Experimental study on the manufacturing of oil paint from natural plants

Kamolwan Saengprom[1*] and Su Jincheng[2]

[1*] Faculty of Fine Arts, Shanghai University

* Corresponding author. E-mail address: num_kamolwan@hotmail.com

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ABSTRACT

The objectives of this experimental research on the oil paint from natural plants were to research and experiment with the use of oil plants from the natural plants to substitute the ore, to analyze the quality of oil paint from natural plants, and to evaluate user satisfaction towards the oil paint from natural plants. Relevant documents were reviewed and the production of pigments from natural plants was learned from Prof. Qiuben Guitou at Tokyo University of Arts. All data were compiled to produce the oil paint from natural plants. The satisfaction of the 3 sample groups involving teachers of oil painting, oil painting artists and students from the oil painting program at Shanghai University was evaluated. The findings illustrated that all sample groups were satisfied with the use of oil paint from natural plants at a moderate to high level in terms of pigments resolution, viscosity and color of the paint ($\bar{x}$ = 3.87, S.D.= 0.50).

Keywords: Oil paint, Natural plants, Pigment

Introduction

Oil paint has existed in Northern Europe since the 12th Century (Jones, S. 2020). The key compositions of oil paint are oil and pigments, some of which contain harmful substances to health. Although oil paint has been inherited and developed constantly, a number of oil paint manufacturers remain concerned about the safety of application. Some oil paint contains toxic pigments and heavy metals such as lead-white, cadmium, and cobalt. These compositions will show the impacts after direct consumption or inhalation, which most users are unable to avoid (Ploeg, S. 2018).

Most pigments are made from ore. The book *Mineral Facts and Problems* mentions the use of ore in color production in that, “Ore is widely used in color production. It was expected that 400,000 tons of talc was used in color production in 2000, and the rate will be increasing, which will impact higher demand for such ore in the future.” (The Staff Bureau of mines.1976:1086). Furthermore, the selection of limited raw material and the complicated pigments extraction process lead to costly oil paint, such as the blue color from Lapis Lazuli, which is a rare ore for producing high-quality colors, Tyrian purple from the sea slug, which is called “Murex brandaris Tyrian purple” and the most expensive color in the past because 12,000 sea slugs were needed for extraction of only 1.4 g. of pure color (Colazingari,M.2011:171), or Indian yellow, which used traditional production from the urine of cows fed with mango leaves and water only (Finlay,V.2003:214).

For the above reasons, the researcher was interested in using natural plants to substitute for ore or animal bones to minimize the risk of toxins from some pigments and reduce the use of limited rare resources. Moreover, the production of pigments could decrease the import of color from overseas sources.

Research objectives

1. To research and experiment with the use of oil paint from natural plants instead of from ore
2. To analyze the quality of oil paint from natural plants
3. To evaluate the user satisfaction towards the oil paint from natural plants

Scope of research

1. Scope of the sample group

A total of 100 samples from 3 groups were enrolled consisting of 30 professors, 30 artists, and 40 students from Shanghai University for evaluating the satisfaction towards the use of oil paint from natural plants.

2. Scope of raw material

The researcher conducted the experiment using 10 natural plants that gave different colors involving the group of green color, including coriander and Asiatica, the group of blue and purple color, including butterfly pea, purple sweet potato, purple cabbage, the group of yellow and orange color, including carrot, safflower, and orange peel, and the group of red color, including dragon fruit peel and Roselle.

3. Scope of experiment

This research applied the extraction method by boiling and controlling the neutral pH (pH7) by adding alum and lime to produce the oil paint from natural plants. The researcher used poppy oil to mix with the pigments.

Research methodology

Step 1 Study the oil paints production process from the relevant documents and textbooks.

1. Documentary data were compiled from the relevant documents and studies to the pigment extraction process from plants and the oil paint production process. Data were sorted for analysis and summary for the experiment in the next step.

2. Field data were obtained when the researcher studied the pigment production process from natural plants, and the qualities of each type of oil used in painting from Prof. Qiuben Guitou (Qiuben, G.2019) at Tokyo University of Arts.

