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Research Article
Effect of Merbau Wood Liquid Smoke (*Intsia bijuga*) in Correct Liver Cell Regeneration Mice (*Mus musculus*) Exposed to Boraks

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Abstract

Background and Objective: Borax is a toxic substance for cells, which can cause damage to liver cells resulting in the release of SGPT enzymes in the cytoplasm. One way to improve liver cells is by giving liquid smoke that has phenol compounds that play a role in inhibiting cell death. The purpose of this study was to determine the effect of Merbau liquid smoke in repairing liver cells and to reduce SGPT levels in mice. **Materials and Methods:** The design of this study used a post-test control group design with 30 samples of mice divided into 6 groups, namely K0 (Aquades), K1 (Borax), K2 (50 mg kg^{-1} BB), K3 (500 mg kg^{-1} BB), K4 (5000 mg/b.wt.) and K5 (15000 mg kg^{-1}). Liquid smoke was analyzed using GCMS. The effect of liquid smoke on liver cell regeneration was observed by a histopathological description of the liver and calculation of the number of liver cells and serum collection to see the level of SGPT. Statistical analysis using one-way ANOVA and continued with Dunmay test. **Results:** GCMS analysis results showed there were 17 compounds in Merbau liquid smoke consisting of phenols, furans, ketones and other compounds. In addition to the histological description, the average number of liver cells and SGPT levels indicate the administration of borax to cause cell damage following an increase in SGPT levels after being given liquid smoke. **Conclusion:** Liquid smoke can cause cell repair through cell regeneration and can reduce SGPT levels in mice.

Key words: Liquid smoke, wood Merbau, liver cell, cell regeneration, SGPT level, borax, cell death, histopathological

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Borax has the toxicity to humans, including developmental toxicity, neurotoxicity and nephrotoxicity. The degree of borax toxicity depends on the dose or concentration that the human received. The most sensitive endpoints of borax toxicity is developmental body toxicity[1]. Boron's content in borax which interacts with liver enzyme increases the amount of ROS (*Reactive Oxygen* Species), causes abnormalities in liver cell integrity so that gives rise to be giving a trace to the liver and trigger an inflammation response[2]. Toxicological tests have been carried out to see the side effects of borax including liver necrosis, acute kidney injury, neurological disorders of genotoxicity and nephrotoxicity[3,4]. Liver abnormality both macroscopically and microscopically is one of the impacts of the use of borax. Broadly speaking, borax is radical in the human body which causes oxidative stress. The oxidative stress caused by boron content in borax interacts with liver enzymes and increases the amount of ROS (Reactive Oxygen Species). ROS itself plays a role in the process of oxidative reactions and causes abnormalities in the integrity of liver cells, causing lesions in the liver and trigger an inflammatory response[2].

To overcome cell damage due to toxic substances then could use natural ingredients that have compounds which can fix cell performance or help cells to regenerate[5,6]. Many ingredients in nature may be utilized, one of which is obtained from plants. The compound composition in it varies greatly. The natural ingredients that may be directly used are managed and made in various products one of which is liquid smoke.

Liquid smoke is one of the results plant or wood pyrolysis at a temperature around 400°C[7]. Various types of wood may be used as basic ingredients in making liquid smoke. To get quality liquid smoke ought to use hardwood[8]. According to Chen and Lin[9], liquid smoke has excess. Namely (1) during the manufacture of liquid smoke, compounds are carcinogenic ie PAH (Polycyclic Aromatic Hydrocarbon) compounds may be removed, (2) the concentration of liquid smoke use may be regulated and controlled and the final product's quality becomes more uniform, (3) air pollution may be suppressed and (4) the liquid smoke is easier namely by soaked or spraying and mixed directly into the food.

Liquid smoke generally contains phenol, furan and ketone compounds. These compounds are obtained from pyrolysis results. This depends on the type of wood used. Liquid smoke use is rated good and safe for health[10]. Liquid smoke a combination of dregs sago and plant sago's bark has less strong antioxidant activity[11]. Furthermore, append eucalyptus liquid smoke can capture free radicals by DPPH method[12].

