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Research Article
Formulation of High-Quality White Peony Tea Made of Local Clones of Gambung 7, Kiara and RBS

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Abstract

Background and Objective: White Peony is a type of white tea consisting of 1-2 leaves and buds. This tea has very good demand because of its distinctive taste. Catechins and Epigallocatechin Gallate (EGCG) are the main compounds that affect the taste. This study was aimed to find white tea optimal compositions made of local tea clones of Gambung 7, Kiara and RBS based on components that affect taste attributes. **Materials and Methods:** The catechin and EGCG contents were measured using High-Performance Liquid Chromatography (HPLC). The moisture content of the sample and controls was 7, 8, 9.7 and 7.6% for Gambung 7, Kiara, RBS and control, respectively. A formulation was made based on total catechins and EGCG using Linear Programming then compared with the control. **Results:** The proposed formula composition of every 10 g was 4.49 g Gambung 7, 0.81 g Kiara and 4.70 g RBS. The catechin and EGCG represented the taste and aroma of the white peony tea. The duo-trio test showed that the proposed formula has a similar taste and aroma to that of the control while the colours had not been similar. **Conclusion:** White Peony Tea can be made from the local clones of similar taste and aroma at a certain composition. However, the colour was not similar that need to be further improved.

Key words: White tea, formulation, catechin, Gambung 7, Kiara, RBS

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Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

White tea is an unfermented product of young shoots of *Camellia sinensis*[1], after withering and drying processes to increase polyphenols more than other kinds of tea[2,3]. There are two types of white tea which are distinguished by the number of leaves, that is white tea produced from unopened buds, classified as S*ilver needle* and white tea produced from incorporating an unopened bud and two immature leaves named *White peony*[4]. All variances in these teas have very high demand due to their special taste[5], which is mainly influenced by the polyphenols content[6].

There are two main variances in white tea that is made from Sinensis and Assamica. They are being differentiated according to the tea plant origin. Sinensis came from China with the characteristics of leaves that have a size of 3.8-6.4 cm, while Assamica came from India and has longer leaves[7]. Tea plants that are genetically identical to the parent, originating by vegetative propagation such as cuttings or grafts are taken from the tea bush named Clone[8]. Gambung 7 and RBS are clone types of Assamica with the advantage of high productivity while Kiara is a clone of Sinensis with the high content of shoot polyphenol[7]. A combination of these three clones would have an advantage in the high productivity and good polyphenol content of white tea.

Gambung 7, RBS and Kiara are locally developed plants and have relatively low price and limited market. Efforts should be done to improve their value of customer acceptance and finally enlarging the market. Considering the different concentration of their polyphenol contents, an optimum composition would be possible to be made by mixing them in a formula. This is to improve the use of local clones as alternative raw materials for the formulation of white tea product based on attribute components of the taste, aroma and colour. Tea processing involves a process to increase the polyphenol content which distinguishes the final result of each clone. This research was aimed at studying the taste attribute as the most important parameter of market acceptance of a formulated white tea.

Formulation of white tea was set by blending the three clones based on pre-determined composition calculated using Linear Programming (LP). The LP is a systematic method to determine the optimum mixture of composition which fulfils a series of polyphenol content and EGCG requirement. This optimization replaces repetitive experiments of laboratory work in finding the optimum blending composition of each tea clone. The formulation result was tested for similarities and differences toward control (best white tea in the market) using duo-triotest[9].

The purpose of this study was to obtain a formula that has the same taste as commercial white tea by optimally mixing the local tea clones of Gambung 7, Kiara and RBS. The formulation was based on components that affect the taste attributes so that they are similar to the marketed white tea. It was expected that this research would contribute to the use of local tea clones to produce high-quality white tea. The finding would contribute to increasing the added value of local tea clones in terms of market expansion and better selling price.