Step 2 Try out the oil paint production with natural plants. Firstly, produce the pigment from natural plants using the sedimentation technique before mixing the pigment with dry oil to obtain the oil paint.

Step 3 Evaluate the satisfaction of a total of 100 professors, artists, and students from the oil painting program at Shanghai University.

Analysis results of oil paint production process from natural plants

The researcher studied documents about oil paint production with the aim of being consistent with the research objectives. The analysis results were as follows.

Oil paint consisted of pigments and oil which blended the pigments to adhere to the painting surface. Pigments and oil were found in nature; humans had utilized them for a long time (Qiuben, G. 2019:3). Most pigments used to produce oil paint were from ore, such as Cinnabar, Realgar, lead-white, cadmium, and cobalt. However, some of them had negative effects on health if they were inhaled or contacted, such as lead-white, cadmium, and cobalt (Ploeg, S. 2018). Consequently, the researcher studied and produced the oil paint from natural plants instead of ore.

Several pieces of research relevant to the utilization of color from natural plants illustrated that some researchers extracted the color from plants to make dye, food colors, drinks, herbs and drugs, cosmetics, and printing materials (Woranun Narongdecha,W.2019:6). The researchers discovered that the plant comprised of 4 types of colorants including Chlorophyll giving green color (Explorations of everyday chemical compounds. 2014), Xanthophylls giving yellow color, Carotenoids which was the organic compound mostly found in plants and bacteria that could photosynthesize giving orange, red and yellow color (Ratchanee Kongchuichai and Rin Charoensiri. 2011:641), and Anthocyanins, the flavonoid which was soluble and found in the blue, purple and red plants giving red, purple and blue to the leaf, flower and fruit (Chothipa Sakulsingharoj, Srimek Chowpongpang, Seangtong Pongjaroenkit and Waraporn Sangtong. 2014:11). Different amounts of such compounds in the plants resulted in the different colors.

Color extraction from natural plants could be done using with 2 different methods.

1. Water extraction used 2 methods, including hot extraction by boiling and cold extraction by fermentation (Nanthip Hasin and Chatdow Chailor. 2015:7). Hot extraction was more popular because boiling more effectively extracted the colorant from plants. Color concentration depended on the ratio of plant to boiling duration. Woranun Narongdecha (2019:6) suggested the hot extraction process by boiling in the water at 100^{o}C. This was consistent with Chanoknart Mayusoh (2012:28), who recommended boiling the plant in boiling water for 20 minutes.

2. Alcohol extraction (ethanol) is a better solvent than water as it has an anti-growth effect on microorganisms. However, this method is costly, so it is applied to extract the herbs as the initial substance or solvent for producing cosmetics, drugs and perfumes. Plants were fermented for 7 days or as prescribed by pharmacopeia until they produced the solution (Woranun Narongdecha. 2019:6).

The limitation on color extraction from plants was the durability of pigments that were changeable to contact with air, pH or time. For instance, the vivid red leaf in autumn gradually changed to brown over time or a green color from chlorophyll faded within a few hours after extraction (Neddo, N. 2015:104). Therefore, the study of research concerned with water extraction revealed that mordant, which contains acidic and alkaline salt properties, was added to the extracted color water. The acidic mordant involved alum, lime, tamarind juice, and soap pod. The alkaline salt mordant included alkali water or soda ash and lime. Mordant reacted with the article, which made them colorful and durable (Nanthip Hasin and Chatdow Chailor. 2015:6).

Both colorant extraction methods resulted in liquid mordant which was inapplicable for oil paint production immediately as water and oil could not be blended. According to the emulsion process, when mixing two incompatible liquids, they would not mix homogeneously due to the surface tension between the two substances. However, after shaking to increase the free energy at the surface, the liquid dispersed in the small drops, into the other. Anyhow, the emulsion was temporary and liquid stratification would finally occur (Supakchon Klongdee. 2012:288). Thus, the colorant used for producing oil paint should be in a form of moisture-free dry powder.

Transformation of liquid extracted colorant into dry powder could be done with 2 different methods.

