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The Effectiveness of using the Biofilter made from Bidara (Sidr) to reduce the negative effects of Mice Cigarette Smoke

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Abstract

This study aims to determine the effect of exposure to cigarette smoke with a biofilter of bidara leaf powder on the histology of the liver, lungs and blood viscosity of mice. This test was carried out for 28 days by giving cigarette smoke with a biofilter of bidara leaf powder and observing the histology of the liver, lungs and blood viscosity. The results showed that exposure to cigarette smoke with a biofilter of bidara leaf powder was very effective in reducing damage to the liver and lungs of mice, and also very effective in reducing blood viscosity as in normal mice blood viscosity. The use of Bidara leaf powder biofilter can affect the histology of the liver, lungs and blood viscosity in mice. Bidara leaf powder biofilter can minimize the negative impact of cigarette smoke.

Keywords: Biofilter, Bidara leaf, Mice Liver, MiceLung, MiceBlood Viscosity

1. Introduction

Cigarettes are processed tobacco products, that are burned and will produce cigarette smoke that contains free radicals[1]. Cigarette smoke is a mixture of smoke and particles, in addition this smoke consists of 4000 chemical compounds mixed, including toxic substances and some of them are cancer-causing ingredients[2]. Free radicals generated from cigarette smoke cause thickening of the alveolar walls, widening of the alveolus lumen and inflammation of the alveoli which is characterized by an increase in the number of leukocytes and alveolar macrophages.[3].

Cigarette smoke contains free radicals that harm the body. Free radicals can cause oxidative stress which is the cause of degenerative diseases[4]. So there needs to be innovation to develop a product that can minimize the negative impacts caused by cigarette smoke.

Several studies have shown that one of the dangers of inhaling cigarette smoke is the accumulation of free radicals in the body, causing disease[5]. Cigarette smoke that has the potential to cause cancer will become harmless with the addition of a biofilter. The active role of biofilters is to change cigarette smoke which contains harmful substances and free radicals to become harmless to health [6].

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The biofilter is a component of a closed recirculation system that causes the neutralization of toxic substances. There are seven types of free radicals in cigarettes without a biofilter that can be detected by LeyboldHeracus Electron Spin Resonance (ESR), namely Hydroperoxides, CO_2-, C, Peroxy, O_2-, CuOx, $CuGeO_3$. On the other hand, Biofilter consists of natural ingredients that contain antioxidants as free radical scavengers[7].
Many studies on special filters made from natural ingredients have been shown to capture free radicals in cigarette smoke. One of the uses of date palm seed composite membranes can absorb free radicals in cigarette smoke with a ratio of 0.7 g of date powder to 0.3 ml of polyetylene glycol (PEG)[8], also they stated that the composition of the mass of date palm seeds affects the density of the biofilter, which also affects the effectiveness of free radical absorption. Another study showed that the size of the filler in the biofilter also affects the absorption of free radicals [9]. In addition, pomegranate leaf powder can absorb free radicals from cigarette smoke with a composition ratio of 0.9 g with a PEG matrix of 0.3 ml[10].

Based on this description, it can be concluded that natural ingredients with certain compositions are proven to be able to ward off free radicals. However, there has been no research examining the effect of cigarette smoke with a biofilter made from Bidara leaf powder on the liver, lungs and blood viscosity of mice.

Bidara leaves are a source of antioxidants that have many benefits for the human body[11;12]. So this study was conducted for the purpose of looking at the effect of exposure to cigarette smoke with a biofilter of bidara leaf powder on the histological picture of the liver, lungs, and blood viscosity in mice.

2. Materials and Methods

Research on the effect of exposure to cigarette smoke with a biofilter of bidara leaf powder on histology of the liver, lungs, and blood viscosity of mice (Mus musculus) is an experimental study with 3 treatments and 6 replications. The treatments used were treatment without exposure to cigarette smoke (C-), treatment with exposure to cigarette smoke without a biofilter (C+), treatment with exposure to cigarette smoke with a biofilter of bidara leaf powder (B). Exposure to cigarette smoke was carried out for 28 days. Exposure is carried out for 28 days, in March 2021.

