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Sensory Evaluation of Brewed Black Tea (*Camellia sinensis* sp) and Stevia (*Stevia rebaudiana* Bert) Leaves. Case Study: Threshold of Phenolic Bitterness Consumer Preference Test

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Abstract: Currently the consumer needs for anti-diabetic products are very large and require answer from healthy food provider answers. Products that are commonly known are tea and stevia. Tea and stevia have advantages as an antioxidant and anti-diabetic. The use of commercially available products is very depended on sensory characteristics which can be accepted by consumers. How much is consumed (*food intake*) depends on the sensory sensitivity of the consumer. Tea and stevia products are products that contain poly phenols which give a sense of briskness or bitterness. At the time of serving alone, stevia tea and steeping have a certain value, which will be different if brewed simultaneously. The study aims to determine the sensory acceptance threshold value, to steeping a mixture of black tea and dried stevia leaves. The study was conducted using the absolute threshold test, using a proportion of the concentration of stevia black tea between 20:1 to 4:1(w/w) and maximum weight of 2 grams. The mixture was brewed using 200 mL hot water with a temperature of 90^0 Celsius for 5 minutes. The steeped product was then tested by 80 untrained panels to find out the absolute threshold for sweet and bitter taste. From the research it was known that the absolute threshold value for sweetness of stevia-black tea was 0.39% (w/v) and bitterness of stevia - black tea was 0.42% (w/v).

Keywords: Black tea, Preference test, Sensory evaluation, Stevia, Threshold

I. INTRODUCTION

At present, the needs of consumers for anti-diabetic products are very large and require answers from healthy food providers. Antidiabetic products that are commonly known are tea[1] and stevia [2]. Both have the advantage of playing an antioxidant and antidiabetic role [3,4,5,6,7]which prioritizes the ability of type 2 diabetes [8]. They can be consumed together, then brewed as drinks, or into other products, to benefit from functional properties synergy. The use of commercially available products is highly dependent on sensory characteristics that can be accepted by consumers. However, how much is consumed (food intake) depends on consumer sensory sensitivity. The sensitivity of consumers in receiving the taste of stevia mixture, mainly determined by the sweet and bitter taste of the mixture. It turns out that the sweet taste is sourced from stevia, but tea and stevia are both products that contain compounds that give a bitter taste as well. The bitter taste of black tea is caused by the contribution of a collection of phenols, namely galloylated catechins [9]and epicatechin [10], even though blacktea is not as bitter as green tea due to changes during its processing [11]. Whereas stevia is caused by glycoside molecules which provide a bitter aftertaste [12]. When served alone, stevia and steeping tea have certain threshold values [13], which will be different if brewed simultaneously. The threshold test was carried out in accordance with Lawless [14], with the graph curve method between response and combination composition. This study aims to determine the threshold value of sensory acceptance, and preference test for steeping a mixture of black tea and dried stevia leaves. This research was a preliminary study to get the right ingredients for making tea-stevia and cocoa-based products [15].

II. MATERIAL AND METHODS

Materials preparation

The materials used were a mixture of black tea and stevia. Dried stevia leaves comes from around Mount Lawu, Central Java and the material was obtained from suppliers in Semarang, and dried black tea in premium grade packaging from

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PT R in Lawang Malang. For threshold testing the concentration prepared were 0.0; 0.012; 0.024, 0.036; 0.048; 0.06; 0.072; 0.084; 0.096; 0.108; and 0.120%. The preference test used a mixture of the two ingredients of stevia powder dried leaves and black tea powder mixed according to the ratio of black tea: stevia treatment starting from (0.5: 0), (0.5: 0.05), (0.5: 0.13), (0.5: 0.21), (0.5: 0.29) and (0.5: 0.37) (w/w), so that we get 0.0; 0.05; 0.13; 0.21; 0.29; and 0.37% (w/v), the material was grinded to pass the size of 40 mesh, the material was weighed with a weight of 2 gram each, then put in a tea bag, then brewed with hot water at a temperature of 90^0C for 5 minutes. Threshold tests were prepared about 30 minutes after preparing the solution in the sensory chamber, with the temperature of the solution ranging from 30 ± 3^0Celsius. With reference ingredients the sweet taste was sucrose (Merck) and bitter taste (*sepat*) was catechin (Sigma).