1. Drying or spray drying requires developed scientific equipment for food processing. Spray dry was the process to disperse liquid in aerosol using assorted sizes of spray nozzles to spray the material to contact with heat and steam would evaporate and only dry powder colorant remained (Kloyjai Cheuyglintase. 2013:23-25). Pure colorant was obtained from this method, which was in line with Tatdao Paseephol, Prapaporn Phiasungka and Teratree Jaengsanam (2019) who reported that the color of Ceylon spinach fruit contained betalen, which was a colorant with low stability to heat, especially when it was dissolved in water and changed into brown color. Consequently, there were more limitations to the utilization and storage of liquid colorant, whereas the spray dry method maintained the colorant efficiently (Tatdao Paseephol, Prapaporn Phiasungka and Teratree Jaengsanam. 2019:1374).

2. Color sedimentation was the process to mix the extracted plant with acid or alkaline salt, after which it was allowed to precipitate. Then, filter water and sundry the color completely before grinding (Qiuben, G.2019:3). Another method was to add salt into the extract color water and let the salt absorb water and precipitate into the pigment (Phairat Punyacharoennon, Kanchana Luepong and Chamlong Sarikanon. 2014:30-31).

Study of the oil properties and oil paint production process

Oil paint was made by mixing the pigments with oil or animal fat that was tentatively not rancid. Oil interlocked pigments with the painting surface. A different amount of oil could be used to test the constant color texture (Neddo, N. 2015:105). The oil used in painting was classified into 2 types, crude oil and processed oil. Crude oil was classified into 3 types: drying oil, semi-drying oil and non-drying oil. Drying oil was the most popular kind for producing oil paint because it was thick, adhesive and turned into a solid film in a short time after contact with air, such as linseed oil, safflower oil, walnut oil, poppy oil, etc. (Hoofnagle,W.S., Bayton,J.A. and Dwoskin, P.B. 1955:29). Semi-drying oil and non-drying oil were not popular for oil painting; semi-drying oil dried slower than drying oil so it was used as the raw material for the industrial products while non-drying oil could not be used directly with painting as it could not get dry and required special processing to become drying oil (Qiuben, G.2019:4).

Processed oil, such as linseed stand oil, was processed through the air blocking condition technique and heated up to 300°C (OPUS framing and art supplies. 2009); the sun-thickened linseed oil was the equal mixture between water and oil that was in contact with sunlight for 2-3 months, so it dried quicker than other linseed oil as well as being durable and transparent (Qiuben, G.2019:4).

Prof. Qiuben Guitou (Qiuben, G.2019:2-3) summarized the properties of drying oil during the reaction with oxygen during the drying process; at low temperature or low light, drying oil dried quicker than at high temperature or high light. In addition, in dried quicker when it was used with pigments containing metal, such as blue cobalt, manganese, and lead. However, some factors affect the dryness of oil paint, such as material surface, the thickness of color, type of oil to mix with color, temperature, moisture, and sunlight, as shown in Figure 1.

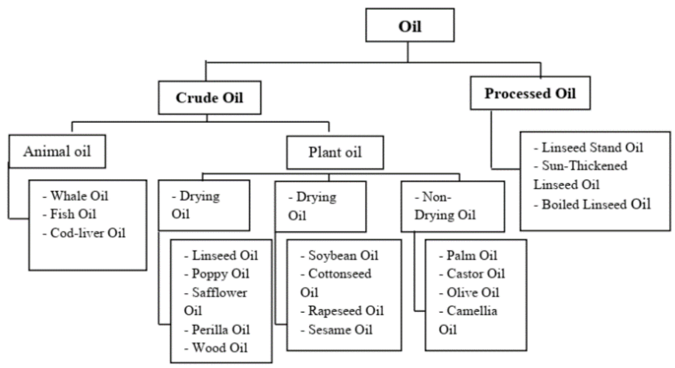
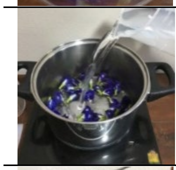
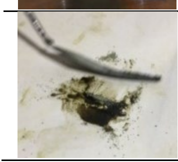


Figure 1 A chart showing the type of oil used in painting

Experiment steps and results of the oil paint produced from the natural plants

1. Experiment steps for oil paints production from the natural plants

The researcher applied the hot extraction method by boiling water at 100°C and processing the liquid colorant to the dry powder. 6 g. of alum, which is an acidic substance, was dissolved in 100 g. of hot water and 6 g. of lime, which was alkaline, dissolving in 100 g. of hot water were added. pH was tested using litmus to control it at pH7. Then, the color was allowed to precipitate before being filtered with filter paper. After the color on the paper dried completely, it was ground into a fine powder and mixed with poppy oil. A summary of the experiment process in terms of oil paint production from natural plants is given as follows.