Making a biofilter is done by mixing bidara leaf powder with polyethylene glycol (PEG) adhesive, then stirring with a spatula until homogeneous. The composite was molded with a hose with a diameter of 0.7 mm and a height of 2 cm, and allowed to dry. After drying, the biofilter composite was removed from the mold and baked at 105^0C for 20 minutes.
In these 3 treatments, testing was carried out for 28 days with a volume of the smoke of 10 ml per exposure and the administration of cigarette smoke for 15 exposures with an interval of 1 minute for each administration of cigarette smoke. The steps in this research are as follows:
1. Experimental animals are put into cages that have been specially designed.
2. The biofilter is inserted into the cigarette
3. Cigarettes with biofilters are inserted into the hose as a connector between the cigarette and the suction/injection.
4. Cigarettes were burned and cigarette smoke was exposed to experimental animals for 15 times with an interval of 1 minute.

For the sampling of experimental animals to observe the histology of the liver, lungs, and blood viscosity as follows:
1. Prepared the treated animals

2. Experimental animals were dislocated necks to avoid contamination of chemical compounds in the sample.
3. Blood sampling for blood viscosity testing.
4. Liver and lung removal for histological observation.
5. Histological observations of the liver and lungs.
6. Provide a score of liver and lung histology according to the assessment reference (Tables 1 and 2)[13;14].

Table 1: Reference for Assessment or Scoring of Liver Histology

Liver Organs	Score
Normal (looks like polygonal cells, homogeneous red cytoplasm, well-defined cell walls)	1
Damage at the stage of parenchymatous degeneration, hydropic degeneration, and necrosis reach less than or equal to half the long field area	2
Damage at the stage of parenchymatous degeneration, hydropic degeneration, and necrosis reaches more than half of the long field area	3
Damage at the level of the number of cell nuclei disappears each less than or equal to half the long field area	4
Damage at the level of the number of cell nuclei disappears reaches more than half of the long field area	5

Table 2: The score of the degree of lung tissue damage in mice with the parameters of the lumen and alveolar membrane widening

Histological Overview	Score		
	1	2	3
Alveolar membrane	Alveolar membrane intact, nucleated and complete with endothelium cells >75%	Alveolar membrane intact, nucleated and complete with endothelium cells 25-75%	Alveolar membrane intact, nucleated and complete with endothelium cells <25%
Lumen Alveolus	Rounding proportional size >75%	Make proportional size 25-75%	Make proportional size <25%
Relationship between Aveoli	Meeting >75%	Meeting 25-75%	Meeting <25%

The chemical components contained in cigarette smoke are gases and particles [15]. Some of the gaseous compounds and particles of cigarette smoke are radicals. Although most of these free radicals are short-lived, nitrous oxide and quinone radicals can reach the lungs [16].

The measurement of the viscosity of the blood of mice is done by centrifuging the blood so that the blood and serum are separated. Blood was centrifuged for 15 minutes at 3000 rpm. After the blood and serum are separated, then measure the blood height and overall height (blood+serum) and calculate the viscosity.

Then the data that has been collected is statistically analyzed in one way Anova to see the effect or difference of the treatment.

3. Result and Discussion

Effect of exposure to cigarette smoke with a biofilter of bidara leaf powder on the liver histology of mice

Based on Figure 1 shows the C- treatment has the lowest damage compared to the treatment with exposure to cigarette smoke. The C+ treatment had the highest score of the degree of liver microanatomical damage. Liver damage in the treatment of exposure to cigarette smoke with bidara leaf powder biofilter was not significantly different when compared to the C-treatment. This shows that the bidara leaf powder biofilter is very effective in minimizing the negative impact of cigarette smoke.

In treatment C- had the lowest score of the liver microanatomy damage degree. Treatment C- had not been exposed to cigarette smoke, so the hepatocyte cells still had intact cell nuclei, the cell nuclei were intact and did not divide and the hepatocyte cell walls remained strong and did not break. Meanwhile, in the central vein, there is no inflammation and widening of the centrifugation line. The C+ treatment had the highest degree of damage score, because it was exposed to free radicals from cigarette smoke.