Panelists Preparation

Panelists were students of the Food Technology Study Program, Widya Mandala Catholic University in Surabaya, aged between 19 to 23 years, have been introduced and trained to test the threshold, a total of 80 panelists, consisting of 17 men and 63 women.

Implementation of threshold and preference testing

The test was carried out in the Sensory Testing Laboratory room, Widya Mandala Catholic University, Surabaya. The sample was given in a cup consisting of 7 (seven) cups of samples according to treatment and 2 (two) cups of the highest lowest limit as a reference. Each cup contains 20 ml of serving. In addition, a cup is also provided stirrer, and a stir for a taster, and a glass of water to rinse the mouth. In front of each panelist, a questionnaire sheet was provided which contained questions among the samples provided different samples were used as a reference and a sweet taste had already appeared (lowest sample 21:1). For each test it has its own reference, for sweet by Reference 1 and for bitterness by Reference 2. Furthermore, from 80 panelists taken as, many as 10 panelists, who will test the assessment detected aspects of sweetness, bitterness, astringency and aftertaste with a value of zero (0) not detected until a value of four (4) is detected very high, then displayed in a graph according to the results. Tests carried out on the concentration of the threshold results for each test.

After that the bitter and sweetness sensation of the solution was measured in the mouth, after the appearance was felt in the oral cavity using a stopwatch, by 10 panelists, on the sweet taste of steeping blacktea, stevia and stevia- blacktea mixture (according to the results of the threshold).

The preference test for stevia-black tea mixture was carried out using a comparison concentration of stevia with aquadest containing 0.5% (w/ v) of black tea. The solution was prepared to be tested using 0.0; 0.05; 0.13; 0.21; 0.29; and 0.37 g respectively of stevia to be dissolved each in 100 mL of a solution containing 0.5% (w/v) of black tea already in the tea bag. Questionnaires contains ratings with member rating of 1 (very dislike), 2 (dislike), 3 (neutral), 4 (like), and 5 (very like).

Data analysis

Data were collected from 80 questionnaires, then threshold tests were processed using Microsoft Excel 2007, using scatter plots. Absolute threshold values were obtained from data interpolation which showed 50% of panelists recognized the smallest concentration that distinguishes the presence of stevia in the steeping mixture between stevia and tea. As for the favorite test, it was conducted using Minitab 16, one way continued with post hoc testing using Tukeys, with a significance level of 5%. The best treatment between neutral (3) to very like (5) will be obtained.

III. RESULT AND DISCUSSION

The threshold experiments obtained information about the acquisition of astringency, sweet, and bitter. From the 80 panels the threshold for sucrose sweetness (at 30^0C) was obtained 0.13%. The sweet taste of sucrose is used as an adaptation of the panelists who will give the sweet and bitter taste of the stevia black tea mixture to be purchased. In testing the threshold of stevia, the initial concentration of stevia has shown a distinctive minty aroma of herbal medicine, although it has not yet considered the sweetness. At higher concentrations it turns out that the sweet taste has begun to be detected by panelists. The detection of the sweet taste in black tea, a sweet taste has appeared but is covered by a taste of bitter (*Indonesian:* "*sepat*"), that's what gradually with increasing concentration the sweetness is increasingly obscured by the taste of sepat. For this reason a fixed concentration of 0.5% of black tea (0.5 gram of black tea powder in 100 mL of distilled water or 1 gram of black tea in 200 mL of distilled water) was used, where the dominant sweetness was known.

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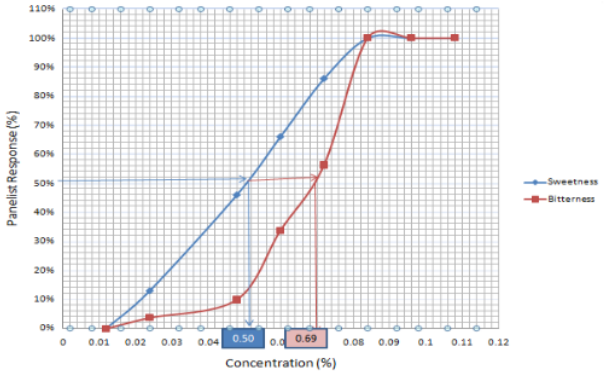

Fig.1. Threshold for stevia leaf sweetness and bitterness

From Fig 1, it was known that the threshold value for the sweet taste of stevia is 0.05% and bitterness is 0.069%. As for the sweet taste threshold value of blacktea solution was 0.039% and bitterness is 0.042% as presented in Fig 2.

