based of rhizome added with breadfruit leaves and tamarind leaves [6], black rice bran [7], cat's whiskers [8].

In this study, a candidate for functional drink made from wedang empon will be processed with the addition of ingredients such as roselle flowers, kiwi fruit, lakum fruit and pineapple fruit as a source of vitamin C. Based on our best knowledge, the blend variations of rhizomes and fruits juice (such as pineapple, lakum, kiwi, and roselle) has not been studied. Furthermore, in this study, we estimate that a mixture of wedang empon with juices from some of certain fruits and flower can produce different characteristics of functional drinks based on rhizomes in terms of nutrition, functional biochemical properties, and better sensory quality of drinks. It is hoped that it can become a functional drink with a taste, smell, and color that is widely accepted by the public. Changes in sensory attributes and nutritional value of this drink can also promise as a candidate for a new functional drink. The development of empon-based beverages better is developed in a business that can be packaged in a modern way with a longer shelf life and is practical in serving.

The purpose of this study was to develop a traditional Indonesian herbal drink wedang empon with the addition of roselle, lakum, kiwi, and pineapple. In addition, analyzing the characteristics of the drink and testing the level of consumer preference for the drink. The processing of functional drinks made from rhizomes by mixing with fruit and flower juices in this study was carried out systematically, starting from the selection of good ingredients, determining the formulation of ingredients, and applying good processing methods based on previous studies. This process is important to do in order to obtain a suitable mixture of ingredients to be used as food ingredients with safety and health values and can be accepted by the community.

2. Materials and Methods

2.1. Preparation

This research was conducted in July-December 2020 at the Agricultural Laboratory, Department of Agricultural Technology, Ketapang State Polytechnic, West Kalimantan. The ingredients used in this study were divided into 2 groups, namely the main ingredients (Zingiber officinale, Curcuma zanthorrhiza, Curcuma longa, Kaempferia galanga, lemongrass, cinnamon, and sappan wood) and the second group is the additional ingredients such as pineapple (Ananas comosus), lakum (Cayratia trifolia), kiwi (Actinidia deliciosa), and roselle (Hibiscus sabdariffa). All materials used to produce wedang empon drink (both main ingredients and additives) were collected, washed, and sliced 0.5 cm thick. The ingredients are then drained on a drying tray that has been previously lined with parchment paper. The drying process uses a cabinet dryer at 60°C until all of the ingredients are dried. The materials used for chemical analysis such as aquadest, 96% ethanol, folin reagent, sodium carbonate, gallic acid, and starch indicator.

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Table 1: Ingredients used in the formulation of the Wedang Empon (gram of total).

| Component (g) | WE  | WE+Lakum | WE+Pineapple | WE+Roselle | WE+Kiwi |
|---------------|-----|----------|--------------|------------|--------|
| Additional ingredients for wedang empon drinks | -   | 2        | 2            | 2          | 2      |
| Zingiber officinale | 1.5 | 1.5      | 1.5          | 1.5        | 1.5    |
| Curcuma zanthorrhiza | 1.5 | 1.5      | 1.5          | 1.5        | 1.5    |
| Curcuma longa | 1.5 | 1.5      | 1.5          | 1.5        | 1.5    |
| Kaempferia galanga | 0.5 | 0.5      | 0.5          | 0.5        | 0.5    |
| Lemongrass | 0.5 | 0.5      | 0.5          | 0.5        | 0.5    |
| Cinnamon | 0.5 | 0.5      | 0.5          | 0.5        | 0.5    |
| Sappan wood | 0.5 | 0.5      | 0.5          | 0.5        | 0.5    |
| Brown sugar | 1.5 | 1.5      | 1.5          | 1.5        | 1.5    |

WE: Wedang Empon recipe

After all the ingredients were dried, then each ingredient was weighed according to the ratio based on Table 1. After that, all of the dried materials were packed in a plastic lid, one package weighed 60 g. the process of serving the drink is done by boiling one pack which is weighed 60 g until the water boils. Boiled water from this process is placed in a dark glass container for further analysis.