MATERIALS AND METHODS

Study area: The fieldwork was conducted from October 2018 to January 2019 at a tea plantation in Garut, West Java Indonesia. The analysis and interpretation of the result were completed during February-May, 2019 at Bogor Postharvest Research Center and the Department of Agroindustrial Technology, IPB University. The samples of local tea were taken from the Cisaruni Tea Plantation and the control (commercial white tea product) was obtained from State-Owned Plantation 8 (PTPN 8) that has widely been in the market. Both Plantations are in West Java Indonesia.

Moisture, catechins and EGCG contents: Moisture content analysis was done using AOAC 935.29 method[10]. Petri dish was dried at 105°C for 15 min in the oven, transfer to desiccator to cool then weighted. Some 3 g of each sample was put on the petri dish and placed in the oven which was set at 105°C. The drying process runs for 4 hrs. After drying, the petri dish transferred to the desiccator to cool. Reweight the dish with the dried sample. This procedure was carried out to get a constant weight. All samples were tested for moisture content. The moisture content was calculated using the formula below:

$$\text{Moisture content (\%)} = \frac{A - B}{A} \times 100 \quad (1)$$

Where:

A = Wet sample weight (before drying in g)
B = Dried sample weight (after drying in g)

For calculation of the tea formula composition, the dry weight base moisture content was used. The formula below is to convert moisture content of wet to dry basis:

$$\text{Dry weight (\%)} = \frac{10 \times \text{Fresh weight (\%)}}{10 - (10 \times \text{Moisture content (\%)})} \quad (2)$$

Catechins and EGCC contents in white tea were analyzed using High-Performance Liquid Chromatography (HPLC) at Balai Besar Pascapanen (Post-Harvest Research Center) Bogor.

White tea formulation: The white tea formulation was designed by using mathematical modelling of Linear Programming. The objective function (Z) can be written as:

$$\text{Maximize } Z = X_1+X_2+X_3$$

with constrains are:

$$A_1X_1+A_2X_2+A_3X_3 = A$$

$$B_1X_1+B_2X_2+B_3X_3 = B$$

$$X_1+X_2+X_3 = 10$$

$$X_1>0$$

$$X_2>0$$

$$X_3>0$$

Where:

X_1 = Clone Gambung 7 (g)
X_2 = Clone Kiara (g)
X_3 = Clone RBS (g)
A_1 = Dry weight (%) of total catechins of Gambung 7
A_2 = Dry weight (%) of total catechins of Kiara
A_3 = Dry weight (%) of total catechins of RBS
A = Dry weight (%) of total catechins of control×10 g
B_1 = Dry weight (%) EGCG Gambung 7
B_2 = Dry weight (%) EGCG Kiara
B_3 = Dry weight (%) EGCG RBS
B = Dry weight (%) EGCG of control×10 g

Sensory analysis (Duo-Trio test): Sensory analysis in this study was to determine the tea quality and sensory attribute differences between each clone, proposed formula and control using Duo-Trio Test. The quality of tea was determined by sensory attributes such as taste, aroma and color[11]. Sample preparation was done by mixing the formula then put as much as 2.8 g of formula for 110cc of cups. Brewing was done for 6 min at 96-97°C. The next step, the Duo-Trio test was carried out[9], by presenting 3 types of white tea, they were controlled white tea (820), formulation result of white tea (372) and one type of local teas (Kiara) (523). The 15 trained panellists were asked to determine which of the two samples (372 and 523) have similarities or differences with the control (820).

RESULTS AND DISCUSSION

The results include the moisture content of white tea, catechins and EGCG contents of white teas and the Duo-Trio Test. The moisture content affects the proportion of the catechin content and EGCG, therefore the formulation was based on a dry weight basis. This becomes a reference to formulate the *Linear Programming* equations. LINGO Software was used to determine the weight of each clone (g) for white tea of each clone mixture composition. The Duo-trio test was useful to examine the taste preference.

