Pirdot (Saurauia bracteosa DC) Leaf Processing Technique for Making Herbal Tea

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Abstract. Pirdot is one of forest plants that have the potential to be made into herbal tea. This study aims to obtain the best processing techniques and herbal tea formulas for processing pirdot leaves into herbal tea in the form of tea bags. The processing of pirdot herbal tea used three or five fresh pirdot leaves count from the shoots. Leaves processing was held in two ways, through a fermentation and without fermentation process. Organoleptic test of 15 panelists were carried out to test tea color, aroma and taste. Data were analyzed by applying Kendal's tau multilevel correlation test. The results showed that the mixture of the top five leaves gave better result in color, aroma and taste of pirdot tea. Fermentation process also gave better results in terms of color, taste and aroma of pirdot tea compared to no fermented tea. However, optimum condition in fermentation process is still being studied.

1. Introduction

Tea is a beverage originating from various types of plant leaves, especially tea plants and a common beverage. In its development, tea is not only derived from the processing of tea plants but also other various types of plants. According to [1] tea can be grouped into two classes, namely herbal tea and non-herbal tea. Non-herbal teas are grouped into three: black tea, green tea and oolong tea. Herbal tea is the result of processing of flowers, barks seeds, leaves and roots of various plants. One of the plants that has the potential to be processed for herbal tea is Pirdot (Saurauia bracteosa DC).

Pirdot is one of the endemic plants that grows in various places in Indonesia and is used primarily by the Batak as a medicine. In North Sumatera Province, this tree is found in Simalungun Regency in the north to Tapanuli Selatan in the south especially in the highland. Even though it spreads in many places, this species is categorized as vulnerable according to IUCN (1998) and [2] classified pirdot in critical categories. Batak especially in Toba, use pirdot as a traditional medicine to reduce blood sugar levels, prevent high blood pressure and reduce blood cholesterol levels. Pirdot is a pioneer tree species that grows in open area, along rivers and in humid places, at altitudes of 600 - 1,200 meter above sea level [3]. This species is categorized as small-medium tree species with a height between 3-15 meters [3]. The trunk is easily broken and because it is relatively small so it is not widely used by the community. The spread occurs naturally, the propagation and cultivation knowledge is still unknown. The benefits of pirdot in the world of health have been widely carried out, among others, as anti-oxidants [4] [5] [6]. This study aims to obtain the best techniques in processing pirdot leaves into herbal tea in the form of tea bags.

2. Materials and method

2.1. Materials

The materials used in this study was fresh pirdot leaves that collected from arboretum of Environmental and Forestry Research and Development Institute of Aek Nauli. The equipment used
were tea bags, sealers, incubation chambers, thermometers, hygrometers, ovens, digital scales, storage containers, knives, checks and gloves.

2.2. Research Design
First Step. Determination of pirdot processing techniques
At this stage there are two basic treatments, namely material differences and manufacturing methods differences. The different age of the leaves was considered affecting the quality of the leaves from their chemical content, as well as the processing of herbal medicines [8]. The difference in treatment of different raw materials was needed to find out the best raw materials used in processing pirdot herbal tea. In this case there were two different types of raw materials:

- The top 5 pirdot leaves (top shoots were counted from above)
- The top 3 pirdot leaves.

Afterwards, treatment processing was performed. There were two categories of the treatment processing:

- No enzymatic oxidation (no fermented)
- Enzymatic oxidation (fermented)

The extend treatment levels were as follows:

- P1 = top 5 pirdot leaves were not oxidized (no fermented)
- P2 = top 3 pirdot leaves were not oxidized (no fermented)
- P3 = top 5 pirdot leaves were oxidized (fermented)
- P4 = top 3 pirdot leaves were oxidized (fermented)

![Figure 1. Pirdot leaves as raw material.](image)

The procedure of tea processing was as follows:

- Fresh pirdot leaves were collected and sorted
- For non-fermented treatment, the leaves were sliced 1-2 cm wide, then dried for 4 days in room temperature (until water content 10-15%)
- Dried leaves were mashed by coarse tendering, and ready to further process.
- For fermentation treatment, fresh leaves were left wilted (1-2 days, depending on the room temperature and moisture content). Wilted leaves were recognized by squeezing the leaves whether they have felt wilted or still break easily.
- Wilted leaves were twisted (rolled), kneaded, and/or sliced into a small size and then spread on fermentation (oxidation) slabs with 1-2cm thickness.
- Sliced leaves were then incubated in the incubator room in controlled temperature, humidity for 6 hours
- Fermented leaves were dried until reach 8-10% moisture content 8-10%
- Dried leaves were put into tea bag and tested

In the fermentation process of pirdot leaves, the condition of the processing room could be modified to get the most ideal humidity and temperature. Modification was made based on tea leaves
fermentation which humidity (RH) is above 90% and temperatures is ranging from 23-27°C. Moisture could be added by fading the chamber if it is too low. Oxidation was carried out for 6 hours.

2.3 Data Analysis
The characteristics of tea were determined by powder size, powder color, steeping water color, aroma and taste [9]. Organoleptic test was performed by comparing the results of each treatments. The testing parameters were color, aroma, and taste of the steeping tea. The grading of scores was Likert scale, were as follows:
1 = dislike extremely
2 = dislike (very much)
3 = neither like or dislike = like
5 = like very much

Data obtained from the first step testing (treatment of raw material differences and processing processes) were tested with a multilevel correlation (Kendal Tau) using SPSS 23.0. Testing Kendal Tau was chosen because the type of data produced was ordinal data, and the parameters observed do not have a level (in the form of a treatment group).

3. Result and discussion
Polyphenol or phenolic compounds are bioactive components that have antioxidant activity which is naturally found in vegetables and fruits such as tea (tree/plant/shrub). Polyphenolic compounds consist of several subclasses, such as flavonol, flavone, antocianidine, catechin and biflavan [10]. Phenolic compounds of flavonoids are also found in pirdot leaves. Additionally, pirdot leaves also contains secondary metabolites such as alkaloids, steroids, and tannins [7].

Tea is rich in polyphenolic flavonoids which have shown strong antioxidant potential and have been tested in vitro and in vivo. The content of polyphenolic flavonoids in tea depends on the type of raw material and the processing method [11]. Herbal tea is one of tea and herbal drink products that helps in health treatment [12].

Pirdot leaves are commonly consumed in the form of tea. Pirdot leaves are widely used, especially in North Sumatra for its health benefit. Pirdot leaves are also consumed as stamina booster. Based on a survey conducted by several respondents around Toba Lake (Districts of Simalungun and Toba Samosir), it was stated that several diseases can be cured by consuming pirdot leaves. Some of them were lymph node cancer, thyroid cancer, uterine tumors, high blood pressure, diabetes, gout, and various open wounds due to itching, boils, cut wounds that occur in humans or livestock [13]. However, it needs laboratory-scale testing both in-vitro and in-vivo tests to prove the efficacy of pirdot leaf as a medicine. This study focused on the processing of pirdot leaves, thus its utilization and added value can be improved.

During this time, the use of pirdot leaves by the community is still very simple through boiling. The trial of processing pirdot herbal tea is the first step to better utilize pirdot leaves for wider consumers. The processing of this traditional method needs to be improved so that the presentation is easier, the dosage is more precise, the appearance is more attractive, and easily distributed. Efforts to improve primary processing technology are carried out by making pirdot tea bag. [14] argued that the transformation of the supply of herbal tea from traditional methods to more modern, supervised, and standardized processing techniques was to increase the added value, to prevent contamination during the processing, and to provide a more appropriate presentation and dosage.