Treatment B (exposure to cigarette smoke with a biofilter of bidara leaf powder) as a treatment also had a score degree of microanatomical damage degree to the liver of mice which was almost the same as treatment C-.

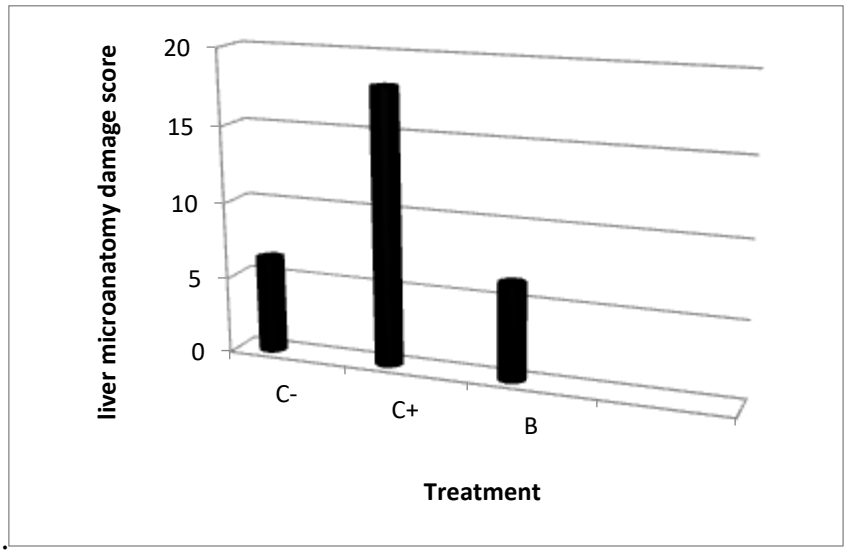

Figure 1: Liver microanatomical damage score.

The results of statistical analysis using ANOVA showed that there was a significant difference in the liver histology damage of mice in the three treatments of exposure to cigarette smoke.

Table 3: ANOVA statistical analysis of liver histology damage data

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	386.254	2	193.127	25.084	.000
Within Groups	115.489	15	7.699		
Total	501.742	17			

From the lungs, free radicals are circulated to the heart and liver[17]. Liver cell necrosis is based on cell membrane damage[18]. Exposure to cigarette smoke can cause liver cell necrosis[19]. One of the organs that are vulnerable is the liver, because the liver is a filter from toxins that enter the body. The double circulation system in the liver can cause a greater accumulation of toxins in the liver[20]. Free radicals can cause changes in the structure and function of the liver[21].

The results of this study indicate that exposure to cigarette smoke with a biofilter of bidara leaf powder can minimize damage to the liver.

Effect of exposure to cigarette smoke with a biofilter of bidara leaf powder on the histological picture of mice's lungs

Figure 2 shows that the C- treatment has the lowest score for the degree of lung microanatomy. Treatment C+ had the highest score of lung microanatomy degree. Treatment B had a relatively slightly higher lung microanatomy score than treatment C-.

Treatment C- (without cigarette smoke) has a lower degree score. Histological features in the C-treatment were the alveolar membranes were intact, the alveolus lumen was completely round and the connections between the alveoli were tight. While the highest value is the C+ treatment. Histological features in the C+ treatment were that the alveolar membrane was not intact, the alveolus lumen was not completely round and the relationship between the alveoli was not tight.

