Black Carbon Pigment from Coconut Shell Sawit Innovation InkjetPrinting Ink for Acrylic Polymer Styrene Textile Fabric

Leli Nurhamiyah[1], Delovita Ginting[2], Romi Fadli Syahputra[3], Ayu Risti Candini[4], Piza[5], Fitra Perdana[6]
[1,2,3,4,5,6]Universitas Muhammadiyah Riau, Indonesia
E-mail: delovita@umri.ac.id

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Abstract
This research proposes an innovation in the development of inkjet printing ink that uses black carbon pigment obtained from palm coconutshells. The main objective of this study was to look at thecharacterization of textile inkjet ink from the black carbon pigments of the palm coconut shell. The black carbon pigment produced from the coconut coat has been identified as the source of the pontentionalprinting ink of the textile fabric based on the polymer of acrylic styrene. The research method involves the extraction and purification of carbon pigments from palm coconut shells, as well as the formulation of inkjetprinting. The composition of the textile inkjet used in this study is that black carbon pigments come from palm coconut shells while the adhesives used are acrylic styrene, aquadest, potassium hydroxide (KOH), poly (natrium 4- styrenesulfonat). The research included the physical characteristics of the black carbon pigments produced and the evaluation of inkjet printing textiles using pigments. Textile inkjetcharacteristics. Results of ink testing using Binocular Microscope Scanbest sample CAST1. The results of ink pigment testing on wool fabrics and image analysis testing the lowest values are found on CAST1 sample.The result of the viscosity test that the ink viskosity value CAST1 of 13.1 is close to the value of commercial ink.

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Abstrak
Penelitian ini mengusulkan suatu inovasi pengembangan tinta cetak inkjet yang menggunakan pigmen karbon hitam yang diperoleh dari tempurung kelapa sawit. Tujuan utama penelitian ini adalah untuk melihat karakterisasi tinta inkjet tekstil dari pigmen karbon hitam tempurung kelapa sawit. Pigmen karbon hitam yang dihasilkan dari lapisan kelapa telah diidentifikasi sebagai sumber tinta cetak pontensional pada kain tekstil berdasarkan polimer stirena akrilik. Metode penelitiannya meliputi ekstraksi dan pemurnian pigmen karbon dari tempurung kelapa sawit, serta formulasi pencetakan inkjet. Komposisi bahan inkjet tekstil yang digunakan pada penelitian ini adalah pigmen karbon hitam berasal dari tempurung kelapa sawit sedangkan bahan perekat yang digunakan adalah akrilik styrene, aquadest, potassium hydroxide (KOH), poly (natrium 4-styrenesulfonat). Penelitian tersebut meliputi karakteristik fisik pigmen karbon hitam yang dihasilkan dan evaluasi tekstil cetak inkjet menggunakan pigmen. Karakteristik inkjet tekstil. Hasil pengujian tinta menggunakan Binocular Microscope Scanbest sampel CAST1. Hasil pengujian pigmen tinta pada kain wool dan pengujian analisis gambar nilai terendah terdapat pada sampel CAST1. Hasil uji kekentalan menunjukkan nilai kekentalan tinta CAST1 sebesar 13,1 mendekati nilai tinta komersil.

I. INTRODUCTION

Inkjet printing is a textile printing that has advantages in efficiency process, cost efficiency, and a good environmental impact. Textile inkjet Printing has become one of the leading methods in printing designs of various types of fabrics. Inkjet prints provide advantages compared to traditional methods of printing textiles such as templates thus bringing opportunities for designers, printing, and consumers in a variety of industries such as fashion, interior, textile and others. In addition to the ink machine there are some other technological componentsthat are very important in the process of digital fabric printing (Pati et al., 2016).

Textile industry growth of 6.33% shows that the textile industry is experiencing an increase in output by 2022, some of the factors that can influence this growth are strong market demand, innovation in textile design and technology, as well as the trend of consumption. The development of the textile industry can also have significant environmental and social impacts. Textile production processes often involve the use of hazardous chemicals (BPS, 2022) (Dimawarnita et al., 2022). The volume of textile production increases and the amount of industrial waste that is produced increases. The only solution to reduce industrial waste is by reducing liquid waste that uses chemicals that can harm the environment by using natural dyes. The produced dye can be obtained through extracts of plants that exist in nature. (Abdurahman & Kahdar, 2021).