Merbau Wood with a scientific name *Intsia bjunga* and local name Ironwood is the name of a kind of high-quality hardwood-producing tree[13,14]. Types of *hardwood* many contain cellulose, lignin, dan hemicellulose. Merbau wood is one of the woods that has a high level of lignin[15]. If that compound undergoes pyrolysis so that will break down into phenol compounds[16]. Phenol compounds may act as hydrogen donors and effective in very small amounts to inhibit fat autoxidation[17]. Phenol compound donates hydrogen to free radicals so that inhibiting the chain reactions and reducing the oxidation process of unsaturated fatty acids with the inhibition of hydroperoxide formation at the propagation stage consequently oxidized compounds become neutral so that cell death may be avoided[18-20]. Proved phenol compounds given may reduce SGPT levels by a cut off a chain reaction from fat peroxidation and protein due to free radicals effect[21]. Thus sustainable cell damage may be prevented. This proves that the phenol compound has a role and an ability in cell regeneration which is also related to SGPT levels. Therefore, the purpose of this study was to determine the effect of merbau wood liquid smoke in repairing liver cells and to determine the decrease in SGPT levels in mice.

MATERIALS AND METHODS

Study area: The study lasted for 4 months, from August-November, 2018, with the following research locations: Making this liquid smoke was conducted at Fisheries Product Technology Laboratory, Faculty of Fisheries and Marine Science Pattimura University, Ambon-Maluku. Analysis of compounds with GCMS was carried out at the Organic Chemistry Laboratory, Faculty Mathematics and Natural Science Pattimura University, Ambon-Maluku. The SGPT levels observation was carried out at the Health Laboratory Center in Maluku Province and Observation of liver cell histology conducted at the Environmental Laboratory, Deep-Sea Research Institute in the Indonesian Institute of Sciences Ambon-Maluku.

Material: Merbau wood which used for making liquid smoke is 5 kg. Merbau wood liquid smoke that used for analysis is grade 1 by use GCMS. Mice that used on this research is male mice by average age 3 months as much as 30 rats with weight 30 g and grouped into 6 namely K0 (Aquades), K1 (Boraks), K2 (50 mg kg^{-1} BB), K3 (500 mg kg^{-1} BB), K4 (5000 mg kg^{-1} BB) and K5 (15000 mg kg^{-1} BB). This research was conducted for 16 days with 7 days of acclimatization period, 8 days of treatment and on the 16th-day liver was taken for making liver cell histology preparation with HE method and be calculated the number of liver cells and taking serum to see SGPT level.

Methodology: Merbau wood is inserted in the pyrolysis reactor with a constant temperature of 400°C, after that the condensation results are accommodated in the Erlenmeyer tube until it doesn't drip again. Then deposited for 24 h. After that, the supernatant is separated from deposition and distilled using soxhlet at a temperature of 125°C, furthermore, redistilled to get Merbau wood liquid smoke *Grade 1*. Making this liquid smoke was conducted at Fisheries Product Technology Laboratory, Faculty of Fisheries and Marine Science Pattimura University, Ambon-Maluku.

Analysis of compounds with GCMS was carried out at the Organic Chemistry Laboratory, Faculty Mathematics and Natural Science Pattimura University, Ambon- Maluku. 30 mL of liquid smoke was inserted into separating flask plus 10 mL of *Dichloromethane* then shaken out briefly and left for 1 h. Take the bottom fraction and insert it into Erlenmeyer, put in 10 mL of *Dichloromethane*, shaken out and left for 1 h. The bottom fraction was taking and added with the first and filtered with Whatman paper 42 and added $NaSO_4$. GCMS (QP2010S) optimized at an oven temperature of 100°C maintained for 4 min. The oven temperature was increased to 200°C with an increase in temperature of 20°C min^{-1} and maintained for 2 min. The oven temperature was increased to 300°C with an increase in temperature of 20°C min^{-1} which was maintained for 16 min (the injector temperature is 260°C and the temperature at the ion source is 230°C). This analysis uses helium gas with a purity of 99.99%. Gas pressure was set to 62.7 kPa. Liquid smoke was taken as much as 1 µL then injected. Analyze the molecular weight of 50.00-500.00 in 3-32 min.

Giving Borak to mice uses 23 mg of borax in 0.5 mL of equates per day[22]. Borax was weighed as much as 2,070 mg and measure equates as much as 45 mL. Put it into Erlenmeyer and shake. Then give to the mice orally as much as 0.5 mL for 3 days.

Furthermore, giving the liquid smoke was carried out as long as 5 days based on the prescribed dose group orally as much as 0.5 mL. After treatment with liquid smoke, hereafter, mice were killed for their liver and taking serum. This stage was conducted at the Zoological Laboratory Biology Department, Faculty Mathematics and Natural Science, Pattimura University, Ambon-Maluku.