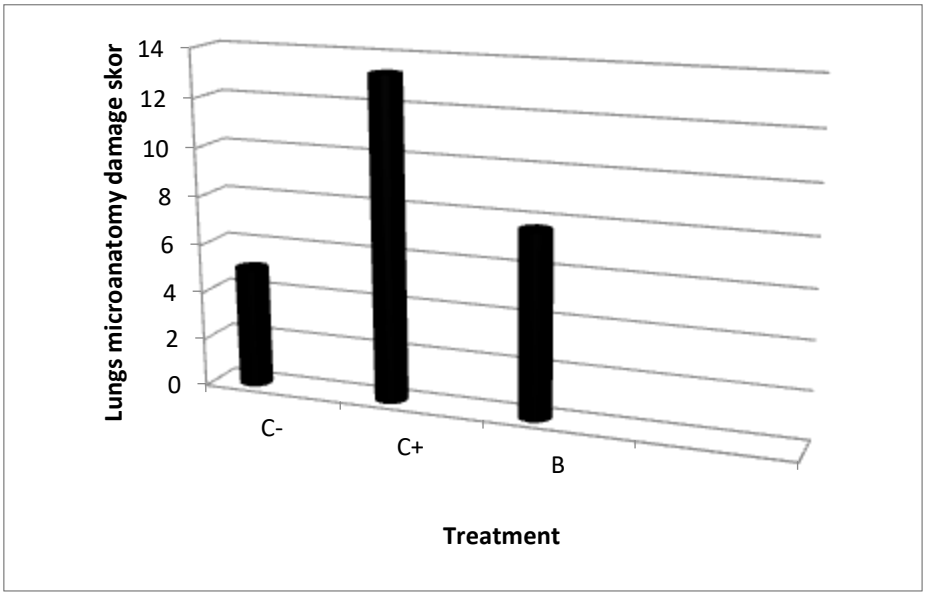

Figure 2: Score of the degree of damage to the microanatomy of the lungs

The results of statistical analysis using ANOVA (Table 4), showed that there was a significant difference (p=0.000) in the lung histology damage of mice in the three treatments of exposure to cigarette smoke.

Table 4: ANOVA statistical analysis of lung histology damage data

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	216.325	2	108.162	8.201E4	.000
Within Groups	.020	15	.001		
Total	216.345	17			

Cigarette smoke particles that enter the lungs will be phagocytosed by alveolar macrophages. The bond formed between receptors on the surface of macrophages and cigarette smoke particles will activate the release of inflammatory mediators. The release of inflammatory mediators causes the migration of peripheral neutrophils and monocytes to the alveolar and alveolar septum. Macrophages and neutrophils will produce protease enzymes and free radicals that can cause lung tissue damage[22].

In the body, there is an alpha1-antiproteinase enzyme that can prevent lung damage through the inhibition of protease enzyme activity[23]. However, continuous exposure to cigarette smoke can cause an imbalance between the amount of proteases and anti-proteases in the lungs of mice. This causes damage to the extracellular matrix and damage to the alveolar walls. The extracellular matrix of the lung, especially elastin, is the main component that maintains the integrity of the alveolar membrane. As a result, there is damage to the alveolar membrane that also affects the size of the alveolus lumen to not be proportionally rounded, and the relationship between the alveoli becomes stretched.[24].

The results of exposure to cigarette smoke with a biofilter of bidara leaf powder can minimize damage to the lung histology of mice. This shows that the bidara leaf powder biofilter is quite effective at capturing free radicals from cigarette smoke. Bidara leaf powder biofilter contains antioxidants and can capture free radicals of cigarette smoke and is able to minimize the harmful content of cigarette smoke, so that the quality of cigarette smoke has a better quality[25].

Effect of exposure to cigarette smoke with a biofilter of bidara leaf powder on the blood viscosity of mice

Figure 3 shows that treatment B has a blood viscosity value that is close to the blood viscosity value of treatment C-. In the treatment group C+ had the highest blood viscosity value.