In processing herbal tea, the quality of tea is greatly influenced by the level of aging of the leaves and the method of processing. Leaf composition affects the content and type of polyphenols [15]. In tea leaves (Camellia sinensis), levels of young leaf polyphenols are higher than the levels of old one [16]. On the other hand, [17] found that old breadfruit leaves have higher levels of polyphenols than young leaves. Based on these results, polyphenol content varies in young and old leaves, thus it could not be standardized that the older the leaves, the lower the content of the polyphenols and vice versa.
Differences in raw material sources and processing techniques are also carried out in the manufacture of pirdot herbal tea. The results of organoleptic testing of different sources of raw materials and tea processing techniques can be seen in Table 1:

Table 1. Results of organoleptic test of differences of raw material sources and tea processing techniques.

| Treatment | Color | Aroma | Taste | Average |
|-----------|-------|-------|-------|---------|
| P1        | 1.80  | 2.27  | 2.60  | 2.22    |
| P2        | 1.33  | 2.47  | 2.47  | 2.09    |
| P3        | 2.87  | 4.07  | 3.80  | 3.58    |
| P4        | 2.40  | 3.13  | 3.27  | 2.93    |
| Average   | 2.10  | 2.98  | 3.03  |         |

Note: Total respondent = 15 panelists

The results in Table 1 descriptively show that there were differences in color quality, aroma, and taste of pirdot herbal tea processed from leaves from the top 5 and 3 shoots, as well as oxidation process. Leaves obtained from the top 5 pirdot leaves were more prefer for its color, aroma and taste (P1 and P3). Furthermore, oxidation activities improved the value of the respondent's preference for the tested parameters.

3.1. Color

The results of brewing pirdot herbal tea appear to be disliked by respondents (average score of 2.10). Pirdot tea steeping showed that the color of steeping water does not look bright when compared to other teas, such as green tea, jasmine tea, and others. Tea is identical to the color of steeping which has a bright color adjusted to its base material. The color of pirdot herbal tea tends to be less bright or less attractive, which is likely to have low phenolic leaves. Further research to identify the phenolic types and to test quantitative phenolic levels in pirdot leaves is indispensable. Although colors are less bright than commonly consumed tea, different types of raw materials and processing techniques gave different results. The results of tea pirdot steeping with four types of treatment were shown in Figure 3.
Figure 3. Results of brewing pirdot herbal tea.

From Table 1, it can be seen that the best color quality of pirdot leaves is obtained from a combination of older age leaves and oxidation process. From these results it could be seen that the content of phenolic compounds of leaves derived from older leaves is higher when compared to leaves from young shoots. To prove this result, laboratory tests are still needed, such as testing phenolic content and antioxidants in herbal tea powder. The results in steeping water quality from leaves without oxidation (no fermented) and with oxidation (fermented) were also different where fermented leaves produces darker color. According to [18] the enzymatic oxidation process contained is responsible for color changes in various plant tissues containing phenolic. This term is known as enzymatic browning. The difference in the color of the pirdot herbal tea made by oxidation is due to the fact that during the oxidation process, there is an enzymatic process that produces brownish color to the food.

Correlation test (Kendal tau test) was carried out to test the significance relationship between parameters of leaf aging and oxidation treatment against respondent’s preference. Result of Kendal tau correlation can be seen in Table 2.

Table 2 showed that there were very significant differences in processing techniques for color quality that applied in treatment P1 and P3 (with oxidation and not oxidized). Nevertheless, differences in raw materials (level of aging) had no significance correlation in the treatment. These results indicated that the treatment of processing techniques greatly affects the color of tea. The difference in color of pirdot herbal tea produced by oxidation process was due to the fact that during the oxidation process there was an enzymatic process which produces brown color on the wet tea powder. Enzymatic browning occurs in foodstuffs including leaves that contain many phenolic substrates. This reaction occurs if plant tissue is cut, peeled and due to mechanical damage that can cause damage to plant tissue integrity. This causes enzymes come into contact with the substrate which is usually an amino acid tyrosine and phenolic components such as catechins, caffeic acid, and chlorogeneric acid. That process made phenolic substrate in the plant then hydroxylated to 3,4-dihydroxyphenylalanine (dopa) and oxidized to quinone by phenolase enzymes causing the color of food ingredients to become brownish [18]. During oxidation process, the oxidation chamber was conditioned so that temperature and humidity were adjusted to the optimum activity of oxidizing enzymes (phenolase). Water content during the oxidation process was also considered to greatly affect the quality of tea color and provide uniformity of tea color [19].
Table 2. Correlation of leaves aging and oxidation process on pirdot tea color.