Serum retrieval is done through the heart (*intra cardinal*) with the syringes as much ±1 mL. The blood that had been taken then inserted into a clean and dry tube and centrifuged at speed 3000 rpm for 10 min. A separate serum was taken and inserted in another tube that was cleaned and dry and covered. Serum mixed with *reagent kit* at temperature 25/30. The serum was taken as much as 200 microliters and *reagent kit* as many as 1000 microliters. After homogeneous read the absorbance at min 1, 2 and 3 using a spectrophotometer with a wavelength of 334 nm. The results of SGPT activities were expressed in units/liters (U L^{-1}). The SGPT levels observation was carried out at the Health Laboratory Center in Maluku Province. Hereinafter, the liver was washed and fixed using 4% formalin. Subsequently, liver histology prepared was made according to procedure[23]. Furthermore, calculate the mean weight score of liver histopathology changes from five fields of view from each mice Skoring Histopathology Manja Roenigk (Table 1). Observation of liver cell histology conducted at the Environmental Laboratory, Deep-Sea Research Institute in Indonesian Institute of Sciences Ambon-Maluku.

Table 1: Degree assessment criteria liver histology models Skoring Histopathology Manja Roenigk

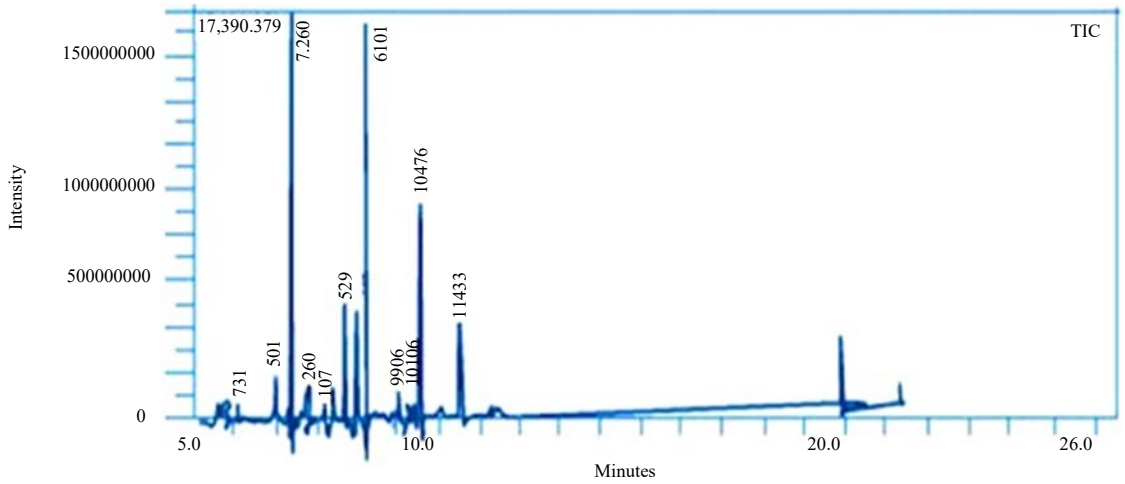
Change level	Grade	Criteria
Normal	1	Polyhedral shape
		Cell nucleus in the middle
Degeneracy Parenkimatosa	2	Cloudy cytoplasm
		Cell swelling
Degeneracy Hidropik	3	There are many vacuoles, limpid and small
Necrosis	4	Black cell nucleus
		Hepatocytes shrink

Source: Sativani[24]

Statistical analysis: Observational data obtained then analyzed using the descriptive analysis to explain the content to Merbau wood liquid smoke grade 1 and histopathology description in mice after giving Merbau wood liquid smoke. For data on the average number of mice liver cells and SGPT level conducted normality test and homogeneity test if data meets the requirements ($\alpha = 0.05$) hereinafter done by test one way ANOVA. If there is a significant value $p<0.05$, then continued with Dunmay's further test. Data was displayed in the form of Mean±Standard Deviation (SD).