Figure showing the production steps for oil paint	**Step of oil paints production**
	1. Boil 20 g. of the plant in 1 liter of water.
	2. Boil for 20-30 minutes.
	3. Add 6 g. of alum dissolved in 100 g. of hot water and 6 g. of lime dissolved in 100 g. of hot water gradually and test pH with litmus to control it at pH7.
	4. Filter the color with the filter paper before letting it dry in the shade.
	5. Grind the color well and mix with drying oil (poppy oil) at a ratio of 10 g. / 6 g.

2.Experiment results of oil paint production from natural plants

From the experiment with 4 groups of colors, the color of oil produced from the natural plant changed after processing using the above process, as shown in Table 1.

Table 1 The change of oil paints produced from natural plants after the production process.

Group of Colors	Plants	Color Changes after Processing
1. Blue-Purple	Butterfly pea	Color changed from blue to green.
	Purple potato	Color changed from purple to blue.
	Purple cabbage	Color changed from purple to blue.
2. Green	Coriander	Color changed from green to brown-green.
	Asiatica	Color changed from green to yellow.
3. Yellow-Orange	Safflower	Color changed from yellow to brown-yellow.
	Carrot	Color changed from orange to brown-orange.
	Orange peel	Color changed from yellow to brown-yellow.
4. Red	Dragon fruit peel	Color changed from red to brown-yellow.
	Roselle	Color changed from red to black.

Table 1 shows the change of colors after the production process of oil paint due to different causes, such as thermal change during heat extraction by boiling or pH control. The color changes could be classified into new color groups, as shown in Table 2.

Table 2 The color of oil paints produced from natural plants

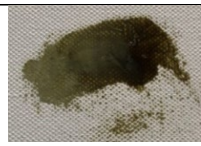
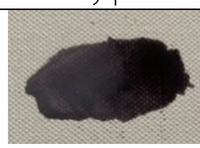
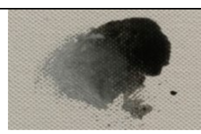
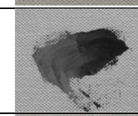
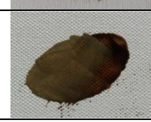
Group of Color	Types of Plants and Colors after the Production Process				
Group 1 Green	 Butterfly pea	 Coriander			
Group 2 Blue	 Purple potato	 Purple cabbage			
Group 3 Yellow-Orange-Brown-Yellow	 Asiatica	 Safflower	 Carrot	 Orange peel	 Dragon fruit peel
Group 4 Black	 Roselle				

Table 2 shows the colors after the production process from 4 groups of natural plants: Group 1 was green color from butterfly pea and coriander, Group 2 was a blue color from purple potato and purple cabbage, Group 3 was yellow-orange-brown-yellow from Asiatica, safflower, carrot, orange peel, and dragon fruit peel, while Group 4 was a black color from Roselle.

Although pH control during the extraction from natural plants resulted in the change of oil colors, such control provides higher color stability with fewer changes. The researcher illustrated the results of oil paint produced from natural plants by comparing photos taken on 21 February 2020 and 20 August 2020, which spanned 6 months (as shown in Table 3). It was obvious that the oil paint from Roselle and Asiatica was slightly pale, while those from butterfly pea, coriander, purple potato, and Asiatica had a more brown tone. Oil paint from the purple cabbage, carrot, dragon fruit and orange peel had a darker and black color.