| Kendall’s tau_b | P1 Color | P2 Color | P3 Color | P4 Color |
|-----------------|----------|----------|----------|----------|
|                 | 1.000    | -0.020   | 0.691(**) | 0.222    |
| P1 color        | .        | 0.938    | .006     | 0.382    |
| P2 color        | -0.020   | 1.000    | 0.408    | 0.318    |
| P3 color        | 0.938    | .        | 0.104    | 0.212    |
| P4 color        | 0.691(**)| 0.408    | 1.000    | 0.380    |
|                 | 0.006    | 0.104    | .        | 0.129    |
|                 | 0.222    | 0.318    | 0.380    | 1.000    |
|                 | 0.382    | 0.212    | 0.129    | .        |

Note: **Correlation is significant at 0.01 level (2-tailed). N = 15

In line with the results of fermentation treatment in other studies that provide significant results in the color of pirdot tea steeping, research conducted by [20] also produces results that are not different. In his research on the manufacture of herbal teas which are processed from chrysanthemum flowers, fermentation process resulted stronger color in steeping water.

3.2. Aroma

The average value of panelist preference for the aroma of pirdot herbal tea (Table 1) looks better compared to color preference (average value of 2.98). From these results, oxidized pirdot leaves were more preferred in aroma rather than the nonoxidized. The difference in leave ageing did not show linear results. A correlation test result of the treatment could be seen in Table 3.

Table 3. Correlation of leaves aging and oxidation process on pirdot tea aroma.

| Kendall’s tau_b | P1 Aroma | P2 Aroma | P3 Aroma | P4 Aroma |
|-----------------|----------|----------|----------|----------|
|                 | 1.000    | -0.262   | 0.587(*) | 0.132    |
| P1 Aroma        | .        | 0.327    | 0.025    | 0.613    |
| P2 Aroma        | -0.262   | 1.000    | 0.152    | 0.546(*) |
| P3 Aroma        | 0.327    | .        | 0.562    | 0.036    |
| P4 Aroma        | 0.587(*) | 0.152    | 1.000    | 0.521(*) |
|                 | 0.025    | 0.562    | .        | 0.042    |
|                 | 0.132    | 0.546(*) | 0.521(*) | 1.000    |
|                 | 0.613    | 0.036    | 0.042    | .        |

Note: *Correlation is significant at 0.05 level (2-tailed). N = 15

The correlation between oxidation treatment and leaves aging provide significant results in the aroma of pirdot tea steeping. This could be seen from the difference in treatment without oxidation and after oxidation in treatment P1 and P3, and between P2 and P4. Furthermore, the treatment is oxidized on raw materials which have different levels of aging (P3 and P4) also provide significant results. The content of plants that provide aroma to herbal plants is due to the presence of volatile compounds that easily reach the sense of smell and when there is sufficient concentration of aroma compounds in the plant [21]. The GC-MS testing in the earlier study [13] showed that there were at least 20 types of chemical compounds found in pirdot leaves. However, the classification of aroma and volatile compounds in pirdot leaves have not been carried out.
Non-oxidized treatment (P1 and P2) result showed that there was no significant difference in the in leaves aging level to the tea aroma. Nevertheless there were significant differences (level 0.05) to the tea aroma after oxidation treatment (P3 and P4). Based on these results, it can be seen that there were differences in aroma triggered from different leaves age, where the older leaves have better aroma quality compared to the younger leaves. The chemical content in plant leaves is a scent or an aroma of herbal tea. Oxidation activities such as drying, roasting, or fermentation and other activities are carried out to reduce enzymes along with reduced water, temperature, or other activities to obtain a better aroma of herbal tea.

Enzymatic oxidation treatment in pirdot herbal tea manufacture yielded significant results of the two types of leaves (raw materials) tested. Oxidation treatment omitted raw odor which is caused bad smell in herbal teas. Unfermented tea has raw taste and aroma like green grass because there are still many enzymes that cause odor [19]. The process of oxidation (fermentation) activities such as withering and grinding results the trapped enzymes and the odor in cells to be broken down and evaporate during the grinding process, and become non-active due to a decrease in moisture in the drying. The leaf grinding process, in addition to extracting enzymes, also functions to extract the chemical content (source of aroma) contained in the leaves so that the aroma and flavor becomes increased. Furthermore, in fermentation process, the enzymatic activity of phenolase compounds also inhibits the activity of other enzymes in obtaining substrate. Considering this process, the combination of activities in the oxidation process such as withering, rolling, fermentation, and drying resulted in increased aroma through the extraction of aroma-producing chemical compounds and non-active enzymes that cause the raw odor in pirdot herbal tea.