RESULT

The results of GCMS analysis obtained chromatogram data which showed that there are 17 compounds identified in the Merbau wood liquid smoke which may be seen in Fig. 1. These compounds consist of phenol compounds namely *p-Phenolsulfonic acid* (23.96%), 2-methylphenol (7.05%), 3-methylphenol (6.78%), Guaiacol (22.90%), 2,3-dimethylphenol (1.86%), 2-ethylphenol (1.21%), 4-methoxy-3-methylphenol (12.65%) and 4-ethyl-2- methoxyphenol (5.91%). Furan namely 2-methyltetrahydrofuran (0.83%), 5-methylfuran-2-carboxaldehyde (2.75%) and tetrahydro-2-methyl-2-furanol (2.07%). Ketone i.e., 4-methyl-3-pentanone (1.48%), 2,3-



Peak Report TIC

Peak	R.Time	I.Time	F.Time	Area	Area (%)	Height	Height (%)	A/H name
1	5.713	5.675	5.942	3121227	1.60	605043	083	515
2	6.889	6.825	6.942	6784354	3.48	1997567	275	339
3	6.979	9.942	7.067	3815620	1.96	1076085	148	354
4	7.266	7.208	7.292	40483027	20.96	17388447	2396	235
5	7.622	7.592	7.683	3566152	1.83	1302205	179	273
6	7.712	7.683	7.817	4526498	2.32	1499337	207	301
7	1.097	8.067	8.203	3485865	1.79	800891	110	435
8	1.290	8.208	8.425	5926622	3.04	1690676	233	350
9	1.554	8.517	8.617	11292463	5.79	5117352	706	220
10	8.890	8.825	9.050	14166414	7.62	4919185	678	302
11	9.103	9.050	9.142	37570901	19.26	16616414	2290	226
12	9.181	9.142	9.242	3740853	1.92	922715	127	105
13	9.906	9.817	10.000	5329589	2.73	1349174	186	395
14	10.160	10.083	10.217	3557317	1.82	876188	121	405
15	10.476	10.433	11.400	23911579	12.26	9179723	265	260
16	11.453	11.400	11.517	8668549	4.44	4291364	319	201
17	20.711	20.650	22.067	14009674	7.18	2932119	404	477
				195057104	100.00	7254485	100.00	

Fig. 1: Merbau wood liquid smoke chromatogram

Phenol compounds were found in the amount of 78.27. These compounds consist of phenol compounds namely p-Phenolsulfonic acid (23.96%), 2-methylphenol (7.05%), 3- methylphenol (6.78%), Guaiacol (22.90%), 2,3-dimethylphenol (1.86%), 2-ethylphenol (1.21%), 4-methoxy-3-methylphenol (12.65%) and 4-ethyl-2-methoxyphenol (5.19%)

Dimethyl-2-cyclopenten-1-one (2.33%), 2-hydroxy-3-methyl-2-cyclopenten-1-one (1.1%) and 4,5-dimethyl-4-hexen-3-one (1.27%). Other organic compounds as 2,5-Dimethyl-2-Hexene (1.79%) and also one of the compounds identified plasticzer namely Dioctyl phthalate (4.04%).

Furthermore, histopathological observations showed changes in each treatment group (Fig. 2). K0 in this study reveals histopathology in normal conditions. While K1 shows a picture of the hepatocyte cells which run into damaged by giving borax. In K2, hepatocyte cells are still damaged and there are cells that run into necrosis. However, in the treatment of K3, K4 and K5 the hepatocyte cells have been repaired.

From observational data, then analyzed and obtained the average number of cells in each treatment group (Table 2).

Table 2: Average number mice liver cell after giving merbau wood liquid smoke (*Intsia bijuga*)

Treatment	Mean (U L^{-1}) ±SD
K0	73.2 ± 6.30079^{ab}
K1	119.2 ± 1.1144^{e}
K2	109.4 ± 5.17687^{dc}
K3	100.6 ± 7.23187^{d}
K4	79.8 ± 5.80517^{abc}
K5	70.4 ± 1.13710^{a}

K0: Aquades, K1: Boraks, K2: 50 mg kg^{-1} BB, K3: 500 mg kg^{-1} BB, K4: 5000 mg kg^{-1} BB and K5: 15000 mg kg^{-1} BB, *The different superscript reveals significant differences in confidence levels 95% ($p<0.05$) based on ANOVA tests, continued by Dunmay's tests

The highest average number of cells has found in group K1 where the liver cells show the highest damage. While the lowest is in K5 which shows a decrease in the amount of damage which means the occurred cell repair.

