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Eyeliner Fabrication from Coconut Shell Waste (Cocos Nucifera) with Xanthan Gum Binder ($C_{35}H_{49}O_{29}$)

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Abstract

Eyeliner is a decorative cosmetic or make-up product. Eyeliner functions to help emphasize and make the shape of the eyes more prominent and more expressive, make makeup more dramatic without doing many steps, and cover the false eyelash line that sticks to the eyes. This study aims to determine whether activated carbon from coconut shell waste can be used as a natural dye in eyeliner fabrication. This research uses a laboratory experiment method, namely by mixing materials consisting of distilled water, xanthan gum, tween 80, propylene glycol, methylparaben, CH_3COOH solution with distilled water, ethanol, and carbon pigments in it. Xanthan gum and carbon are mixed in a ratio of 1:10; 1:12; 1:14; 1:16; 1:8; and 1:20 until homogeneous. Fabrication properties were tested, namely homogeneity, pH, drying time, and color tests on eyeliner fabrication. the results were analyzed descriptively. Based on the results obtained, the six fabricated formulations have a deep black color and have an average particle size of 8.1 µm, have an average pH of 6.3, an average drying time of 303 seconds, the six formulations have an Sinister Minister color. , After Dark, Deep Forest chocolate, Holy Crow, Smoked black coffee, Indigo brown ink. It was concluded that pigments from coconut shell carbon can be used as natural dyes in eyeliner fabrication. However, in the physical properties test, namely the homogeneity test and dry time test for eyeliner fabrication, there are still discrepancies in the literature.

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INTRODUCTION

Cosmetics are preparations or mixtures of ingredients used on the outside of the body to clean, increase attractiveness, protect it so it remains clean, and eliminate body odor (Febriyanti & Barlian, 2019). Modern cosmetics are not only dangerous for consumers but also for nature. The use of chemicals that are dangerous and difficult to decompose, as well as all types of materials originating from living creatures, can endanger the survival of living creatures (Ariva, 2022). Therefore, cosmetic manufacturers must consider further how to make environmentally friendly cosmetic products (Febrya, 2016).

Cosmetics made from natural ingredients are safer for the skin because of the awareness of the dangers of chemical products(Suwarno et al., 2024). Natural dyes are increasingly popular in the cosmetics industry. Its biodegradable, non-toxic and biodegradable properties make it safer to use than synthetic dyes, which can sometimes be harmful to human health and the environment. Natural dyes and pigments can be used to make cosmetics(Vinola et al., 2021). They come from natural materials such as leaves, roots, bark, insect secretions, and minerals. One cosmetic product that can be made with natural dyes is eyeliner (Syahrana, 2024).

Cosmetic products such as eyeliner have been used to make up the eyes, especially the eyelids (Purwaning Rahayu et al., 2020). Painting your eyelids with eyeliner, which is usually black, can make your eyes look bigger and clearer (Venkat, 2023). Eyeliner can be used to emphasize the contour of the eyes and provide better definition and attractiveness (Nichols, 2022). It can cover false eyelashes and make makeup more dramatic without many steps. The eyeliner is usually applied to the line that traces the upper and lower edges of the eyelid, also known as the "eye line." In general, eyeliner is used symmetrically and in a smooth line along the eyelid (Steitz, 2015). In the traditional view, liquid eyeliner is considered a special makeup artist's prop. However, with the increase in women's knowledge and ownership of color cosmetics and the demand for makeup effects, liquid eyeliner has also developed into a "civilian" product (Prosser & Popa, 2020).