Moisture content of white tea: The moisture content of white tea for each sample can be seen in Table 1. The samples moisture content ranges from 7.00-9.70% that means the water content of Gambung 7, RBS, Kiara and Control meet the requirements. Tea is a hygroscopic material that is easy to absorb water[12], where moisture content affects the quality and shelf life of teas[13]. Determination of moisture content of the white tea was used for finding out the dry weight of catechins and EGCG contents.

The differences in moisture content of clones are caused by storage factors, processing technology and clone type. Packaging material with lower permeability has the higher ability to prevent water absorption and moisture content addition[12]. From the processing point of view, whitening and drying affect the moisture content during which water evaporation was taking place[13]. For these reasons, the maximum moisture content is regulated and become one of the quality parameters. Therefore, it is suggested that the moisture content of raw materials (local tea clones) should be analyzed before making a formulation to enable the determination of the accurate composition of the formula.

Total catechins and EGCG of white tea: Catechins and EGCG contents in the white tea was analyzed by using HPLC that is a method of chemical analysis to separate, identify and quantify compounds in the mixture or bioactive component[14]. HPLC produces chromatograms that show the composition or proportion of the material being analyzed. The basic principle of HPLC is the separation of the analyte in the column based on its polarity in the mobile phase flow which carries the analyte mixture through the stationary phase. In the stationary

Table 1: Moisture content of white tea (%)

Clone	Moisture content
Gambung 7	7.00
RBS	9.70
Kiara	8.00
Control	7.60

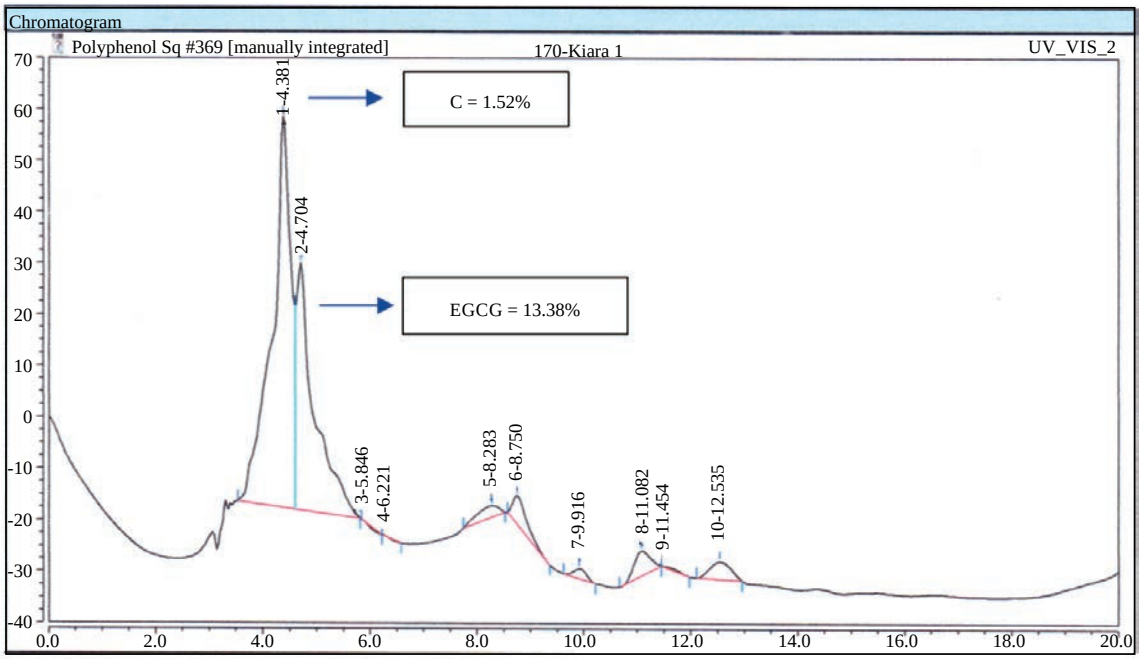

Fig. 1: HPLC profile clone of Kiara with UV-VIS detector and analysis by polyphenol method
C: Catechins, EGCG: Epigallo catechin gallate