2.2. Observation Parameter

2.2.1. Moisture Test (%). The water content test was carried out based on the [9] method. The principle of determining the water content is to evaporate the water content contained in the material using a temperature of 135°C. Beginning with the oven sample container to remove the remaining water content in the sample container. Put the sample as much as 2 g in the container that has been obtained constant weight. Put the sample in the oven. Heat the sample for 2 hours. Remove the sample, cover, then cool in a desiccator for about 15 minutes. Then heated again in the oven at 105°C for 1 hour, cooled in a desiccator for 15 minutes, weighed the container containing the sample, repeated heating and repetition until reached a constant weight then calculated.

2.2.2. Total Phenolic. Sample preparation was carried out using the ISO 14502-1 [10] method with a few modifications. Weight 3 g of the material and then dissolve it with 100 ml of warm water. This solution was then pipetted again as much as 1 ml and added 2.5 ml of *Folin Ciocalteu* reagent (10%) in a 10 ml test tube. Let stand for 3 minutes, then add 2 ml of 7.5% sodium carbonate. Vortex the solution mixture for 5 minutes and incubate at 28°C for 1 hour before measuring using spectrophotometry with a wavelength of 765 nm. Gallic acid was used as a calibration curve and the results were expressed as mg of gallic acid equivalents per 100 mL sample.

Preparation of stock standard solution of gallic acid as much as 10 mg of gallic acid powder, put into a 10 ml volumetric flask dissolved with methanol until reached the marked line (concentration 1000 g/ml = 1 ppm). The gallic acid stock solution with a concentration of 1000 g/ml was pipetted as much as 0.0 ml blank; 0.1 ml; 0.2 ml; 0.3 ml; and 0.4 ml. Then it was put into a 10 ml volumetric flask and added with methanol up to the marked line (blank concentration (0 g/ml), 10 g/ml, 20 g/ml, 30 g/ml, 40 g/ml). As much as 0.5 ml of each concentration of the solution in a 10 ml volumetric flask was added 7.5 ml of distilled water and 0.5 ml of Folin-Ciocalteu solution, then homogenized with a vortex for 1 minute and incubated for about 1-5 minute at room temperature. After that, the solution was added with 1.5 ml of sodium solution carbonate 20% and allowed to stand for 90 minutes, the absorbance was measured at the maximum wavelength 675 nm using UV-VIS Spectrophotometer and the gallic acid calibration curve was obtained and the linear equation y = ax + b. The resulting of calibration curve are used to determine the value of the concentration of phenolic compounds (GAE mg/g).

2.2.3. Vitamin C. The procedure for analyzing vitamin C is based on the method of [12]. The analysis stage begins with filtering the sample and then diluting it to obtain a sample solution of 100 ml. The filtrate obtained was taken 20 ml and put in a 250 ml Erlenmeyer then added 150 ml of distilled water.
and 1 ml of starch indicator solution. Titrate the sample with 0.005 mol L\(^{-1}\) iodine solution. The end point of the titration is indicated by the formation of a dark blue color due to the formation of complex compounds resulting from the reaction between starch indicator and iodine solution.

2.2.4. Hedonic test. The acceptance test was used to verify whether the consumer liked or disliked rhizome drink (wedang empon) in color, aroma and flavor. The number of panelists used in this test were about 25 students from Ketapang State Polytechnic from Agroindustry Deparment as panelist. The panelists were chosen in healthy condition, not hungry, and liked wedang empon. The time of the test was from 9.00 to 11:00 am.

Each sample added was presented individually to the panelis in trays containing one hedonic questionnaire sheet, a glass of water, and five samples. Twenty five consumers evaluated the coffee aroma and flavor attributes of the five samples in different sessions using a hedonic scale. Before conducting the test, panelists will be given an explanation of the attributes to be tested. The hedonic method offers an assessment of preference for the product being tested, using a hedonic scale (9-point hedonic). On a scale of 9, panelists can choose an expression related to their perception and acceptance of the product in the form of a numerical answer, for example, 1 = very dislike to 9 = very much like [13][14]. The average value obtained can be used to indicate the level of consumer acceptance of the sensory properties of the product. The average value of 7 or higher on the 9 scales used in the test, indicates that the value of consumer acceptance of the product is very high [15][16]. The results were evaluated by the analysis of variance (ANOVA). A significant level \( \alpha = 0.05 \) was applied to all the analyses.