Natural dyes and chemical dyes are used in eyeliner formulations. One of the natural ingredients commonly used is carbon, which has a deep black color and is suitable as a mixture in products such as eyeliner (Narulita et al., 2018). This carbon is often used in cosmetics for health and beauty purposes. For example, research by Maulidah (2020) utilized carbon from activated coconut shells to open pores on the surface of charcoal, thereby increasing the adsorption capacity of dyes. In making eyeliner, the right formula is needed to produce a standardized and good-quality product. Carbon is used as a colorant for water-based cosmetics. For eyeliners, carbon black is used in areas around the eyes, such as the eyelids, to add color and pattern and give an attractive impression (Narulita et al., 2018; Takachiyo K & Sakuma S, 2022). The study found that carbon from wood sawdust and coconut shells can be used as a natural dye for eyeliner, replacing synthetic dyes and producing high-quality eyeliner that meets physical property test standards (Narulita et al., 2018; Putri Maulidah et al., 2020)

Coconut shell (Cocos nucifera) or coconut shell has a thickness of around 3 to 5 millimeters after the coir layer. Many people throw away coconut shells, turning them into waste that pollutes the environment (Hermita, 2019). Coconut shell charcoal is very valuable because it is made from carbon that comes from mining, animal, or plant sources (Wasis et al., 2019). Coconut is considered the best source of charcoal because it has many micropores, low ash content, high reactivity, and is soluble in water. If calculated, the pore surface of one gram of activated carbon ranges between 0.5 and 1.5 square kilometers (Goni et al., 2019; Lee, 2022). The charcoal component may consist of several units of powder, particles, granules, extrudates, pellets, or a combination thereof. In some forms, the charcoal component may consist of activated charcoal powder (Lee, 2022). This researchpefulikely tort coconut shell waste into natural-based eyeliner products.

Xanthan gum produces a gel that can accommodate water-soluble active ingredients, has strong synergy, and increases viscosity. It is produced through the fermentation of the bacteria Xanthomonas campestris with carbohydrates (Yadav & Soundatti, 2023). The pseudoplastic nature of xanthan gum allows its viscosity to decrease when exposed to shear forces, such as agitation, and return to normal once the force is removed. This facilitates processing and pouring and maintains product quality without permanent loss of viscosity (Alhalmi et al., 2018). Xanthan gum is the only biopolymer with low toxicity to the environment, which makes it a sustainable product. In addition, its ability as a binder with various ingredients, which can increase or decrease its activity, is an additional feature of xanthan gum (Dhiendy Tri Novebry et al., 2015; Furtado et al., 2022)

This research aims to fabricate eyeliner using natural carbon dye from coconut shells, requiring additional materials such as solvents and binders. In this study, the binder used was xanthan gum. It characterized and tested the suitability of natural eyeliner using pigments from coconut shell carbon as coloring, distilled water as a solvent, xanthan gum as a binder, Tween 80 as a wetting agent, propylene glycol as a solubility enhancer, methyl parabens and 96% ethanol function as preservatives and speed up the drying of the fabric after application, as well as a solution of distilled water + kitchen vinegar [CH_3COOH] as pH neutralizer.

According to research by Narulita (2018), pigment extraction was done using 120 mesh sieving. Next, xanthan gum is mixed with different pigment extract concentrations (1.0 grams, 1.2 grams, 1.4 grams, 1.6 grams, 1.8 grams, and 2.0 grams) to produce the ideal ink formulation. Homogeneity testing using a CCD microscope, pH testing using a pH meter, color testing using a colorimeter, and dry power testing using a stopwatch are all examples of eyeliner characterization.

METHOD

The materials used in this research were charcoal briquettes, xanthan gum, distilled water, 95% alcohol, propylene glycol, Tween 80, methylparaben, and aqueous solution + kitchen vinegar [CH_3COOH]. Meanwhile, the equipment used is a chemical glass, mortar, pestle, measuring glass, magnetic stirrer, stirring rod, deg glass, and 120 (micron) mesh. The 120 mesh screen printing screen has a hole diameter of 0.125 mm, chosen because of the success of previous research conducted by Narulita (2018) using charcoal as eyeliner.