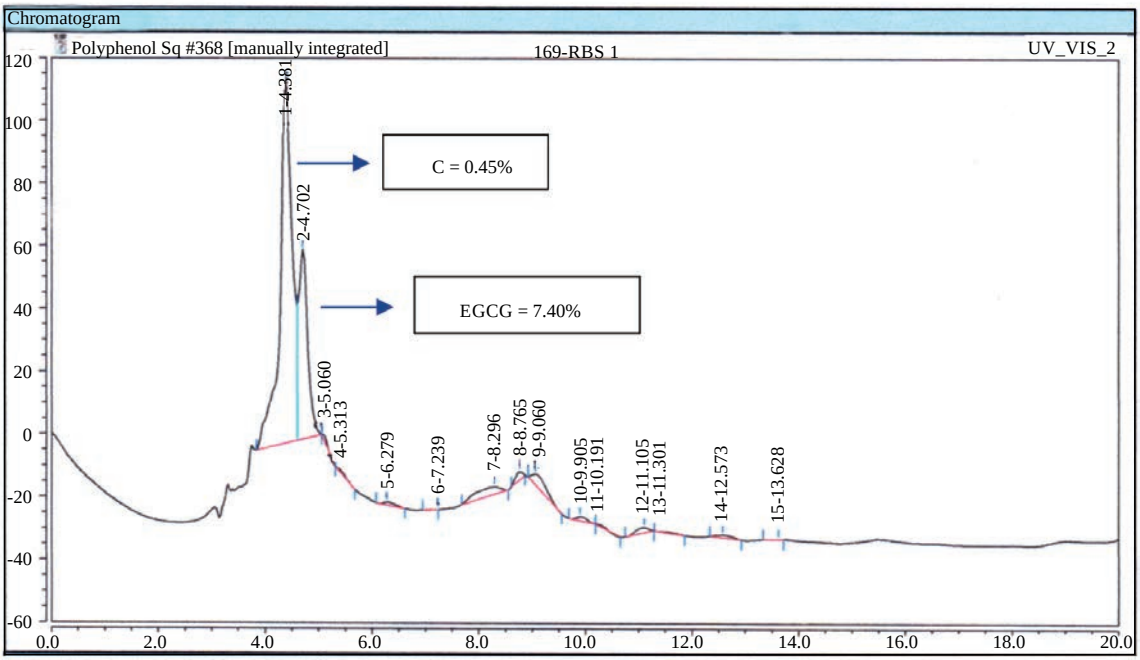

Fig. 2: HPLC profile clone of RBS with UV-VIS detector and analysis by polyphenol method
C: Catechins, EGCG: Epigallo catechin gallate

phase, separation of the components occurs due to differences in the strength of the interaction between the solute and the stationary phase so that there is a difference in transfer time of each component in the mixture. In Fig. 1-4 HPLC analysis showing the concentration of each sample main substances. Figure 1 showed the HPLC profile of the Kiara clone with two significant peaks i.e., catechins (1.52%) and EGCG (13.38%). Figure 2 showed the RBS clone catechin