2.2.5. Statistical analysis. Each sample was triplicated in this research. The sample was divided into 4 treatments based on differences in the addition of additives. The control used was wedang empon drink without the addition of fruits to see the difference in biochemical properties seen based on the parameters of phenol and vitamin C levels, as well as product acceptance based on sensory data from the hedonic test of the product. Therefore, each treatment was replicated 3 times to obtain more valid analysis results. The results of the test, both chemical and organoleptic analysis, were analyzed by Analysis of Variance (ANOVA) (\( \alpha = 0.05 \)) and mean separation was done with Duncan’s Multiple Range Test (DMRT).

3. Result and discussion

Fruit is known as the best source of nutrition in the world, because fruit is a source of vitamins, minerals and bioactive substances that are useful for the body such as flavonoids, anthocyanins, and carotenoids. Therefore, many researchers use fruits or other ingredients such as edible flowers as additives for functional foods and beverages. Wedang empon is a traditional Indonesian drink that is quite popular because of its taste and most importantly because of its benefits for the body. Modification of rhizome drinks with the addition of fruits can be one way to develop rhizome-based drinks in order to increase added value and be preferred by consumers. Functional properties usually studied in the development of natural beverages include antioxidant activity, containing phenolic, total phenols and anthocyanins, and vitamin C among others [17]. In this study, we combined rhizome drink with dried fruits and edible flowers to see the characteristics of the product as a functional food product. The product of our processing is documented in Figure 1.
Figure 1. The photo above show the different colour of steeping water of wedang empon in varying addition with fruit and flower (WE+0: Wedang Empon, WE+L: Wedang Empon with Lakum, WE+K: Wedang Empon with Kiwi, WE+R: Wedang Empon with Roselle, WE+N: Wedang Empon with Pineapple).

3.1. Water content
Based on the results of the analysis that has been carried out the level of water content in the material can be seen in Figure 1.

Figure 2. Percentage of water content of empon, lakum, pineapple, rosella and kiwi. Data show the mean ± SD (n = 3; p<0.5).

Based on Figure 1, it can be seen that the highest value of water content was obtained from kiwi, then followed by rosella, turmeric, lakum, pineapple, secang, and other ingredients with a percentage value below 10%. Water content analysis aims to determine the percentage of dry matter moisture content that will be used to make drinks. The water content is expected to reach a percentage of 10-15%. Materials in dry form have a longer shelf life and can also prevent the growth of microorganisms that can lead to changes in the quality and composition of the ingredients before use.
3.2. Total Phenol Level

The principle of determining the phenol content is based on the reaction between the Folin Ciocalteau reagent and the hydroxyl group of phenolic compounds to form a molybdenum-tungsten complex. If the phenol content in a material is increasing, the molybdenum-tungsten complex will be more blue in color, indicating that the greater the concentration of phenolic compounds contained in the sample. The results of the analysis of the phenol content of empon drinks can be seen in Table 1.

![Bar chart showing total phenolic content of wedang empon beverage in various variations with the addition of some fruit and edible flowers](image)

**Figure 3.** Total Phenolic content of wedang empon beverage in various variations with the addition of some fruit and edible flowers. Data show the mean ± SD (n = 3; p<0.5).

The bar chart (Figure 2) shows the percentage of the total phenolic content showed as GEA mg/g from rhizome wedang, lakum, pineapple, rosella and kiwi (a) and the total phenolic content from the combination between rhizome and lakum, pineapple, rosella and kiwi. We can see from the data, in general it was clearly observed that a significant difference could be seen between the total phenol content additional ingredients used in wedang empon and the total phenol obtained from the combination between wedang empon and additional ingredients.

