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The application of copper sulfate mixed with *Caesalpinia sappan* L. extract to increase colorfastness in pressed blush products

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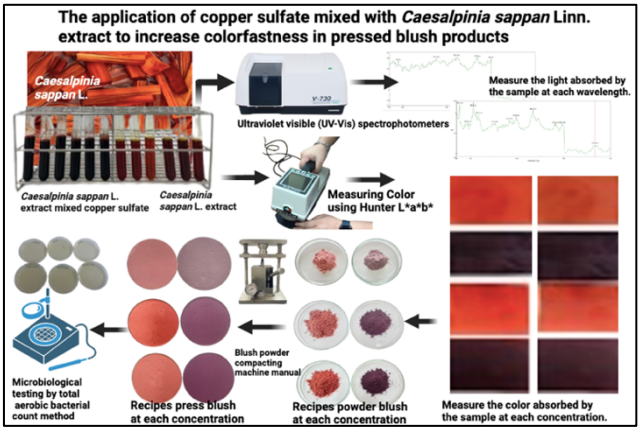
Abstract

This study aims to increase the colorfastness of pressed blush products by combining copper sulfate with *Caesalpinia sappan* L. extract. This experiment consisted of four conditions used for color extraction: 70% w w^{-1}, 95% w w^{-1}, 70% w w^{-1} with 10% w w^{-1} copper sulfate, and 95% w w^{-1} with 10% w w^{-1} copper sulfate. The highest yield percentage of crude extract was found at 70% w w^{-1}, with the highest absorption value (λ_{max}) at 70% methanol with 10% w w^{-1} copper sulfate. The darkest shade of red was found at 70% w w^{-1} with 10% w w^{-1} copper sulfate. The development of pressed blush occurred when corn starch was mixed with more white color and smell than arrowroot flour. The highest red color was achieved at 4.5% w w^{-1}, with the highest red - purple intensity. The microbial contamination test showed no microbial contamination in pressed blush products.



Keyword: *Caesalpinia sappan* L.; Mordant; Pressed blush

1. Introduction

Blush cosmetics can enhance color and give a youthful, healthy look to the face. Natural blush colors, derived from plant extracts, minerals, and other sustainable sources, offer a safer and more environmentally responsible alternative to synthetic pigments. Red beetroot extract, a natural coloring ingredient, allows even the most sensitive skin types to use the blush without irritating chemicals [1].

Caesalpinia sappan L. produces a red pigment called brazilin, which is responsible for the reddish color of its heartwood extract [2]. The sappan wood extract exhibits a range of colors depending on the pH of the medium, with the darkest colors produced by calcium chloride [3].

Mordanting enhances the colorfastness properties of natural dyed fabrics by chemically bonding natural colorants to textile fibers [4]. Mordanted colored textiles exhibit enhanced fastness characteristics compared to unmordanted ones due to covalent, coordinate, and hydrogen bonds, along with intricate dye-metal-fabric complexes [5]. Copper sulfate is a frequently used mordant in natural dyeing that can enhance the colorfastness of colored textiles. It generates a spectrum of hues from blue-greens to purples and has a strong affinity for protein fibers like silk [6]. Materials mordanted with copper sulfate often show superior lightfastness compared to textiles mordanted with alum. When used as a mordant, copper sulfate may fade colors and convert them to blue-green, allowing for a more natural and sustainable approach to cosmetics [7].

2. Materials and Methods

Materials

The samples of *Caesalpinia sappan* L. from Kanchanaburi province, Thailand. It shown in Fig. 1. The chemicals consisted of methanol AR grade (RCI Labscan,Thailand), Copper Sulfate AR grade (Qrec,Newzealand) Sulfuric acid (Qrec,Newzea- land), Dichloromethane (RCI Labscan,Thailand), Ammonia ACS grade (PanReacAppliChem,Spain), Hydro-chloric acid (RCI Labscan,Thailand), Corn starch (Chemipan,Thailand), Arrowroot, (Dragonfish, Thailand), The equipment consisted of Rotary evaporator (Buchi R300,Switzerland), Colorimeter (MiniScan EZ4500,HunterLab), Press blush machine (NP Commercials, Thailand), UV-Vis spectrophotometer (V-730,Jasco), Colony Counter (ColonyStar, Funke Gerber).

Fig. 1 Morphology of *Caesalpinia sappan* L.

