Sensory expectation and perception of red bverages prepared from sappanwood (*Caesalpinia sappan* L.) water extract

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Abstract

The red color from water extracts of sappanwood (heartwood of *Caesalpinia sappan* L.) has been used in some Asian beverages for hundreds of years. In this study, water extract of sappanwood was evaluated on their expectation and perception of color and taste. When appearance was evaluated without taste testing, red beverage prepared from sappanwood (SPB) was expected to be sweeter, less sour and bitterer than red beverage prepared with erythrosine (ERB), while overall liking among the two samples were not significantly different. However, liking score in the taste test for sweetness, aroma, and overall taste of SPB were significantly higher than ERB. These results suggested the potential use of sappanwood extract as a natural red colorant for food and beverage products without any detectable off-color or off-flavor.

Keywords: sappanwood, *Caesalpinia sappan* L., natural red colorant

Introduction

Since color is the first sensory character that consumers perceive even before purchasing food products, it has very high impact in consumer purchase decision. The adding of colorants in food products has been in particular interest of consumers, especially after July 2010 when the U.K. Food Standards Agency mandated food manufacturers across European Union to put a health warning "may have an adverse effect on activity and attention in children" on food and drink products containing synthetic dyes (U.K. Food Standard Agency, 2010). Thus, the search for natural substitutes of synthetic dyes is of particular interest.

For red color, the most common plant pigments are anthocyanins and betalains. However, they are susceptible to degradation especially with light and heat, their use is limited to low pH foods, and usually not economical due to low extraction yield. Other problems include the fact their seasonal harvesting and potential of contamination of insecticides and bacteria (Castaneda-Ovando et al., 2009; Griffiths, 2005, Wrolstad, 2004). On the other hand, insect source of red color such as carmine has been casted negatively due to potential allergic reaction and the fact that it is a non-vegetarian source (U.S. FDA, 2009; Nachay, 2009).

In light of all the above, the identification of other plant-derived red coloring agents besides the anthocyanins and betalains is of interest. One of nature-derived red coloring sources is heartwood of *Caesalpinia sappan* L or sappanwood. The sappanwood trees were called East Indian redwood for its origin and red color (Kenedy et al., 2004). The water extract of

sappanwood has been used as an ingredient in herbal drink in Thailand, Indonesia, and India (Det-anand, 1975; Batubara et al., 2009; Roesnadi et al., 1977, Badami et al., 2004). The herbal drink in Thailand is called Ya U-tai, the one from Indonesia is called BirPletok, Wedanguwuh, and WedangSecang. The main function of the water extract of sappanwood in these drinks is as red colorant.

The current research explored the possibility of using sappanwood water extract in food and beverage products by evaluating its sensory quality to detect any potential off-color and off-flavor.

Methodology

Raw Materials
Sappanwood was purchased in 2014 from Jao-Krom-Poe, the oldest and most reputable Thai herb pharmacy in Bangkok, Thailand (Usuparatana, 1997). Commercial synthetic red food colorant used was Kantanoo brand, the declared ingredient was 100% Erythrosine. It was purchased from a food ingredients shop in Bangbuatong area.

Sappanwood Extract Preparation
The traditional method of extraction mimicking the brewing of herbal drink was used. On this regard, 200 g of sappanwood chips were boiled with 2L of local tap water for 10 minutes. The boiling water solution (BWS) obtained was filtered through cheese cloth for further dilution to desired color. The BWS was freshly prepared right before the sample preparation for sensory evaluation.

Sample Preparation for Sensory Evaluation
Two types of sucrose-sweetened red color beverages were prepared with different colorants (BWS and erythrosine) to achieve the same final concentration of sucrose (5% w/v) and same lightness (L* value). Local tap water at Mahidol University on Salaya campus which had a pH of 8.2 was used in preparation of both samples.

Color characteristics as recommended by The International Commission on Illumination (CIE) were measured as L*, a*, b*, hue, and chroma using a Minolta CT-310 colorimeter (Minolta Corporation, Ramsey, NJ, U.S.A.). Lightness or L* value of both beverages were adjusted to match with the L* of local commercial red-colored soda (est ®) which was approximately 21.5.

In brief, for each beverage, approximately 1.5L of tap water was boiled with 100g of sucrose. Then a solution of colorant as well as boiled tap water were carefully added to obtain the desired L* at the total of volume of 2L. Lab color space, with chroma and hue angle, of these two samples is demonstrated in Table 1. The red beverage prepared with sappanwood colorant was identified as SPB, the other sample with erythrosine was identified as ERB.

Sensory Evaluation Procedure
Sensory testing was performed in a sensory testing laboratory at the Institute of Nutrition Mahidol University. The sensory testing room was operated under fluorescent lights. Fifty subjects for this study were students and staffs recruited from Mahidol University, Salaya campus. Before the actual sensory acceptance test was performed, the panelists were asked to rate their expected intensities of sweetness, sourness and bitterness, as well as overall liking, solely by looking at the 2 beverages. The 5-point hedonic scale was used, from 1

being "likely to be unnoticeable" to 5 being "likely to be very sweet/sour/bitter" (1 – 5). Overall liking of the appearance was rated using a 9-point hedonic scale, from the score of 1 for "dislike extremely" to the score of 9 for" like extremely" (1 - 9). Results are regarded as expectations of intensities of sweetness, sourness, and bitterness, and overall liking of colors of the two samples.