Previous research of black carbon pigments produced from avocado seed waste as a dye in the manufacture of textile ink is an example of the application of natural materials in the textile industry. Avocados contain natura pigment compounds that can give color to textile materials. (Ratnasari et al., 2019). Previous research also mentioned that black carbon pigments for textile ink can be produced from mango leaves. (Batik et al., 2019). Natural dyes like this have the advantage in their production processes are more likely to be environmentally friendly than synthetic dyes, thus becoming an attractive alternative to natural dyes.

Black ink is one of the most commonly used ink types in the textile industry. One of the pigment options used in this textile ink research is black carbon obtained from palm coconut shells. Black carbon can be derived from a number of organic materials that contain cellulose obtaining from carbonization processes such as palm Coconut Shell (Viena et al., 2019), coconut furnace (Winata et al. 2021), palm palm empty shell (Muhammad et al, 2019). The palm carbon shell used in the manufacture of this active carbon has the potential to produce active carbon because it has a high carbon content. (Nasution et al., 2018). The active carbon used in this study has a large porous surface, making it excellent in absorbing chemicals and particulate particles in a variety of applications such as water purification, poison treatment and more (Ho & Khan, 2020).

Inks generally consist of some major components such as polymers, dyes, adhesives and other additives (Medi et al., 2022). The quality of textile ink is very influential in the process of fabric printing, so the selection of polymers is very important in the manufacture of textiles ink. Polymers are one of the materials that are often used in textile inks formulation to give certain properties. One of the good polymers is acrylic styrene. Acrylic Styrene has been widely used as adhesive in the manufacture of textile ink, among other things, good clamping strength, water resistance, good durability and so on (Kai et al., 2020). (Saribyekova et al., 2017).

This research will do inkjet inks for textile fabrics applications. The pigments used in this purchase are black carbon from palm coconut shells, given the increased demand for black ink, so it made use of palm Coconut shell waste as black pigment using acrylic styrene polymer. Additional ingredients are aquadest, KOH, poly (sodium 4-stirenasulfonat). The black pigments obtained will be tested for ashes, vapour, water, carbon binding and PSA. (Particle Size Analizer). The resulting textile ink will perform tests such as SEM (Scanning Electron Microscopy), FTIR (Fourier Transform Infared Spectroscopy), viscosity, pigment or image.

II. METHOD

A. Tools and Materials

The materials used in this study are palm coconut shells derived from palm crates, Indonesia, acrylic styrene, aquadest, potassium hydroxide (KOH), chloric acid (HCl), poly (sodium 4-stirenasulfonat). The tools used in this study are oven, furnace, scales, 500 mesh sheets, beaker glass, hot plate, whatman paper, dryer, cup of cylinders, petri cup, pH paper, container, bottle storage of liquid ink and aluminum foil. The commercial ink used in this study is the Epson T49P1.

B. Activated Carbon Production

Production of active carbon initially by preparation of palm coconut shell like Figure 1(a), palm coke shell ovens at a temperature of 105°C for 24 hours as shown in Fig. 1(b), already dried carbon halucination as seen in Figure 2(c), re-washing of active charcoal using HCl until its pH is neutral as shown on Figure 3(d), oven returns for 3 hours like Fig. 2(e), dried charcoals are then refined using 500 mesh coatings as shown at Figure 4(f). The process of producing active carbon can be seen on Fig. 1.

Figure 1. Activated carbon production process of palm coconut shell (a) washing, (b) fermentation, (c)carbonization, (d) laundering, (e) drying

C. Textile Inkjet Manufacturing

The manufacture of textile inkjet ink is done with 3 variations of mixture of acrylic styrene, poly (sodium 4-stirenasulfonate), and potassium hydroxide (KOH), active carbon and aquadest as shown in Table 1. Potassium hidroxide on and Aquadest is dissolved with potasium hydrogen oxide (KoH) while mixed to form a solution of potassial hydroxyde. Then activated carbon, poly, and acrylium styrene are mixed into the solution of already heated potasyloxide, then mixed using a magnetic stirrer at a speed of 200 rpm for 6 hours.