Table 3 Comparison of color changes in the oil paint from natural plants (during 6 months)

Colors Changes of Oil Paints from Natural Plants (during 6 months)					
Types of Oil Paint	Photo taken on 21 February 2020	Photo taken on 20 August 2020	**Types of Oil Paint**	Photo taken on 21 February 2020	Photo taken on 20 August 2020
1. Butterfly pea			6. Coriander		
2. Purple potato			7. Purple cabbage		
3. Asiatica			8. Carrot		
4. Safflower			9. Orange peel		
5. Dragon Fruit peel			10 Roselle		

Summary

The experiment results for oil paint production from the 4 groups of natural plants consisting of green color: coriander and Asiatica, the group of blue and purple color: butterfly pea, purple sweet potato, purple cabbage, the group of yellow and orange color: carrot, safflower and orange peel, and the group of red color: dragon fruit peel and Roselle, showed that the color of plants changed. The new color shades were green oil paint from butterfly pea and coriander, blue oil paint from purple potato and purple cabbage, yellow-orange-brown oil paint from Asiatica, safflower, carrot, orange and dragon fruit peel, and black oil paint from Roselle.

When analyzing the data from the documents and studies relevant to changes in plant colors, it was concluded that the changes occurred when the plants were heated and alum and lime were added to the extracted color water to control pH. The colors from butterfly pea and Roselle were changed. Scientific principles were applied to explain that butterfly pea and Roselle were the blue-purple-red color plants, while anthocyanin was the main compound containing the dark blue in the alkaline condition or purple in the neutral condition, or red to orange in the acidic condition (Chothipa Sakulsingharoj, Srimek Chowpongpang, Seangtong Pongjaroenkit and Waraporn Sangtong. 2014:11). The pH condition and storage duration affected the stability of anthocyanin. That being said, the volume of anthocyanin was higher at the high acidic condition than that at the low acidic condition. Moreover, the volume of anthocyanin decreased when the storage time was longer (Rattana Muangrat, Kronwika Sakulkaipeera, Tanyarat Burakhum and Leelawade Chomnan. 2014:367).

When the researcher used the butterfly pea and Roselle plants containing high anthocyanin to produce the pigments by controlling pH at the neutral condition, the pigments in such plants were destroyed. Similarly, it was noticeable that the red color in the other 3 plants giving purple and red color, purple potato, purple cabbage, and dragon fruit peel, was destroyed. Meanwhile, there was less change in the green and yellow-orange plants. Though experimenting with such a method resulted in oil paint colors that were obviously different from those of the initial plants, the color would have fewer changes after 6 months.

Evaluation of satisfaction towards oil paint from natural plants

The satisfaction levels of 100 artists, professors, and students who studied the oil painting technique at Shanghai University were evaluated and summarized with statistical methods. Mean ($\bar{X}$) and standard deviation (S.D.) were used as the indicators. The satisfaction criteria were as follows.

1. Pigments resolution
2. Color viscosity
3. Oil color

Table 4 Evaluation results for satisfaction towards the oil paint from natural plants in terms of pigment resolution

Group of Color	Pigment resolution	The 3 samples group						Mean	Standard deviation (S.D.)
		Artists		Professors		Students			
		$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	
Group 1 Green	1. Butterfly pea	4.3	0.63	4.2	0.36	4.375	0.46	4.29	0.48
	2. Coriander	4.33	0.33	4.26	0.28	4.33	0.38	4.31	0.33
Group 2 Blue	3.. Purple potato	4.56	0.43	4.71	0.40	4.7	0.45	4.66	0.42
	4. Purple cabbage	4.7	0.42	4.9	0.24	4.85	0.36	4.81	0.34
Group 3 Yellow-Orange-Brown	5. Asiatica	4.66	0.47	4.5	0.50	4.45	0.50	4.53	0.49
	6. Safflower	4.63	0.36	4.63	0.36	4.67	0.40	4.64	0.38
	7. Carrot	3.73	0.44	3.95	0.33	4.27	0.50	3.98	0.42
	8. Orange peel	3.45	0.42	3.48	0.44	4.47	0.50	3.80	0.45
	9. Dragon Fruit peel	3.45	0.42	3.41	0.49	4.4	0.49	3.75	0.47
Group 4 Black	10. Roselle	3.21	0.33	3.23	0.40	4.45	0.50	3.63	0.41
Total		4.10	0.43	4.13	0.38	4.49	0.45	4.24	0.42

Table 4 shows that a total of 100 samples from the 3 sample groups were mostly satisfied with the oil paint from the purple cabbage at a high level ($\bar{x}$ = 4.81, S.D.= 0.34), followed by the oil paint from purple potato, safflower, Asiatica, coriander, butterfly pea, carrot, orange peel, dragon fruit peel, and Roselle, respectively.