The first stage in this research is to grind the activated carbon in a mortar and sift the carbon powder with a 120 mesh. After weighing each ingredient, put the carbon and xanthan gum into the mortar and weigh 1.1 grams for mixture B. Next, use a stirrer (mixture A) to heat a mixture of distilled water, ethanol, propylene glycol, and Tween 80 in a beaker. Heating is carried out to 75°C to form a solution. Then, mix mixture B into mixture A for 15 minutes until smooth, and reduce the temperature to 50°C for the same eyeliner consistency. Then, mix methylparaben, ethanol, distilled water, and kitchen vinegar [CH_3COOH]. Stir until homogeneous (modified Narulita, 2018). The fabrication that has been stirred for 15 minutes is then stored in a closed container. Next, homogeneity testing was carried out using a CCD microscope, and pH testing was done using a pH meter, dry power testing was done using a stopwatch, and color testing was done using a colorimeter

RESULTS AND DISCUSSION

This research focuses on the characterization of natural pigments of charcoal briquettes from coconut shells for manufacturing eyeliner that is environmentally friendly and safe for the skin. Using natural pigments is an essential step towards more sustainable eyeliner fabrication, reducing dependence on synthetic eyeliner fabrication, which negatively impacts the skin in the long term (Dhiendy Tri Novebry et al., 2015).

The carbon pigment from the varied charcoal briquettes is mixed with distilled water, 95% alcohol, propylene glycol, Tween 80, methylparaben, as well as a distilled water solution + kitchen vinegar [CH_3COOH] and xanthan gum binder. The resulting fabrication is dark black, as shown in Figure 1. This color is due to the carbon content, a natural pigment that can produce a black color.

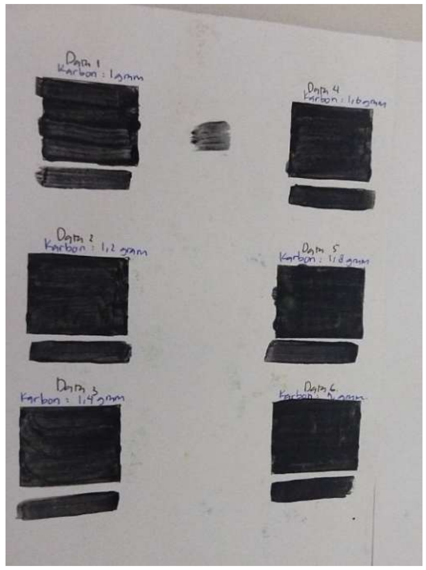

Figure 1. Variational Carbon Eyeliner Fabrication.

Eyeliner Characteristics

Eyeliner characterization was done by testing homogeneity, pH, drying time, and color.

1. **Homogeneity Test**

A statistical test process that shows that two or more groups of data samples from a population have the same variance (Sianturi, 2022). A small amount of eyeliner fabrication was taken to test homogeneity, placed on a glass object covered with deg glass, and observed with a CCD (charge-coupled device) microscope. The fabricated particle size is compared with commercial eyeliners available in the market. The homogeneity test is carried out to determine whether the ingredients used to make eyeliner have been mixed evenly. This also ensures that the carbon pigment substance is appropriately distributed in the eyeliner fabrication, which can directly affect the results when applied to the skin. If the preparation is homogeneous, the results will be better when applied to the skin.

Table 1. Homogeneity Test.

Formula	**Homogeneity (µm)**	**commercial eyeliner (x) (µm)**
1	8.30	
2	8.04	
3	7.80	1.91
4	8.50	
5	7.40	
6	8.30	

Based on the data above, the results of the homogeneity test comparison between commercial eyeliner fabrication (x) and eyeliner fabrication made from coconut shell pigment show significant differences in particle size. The particle size of coconut shell eyeliner fabrication shows an average particle size of 8.10 µm. Compared to commercial eyeliner, which has a particle size of 1.91 µm, the test results show that the fabrication of coconut shell eyeliner is not homogeneous. If compared, the difference in particle size is 6.20 µm. Then, several things cause the fabrication of eyeliner from coconut shells to be nonhomogeneous. The first is that the particle size is significant during the sieving process if it is used as eyeliner. The second is the stirring process, where the magnetic stirrer for each formulation uses a different stir magnet size, which can affect the solubility of the formulation sample.