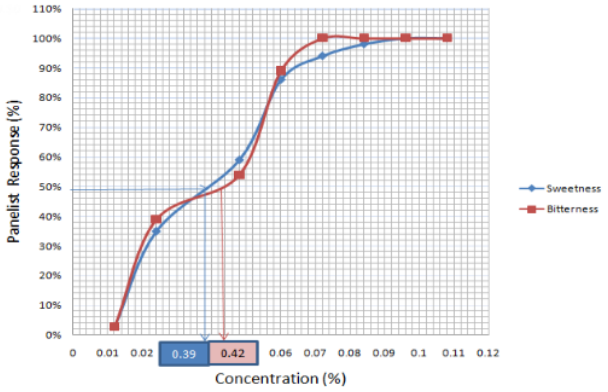

Fig.2. Threshold for blacktea sweetness and bitterness

From the experiments to sort between the nature of the sensations of sweetness, bitterness, astringency, and aftertaste, as shown in Fig.3

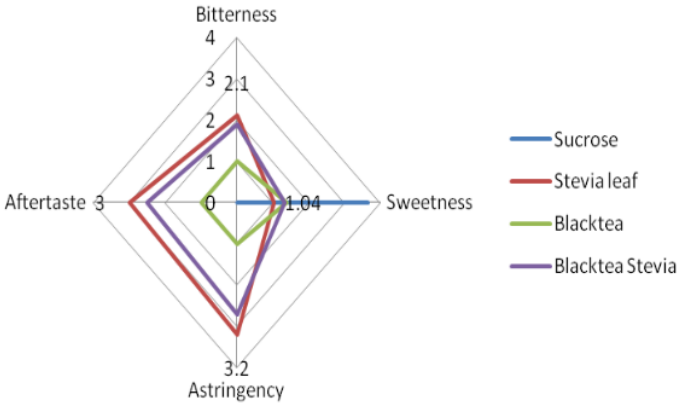

Fig.3. Sensory test of sucrose, stevia leaves, black tea and blacktea-stevia

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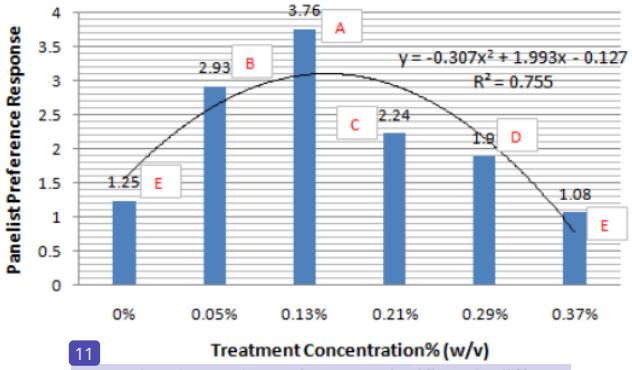
In Fig.3., the sequence, for aftertastes it turns out that stevia leaves which is consumed alone gives the longest and most noticeable aftertaste compared to blacktea and blacktea stevia mixture. From the sweetness level, the mixture of black tea–stevia and only black tea have almost the same sweet taste, but has a different after taste and bitterness. Black tea stevia mixture has lower after taste, bitterness and astringency values compared to stevia leaves itself. After taste is caused by the presence of compounds that are still left in the mouth and affects the nerve response. The sweetness of stevia cause of steviolbioside [16,17]. Bitterness and astringency of black tea felt in the mouth are influenced by polyphenol compounds, caffeine compounds and proteins [18]. Astringency and bitterness in steeping black tea are caused by flavanol-3 glycoside [9], and based on his research there is a relationship between bitter taste and epicatechin-3 gallate, epicatechin, and gallocatechin-3-gallate contained in the black tea steeping. Similarly, in stevia there is bitterness caused by flavonoid glycosides and aglycons compounds [19].