Table 5 Evaluation results for satisfaction towards the oil paint from the natural plants in terms of color Viscosity

Group of Color	**Color viscosity**	**The 3 samples group**						**Mean**	**Standard deviation (S.D.)**
		Artists		**Professors**		**Students**			
		$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	
Group 1 Green	1. Butterfly pea	3.8	0.46	4.36	0.49	4.27	0.45	4.14	0.46
	2. Coriander	2.6	0.40	2.91	0.18	3.52	0.50	3.01	0.36
Group 2 Blue	3.. Purple potato	3.11	0.21	3.58	0.47	4.42	0.50	3.70	0.39
	4. Purple cabbage	4.86	0.22	4.96	0.12	4.87	0.33	4.90	0.22
Group 3 Yellow-Orange-Brown	5. Asiatica	3.33	0.47	3.56	0.50	3.5	0.503	3.48	0.49
	6. Safflower	2.66	0.40	3.06	0.17	3.21	0.39	2.98	0.32
	7. Carrot	2.5	0.39	2.66	0.40	3.08	0.27	2.75	0.35
	8. Orange peel	2.43	0.36	2.46	0.41	2.96	0.17	2.62	0.31
	9. Dragon Fruit peel	2.3	0.36	2.33	0.44	2.6	0.49	2.41	0.43
Group 4 Black	10. Roselle	2.78	0.33	3.2	0.46	3.87	0.46	3.28	0.42
Total		3.04	0.36	3.31	0.36	3.63	0.40	3.33	0.38

Table 5 shows that a total of 100 samples from the 3 samples groups were mostly satisfied with the oil paint from the purple cabbage at a high level ($\bar{x}$= 4.90, S.D.= 0.22), followed by the oil paint from butterfly pea, purple potato, Asiatica, Roselle, coriander, safflower, carrot, orange peel, and dragon fruit peel, respectively.

Table 6 Evaluation results for satisfaction towards the oil paint from natural plants in terms of oil color

Group of Color	Oil color	The 3 samples group						Mean $\bar{x}$	Standard deviation (S.D.)
		Artists		Professors		Students			
		$\bar{x}$	S.D.	$\bar{x}$	S.D.	$\bar{x}$	S.D.		
Group 1 Green	1. Butterfly pea	4.13	0.22	4.05	0.15	4.45	0.50	4.21	0.29
	2. Coriander	3.93	0.17	3.68	0.53	4.45	0.50	4.02	0.4
Group 2 Blue	3.. Purple potato	4.66	0.47	4.7	0.46	4.67	0.47	4.68	0.47
	4. Purple cabbage	4.86	0.26	4.88	0.28	4.875	0.33	4.87	0.29
Group 3 Yellow-Orange-Brown	5. Asiatica	4.3	0.36	4.36	0.49	4.65	0.48	4.43	0.44
	6. Safflower	4.2	0.24	4.11	0.28	4.31	0.46	4.20	0.33
	7. Carrot	3.78	0.36	3.63	0.49	4.1	0.70	3.83	0.52
	8. Orange peel	3.08	0.26	3.08	0.26	3.91	0.79	3.35	0.44
	9. Dragon Fruit peel	3.13	0.31	3.06	0.17	3.22	0.42	3.14	0.3
Group 4 Black	10. Roselle	3.93	0.21	3.8	0.38	3.75	0.43	3.82	0.34
Total		4.00	0.29	3.93	0.35	4.24	0.51	4.06	0.38

Table 6 showed that a total of 100 samples from the 3 samples group were mostly satisfied with the oil paint from the purple cabbage at a high level ($\bar{x}$ = 4.87, S.D.= 0.29), followed by the color from purple potato, Asiatica, butterfly pea, safflower, coriander, carrot, Roselle, orange peel, and dragon fruit peel, respectively.