Once a panelist completed the expectation test, the SPB and ERB were served cold with ice cubes for the acceptance test. After tasting each sample, the panelists rated their liking for sweetness, aroma, and overall taste on a 9 point hedonic scale ranging from "dislike" extremely to "like extremely" (score of 1 - 9). All samples were served within 4 hours of preparation and were presented as 3-digit codes and presented in randomized order.

Data analysis

T-tests were conducted on Excel (Microsoft Corporation, USA) to measure differences in the ratings of the expected and perceived acceptance and likeability between the SPB and ERB. The significant differences on the panelist responses where checked at the $p < 0.05$ level.

Table 1 Color characteristics of commercial red soda (est®), SPB and ERB

	L*	a*	b*	C*	h
local red soda	21.43	5.65	1.30	5.80	12.90
SPB	20.70	4.59	0.58	4.62	7.24
ERB	22.21	6.71	2.58	7.18	21.02

Results

Sensory Evaluation of Red Beverages

Table 2 showed the mean score of expected intensity of sweetness, sourness, and bitterness upon the inspection of appearance of red beverages prepared by the sappanwood (SPB) and by erythrosine (ERB). T-test was used to compare the mean scores of attribute intensities and overall likeability among these two beverages. Intensities of all three attributes of the SPB were significantly different from those of the ERB. Mean scores for expected sweetness and bitterness of SPB were significantly higher than the ERB, but ERB had significantly higher mean scores of expected sourness. The overall liking scores of the appearance were not significantly different.

For the acceptance rating scores on the taste test (Table 3), results showed the liking for sweetness, aroma, and overall taste of SPB were significantly different from ERB. Mean scores of all three attributes of SPB were higher than ERB.

Figure 1 Traditional extraction of sappanwood by boiling of sappanwood chips in water (BWS)

Table 2 Expected intensity of sweetness, sourness, bitterness, and overall likeability of red beverages SPB and ERB evaluated solely from appearance

	SPB	ERB
Expected sweetness	4.14 ± 1.09 [b]	2.74 ± 0.75 [a]
Expected sourness	1.74 ± 0.88 [a]	2.40 ± 1.40 [b]
expecteded bitterness	1.86 ± 1.03 [b]	1.36 ± 0.75 [a]
Overall liking	6.22 ± 1.36 [a]	6.20 ± 1.74 [a]

Values expressed are mean ± standard deviation (n = 50).
[a-b] Different upper case letters in the same rows represent values that are significantly different ($p<0.05$)

Table 3 Perceived liking of sweetness, sourness, bitterness, and overall taste of red beverages SPB and ERB evaluated by taste test

	SPB	ERB
Sweetness	4.78 ± 1.64 [b]	4.02 ± 1.79 [a]
Aroma	5.08 ± 1.06 [b]	3.92 ± 1.74 [a]
Overall taste	5.10 ± 1.53 [b]	3.67 ± 1.79 [a]

Values expressed are mean ± standard deviation (n = 50).
[a-b] Different upper case letters in the same rows represent values that are significantly different ($p<0.05$)

Discussion

Since the local tap water with a pH of 8.2 was used during the boiling to obtain BWS and also during the preparation, the finished product (SPB, pH = 8.2) appeared red as expected with no further pH adjustment needed. Sappanwood drink is commercially available throughout Thailand, with some recipe called for an addition of lime juice, hence the appearance of the drink can be either yellow or red. At pH the of 8.2, SPB had higher

expected sweetness/bitterness score and lower expected sourness score than ERB, while overall liking were not significantly different. These expected intensity scores suggested that the shade of red in SPB (which was provided by BWS) did not imply any off-flavor or off color.

The taste test also positively supported the use of sappanwood extract as red food colorant since the acceptance test also did not indicate toward any flaws on the taste or aroma of sappanwood beverage. Because tap water was specifically chosen in this study for preparation of both beverages to mimic the traditional brewing method, aroma of chlorine added during the treatment of the municipal water might have interfered with the results. For a subsequent sensory evaluation of sappanwood extract in the future without chlorine aroma, other types of water treatment such as deionization or reverse osmosis and with further pH adjustment to achieve a pH of approximately 8 should be used.

According to Ferreira et al. (2004), the responsible compound for red color in sappanwood is brazilein. Extraction and purification of the brazilein from sappanwood for further understanding of its properties may be helpful in developing sappanwood into red colorant food additive for low acid foods and beverages.

Conclusion

Water extract of sappanwood, which has a long history of usage as traditional red colorant in Thai herbal drink, was visually red when prepared with water at pH 8.2. Consumers' acceptance of sappanwood drink toward the appearance as well as the taste and aroma indicated in the sensory evaluation from this study was encouraging. Further studies on its properties may help to develop sappanwood water extract into an alternative for synthetic red colorant as well as natural red colorant for low acid foods and beverages.

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