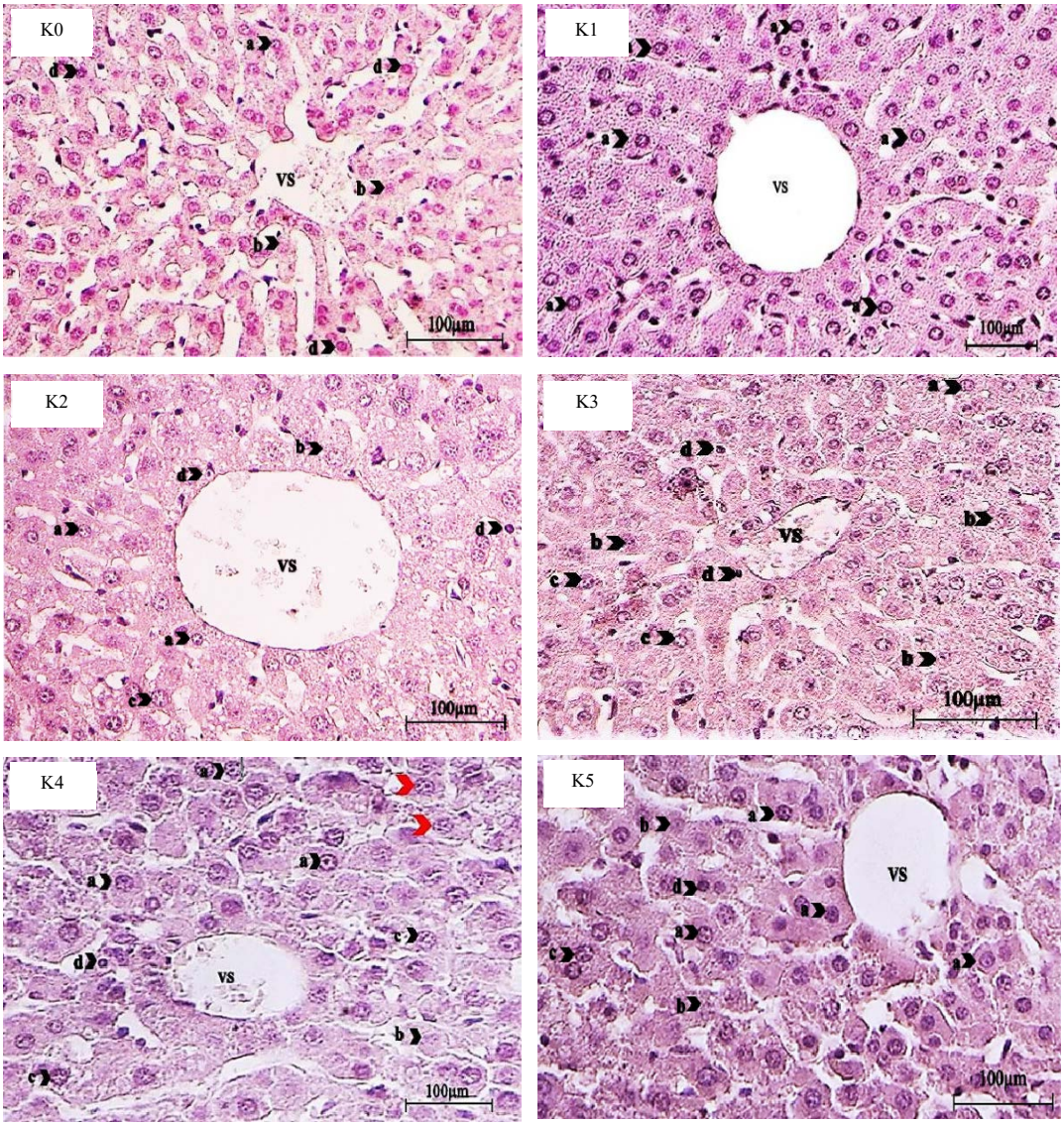


Fig. 2: Mice liver cell histology picture after giving Merbau Wood liquid smoke

K0: Negative control, K1: Positive control, K2: 50 mg kg^{-1} BB, K3: 500 mg kg^{-1} BB, K4: 5000 mg kg^{-1} BB and K5: 15000 mg kg^{-1} BB, (a) Normal hepatocyte cells, (b) Parenchymatic degeneration, (c) Hydropic degeneration (d) Necrosis and (vs) Central veins, (red arrows) with two-core cells

Table 3: Average of SGPT levels in mice in each treatment group

Treatment	Mean (U L^{-1}) ±SD
K0	99.2±2.16795^{a}
K1	117.0±3.00000^{cde}
K2	119.8±1.48324^{dc}
K3	115.0±9.13783^{cd}
K4	113.4±3.57771^{c}
K5	100.0±1.5114^{ab}