Table 7 Evaluation summary of the satisfaction among the 3 sample groups with the 3 aspects towards the oil paint from the natural plants

Group of Color	Group of plants/ Oil paint quality	1. Pigment resolution	2. Color viscosity	3. Oil color	Mean $\bar{x}$	Standard deviation (S.D.)
Group 1 Green	1. Butterfly pea	4.29	4.14	4.21	4.21	0.07
	2. Coriander	4.31	3.01	4.02	3.78	0.68
Group 2 Blue	3.. Purple potato	4.66	3.7	4.68	4.34	0.56
	4. Purple cabbage	4.81	4.9	4.87	4.86	0.04
Group 3 Yellow-Orange-Brown	5. Asiatica	4.53	3.48	4.43	4.14	0.57
	6. Safflower	4.64	2.98	4.2	3.94	0.86
	7. Carrot	3.98	2.75	3.83	3.52	0.67
	8. Orange peel	3.8	2.62	3.35	3.26	0.59
	9. Dragon Fruit peel	3.75	2.41	3.14	3.1	0.67
Group 4 Black	10. Roselle	3.63	3.28	3.82	3.58	0.27
Total		4.24	3.33	4.06	3.87	0.50

In terms of pigment resolution, color viscosity, and oil color, all 3 sample groups were the most satisfied with the oil paint from the purple cabbage ($\bar{x}$= 4.86, S.D.= 0.04), followed by the oil paint from purple potato, butterfly pea, Asiatica, safflower, coriander, Roselle, orange peel, and dragon fruit peel, respectively.

In short, all 3 sample groups were satisfied with the oil paint from all 10 natural plants at a high level ($\bar{x}$= 3.87, S.D. = 0.50).

Discussion

From the study, it was found that the 2 main compounds of oil paint were pigment and oil. Natural ore was mostly used due to its color durability. However, some ores were harmful to health if they were inhaled or contacted, such as lead-white, cadmium, or cobalt (Ploeg, S.2018). Furthermore, some ores were rare and limited, so the cost of oil paint was high. For this reason, the researcher studied and experimented with the production of oil paint from natural plants to substitute for ores. The plants used in the experiment included coriander, Asiatica, butterfly pea, purple cabbage, purple potato, safflower, carrot, orange peel,dragon fruit peel, and Roselle. Pigment extraction and pH control were applied by adding alum, which was an acidic substance, and lime, which was the alkaline salt. As a result, the color of oil paint changed, but color stability increased.

Although the oil paint from natural plants was less colorful and the color was less durable than that from ores, they were safer, meaning not harmful to health or the environment in terms of pollution (Keycolour, 2016). It was in line with the research on the extraction of natural color from the plants for tie-dye (2015), which indicated the benefits of using the colors from natural plants in that it minimized the use of chemicals that cause respiratory disease, cancer and skin disease caused by chemicals accumulation. The natural colors were beautiful but not too bright, which was a unique property of the natural colors. Additionally, the use of natural colors minimized potential environmental and health problems (Nanthip Hasin and Chatdow Chailor.2015:3).

Concerning satisfaction among a total of 100 samples of artists, professors and students who studied the oil painting technique at Shanghai University, they agreed that the oil paint from the purple cabbage was the best one containing the 3 properties including pigment resolution, color viscosity and oil color, making it the most suitable for oil painting. Other suitable oil paints were those from purple potato, butterfly pea, Asiatica, safflower, coriander, Roselle, orange peel, and dragon fruit peel, respectively, which showed evaluation results at a moderate to high level ($\bar{x}$= 3.87, S.D. = 0.50). The evaluation results illustrated that the sample group was interested in the oil paint from natural plants. This was a positive trend to expand the oil paint production from various plants in the future to find the plants that provide the required colors for users.

Benefits of the research

1. The production of oil paint from natural plants promotes the utilization of natural resources for the highest benefits.
2. It helps to minimize the use of synthetic colors or certain ores which have negative health effects and can reduce the import of oil paint.
3. The findings can be applied as guidelines for the production of oil paint from natural plants in the future.

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