In the measurement of bitter sensation in the mouth using a stopwatch, it turns out that the longer the stay is stevia (35-40"), then black tea-stevia (20-35") and black tea (20-30") (Table 1.). While sweetness has a perception duration of between 20-40". Somewhat similar to what has been conveyed by Savita [20] and Fatima [21], stevia sweet taste longer than sucrose. The astringency sensation impression from stevia solution was stronger than the sensation in blacktea solution.

Table1. Bitter sensation in mouth cavity (seconds)

	Range	Mean± SD
Stevia	35-40	37.60 ± 1.58
Blacktea	20-30	25.20 ± 3.88
Blacktea-Stevia	20-35	28.90 ± 5.07

In the preference test, it known that the highest value obtained from the treatment was0.13% (w/v) with preference was 3.76 (the value between neutral to like). This is the highest level of consumer acceptance for a liquid stevia-black tea mixture (Fig 4.).By observing the results of the test of preference, it can be seen the highest value of the panelist response. By looking at trends through existing equations (Y=-0.307X2 + 1.993X-0.127, R2=0.755), the concentration value of 0.13% (w/v)was the most preferred by consumers.



*Means that do not share a letter are significantly different

Fig.4. Preference test of Stevia-black tea

The panels have not been notified of the efficacy of the compounds being tested. The results were solely from sensory preference testing. The development of new low-calorie products for health needs can still be developed through physical, chemical and functional food product development. The development of cacao-stevia-tea products was in line with what Sim [15]has done to improve the nutrition and sensory properties of chocolates.

IV. CONCLUSION

From the research it was known that the absolute threshold value for sweetness of stevia-black tea was 0.39%; (w/v) and bitterness of stevia-black tea was 0.42% (w/v) and it was known that the mixture of stevia-black tea that consumers can accept was stevia concentration of 0.13% (w/v). The use of stevia-blacktea mixture in non-liquid form needs to be investigated.

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Appendix 1. Sensory Data

	Range	Mean
Stevia	35-40	37.60 ± 1.58
Blacktea	20-30	25.20 ± 3.88
Blacktea-Stevia	20-35	28.90 ± 5.07

Panelist	Stevia	Blacktea	Blacktea-Stevia
1	35	20	25
2	36	22	20
3	36	20	25
4	38	24	27
5	38	25	35
6	37	24	27
7	40	29	30
8	39	28	30
9	39	30	35
10	38	30	35
Mean	37.60	25.20	28.90
SD	1.58	3.88	5.07

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Appendix 2. Preference Data

Table 2. Preference Test Blacktea Stevia

Panelists	0%	0.05%	0.13%	0.21%	0.29%	0.37%
1	1	4	5	2	2	1
2	2	3	5	2	2	1
3	1	2	4	2	2	1
4	2	3	4	3	2	1
5	1	2	4	2	2	1
6	1	3	4	3	2	1
7	2	3	4	3	2	1
8	1	2	4	2	2	1
9	2	3	4	3	2	1
10	1	2	3	2	2	1
11	1	3	4	3	2	1
12	2	4	4	3	2	2
13	1	3	4	1	1	1
14	2	2	3	2	2	1
15	1	3	4	3	2	1
16	2	3	4	3	2	1
17	1	2	4	2	2	1
18	1	3	3	3	2	1
19	1	2	3	2	2	1
20	1	4	5	2	2	1
21	1	3	4	3	2	1
22	2	2	3	2	2	2
23	2	2	4	2	2	2
24	1	2	3	2	2	1
25	2	2	3	2	2	2
26	2	3	4	3	3	2
27	1	2	4	2	2	1
28	1	3	4	3	2	1
29	1	2	4	2	2	1
30	1	3	4	3	2	1
31	1	2	4	2	2	1
32	1	3	4	3	2	1
33	1	2	3	2	2	1
34	1	3	3	3	2	1
35	1	4	4	2	2	1
36	1	2	4	2	2	1
37	1	3	3	3	2	1
38	1	4	4	3	3	1
39	1	2	3	2	2	1
40	1	3	3	3	1	1
41	1	4	4	2	2	1
42	1	3	3	3	2	1
43	1	3	3	3	2	1
44	1	4	4	3	2	1
45	1	2	3	2	2	1
46	1	3	4	3	3	1
47	1	2	3	2	2	1
48	1	3	3	2	2	1
49	1	3	3	2	1	1
50	1	3	3	2	2	1
51	1	3	3	2	2	1
52	1	3	3	2	2	1