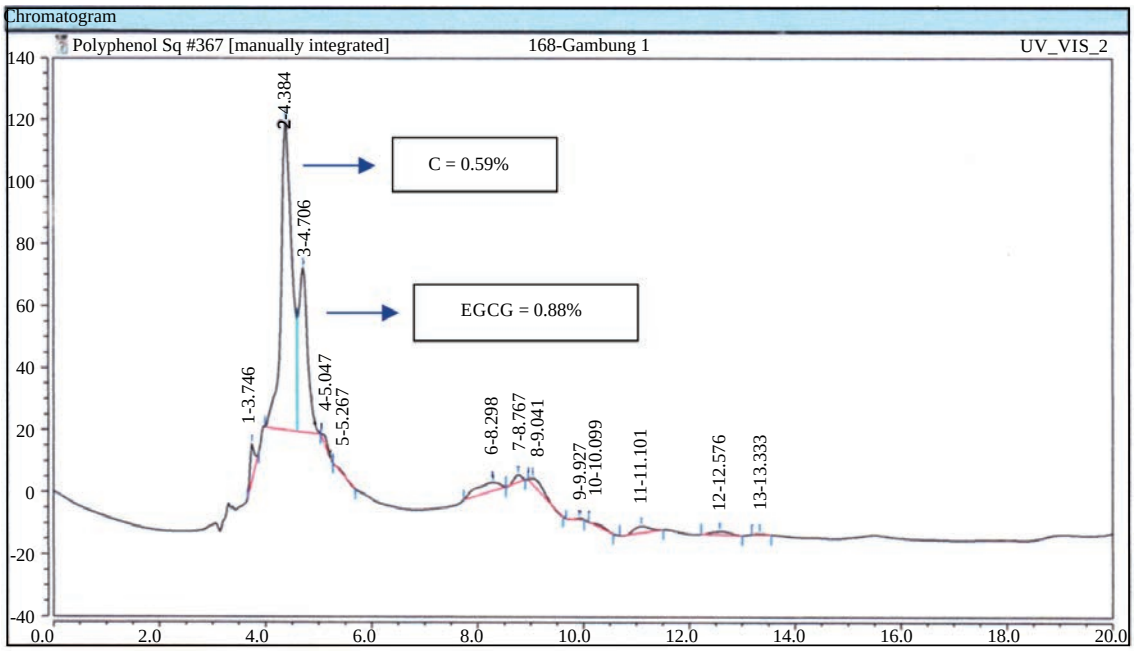

Fig. 3: HPLC profile clone of Gambung 7 with UV-VIS detector and analysis by polyphenol method
C: Catechins, EGCG: Epigallo catechin gallate