3.3. Taste

The average value of panelist preference for the taste of herbal pirdot tea (Table 1) was 3.03. This results showed that tea obtained from top 5 leaves was preferred compared to tea from top 3 leaves and the oxidized tea was preferred with non-oxidized ones.

The average panelist score showed the level of panelist preference is still low (3 = less preferred). This is considered to be normal, because pirdot tea is an herbal tea (medicine) which has a more bitter taste compared to other ordinary well known teas. According to panelists, pirdot tea has a rather bitter taste and is dominated by a feeling of tightness on the tongue. To achieve maximum tea flavor, pirdot tea should be processed into finer powder so it can increase the absorption of color, taste, and aroma in steeping water. Table 4 showed the results of correlation test to find out the differences in the treatment of leaves aging and oxidation treatment on taste quality of pirdot herbal tea.

### Table 4. Correlation of leaves aging and oxidation process on pirdot tea taste.

|       | P1 Taste | P2 Taste | P3 Taste | P4 Taste |
|-------|----------|----------|----------|----------|
| Kendall's tau_b | Correlation Coefficient Sig. (2-tailed) | 1.000 | 0.842(**) | 0.372 | 0.672(**) |
| P1 Taste | . | 0.001 | 0.136 | 0.008 |
| P2 Taste | 0.842(**) | 1.000 | 0.247 | 0.731(**) |
| P3 Taste | . | 0.336 | 0.005 |
| P4 Taste | 0.372 | 0.247 | 0.641(*) | . |

Differences in the aging rate of leaves affected on taste values (treatment P1 and P2 and treatment of P3 and P4) significantly and fermentation treatment also had a very significant effect on taste quality (P2 and P4 treatment). [22] indicated that catechins (major polyphenols) are the main component of
the causes of bitter taste in medicinal products (plants). Besides, caffeine, saponins [23] and alkaloids [24] also contribute to the bitter causes. [25] added that catechins are an important component of tea and contributes to color, pungency and taste characteristics. One function of fermentation and oxidation in tea is to improve taste and aroma. Sufficiently unfermented tea has a raw taste and aroma or taste and aroma like grass [19]. Herbal tea produced from older pirdot leaves has a better taste value compared to leaves obtained from younger one. However, it should be noted that there is an age limit of leaf to be used in tea production and very old leaves are usually less qualified and the tissue is too hard. In this experiment the leaf boundaries used were five leaves from the shoot.

Furthermore, in the treatment of enzymatic oxidation, there was a forging activity and destruction of plant tissue which is carried out slowly. This resulted in the extraction of chemical compounds that cause taste. The existence of a combination of activities in the oxidation process such as withering, rolling (milling), fermentation, and drying resulted in an increase in taste through the extraction of chemical compounds that produce aroma and non-active enzymes that cause odors and raw flavors.

4. Conclusions and recommendations

The differences in the level of leaves aging and oxidation treatment had a significant effect on the quality of color, aroma, and taste of pirdot herbal tea. Herbal tea obtained from the top five leaves showed better quality of color, aroma and taste compared to tea obtained from the top three leaves. This indicated that the chemical content in older pirdot leaves such as flavonoid compounds, alkaloids, or other chemical compounds was higher than the younger ones. Oxidizing enzymatic treatment (fermentation) in the manufacture of herbal tea pirdot provide a better quality in color, aroma, and taste. The milling process (tissue destruction) and oxidation were conducted in controlled temperature, humidity, and time to support the enzymatic browning that can enhance the color, aroma, and taste of herbal tea. Enhance information about chemical content of pirdot leaf such as the content of tannin, anti-oxidants and other chemical compounds in the processed tea is required.

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