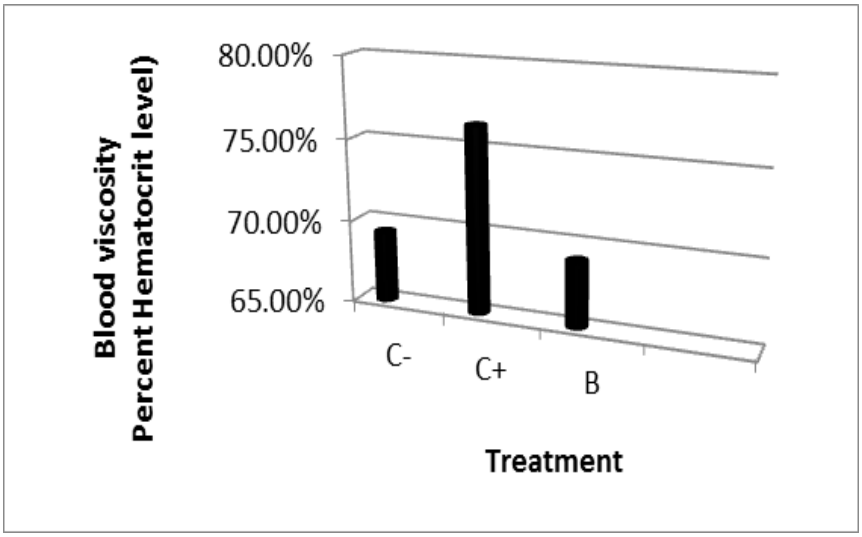

Figure 3: Diagram of mice blood viscosity

The results of statistical analysis using ANOVA (Table 5), showed that there was a significant difference (p=0.000) in the blood viscosity of mice in the three treatments of exposure to cigarette smoke.

Table 5: ANOVA statistical analysis of blood viscosity data

	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	204.003	2	102.001	3.372E3	.000
Within Groups	.454	15	.030		
Total	204.456	17			

Free radicals will cause a decrease in the oxygen transported, to cover the lack of oxygen, increase hemoglobin and the hematocrit, thus affecting blood circulation[16]. Increased levels of albumin, hemoglobin, and hematocrit from normal levels in this study need to be watched out for, because if they are too high it can cause the blood to become thick which can eventually result in impaired blood circulation. Increased levels of circulating plasma components indicate an increase in blood viscosity[26]. An increase in blood viscosity will reduce the speed of blood flow and interfere with oxygen delivery to tissues[27]. And if this happens it will cause diseases.

The results showed that exposure to cigarette smoke with a biofilter of bidara leaf powder did not have an impact on increasing blood viscosity (C+ treatment),

Biofilters from plants contain antioxidants and have the ability to capture free radicals from cigarette smoke and are able to minimize the harmful content of cigarette smoke, so it doesn't have a bad impact on health [28].

4. Conclusion

The use of Bidara leaf powder biofilter can affect the histology of the liver, lungs, and blood viscosity in mice. Bidara leaf powder biofilter can minimize the negative impact of cigarette smoke.

5. Acknowledgments

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6. Ethical Approval

This study and all of the experimental procedures involving animals were conducted in accordance with the animal care guidelines of the State Islamic University of Maulana Malik Ibrahim Malang, Indonesia.

7. References

[1] S. Bakhtiari, S. Azimi, M. Mehdipour, S. Amini, Z. Elmi, and Z. Namazi, "Effect of Cigarette Smoke on Salivary Total Antioxidant Capacity," *J. Dent. Res. Dent. Clin. Dent. Prospects*, vol. 9, no. 4, pp. 281–284, 2015, doi: 10.15171/joddd.2015.049.

[2] S. Astuti, A. I. Susanti, and R. Elista, "Gambaran Paparan Asap Rokok Pada Ibu Hamil Berdasarkan Usia Kehamilan Di Desa Cintamulya Kecamatan Jatinangor Kabupaten Sumedang," *J. Sist. Kesehat.*, vol. 2, no. 1, pp. 22–27, 2016, doi: 10.24198/jsk.v2i1.10413.

[3] A. A. Lopes *et al.*, "Antioxidant action of propolis on mouse lungs exposed to short-term cigarette smoke," *Bioorg. Med. Chem.*, vol. 21, no. 24, pp. 7570–7577, Dec. 2013, doi: 10.1016/J.BMC.2013.10.044.

[4] V. I. Lushchak, "Free radicals, reactive oxygen species, oxidative stress and its classification," *Chem. Biol. Interact.*, vol. 224, no. October, pp. 164–175, 2014, doi: 10.1016/j.cbi.2014.10.016.

[5] K. Prasad, I. Dhar, and G. Caspar-Bell, "Role of advanced glycation end products and its receptors in the pathogenesis of cigarette smoke-induced cardiovascular disease," *Int. J. Angiol.*, vol. 24, no. 2, pp. 75–80, Dec. 2014, doi: 10.1055/S-0034-1396413/ID/JR140094-55.