2. pH Test

The pH test on eyeliner fabrication is carried out using a pH meter by dipping the pH meter into each eyeliner formulation sample. Eyeliner fabrication must have a pH that matches the skin's pH, between 4.5 and 7.5 (Febriyanti & Barlian, 2019). The pH test can be seen as follows:

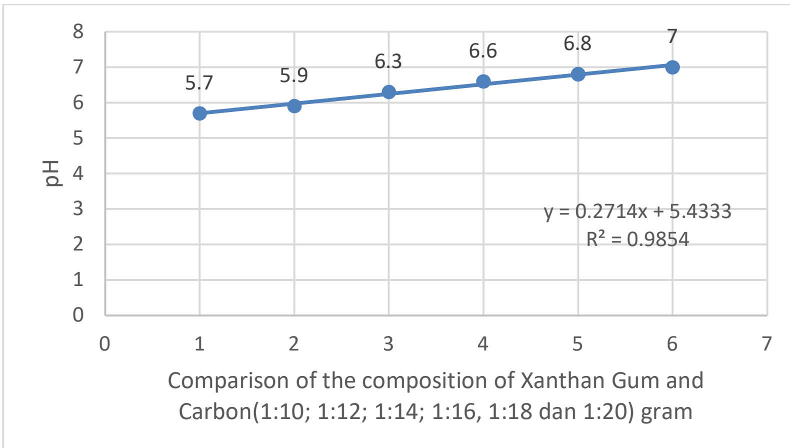

Figure 2. pH test for Eyeliner Fabrication Variations using a pH meter.

Figure 2 shows a positive linear relationship with a coefficient of determination $R^2 = 0.9854$, close to a perfect value because it is still in the same order as $R^2 = 1$. The regression line equation is $y = 0.2714x + 5.4333$, It will describe a strong relationship where the addition of the independent variable, namely carbon mass, will cause an increase in the dependent variable, namely pH eyeliner. The eyeliner is relatively safe, even though the pH value is close to the threshold, as shown in Figure 2 above. The pH that increased in each sample was due to the carbon from coconut shells, which has a relatively alkaline pH of around pH 6–8 (Masriatini & Fatimura, 2019)

3. Test Drying Time

A drying time test is carried out on the fabrication to find out how long the fabrication will take to dry. The test was carried out by applying the eyeliner formulation to the skin of the forearm using an applicator. Once the finger does not rub off the eyeliner and the time is recorded, the eyeliner is considered dry. Table 4.3 shows the drying time test results between eyeliner fabrication from coconut shells and the standard eyeliner time in the Maulidah research (2020), which is around 40-252 seconds.

Table 2. Test Drying Time.

Formula	adverb of time (second)	time standards (second)
1	210	
2	310	
3	340	40-252 (Maulidah,2020)
4	390	
5	240	
6	330	

The results of the drying time test for the application to the inner forearm skin can be obtained in samples 1 and 5, which meet the time standards according to the literature on the Drying time test for eyeliner fabrication, which is 40-252 seconds (Maulidah, 2020). Therefore, the addition of carbon has relatively no impact on the drying time of the eyeliner. The drying process of each sample is influenced by the size of the carbon pigment particles, which are still significant (average 8.1 μm).

4. Color Test

Color testing on carbon pigment eyeliner fabrication with xanthan gum binder was carried out using a colorimeter to evaluate the quality and consistency of the color produced in the LAB color code. The color measurements in the LAB code provide the parameters L* (brightness), a* (green-red axis), and b* (blue-yellow axis), which collectively reflect the accurate color of the ink sample. The working principle of a colorimeter is based on measuring the intensity of light reflected/transmitted by a sample at a specific wavelength (Farida et al., 2021). The results of color testing using a colorimeter are presented in Table 3.

Table 3. Color Test.