Table 1. Textile Ink Composition

Sample Box	Aquadest (ml)	Active Carbon (g)	Potassium hydroxide (KOH) (g)	Poly (sodium 4-styrene sulfonate) (g)	Acrylic Styrene (g)
CAST 1	100	4	4	4	1
CAST 2	100	6	4	4	1
CAST 3	100	8	4	4	1

D. Active Carbon Testing

1. Activated Carbon Ash Test

A test of the ash content of activated carbon is performed to determine the content of ash contained in the active carbon. (Meilianti, 2018). Ash tests are done by drying a porcelain cup and then weighing it to determine its weight, then carbon is inserted into the porcelain glass. The cups containing carbon are burned using a furnace at 800°C for 2 hours so that the carbon becomes ashes. Then the cups are removed from the oven and cooled with a dryer for 30 minutes, after 30 minutes weighing back to find out the final weight of the carbon. Ash tests were carried out with reference to SNI 06-3730-1995. Calculation for testing ash levels on equation (1) as follows:

$$\text{Abu Rate (\%)} = \frac{W_2 - W_0}{W_1 - W_0} \times 100$$

W_0 = empty cup weight (gram),
W_1 = sample initial weight (gram),
W_2 = sample end weight (gram)

2. Testing of activated carbon vaporizing substances

The vaporization test is aimed at determining the amount of vaporizing substance in activated carbon. (Meilianti, 2018). The vaporization test was carried out by weighing 1 gram active carbon into an empty cup. The cup containing the activated carbon is then covered and placed in the oven at 800°C for 7 minutes. The vaporization test was carried out with reference to SNI 06-3730-1995. Calculations for the test of megap substance levels on equation (2) are as follows:

$$\text{Vaporizing substance levels (\%)} = \frac{W_1 - W_2}{W_1} \times 100$$

W_1 = sample initial weight (gram),
W_2 = sample end weight (gram)

3. Activated carbon water test

The water test is intended to determine the absorption of water in activated carbon. (Dewi et al., 2021). The water content can be tested by drying a porcelain cup in the oven for 20 minutes at a temperature of 100 °C. The empty cup is then inserted with activated charcoal. The cup containing the activated carbon is then put into the oven at 105 °C for 3 hours. Ash tests were carried out with reference to SNI 06-3730-1995. Calculations for the ash level test on equation (3) are as follows:

$$\text{Water Rate (\%)} = \frac{W_1 - W_2}{W_1 - W_0} \times 100$$

W_0 = empty cup weight (gram),
W_1 = sample initial weight (gram),
W_2 = sample end weight (gram)

4. Carbon Binding Test

The test of the bound carbon level is intended to determine the level of pure carbon contained in activated carbon (Dewi et al., 2021). This test is the result of the water, vapor, and ash test process. The calculation for the carbon test is bound to the equation (4) as follows:

$$\text{Carbon Binding Rate (\%)} = (M + A + V)$$

M = water level (%),
A = ash rate (%),
V = Vaporizing substance levels (%)

E. Textile Ink Testing

The inks produced in this study were tested, among other things: SEM (Electron Microscopy Scanning) test; performed to observe the surface of ink with 2000x and 5000x magnification PSA (Particle Size Analizer) test, ink pigmenttest performed by rubbing ink fluid on pure white fabric, thus obtaining differences and image analysis test using imageJ application. (Rahayu, 2021). The ink viscosity test is performed using the Oswald method, where ink is measured using viscometry. The viscosity of ink affects how liquid ink can flow (Rahayu, 2021).

III. RESULT AND DISCUSSION

A. Activated Carbon Characterization Results

The active carbon in this study can be seen in Figure 2. The resulting activated carbon is visible from its finer texture, due to the use of 500 mesh, can be visible from the carbon color before it is activated and after activation against the carbon so that it produces a much darker color. The result of the active carbon distribution produced by particle size can be seen in Figure 3. The smallest value of 0.115µm and the largest value of 592.387µm with the mean value of 2.1223µm. Earlier researches mentioned that the result from the test of the distribution of the activated carbon of 0,115 µm and its greatest value is 592,387 µm as well as the average value of 51.2858µm. The average value produced in this study is much larger (Yani et al., 2023).