Based on the graph, the highest total phenolic content was detected in rosella steep water ±72.2142 GAE mg/g and also from its combination with rhizome wedang whereas the rhizome wedang had the lowest ±55.8452 GAE mg/g. The second rate of the phenolic content was the combination between rhizome and kiwi, after that rhizome and pineapple, then the last was rhizome drink blended with lakum. Overall, total phenolic content of the varying formulations ranged between ±14.75 to ±43.32 mg GAE 100 g⁻¹. ANOVA showed the model’s F-value implying that the model is significant. P ≤ 0.05 indicates that the model terms are significant.

The results of the current study indicated that the wedang empon has lower phenolic contents than the combination between the wedang jahe and the additional materials. This could be due to the thermal degradation effect or the dilution effect with additional materials. The phenol content of all products are significantly decreased also for the control sample. During thermal treatment, there are some change could be happened such as cell structure is ruptured and the sensitive compounds, especially phenols, become susceptible to non-enzymatic oxidation.

The results of this study are generally not different from several previous studies that examine the characteristics of mixed drinks with rhizome ingredients with fruit, leaves or other additives. [18] reported a decrease in phenolic levels in functional drinks made from ginger, turmeric, white turmeric, ginger sand, temulawak, meeting mango, lime, secang, rock sugar, brown sugar and water obtained from
two brewing processes,[19] reported variations in the phenol content of beverages made with a variety of fruit mixtures. [20] reported the results of measuring the phenol content of a mixed drink of kesum (Polygonum minus), ginger (Z. officinale) and turmeric (C. longa) extract. The results of this study indicate that there are differences in variations in phenol levels between rhizome-based drinks without any mixing (control) and rhizome-based drinks with a mixture of fruit and flowers. In general, the phenol content of the control was lower than the phenol content of empon-based drinks mixed with fruits and flowers. This can be caused by the addition of additional ingredients in rhizome-based drinks. Changes in phenol content can be caused by many factors ranging from the type of material, processing to product storage. The highest high levels of phenol can be obtained by consuming fresh or raw foods.

In this study, the difference in phenol levels between the control and other samples could also be due to the processing process. Processing processes such as heating, cooling, drying, and fermentation processes and even mixing with different additives can change the bioaccessibility and bioavailability of phenol compounds in processed materials. Food processing aims to convert raw materials into food suitable for consumption according to consumer preferences and composition of nutritional value. Several processing processes can result in the degradation of phenolic compounds and can also increase the content of phenolic compounds and their bioavailability [21][22]. Polyphenols are a group of bioactive compounds that are abundant in plants but can also be obtained from animals and even microorganisms. The phenolic compounds, which naturally occur in many fruit-based beverages, may positively or negatively affect their sensory traits, with important impacts on color, perceived taste and flavor, and astringency. Polyphenols originate from plants due to their secondary metabolism and accumulate in plant organs like leaves, fruits, roots, and stems. They are essential to plant life as they provide defense against harmful microorganisms and make plants unpalatable to predators [23].

This group of compounds attracts many food scientists and nutritionists because of their protective effect on the body from various chronic diseases. Polyphenyl is one of the phytochemical components as a bioactive component in abundant food, one of which is a group of phenolic compounds acting as antioxidants. However, this group of compounds depends on environmental factors and the type of plant species. In addition, the phenolic compound group is also very susceptible to several factors such as temperature, processing, and storage.