[6] A. Mulyono and H. Azhar, "The Effect of Cigarette Smoke through Biofilters with Natural Plant Materials on Mice MDA Level," *Med. J. Islam. Repub. Iran*, vol. 35, no. 1, pp. 1239–1244, 2021, doi: 10.47176/MJIRI.35.182.

[7] U. Syarifah, R. M. S., M. Muthmainnah, and A. Mulyono, "ANALISIS FISIS MEMBRAN BIOFILTER ROKOK DENGAN VARIASI DAUN, BIJI DAN KULIT DELIMA," *J. NeutrinoJurnal Fis. dan Apl.*, vol. 0, no. 0, pp. 112–118, Aug. 2015, doi: 10.18860/NEU.V0I0.3013.

[8] B. Rizqiyah, M. Muthmainnah, U. Syarifah, and A. Mulyono, "Analisis Fisis Membran Biofilter Asap Rokok Berbahan Biji Kurma Untuk Menangkap Radikal Bebas," *J. Neutrino*, vol. 7, no. 1, p. 40, 2014, doi: 10.18860/neu.v7i1.2638.

[9] U. Khoiriyah, "Studi tentang pengaruh paparan asap rokok dengan biofilter berbahan kopi (Cooffea Sp) dan tembakau (Nicotina tabacum) terhadap kadar Glukosa Darah dan gambaran histologi pankreas Mencit (Musmusculus) Diabetes Mellitus (DM)," Sep. 2016.

[10] R. M. Setiawati, "Pengaruh variasi komposisi tanaman delima (Punica granatum linn) terhadap sifat fisis membran komposit untuk menangkap radikal bebas asap rokok," Nov. 2014.

[11] M. Murniyati, W. A. Subaidah, and ..., "Formulasi Dan Uji Aktivitas Antiradikal Bebas Sediaan Gel Ekstrak Etanol Daun Bidara (Ziziphus mauritiana Lamk) Menggunakan Metode DPPH," *Lumbung Farm. J. ...*, vol. 2, no. 2, pp. 96–102, 2021, [Online]. Available: http://journal.ummat.ac.id/index.php/farmasi/article/view/5167.

[12] P. R. Suci, E. Purwanti, C. Ikhda, and N. Hamidah, "FORMULASI DAN UJI MUTU FISIK EKSTRAK DAUN BIDARA (Ziziphus mauritiana L .) PADA SEDIAAN LOTION," pp. 439–444, 2021.

[13] B. P. . Hansel T.T, *An atlas of chronic obstructive pulmonary disease*. london: Parthenon Publishing Group, 2004.

[14] H. R. Al Idrus, I. Iswahyudi, and S. Wahdaningsih, "UJI AKTIVITAS ANTIOKSIDAN EKSTRAK ETANOL DAUN BAWANG MEKAH (Eleutherine americana Merr.) TERHADAP GAMBARAN HISTOPATOLOGI PARU TIKUS (Rattus norvegicus) WISTAR JANTAN PASCA PAPARAN ASAP ROKOK," *J. Fitofarmaka Indones.*, vol. 1, no. 2, 2016, doi: 10.33096/jffi.v1i2.190.

[15] S. Tirtosastro and A. S. Murdiyati, "Kandungan Kimia Tembakau dan Rokok (Chemical Content of Tobacco and Cigarettes)," *Bul. Tanam. Tembakau, Serat Miny. Ind.*, vol. 2, no. 1, pp. 33–43, 2010, [Online]. Available: https://media.neliti.com/media/publications/53962-ID-kandungan-kimia-tembakau-dan-rokok.pdf.

[16] A. Phaniendra, D. B. Jestadi, and L. Periyasamy, "Free Radicals: Properties, Sources, Targets, and Their Implication in Various Diseases," *Indian J. Clin. Biochem.*, vol. 30, no. 1, pp. 11–26, 2015, doi: 10.1007/s12291-014-0446-0.

[17] A. C. Guyton and J. E. Hall, "Buku Ajar Fisiologi Kedokteran," 2007, Accessed: Dec. 08, 2021. [Online]. Available: http://r2kn.litbang.kemkes.go.id:8080/handle/123456789/77598.