Figure 2. Active Carbon Coconut Shell Sawit

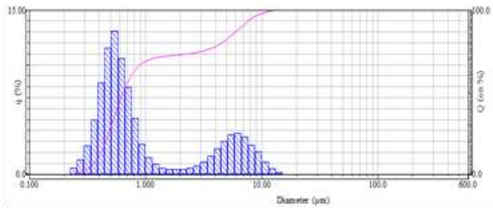


Figure 3. Diameter Distribution of Active Carbon Particle Size of Coconut Shell Sawit

The vapor content test is aimed at determining the amount of vapor substances contained in activated carbon (Meilianti, 2018). Vapor content refers to the components derived from the material during the process of carbonization or heating at high temperatures. This process can lead to increased pores in the active carbon which can then be used to absorb certain substances. (Aryani, 2019). The results obtained after a 3.44% test have been qualified for SNI No. 06-7330-1995 with a maximum SNI quality requirement of 25%. The water test is intended to determine the absorption of water in activated carbon. (Dewi et al., 2021). The water level is usually affected by the length of time the cooling process takes after the activation process is done, long this cooling procedure can also affect the water level in activated charcoal, as the refrigeration process can allow the activated carbon to absorb more air moisture (Wibawa & Luthfi, 2017). The results obtained after a 3% test have qualified SNI No. 06-7330-1995 with a maximum limit of 15%.

The carbon-binding test is aimed at determining the purity of the carbon contained in the activated carbon. (Dewi et al., 2021). The resulting activated carbon has the ability to absorb chemicals and particles in its surface, because it has a very large surface as well as a complex structure of pores. (Aryani, 2019). The results obtained after conducting tests of 43.44% have met the quality of SNI No. 06-7330-1995 with a maximum limit of 65%. Ash testing is aimed at determining the ash content of activated carbon. (Meilianti, 2018). Ash content refers to the components derived from the material during the process of carbonization or heating at high temperatures. The amount of ash produced can reduce the quality of activated charcoal due to the high level of ash that is not good in the activated carbon. Therefore, the lower the amount of ashes produced in the active carbon, the better its ability to absorb certain substances. (Aryani, 2019). The result obtained after the test was 37% while the SNI quality requirement for ash content is 10%. The high ash level is due to the ash content in the carbon material because during the activation process of temperature selection is too high so the ashes content in activated carbon is high. The ash content can provide a deposit on the surface of activated carbon. These reservoirs can reduce the efficiency of activated carbon (Almira et al., 2021). The level of ash generated using NaCl will give the best characterization of the level of ashes resulting in reduced levels of ash. (Permatasari et al., 2014). The ashes produced by the activated carbon testing are still high, from 100% carbon pigment there is still ashes in it, so it can affect the quality of printing. A suggestion for further research that is sought for the manufacture of black carbon pigments containing ashes below 10%.

Table 2. Activated Carbon Characterization Results

Test parameters	Test results (%)	SNI quality criteria(%)	Description
Water level	3	15	Suitable
Vaporizing substance levels	3,44	25	Suitable
Abu rate	37	10	Not Suitable
Vaporizing substance levels	43,44	65	Suitable

B. Textile Ink Production Results

The textile ink produced in this study can be seen in Figure 4. The resulting ink can be seen from the thickness of the ink found on the CAST1 sample with the use of 8 grams of activated carbon. The chemical mixing method used in the ink manufacturing process is included in the process of mixing chemicals evenly (Aprianti et al., 2021). During the process of making ink, textile inkjet can be seen ensuring the mixing of materials properly, as well as the heating used can help in the dilution of ink when mixed. The addition of activated carbon to the manufacture of textile inkjet ink should not be too excessive as it will interfere with other materials present in the ink, so the ink can not print well and can give poor results when printing (Muthatar., et al 2015).

Figure 4. Textile Inkjet Ink

C. Textile Ink Viscosity Test Results

The ink viscosity test aims to find out the degree of stiffness of the ink, if the ink is too low then the ink will spread faster and if it is too high it will not be able to flow properly. The viscosity of ink greatly affects the quality of ink. The carbon used greatly affects the increase in the viscosity of the ink produced, the increased viscousness of ink due to the presence of carbon clamps added, the greater the likelihood of clamp formation, thus eventually increasing the viskozity of ink (Aprianti et al., 2021). (Rahayu, 2021). Figure 5 is clearly visible after a viscosity test of the EPSON T49P1 commercial ink produced the lowest viscosities of 12 mPa.S and was followed by a CAST1 ink sample of 13.1 mpa.S.