K0: Aquades, K1: Boraks, K2: 50 mg kg^{-1} BB, K3: 500 mg kg^{-1} BB, K4: 5000 mg kg^{-1} BB and K5: 15000 mg kg^{-1} BB, *The different superscript reveals significant differences in confidence levels 95% ($p<0.05$) based on ANOVA tests, continued by Dunmay's tests

Table 2 shows K0 is significantly different from K1, K2 and K3. While K1 is significantly different from K0, K3, K4 and K5. On the treatment, K2 was significantly different from K0, K4 and K5. For the dose, K3 is significantly different from K0 and K1 as well as treatments K4 and K5. K4 and K5 are significantly different from K1, K2 and K3. Furthermore, the SGPT levels were examined. The results of the examination showed a decrease in SGPT levels between the groups shown in Table 3.

The Table 3 shows the differences in each treatment group. For K0 and K5, it is significantly different from K1, K2, K3, K4. While K1 and K4 are significantly different from K0 and K5. The K2 treatment is significantly different from K0, K4 and K5. The K3 treatment is significantly different from K0 and K5.

DISCUSSION

Compounds with high concentrations are *p-Phenolsulfonic* acid and *Guaiacol* compounds. While compounds that have low concentrations are 2-methyltetrahydrofuran compound. The compounds in liquid smoke from merbau wood have benefits in cell mechanisms as a giver of taste including 2-methoxyphenols or Guaiacol from Eucalyptus pyroligneous may inhibit lipid peroxidation. 2-Methylphenol and 3-Methylphenol compounds are flavoring compounds. 2,3-dimethylphenol, 2-ethylphenol, 4-Ethyl-2-methoxyphenol, 5-Methyl-2-furaldehyde and 2-hydroxy-3-methyl-2-cyclopenten-1-one as a scent giver. 4-Methoxy-3-methylphenol and 2-hydroxy-3-methyl-2-cyclopenten-1-one which may be used as bio-oil[25,26].

Furthermore, one of the Plasticzer compounds was identified, Dioctyl phthalate. These compounds are not compounds derived from organic materials. So that it is able to say not to come from liquid smoke Merbau wood. During the packaging and storage process, there may be a migration of the packaging plastic from the packaging to the packaged material. Moving material can be in the form of polymer residues (monomers), catalysts or other additives such as fillers, stabilizers, plasticizers and colorants[27]. The results of a study conducted by Carlos *et al.*[28], who investigated fifty-six different samples of food packaging and food processing materials available on the market, found that nine different plasticizers including three phthalates, diethylhexyl phthalate (DEHP), diisononyl phthalate (DINP) and diisodecyl phthalate (DIDP), were identified in the product being tested. The concentration of plasticizer ranges from 1- 53% depending on the type of food contact material and the type of plasticizer.

In the study, on negative controls using distilled water, the study result showed normal liver histology. Normal liver histology has hepatocyte cells in the state of the cell nucleus in the middle, clear and polyhedral cell form. K1 was a positive control using borax shows cells in the liver are experience damaged marked by the number of cells that experience necrosis compared to other treatments. If the liver is continuously exposed to drugs and chemicals for a certain period, the liver cells can experience changes, especially in fat degeneration and necrosis such as hepatocyte cell damage. According to Andreas *et al.*[29]. Hepatocyte damage caused by administering chemicals allegedly due to oxidative stress. In experimental animals exposed to chemicals, there is a decrease in endogenous free radical binding enzymes. Contini *et al.*[30] reported that chemicals induce lipid membrane peroxidation and will continuously form reactive oxygen species (ROS) which cause lipid peroxidation. Lipid peroxidation causes damage to cell membranes and results in abnormal cell structure and damage to cell function.

Liver cell damage in K1 was caused by the boron content in borax which interacts with liver enzymes and increasing the number of ROS (Reactive Oxygen Species) so that the inflammation occurs in the cell. Parenkimatosa degeneration in cells caused cells to look cloudy, this is caused by borax which made the cell buried by protein sediment. In addition, cells also experience hydropic degeneration which was characterized by cell swelling and containing water. Cells that experience hydropic degeneration may be said to experience a more severe degree of damage compared to parenchymatic degeneration. Desprinita[31] put forward that this occurs because of metabolic disorders like hypoxia or chemical poisoning.