3.3. Vitamin C

![Figure 4](image_url)  
**Figure 4**  Vitamin C content of wedang water with lakum, pineapple, rosella and kiwi LSD = Least significant difference. Data show the mean ± SD (n = 3; p<0.5).
The first graph (a) shows the highest vitamin C content is Kiwi followed by lakum, pineapple, rosella, and finally wedang empon. The second graph (b) shows the changes of vitamin C content from each sample and formulation treatment. The vitamin C content declined significantly (p<0.05). The amount of vitamin C in the samples ranged ±42.1013-107 mg/100 g. Sample wedang empon blended with 15% lakum had the highest value with no significant difference with the amount of vitamin C of wedang empon with 15% kiwi after that followed by wedang empon with 15% pineapple then wedang empon with rosella. However the amount of wedang empon without additional materials was lower than other samples. Addition of fruit and edible flowers such as pineapple, lakum, kiwi, and rosella which were used in this research could change the overall amount of vitamin C in each sample. Blending could change the ingredients in the functional properties of blend products. The reason for vitamin C (Ascorbic acid) reduction was probably due to the characteristic of vitamin C which is being sensitive and easy to oxidative deterioration to oxygen, light and heat (temperature).

It is important to consider adding materials such as fruit or edible flowers as a source of vitamin C. Vitamin C plays an important role in helping the body to increase the body's immunity and help prevent disease. Vitamin C has various functions such as an antioxidant, wound healing and repair of damaged body tissues, helping the absorption of iron to help repair and maintain bones and teeths. Although the level of vitamin C in processed products has decreased, it does not result in a loss of vitamin C content in beverages. Based on the results of the analysis, the processing of wedang empon by mixing wedang empon with kiwi fruit, lakum, pineapple and rosella can be a recommendation for functional food products.

3.4. Hedonic Test

![Figure 5](image_url)

Figure 5. Mean consumer acceptability of wedang empon blended with fruit and flower

Acceptability was rated on a 9-point scale from 1 = dislike very much, to 9 = like very much. The results of the color assessment show that consumers like very much on the color of the mixed drink wedang empon with roselle flowers and lakum fruit (a value of 8 out of 9 on a scale), then followed by wedang empon with a mixture of pineapple and wedang empon with a mixture of kiwi at a value of 7 (like moderately).

The highest average value of the hedonic quality test for the taste of wedang empon with lakum got an average value of 9 (like extremetly), after that wedang empon with roselle was 8 (like very much) then wedang empon with pineapple with a value of 7 (like moderately), lastly wedang empon with kiwi about with a value of 6 (like slightly).
Functional drinks made from rhizomes (ginger, temulawak, kaempferia), lemongrass, cinnamon, sappan wood, and a mixture of fruits are cheaper and nutritious to maintain a healthy body. This drink can be one of the more acceptable candidates for functional drinks based on the results of the above-mentioned tests, both in terms of nutritional content and product taste. Mixing the rhizome drink with fruit will help improve the sensory properties of the drink so that this drink can be more accepted by consumers of all ages or for those who don't even like the unpleasant smell of wedang empon drinks.

4. Conclusion

This research is an initial research in the context of developing a functional drink product made from empon with a mixture of various kinds of edible fruits and flowers. The results of the analysis showed that in general the water content value was less than 10%. The total phenol content of all treatments ranged from ±14.75-43.32 mg GAE 100 g−1 and the highest total phenol content was detected in the combination of rosella with wedang empon ingredients. The amount of vitamin C ranged from ±42.103-107 mg/100 g and samples of wedang empon mixed with lakum were the highest. The four wedang empon drinks from different treatments showed an average score of 7 (like moderately). The same value was also shown from the control sample. The highest value was obtained from the taste and color attributes of 2 samples, namely from wedang empon drink with the addition of lakum and wedang empon with the addition of rosella. Based on the test results, the panelists' response values ranged from 7-8, which means that the panelists liked the taste and color of wedang empon which was added with lakum and roselle. In the taste attribute, the highest hedonic test value was wedang empon with the addition of lakum fruit and roselle flowers with a very like response (8 from a scale of 9). In the color attribute, the highest value was obtained from the combination treatment of wedang empon with roselle and the addition of lakum fruit with a very like response (8 from a scale of 9). Overall, wedang empon with a mixture of pineapple, lakum, rosella, and kiwi had higher phenol and vitamin C content than wedang empon without any mixing. Based on the analysis data, information can be obtained that mixing wedang empon drink with fruit and flower extracts can change the taste, color, and aroma to be more preferable compared to so that it can be an alternative way of developing rhizome-based functional drinks.

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