[18] N. Kaplowitz, "Mechanisms of liver cell injury," *J. Hepatol.*, vol. 32, no. SUPPL.1, pp. 39–47, 2000, doi: 10.1016/s0168-8278(00)80414-6.

[19] T. Ramesh, C. Sureka, S. Bhuvana, and V. H. Begum, "Sesbania Grandiflora diminishes oxidative stress and ameliorates antioxidant capacity in liver and kidney of rats exposed to cigarette smoke," *J. Physiol. Pharmacol.*, vol. 61, no. 4, pp. 467–476, 2010.

[20] E. J. Norris, C. R. Culberson, S. Narasimhan, and M. G. Clemens, "The liver as a central regulator of hydrogen sulfide," *Shock*, vol. 36, no. 3, pp. 242–250, 2011, doi: 10.1097/SHK.0b013e3182252ee7.

[21] R. Zhu, Y. Wang, L. Zhang, and Q. Guo, "Oxidative stress and liver disease," *Hepatol. Res.*, vol. 42, no. 8, pp. 741–749, 2012, doi: 10.1111/j.1872-034X.2012.00996.x.

[22] D. F. Church and W. A. Pryor, "Free-radical chemistry of cigarette smoke and its toxicological implications," *Environ. Health Perspect.*, vol. VOL. 64, pp. 111–126, 1985, doi: 10.1289/ehp.8564111.

[23] D. Paleari, G. A. Rossi, G. Nicolini, and D. Olivieri, "Ambroxol: A multifaceted molecule with additional therapeutic potentials in respiratory disorders of childhood," *Expert Opin. Drug Discov.*, vol. 6, no. 11, pp. 1203–1214, 2011, doi: 10.1517/17460441.2011.629646.

[24] E. Roemer, R. Dempsey, and M. K. Schorp, "Toxicological assessment of kretek cigarettes: Part 1: Background, assessment approach, and summary of findings," *Regul. Toxicol. Pharmacol.*, vol. 70, no. S1, pp. S2–S14, 2014, doi: 10.1016/j.yrtph.2014.11.015.

[25] A. Mulyono and W. Sasmitaninghidayah, "Effectiveness of Catching Free Radicals in Cigarette Smoke with Biofilters Made from Bidara Leaf Powder," *J. Pendidik. Fis. dan Keilmuan*, vol. 7, no. 1, Jul. 2021, doi: 10.25273/JPFK.V7I1.9524.

[26] H. Horigome, Y. Hiramatsu, O. Shigeta, T. Nagasawa, and A. Matsui, "Overproduction of platelet microparticles in cyanotic congenital heart disease with polycythemia," *J. Am. Coll. Cardiol.*, vol. 39, no. 6, pp. 1072–1077, 2002, doi: 10.1016/S0735-1097(02)01718-7.

[27] C. S. Broberg *et al.*, "Blood Viscosity and its Relationship to Iron Deficiency, Symptoms, and Exercise Capacity in Adults With Cyanotic Congenital Heart Disease," *J. Am. Coll. Cardiol.*, vol. 48, no. 2, pp. 356–365, 2006, doi: 10.1016/j.jacc.2006.03.040.

[28] N. Abdurrahman, "PENGARUH TANAMAN LIDAH MERTUA (Sansevieria sp) SEBAGAI BIOFILTER TERHADAP GAMBARAN HISTOPATOLOGI TRAKEA PADA TIKUS PUTIH JANTAN (Rattus novergicus) GALUR Sprague dawley YANG DIBERI PAPARAN ASAP ROKOK," *Skripsi*, vol. 2, no. 1, pp. 1–55, 2019, [Online]. Available: http://www.scopus.com/inward/record.url?eid=2-s2.0-84865607390&partnerID=tZOtx3y1%0Ahttp://books.google.com/books?hl=en&lr=&id=2LIMMD9FVXkC&oi=fnd&pg=PR5&dq=Principles+of+Digital+Image+Processing+fundamental+techniques&ots=HjrHeuS_.