Preparation of extracts

The preparation of *Caesalpinia sappan* L. in Kanchanaburi, Thailand, was washed, dried, and extracted using a 95% v v^{-1} and 70% v v^{-1} methanol solvent. The extract was filtered with Whatman 1 filter paper and evaporated using a rotary evaporator. The solution was then calculated for yield, and 10% w v^{-1} copper sulfate was added to the mordant to measure the pH value of the extract.

Phytochemical screening Anthraquinone and Cyanidins

Anthraquinone is detected by weighting 0.02g of extract, filling 10 ml of sulfuric acid solution, warming it for 5 minutes, adding dichloromethane and ammonia, and observing the color change. Cyanidins are tested by filling 4 tubes with 3 ml of extract, 3 drops of ethanol, and 6 drops of hydrochloric acid. If the solution becomes bright pink, it indicates an anthocyanin group substance. The process is repeated until the solution turns bright pink, indicating the presence of anthraquinone [8].

Chemical properties testing.

The study involves a pH meter test and an extract solution test under different conditions. The extractive solution was prepared using 70% v v^{-1} methanol solvent extracts, 70% v v^{-1} methanol solvent extract (10% w v^{-1} copper sulfate), 95% v v^{-1} methanol solvent extract, and

95% v v^{-1} methanol solvent (10% w v^{-1} copper sulfate). The absorptive value was measured using a UV-Vis spectrophotometer, and the experimental results were recorded.

Colorfastness testing of extracts

The process of extracting color measurements using a portable color meter (HunterLab, MiniScan EZ) involves setting the light source to D65 at 10° and selecting the color scale as L*a*b*. The extract is then placed on 1x1 square-centimeter paper, dried, and measured at the desired value. The value is then saved and reset, and the area of measurements is changed. Three tests are performed, and the color value is compared after preparation and 4 weeks.

The development of compress blush recipes

The development of the compress blush product as compress blush recipes (base) consists of a mixture of different types of flour. The first mixture is the corn starch mixture. The second mix is the arrowroot flour mixture, and then compare the characteristics of the product, consisting of texture, color, oil absorbent [9]. and smell. After that, observe and record the experimental results by selecting the best mixture for the extract. The formula is shown in Table 1.

Table 1 The compressed blush (Base) formula.

Phase	Ingredient	Function	Formula1 (% w w^{-1})	Formula2 (%w w^{-1})
A	Corn Starch	Base	84	–
A	Arrowroot	Base	–	84
A	Magnesium Stearate	Binder	10	10
A	Polymethyl Methacrylate	Texture	1	1
A	Nylon – 12	Slip	1	1
B	Isopropyl Myristate	Emollient	3	3
C	Microcare PHC	Preservative	1	1
	Total		100	100

Compression blushing process.

The process involves weighing and mixing ingredients in phases A, B, C, and D. The compressing base blush is created by pressing 10 grams of fine flour powder into a dish and pressing it with a compressing machine at 150 bars. A compress blush product is developed using a mixture of extracts in six different conditions consist of 1.5% w w^{-1} of extract, 1.5% w w^{-1} of extract containing 10% w v^{-1} copper sulfate, 3% w w^{-1} of extract, 3% w w^{-1} of extract containing 10% w v^{-1} copper sulfate, 4.5% w w^{-1} of extract, 4.5% w w^{-1} of extract containing 10% w v^{-1} copper sulfate. The stability of color, pH, texture, and smell is compared, and experimental results are recorded.

Efficacy test of the compress blush product

The assessment of oil and water absorption, which measures 1 gram of powder, drops with castor oil until saturated as a paste, records the weight of the oil used, and evaluates moisture absorption using water instead of castor oil.

Colorfastness testing of the compress blush product

The compress blush measurement using a color meter (HunterLab,MiniScan EZ) involves setting the ill/obs at D65/10° and selecting the color scale as L*a*b*. The extract is then colored on 1x1 square-centimeter paper, dried, and measured at the desired value. The value is then saved and reset. The process involves three tests: comparing the color value after preparation and determining the time it has passed (4 weeks). The process ensures accurate and reliable results.