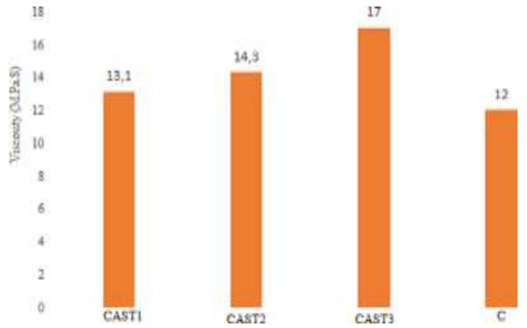
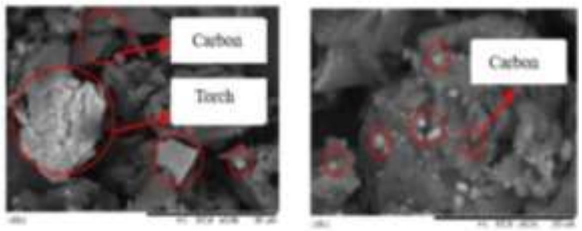


Figure 5. Textile Inkjet Viscosity Test Graph

D. SEM Test Results (Scaning Elektron Microscopy)

The SEM (Electron Microscopy Scanning) test, aimed at identifying, measuring, and analysing the morphology of samples as well as observing the shape, size, distribution, and surface structure carried out to observe the carbon found in textile ink with a 3000x magnification on the left image, and 5000x on the right image. The results of the SEM (Scanning Electron Microscopy) test can be seen in Figure 6. In the Ariyani (2019) study, the total amount of excessive ash contained in activated charcoal affects the quality of ink and the excessively high ash levels contained within activated carbon affects ink quality. Excessive ashes in activate charcoals can be caused at the time of carbon production when using furnaces with too high temperatures, so that the amount of ash produced increases. (Lekatompessy., et al 2022). The results of the SEM (Electron Microscopy Scanning) test study showed that the textile ink carried out in this study can be seen the amount of ash produced is still large so that it affects the manufacture of inkjet textiles. The researchers suspect that the resin found in the ink is marked with white, resulting in high levels of ash produced from activated carbon.



(Zoom 3000x) (Zoom 5000x)

Figure 6. Textile Inkjet Ink Morphology

E. Ink Pigment Test Results and Image Analysis

The ink pigment test was performed to determine the color difference after the carbon added to the manufacture of textile inkjet. In Figure 8, it can be seen that the addition of carbon of the palm coconut shell causes the color of the ink produced to become blacker. The blackest ink in this study is the sample CAST3 with the added concentration of the most carbon amount of 8 grams. The higher the concentration the carbon of palm Coconut Shell used, the more the pigment particles are. If the particles of the pigment are more and more then the perticles will be more tight, so that the pigment of ink produces a more concentrated black color. (Rahayu, 2021). The results of pigment testing using binocular microscopes with 4x and 10x magnification can be read on Figure 7 commercial ink with a fairly even result and on the sample CAST1 has quite a even distribution compared to thesamples CAST2 and CAST3. The results from the image analysis testing using imageJ applications can be seen on the Figure 8 that samples CAST1, with fairly uniform distribution of ink compared with the samples of CAST2, CAST3 still have a lot of ink clamps causing unequal distribution on the fabric. The result of the RGB using the ImageJ application shows that the higher the resulting color value, the whiteer it becomes, the lower the color value that is generated, the blacker it is. The results of ImageJ testing can be seen in Figure 9 clearly showing thelowest RGB value found in commercial ink and followed by the CAST1 ink sample.