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Table 2. Preference Test Blacktea Stevia

Panelists	0%	0.05%	0.13%	0.21%	0.29%	0.37%
53	1	2	3	2	2	1
54	1	2	4	2	2	1
55	1	3	4	1	1	1
56	1	3	3	1	1	1
57	2	3	4	3	1	1
58	1	3	4	1	1	1
59	2	3	4	2	2	2
60	1	3	4	2	2	1
61	2	3	4	1	1	1
62	1	3	4	3	2	1
63	2	3	4	2	2	1
64	1	3	5	3	2	1
65	2	3	3	1	1	1
66	1	3	3	3	2	1
67	2	4	4	1	1	1
68	1	3	3	2	2	1
69	2	3	5	2	2	1
70	1	3	4	2	2	1
71	1	3	5	2	2	1
72	1	3	4	2	2	1
73	1	3	4	2	2	1
74	1	4	4	2	2	1
75	2	4	4	2	2	1
76	1	4	4	2	2	1
77	2	4	4	2	2	1
78	1	4	4	2	2	1
79	1	4	5	2	1	1
80	1	4	4	2	2	1
Mean	1.25	2.93	3.76	2.24	1.90	1.08
SD	0.44	0.67	0.60	0.60	0.41	0.27

Appendix 3. Analysis of variance

Anova: Single Factor

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
0%	80	100	1.25	0.189873
0.05%	80	234	2.925	0.45
0.13%	80	301	3.7625	0.360601
0.21%	80	179	2.2375	0.360601
0.29%	80	152	1.9	0.167089
0.37%	80	86	1.075	0.070253

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	418.0917	5	83.61833	313.8792	7.5E-148	2.233031
Within Groups	126.275	474	0.266403			
Total	544.3667	479				
Total	143834.9	559				

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Appendix 4. Analysis of variance and Post Hoc Tukey's Method

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One-way ANOVA: PREFERENCE versus TREATMENT1

Source	DF	SS	MS	F	P
TREATMENT1	5	418.092	83.618	313.88	0.000
Error	474	126.275	0.266		
Total	479	544.367			

S = 0.5161 R-Sq = 76.80% R-Sq(adj) = 76.56%

Individual 95% CIs For Mean Based on Pooled StDev

Level	N	Mean	StDev	--------+---------+---------+---------+-
0.00%	80	1.2500	0.4357	(-*)
0.05%	80	2.9250	0.6708	(-*)
0.13%	80	3.7625	0.6005	(*)
0.21%	80	2.2375	0.6005	(*)
0.29%	80	1.9000	0.4088	(-*)
0.37%	80	1.0750	0.2651	(*-)

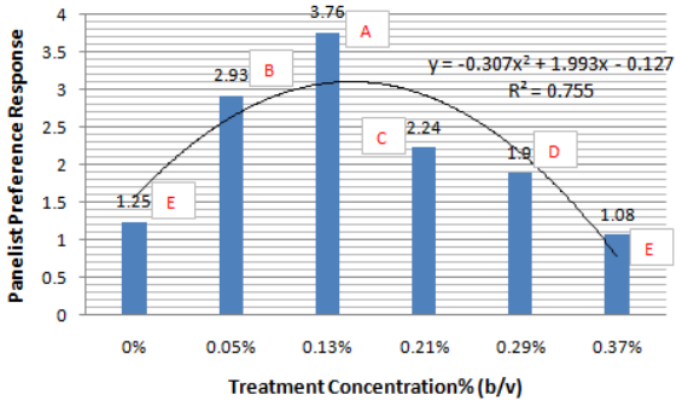
--------+---------+---------+---------+-
1.60 2.40 3.20 4.00

Pooled StDev = 0.5161

Grouping Information Using Tukey Method

TREATMENT1	N	Mean	Grouping
0.13%	80	3.7625	A
0.05%	80	2.9250	B
0.21%	80	2.2375	C
0.29%	80	1.9000	D
0.00%	80	1.2500	E
0.37%	80	1.0750	E

Means that do not share a letter are significantly different.



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