Testing microbial contamination by the total aerobic microbial count method

The method of aerobic plate counting involves pipetting a sample of compress blush product into a test tube containing DI water, mixing it to create a 10^{-1} dilution, then adding 15 to 20 ml of melted NA diameter per fertilizer plate. The fertilizer plate is rotated to mix with the feed, controlled by 1 ml of Butterfield's phosphate buffer. The fertilizers are placed on a fertilizer plate and left to feed at 37 °C for 72 hours [10]. The pour plate is a technique for purifying microorganisms and counting their population. It involves serial dilution, counting micrometers per unit volume, mixing specimens in a culture medium, and allowing

the standard plate count to set at 37 °C for 1 to 2 days. Colony counts are then performed using a colonial counter machine, calculating the colony amount.

3. Results and Discussion

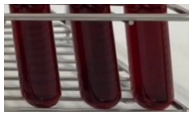
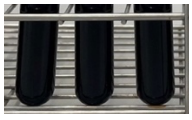
The result of extraction and phytochemical screening

The extraction of *Caesalpinia sappan* L. was conducted using the maceration method with methanol solvent at concentrations of 70% v v^{-1}, 70% v v^{-1} (with added 10% w v^{-1} copper sulfate), 95% v v^{-1}, and 95% v v^{-1} (with added 10 w v^{-1} copper sulfate). The extract showed a percentage yield of 70% v v^{-1} methanol. The phytochemical screening revealed anthraquinone and anthocyanidins, which turned pink [11]. The chemical properties were tested using a pH meter, revealing a pH range of 5.31 – 5.74. The study examined the acidity of colors from *Caesalpinia sappan* L., finding that colors with higher acidity values were more red. The experiment also revealed that color extractions from additive mixtures had lower pH values, resulting in more intense shades. The anthocyanin group of the plant was dependent on acidity, with pH values ranging from 5.46 – 5.74 resulting in different shades. Previous research studies have shown that anthocyanins at pH values greater than 3 produce a bluish-purple color [12,13]. Experiments have revealed that adding copper sulfate, which acts as a mordant, results in a deep purple color in the solution as shown in Table 2.

The light absorption and fastness of color testing

The light absorption test showed that all four conditions can absorb maximum light in the 497 – 513 nanometer range [14]. The highest absorption value was found in 70 % v v^{-1} methanol solvent mixed with mordant (10 % w v^{-1} copper sulfate), with a value of 513.73 ± 1.31. In 95% v v^{-1} methanol solvent, the highest absorption value was 503.87 ± 3.19 as shown in Fig. 2. Adding mordant increased absorption value more than normal conditions. The fastness color testing showed that adding mordant increased the fastness color of the extract, with a value of L*a*b* changing less than normal conditions.

Table 2 The characteristics of *Caesalpinia sappan* L. in different conditions.

Parameter	Appearance (Color of extract)	pH (Mean ± SD)	%Yield (Mean ± SD)	Phytochemical Screening	
				Anthraquinone	Anthocyanidins
70% v v^{-1} Methanol		5.46 ± 0.03	30.06 ± 0.55	+	+
70% v v^{-1} Methanol + Mordant		5.31 ± 0.18	29.08 ± 0.72	+	+
95% v v^{-1} Methanol		5.42 ± 0.32	28.93 ± 1.01	+	+
95% v v^{-1} Methanol + Mordant		5.74 ± 0.21	27.80 ± 0.10	+	+

Note: + = The changing reaction of extracts each condition.

Table 3 The light absorption value and fastness color value tests in different conditions.

Parameter	Absorption (nm) (Mean ± SD)	Fastness color (Mean ± SD)							
		Immediately after preparation				4 weeks			
		Color	L* (Lighting)	a* (Green-Red)	b* (Blue-Yellow)	Color	L* (Lighting)	a* (Green-Red)	b* (Blue-Yellow)
70 % v v^{-1} Methanol	500.21 ± 1.06		46.84 ± 0.50	17.39 ± 1.61	7.40 ± 0.81		40.12 ± 0.72	16.25 ± 0.25	6.21 ± 0.67
70 % v v^{-1} Methanol + Mordant	513.73 ± 1.31		26.49 ± 2.30	42.09 ± 0.66	33.85 ± 0.95		24.14 ± 0.41	41.48 ± 0.89	32.15 ± 0.12
95 % v v^{-1} Methanol	497.27 ± 1.03		54.44 ± 2.23	9.56 ± 1.17	5.95 ± 2.62		51.16 ± 0.63	8.24 ± 0.09	4.15 ± 0.93
95 % v v^{-1} Methanol + Mordant	503.87 ± 3.19		26.77 ± 0.23	34.17 ± 0.42	24.78 ± 1.65		24.15 ± 0.79	32.29 ± 0.58	22.69 ± 0.83