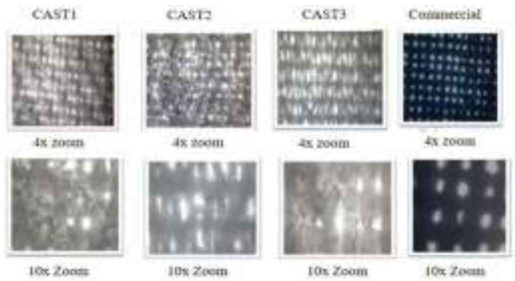


Figure 7. 4x and 10x Zoom Binocular Microscope Scan

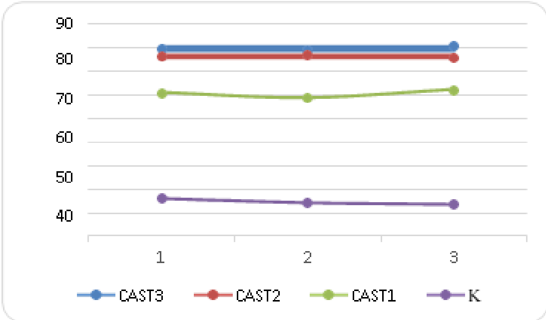


Figure 8. RGB Value Result

IV. CONCLUSION AND SUGGESTION

A. Conclusion

This study produced a textile inkjet ink with a black carbon pigment from palm coconut shell. The active carbon as the black carbon pigment from the palm Coconut Shell produced has met the SNI 06-3730-1995 standard, only on a test of ash levels that did not meet SNI standards. This has a strong influence on the manufactureof textile Inkjet ink. The manufactures of textiles inkjet Ink are made by chemical mixing, with the composition of active carbon in pigment and acrylic styrene as a polymer, with 3 variations of samples CAST1, CAST2, and CAST3. The results of the ink pigment testing that the sample CAST1 with an addition of 8 grams of carbon produces a blacker ink color than the samples of CAST2 and Cast3. Image analysis using imageJ showed that theCAST1 sample showed the lowest RGB value available on the commercial and followed by CAST1.

B. Suggestion

The discussion regarding this research is still very limited and requires a lot of input. The suggestion for future authors is to study it more deeply and comprehensively about Black Carbon Pigment from Coconut Shell Sawit Innovation Inkjet Printing Ink for Acrylic Polymer Styrene Textile Fabric.

REFERENCES

Abdurahman, S. N., & Kahdar, K. (2021). Eksplorasi Ekstrak Pewarna Alami Sebagai Bahan Pewarna Organik Untuk Tekstil Cetak. *Jurnal Rupa*, *6*(2), 134.

Almira, U., Sasmita, A., & Isnaini. (2021). Analisis Kadar Air, Kadar Abu, Volatil Dan Fixed Carbon Pada Biochar Cangkang Sawit Dengan Variasi Suhu Pirolisis. *Jurnal JOM FTEKNIK*, *8*, 1–5.

Aprianti, Y., Khairul, K., Nisa, K., & Saputri, L. H. (2021). Potensi Pelepah Daun Kelapa Sawit Untuk Pembuatan Tinta Printer. *Prosiding Seminar Nasional Aplikasi Sains & Teknologi (SNAST)*, 15–21.

Aryani, F. (2019). Aplikasi Metode Aktivasi Fisika dan Aktivasi Kimia pada Pembuatan Arang Aktif dari Tempurung Kelapa (Cocos nucifera L). *Indonesian Journal of Laboratory*, *1*(2), 16.

Batik, P., Uv-Vis, D., Komang Tribuana, N., Putri, C., Gst, I., Ratnawati, A. A., & Suharta, W. G. (2019). Analisis Pigmen Alami Daun Mangga (Mangifera Indicalinn) Sebagai. *Kappa Journal*, *3*(2), 134–141.

Dewi, R., Azhari, A., & Nofriadi, I. (2021). Aktivasi Karbon Dari Kulit Pinang Dengan Menggunakan Aktivator Kimia Koh. *Jurnal Teknologi Kimia Unimal*, *9*(2), 12.

Dimawarnita, F., Syarif, A. M., Faramitha, Y., Prakoso, H. T., Dimawarnita, F., Syarif, A. M., Faramitha, Y., & Widiastuti, H. (2022). Dekolorisasi Pewarna Tekstil Menggunakan Teknik Batch Dan Rotary Biological Contactor Dengan Tiga Jenis Agen Hayati. *Jurnal Teknologi Industri Pertanian*, *32*(3), 295–304.

Ho, S., & Khan, M. M. H. (2020). Short Review on the Use of Oil Palm Shell in Concrete and Activated Carbon. *World Journal of Nano Science and Engineering*, *10*(01), 1–13.

Kai, D., Guanhua, N., Yuhang, X., Meng, X., Wang, H., Shang, L., Qian, S., & Yunfei, L. (2020). Effect of nano- SiO2/styrene-acrylic emulsion on compactness and strength of mine drilling seal materials. *Powder Technology*, *372*, 325–335.