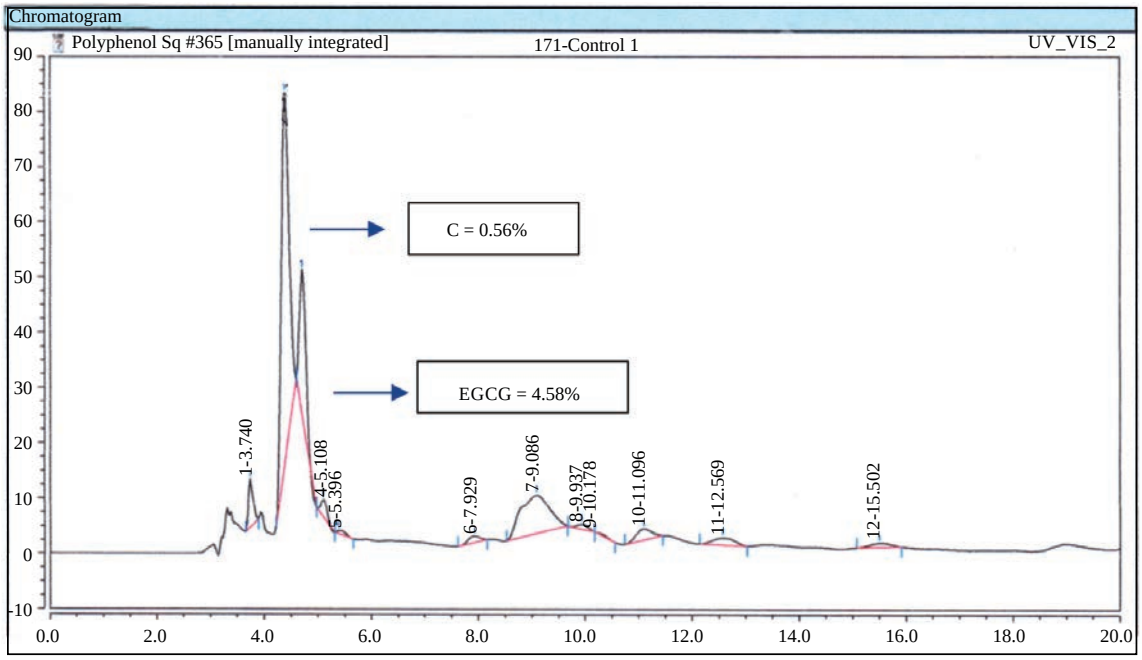

Fig. 4: HPLC profile of control (white tea) with UV-VIS detector and analysis by polyphenol method
C: Catechins, EGCG: Epigallo catechin gallate

content (0.45%) and EGCG (7.40%). Figure 3 showed Gambung 7 clone catechin (0.59%) and EGCG (0.88%) contents. Figure 4 represented catechin (0.56%) and EGCG (4.58%) contents of the white tea control. These figures are summarized in Table 2.

Table 2 showed total catechins of Gambung 7 of 0.55% was very close to, while the others are less than, the control (0.56%). Oppositely, the EGCG content of all samples (6.69-12.31%) was higher than the control (4.58%). The catechins content is very good compare to the average reported content

Table 2: Total catechins and EGCG of white tea in term of wet weight (%)

	Clone			
Compound	Gambung 7	Kiara	RBS	Control
Catechins	0.55	1.40	0.41	0.56
EGCG	0.82	12.31	6.69	4.58

Table 3: Total catechins and EGCG contents of white tea of dry weight (%)

	Clone			
Compound	Gambung 7	Kiara	RBS	Control
Catechins	0.59	1.52	0.45	0.60
EGCG	0.88	13.38	7.40	4.96

of Camellia Sinensis of 0.19-0.27[15] and 0.21-0.31%[16]. Similarly, EGCG content is also higher than reported 2.71-3.32 and 3.37-3.12. This indicated that an optimum composition may be made by mixing the samples to have similar characteristics to the control.

Fresh weight cannot be formulated directly due to the difference in moisture content of each clone and control. The moisture content affects the proportionality of the contained substances. Therefore, fresh weight needs to be converted into dry weight using Equation (2). Total catechins and EGCG contents of White Tea based on dry weight analysis can be seen in Table 3. Percentage values of the chemical were slightly different to those of wet basis. The control catechins content (0.6%) was within the samples range of 0.45-1.52% and EGCG ranges 7.40-13.88% were higher than the control (4.96%).

The phenolic contents are higher than those of black tea as the advantage of the white and green teas. The fermentation process reduces the rate of epicatechin (EC), epigallocatechin (EGC), catechin gallate (CG), gallocatechin gallate (GCG) and total flavonol glycoside[17]. Variance ranges of concentration indicate that the local clones can be mixed to formulate a white peony tea to meet the criteria. The percentages of catechins and ECGC were used as the coefficient of constraint functions of LP.

White tea of Kiara clone has the highest amount of total catechins and EGCG contents. Wijayanto *et al.*[7] state that the polyphenol content of clone *Sinensis* (Kiara) is higher than clone *Assamica* (Gambung 7 and RBS). From the content of main substances, Kiara is good for human health[18-21]. However, the taste attribute is not following the control so that it must be improved by adding the two remaining clones to create a new formula that has similar sensory characteristics to the current widely acceptable white tea products.

White tea formula: Formulation was designed in accordance with the catechins and ECGC contents of each clones as coefficient of constraint as follows:

$$0.59X_1+1.52X_2+0.45X_3 = 6.00$$

$$0.88X_1+13.38X_2+7.40X_3 = 49.60$$

$$X_1+X_2+X_3 = 10$$

Where:

$$X_1>0;\ X_2>0;\ X_3>0$$

LP outputs of X_1, X_2 and X_3 determine the formula composition to possibly meet the taste, aroma and colour were as follows:

$$X_1 = 4.49\ g$$

$$X_2 = 0.81\ g$$

$$X_3 = 4.70\ g$$

Therefore, the proposed formula for every 10 g of white tea consists of 4.49 g Gambung 7, 0.81g Kiara and 4.70 g RBS. This formula was tested for sensory similarity with the control and local clones' white teas. According to the research method, 2.8 g of the formulated white tea was then analyzed using Duo-Trio organoleptic.