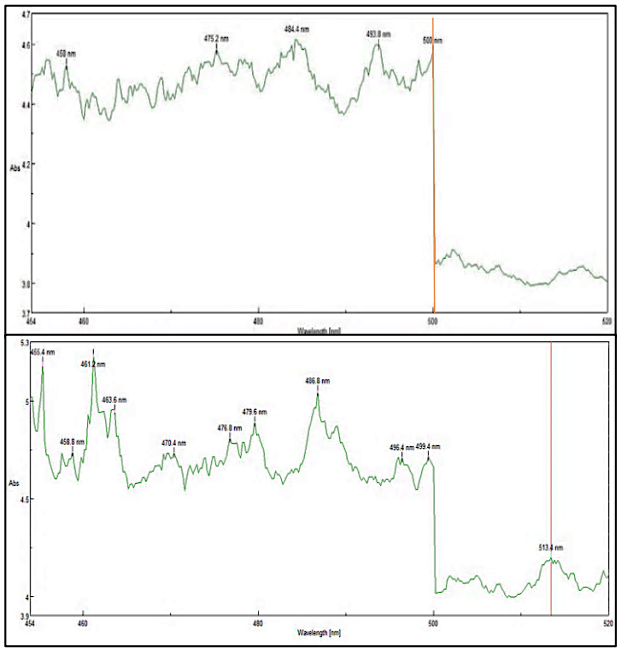


Fig. 2 The absorption chart of the extract at 497 – 513 nm wavelengths.

The results of the development of the compress blush.

The research team developed a compress blush using corn starch and arrowroot flour, comparing texture, color, and smell. They found that corn starch had a lighter texture, color, and easier distribution than arrowroot flour. As a result, they chose corn starch as the main ingredient and added extract to the compress blush recipes as shown in Fig. 3.

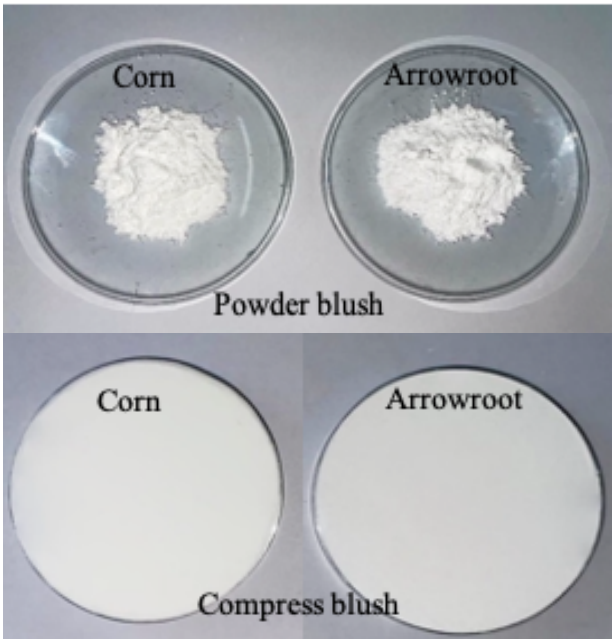


Fig. 3 The base recipes before and after compression by the compress machine manual.

The compress blush-containing extract has been developed in different conditions with varying concentrations. The normal condition has a red-orange color, while the mordant condition has a red-purple color due to copper sulfate being mordant as blue. As the concentration increases, the recipes produce sharper colors and longer-lasting products. The results show that copper sulfate is a mordant in the compress powder. as shown in Fig. 4.

The evaluation ability absorption and fastness of compress blush testing

The study evaluated the absorption of oil and water in compress blush under six conditions: oil absorption using caster oil and water absorption using DI water. The most effective conditions were 4.5% w w^{-1} of extract containing mordant, with a L*a*b* value of 1.12 ± 0.02 and 1.21 ± 0.36, respectively. The fastness color testing showed that adding mordant can increase the fastness color of the compress blush, as shown in Table 4.

Fig. 4 The compress blush as containing extract in deference condition.