No	Carbon Mass (gram)	color coordinates		
		L*	a*	b*
1	1.0	+22.1	+0.3	+1.1
2	1.2	+22.2	+1.4	+1.4
3	1.4	+21.5	+2.2	-0.1
4	1.6	+21.0	+1.4	+1.8
5	1.8	+21.0	+3.4	+0.2
6	2.0	+21.6	+1.4	+1.6

The effect of carbon pigment concentration on color is measured using the LAB system, namely L (brightness), a (green-red axis), and b (blue-yellow axis). Under the condition of adding pigment concentration (1 gram), the brightness value (L) reaches +22.1 with a value of +0.3 and b of +1.1. With the increase in pigment concentration (1.2 grams), the brightness (L) increased to +22.2; the value increased drastically to +1.4, and b increased by +1.4. When the pigment concentration was added to 1.4 grams, the brightness (L) decreased to +21.5, with the a value increasing to +2.2 and b dropping drastically to -0.1. With the increase in pigment concentration (1.6 grams), the brightness (L) decreased to +21.0; the a value was +1.4, and the b value was +1.8. At the pigment concentration (1.8 grams), the brightness value remained stable at +21.0, but there was a drastic increase in the value to +3.4 and b a drastic decrease to +0.2. When adding the last carbon pigment (2.0 grams), there was an increase resulting in the value (L) being +21.6, a value decreased to +1.4, and b increased to +1.6. From these results, increasing pigment concentration can reduce the brightness of eyeliner fabrication.

Based on the results of the LAB color coordinate conversion in Table 3, it can be seen that the colors produced from adding pigment mass vary greatly. Adding a pigmented mass of 1 gram produces the color " Sinister Minister." By adding a pigmented mass of 1.2 grams, the color "After Dark" is produced. The addition of a pigmented mass of 1.4 grams produces the color "Dense forest brown." On the addition of a pigmented mass of 1.6 grams of color, "Holy Crow." Adding a pigmented mass of 1.8 grams changes the color to "Smoked black coffee". Adding a pigmented mass of 2.0 grams changes the color to "Indigo, brown ink". This change shows that the additional mass of carbon pigment shifts the color from "Sinister Minister" to the darker "Indigo, brown ink." Sample 6, with a carbon mass of 2.0 grams, is the darkest.

Table 4. Colorimeter conversion table.

No	Carbon Mass (gram)	HEX	Color Description	Colors
1	1.0	#363533	Sinister minister	
2	1.2	#383434	After dark	
3	1.4	#383234	Deep forest brown	
4	1.6	#36322f	Holy crow	
5	1.8	#393032	Smoked black coffee	
6	2.0	#373331	Indigo ink brown	

It can be seen that the 6th variation of eyeliner, compared to the eyeliner composition, namely 2.0 grams, has the best dark black color, so adding pigment concentration can improve the color quality of the darker eyeliner.

CONCLUSION

The research results show that natural carbon pigments from coconut shell charcoal have great potential in environmentally friendly eyeliner fabrication. Based on the physical properties test results, the fabricated eyeliner has an average particle size of 8.1 μm, which shows that its level of homogeneity is still far from commercial eyeliner. The pH test showed results that were safe for the skin with a pH range of 5.7-7, while the drying time test for eyeliner with a carbon mass of 1.0 grams took 210 seconds and a carbon mass of 1.8 grams with a time of 240 seconds was close to the literature standard, namely 40 -252 seconds. According to LAB code measurements, formulations with carbon masses of 1.6 grams and 1.8 grams produced black with the best density level in the color test.

Although this eyeliner has excellent potential, further research is needed to improve particle homogeneity through finer sieving techniques. Further testing is required, such as a density test and a viscosity test, to determine the density and viscosity of this natural eyeliner and compare it with commercial eyeliner products. Further research is hoped to produce natural eyeliner that can provide commercial product quality. A statistical test process that shows that two or more groups of data samples from a population have the same variance.

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