Duo-Trio test: Table 4 showed that four skilled panellists stated differently to taste attribute and seven panellists stated differently to the aroma attribute. The duo trio test is an effective method to determine the differences between the formulated white tea and control. The test results as presented in Table 4 represented similarity or difference between the tea formula and control. These results showing the similarity in taste, aroma and colour between samples and the control. The number one (1) indicated that the panellist was able to differentiate, while zero (0) indicated that the panellist could not differentiate the samples with the control.

The degree of similarity indicated the acceptance level of the formula to be produced commercially. This showed that no difference in the significance level of 5, 1 dan 0.10% of tea formulation and control for the taste and aroma. There were 13 panellists stated differently to the colour. This showed the significant differences between the formulated tea and control at the significance level of 5, 1 dan 0.10%[9]. These results agreed with Chaturvedula and Indraprakash[6] and Yang *et al.*[19], that taste attributes of the white tea are affected by total catechins and EGCG contents. The duo trio test showed no significant difference in taste attributes then the formula should be acceptable to customers of white tea products. It was also found that there was a similarity in the aroma attribute indirectly. Chemicals that affect the aroma in

Table 4: Duo-trio test results

	White tea formulation			White tea of Kiara		
Trained panellist	Taste	Aroma	Color	Taste	Aroma	Color
P1	0	0	1	1	1	0
P2	0	0	1	1	0	0
P3	0	1	1	0	0	1
P4	1	0	1	0	1	1
P5	0	0	1	1	1	0
P6	0	0	1	0	1	0
P7	0	1	1	1	0	1
P8	1	0	1	1	0	0
P9	0	1	1	0	0	0
P10	0	1	1	1	1	1
P11	0	0	0	1	1	0
P12	0	1	1	0	1	0
P13	1	0	0	0	0	0
P14	1	1	1	1	1	1
P15	0	1	1	0	1	0
Total	4	7	13	8	9	5

P1-15: Panelist 1-15, 0: Same, 1: Different, Total: Number of panelist felt different

white tea are volatile compounds[17]. Therefore, it can be estimated that the formulated tea and control have similar volatile compounds.

The colour attribute between the tea formulation and control was different which indicated the difference in the flavonol compound. An alternative to distracting the colour attribute of tea is using special packaging. The feasible packaging material used for tea is a coloured bottle or coloured container. The white tea seller usually used glass jars to protect tea's taste and aroma[22-24]. Since the taste and aroma were similar, consumers would accept the formulated tea by not seeing the colour.

CONCLUSION

The proposed formulation consists of 4.49 g clone Gambung 7, 0.81 g Kiara and 4.70 g RBS. The duo-trio test saw that there were no differences in taste and aroma attributes significance level of 5, 1 and 0.1% to the control. Brewing colour can be distinguished by the panellist so that the colour can be regarded as the variable that affects consumer preference. While improving the colour, it is advisable to pack the brewed tea in the dark container or serve the dark cup or jar so that consumers would not immediately see the colour.

SIGNIFICANCE STATEMENTS

This study discovered a production method of high-quality peony white tea of local tea clones through special formulation. It is beneficial to producers to enhance their market, increase added values of the products and improve the revenues. This study will help the researchers to uncover the critical areas of tea processing method to enlarge the market and improve the selling price of local tea clones that have been the obstacle to sell the products at a reasonable price. Thus, a new method of mixing local tea at a certain level of composition may have arrived at the optimum price and added value.

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