Kwasi Opoku, B., Isaac, A., Akrofi Micheal, A., Kwesi Bentum, J., & Paul Muyoma, W. (2021). Characterization of Chemically Activated Carbons Produced from Coconut and Palm Kernel Shells Using SEM and FTIR Analyses. *American Journal of Applied Chemistry*, *9*(3), 90.

Medi, Y., Pingak, R. K., & Bukit, M. (2022). Studi Potensi Tinta Printer Berbahan Dasar Pigmen Organik dari Daun Jambu Biji. *Magnetic Research Journal Of Physics and It's Application*, *2*(1), 101–105.

Meilianti, M. (2018). Karakteristik Karbon Aktif Dari Cangkang Buah Karet Menggunakan Aktivator H3Po4. *Jurnal Distilasi*, *2*(2), 1.

Muhammad et al. (2019). Arang Aktif Tandan Kosong Kelapa Sawit Sebagai Adsorben Logam Berat Merkuri (Hg). *In Prosiding Seminar Nasional Sains Dan Teknologi*, *2*(1), 1–14.

Nasution, Z. A., Limbong, H. P., & Nasution, S. S. (2018). Pengolahan Cangkang Kelapa Sawit menjadi Carbon Black Skala IKM dan Studi Kelayakan. *Jurnal Industri Hasil Perkebunan*, *13*(1), 1–10.

Pati, D., Alt, S., Tawiah, B., Howard, E. K., & Asinyo, B. K. (2016). The Chemistry of Inkjet Inks for Digital Textile Printing-Review. *International Journal of Menagement, Information Technology and Engeneering*, *4*(5), 61–78.

Permatasari, A. R., Khasanah, L. U., & Widowati, E. (2014). KARAKTERISASI KARBON AKTIF KULIT SINGKONG (Manihot utilissima) DENGAN VARIASI JENIS AKTIVATOR CHARACTERIZATION OF ACTIVATED CARBON FROM CASSAVA PEELS (Manihot utilissima) WITH DIFFERENT ACTIVATORS. *Jurnal Teknologi Hasil Pertanian*, *VII* (2), 70–75.

Rahayu, T. F. (2021). Pengaruh Variasi Konsentrasi Karbon Tempurung Kelapa Terhadap Karakteristik Tinta Spidol Whiteboard Ramah Lingkungan. *Jurnal Kartika Kimia*, *4*(2), 77–82.

Ratnasari, A. F., Kahdar, K., & Santosa, I. (2019). Pemanfaatan Limbah Biji Alpukat (Persea americana Mill) sebagaiPewarna

AlamuntukModest Couture. *Jurnal Rupa*, *4*(1), 1.

Saribyekova, Y., Kunik, O., Asaulyuk, T., Semeshko, O., & Myasnikov, S. (2017). Development of styrene-acrylic polymeric compositions for the coating of textile materials used for packing. *Eastern-European Journal of Enterprise Technologies*, *5*(6–89), 35–41.

Viena, V., Bahagia, B., & Afrizal, Z. (2019). Produksi Karbon Aktif dari Cangkang Sawit dan Aplikasinya Pada Penyerapan Zat Besi, Mangan Dan ph Air Sumur. *Jurnal Serambi Engineering*, *5*(1), 875–882.

Wibawa, I. G. N. A., & Luthfi, O. M. (2017). Kualitas Air Pada Ekosistem Terumbu Karang Di Selat Sempu, Sendang Biru, Malang (Water Quality of Coral Reef Ecosystem At Sempu Strait, Sendang Biru Malang). *Jurnal Segara, 2017, 13.1.*, *13*(1), 25–35.

Winata, B. Y., Erliyanti, N. K., Yogaswara, R. R., & Saputro, E. A. (2021). Pra Perancangan Pabrik Karbon Aktif dari Tempurung Kelapa dengan Proses Aktifasi Kimia pada Kapasitas 20.000 ton/tahun. *Jurnal Teknik ITS*,*9*(2), 0–5.

Yani, A. F., Lubis, V., Ginting, D., & Syahputra, R. F. (2023). Pemanfaatan Karbon Aktif Tempurung Kelapa Sebagai Carbon Black Tinta Serbuk. *JoP*, *8*(2), 90–95.