Total aerobic plate count

The initial test for microbial contamination, using the aerobic plate count method in the compress blush six type, includes 1.5% w w^{-1} of extract, 1.5% w w^{-1} of extract containing mordant, 3% w w^{-1} of extract, 3% w w^{-1} of extract containing mordant, 4.5% w w^{-1} of extract, and 4.5% w w^{-1} of extract containing mordant. The results of the colony forming unit (CFU) test indicate that none of the samples had any bacterial contamination. In conclusion, all the formulations are safe and sterile.

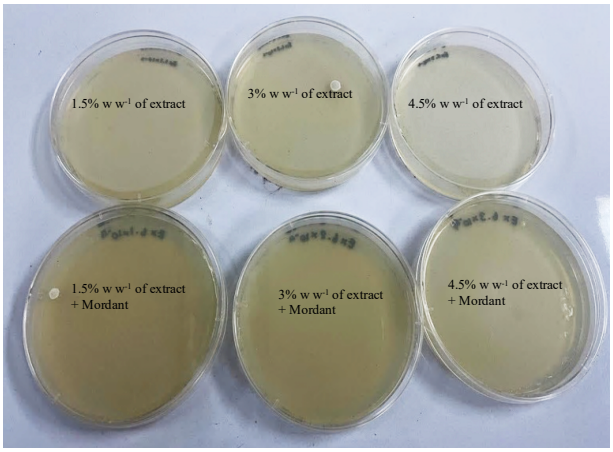


Fig. 5 The result of microbial contamination by the aerobic plate count method.

4. Conclusion

The study investigated the colorfastness of pressed blush products by combining copper sulfate with *Caesalpinia sappan* L. extract. Four conditions were used for color extraction: 70% w w^{-1}, 95% w w^{-1}, 70% w w^{-1} with 10% w w^{-1}, and 95% w w^{-1} with 10% w w^{-1}. The highest yield percentage of crude extract was found at 70% w w^{-1}, with the darkest shade of red at 70% w w^{-1} with 10% w w^{-1} copper sulfate. The highest red color was achieved at 4.5% w w^{-1}, with the highest red to purple intensity. No microbial contamination was found in the pressed blush products.

Table 4 The absorption and fastness of compress blush testing.

Parameter	Absorption value (Mean ± S.D.)		Fastness color (Mean ± SD)							
			Immediately after preparation				4 weeks			
	Castor oil (g)	Water (g)	Color	L* (Lighting)	a* (Green -Red)	b* (Blue-Yellow)	Color	L* (Lighting)	a* (Green -Red)	b* (Blue-Yellow)
1.5% w w^{-1} of extract	0.63 ± 0.15	0.77 ± 0.02		85.5 ± 0.12	7.22 ± 0.05	-12.63 ± 0.16		83.2 ± 0.35	7.24 ± 0.21	-12.41 ± 0.34
1.5% w w^{-1} of extract + Mordant	0.73 ± 0.02	1.13 ± 0.12		81.09 ± 1.78	10.54 ± 0.77	-11.95 ± 0.35		80.61 ± 0.46	10.14 ± 0.52	-11.62 ± 0.62
3% w w^{-1} of extract	0.82 ± 0.04	0.88 ± 0.46		82.14 ± 1.52	9.20 ± 1.07	-11.99 ± 0.35		80.37 ± 0.36	9.15 ± 0.03	-11.36 ± 0.92
3% w w^{-1} of extract + Mordant	0.96 ± 0.04	1.10 ± 0.35		79.25 ± 2.62	10.88 ± 1.08	-9.20 ± 1.51		78.25 ± 0.36	10.52 ± 0.26	-9.11 ± 0.45
4.5% w w^{-1} of extract	0.94 ± 0.06	0.83 ± 0.43		81.75 ± 1.98	11.46 ± 0.14	-7.92 ± 1.29		75.75 ± 0.25	11.41 ± 0.78	-7.23 ± 0.37
4.5% w w^{-1} of extract + Mordant	1.12 ± 0.02	1.21 ± 0.36		73.66 ± 0.25	12.78 ± 1.27	-7.06 ± 0.31		72.66 ± 0.63	12.19 ± 0.35	-7.01 ± 0.82

5. Suggestions

Caesalpinia sappan L. extract, containing pink anthraquinone and anthocyanidins, was extract by maceration to create a compress blush suitable for the cosmetic industry.

6. Acknowledgement

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