The accumulation of toxic materials such as borax results in cell degeneration. Substances that have toxic properties will cause interference with mitochondrial organelles in producing energy Adenosine Triphosphate (ATP) so that ATP production decreases. The decline in ATP production interferes with Na+ pump function on the plasma membrane so that water and Na+ enter the cell. The organelles in cells also swell, degeneration occurred[32]. In K1 treatment, it was found that many cells experienced necrosis, the highest has marked by a black cell nucleus and hepatocytes shrink. Cells that experience necrosis indicates the response to an oxidative reaction that enters in the cell[33].

In the treatment of K2 shows the histological picture of mice liver cells still experience damaged with being found cells that experience parenchymal degeneration, hydropic degeneration and necrosis. In addition, the central vein is fatty. Furthermore, the K3 treatment shows cell in fat is reduced. But there are still cells that experience parenchymatous degeneration, hydropic degeneration and necrosis. Normal cells begin to increase in number compared to K2. The K4 treatment shows cell begins to experience repairs, the average number of cell is nearing the cell number in treatment K1. Furthermore, in the K5 treatment with the highest dose in this study showed cell repair occurs and there are regenerated cells characterized by cells having large nuclei and binucleates. Regeneration that occurs in treatment K5 because the liver cell can repair themselves caused there is GSH (Glutathione). The cell regeneration that occurred indicates that the active cell in mitosis.

Giving liquid smoke repairs cell damage. This is likely to occur because phenol compounds interact in proteins or enzymes contained in liver cells. Borax that enters in the mice's body causes cell damage because it is toxic. Cell membranes that are mostly composed of lipids and proteins attacked by compounds from borax so that forming peroxide lipid compounds. As a result, the cell membrane becomes damaged. Damage to the cell membrane makes the cell metabolic process disrupted. Cells are experienced gradually damaged from parenchymatic degeneration, hydropic degeneration until to necrosis.

Phenol compounds break the radical chain so that the bond becomes neutral or stable again and no lipid peroxide process continues at the propagation stage. Sharma and Shukla[34] added cell repair may occur by destroying free radicals, provide competitive substrates for unsaturated lipids in membranes and or accelerate repair mechanism of damaged cell membranes. In other words, ROS is attenuated by phenol compounds present in Merbau wood liquid smoke inhibits lipid peroxidation and repairs cells that experience minor damage.

High and low levels of SGPT were affected by the presence or absence of damage that occurs in hepatocyte cells so that by itself there is an occurring increase in SGPT levels in blood serum[35]. The highest SGPT level was found in treatment with K1 (117 U L^{-1}) dan K2 (119 U L^{-1}). This is due to a large amount of cell damage that occurs in the treatment. Even thus the K3 treatment is the same, the rate of SGPT levels reached 115 U L^{-1}. This is because at this dose cell damage is found. For K4 treatment the value of the SGPT level is still relatively high amounting to 113 U L^{-1} this is because at doses there was found little damage to the liver cells so that affected the value of the SGPT level. Furthermore, the SGPT level value for K5 amounting to 100 U L^{-1} almost close to the SGPT level value on K0 that use aquades namely 99.2 U L^{-1}. The decrease in SGPT levels is due to on treatment K5 namely liquid smoke dosage 15000 mg kg^{-1} BB, cells have been repaired.

Phenol compounds in Merbau wood liquid smoke and its activity in liver cells which may decrease and repair cell damage accompanied by a decrease in SGPT levels in the blood. Phenol compounds reduce ROS and trigger GSH thereby reducing oxidative stress which then causes changes in mitochondrial transmembrane potential. That changes cause the GPT enzyme production activity in the blood to decrease. This is proven by Surya *et al.*[21] in his research that compounds that have phenol groups may reduce SGPT levels by break off the chain reaction from fat peroxidation and protein due to the effects of free radicals so that cell damage to experience necrosis may be prevented.

CONCLUSION AND SUGGESTIONS

Compounds found in Merbau wood liquid smoke consist of phenol, furan ketone and other organic compounds. Merbau wood liquid smoke may help regenerate liver cells and reduce SGPT levels in mice exposed to borax. The results of this study also need to be continued by being applied to food to knowing its ability as antibacterial.

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SIGNIFICANCE STATEMENT

This study found that the Merbau wood liquid smoke had compounds with high concentrations, namely p-phenolsulfonic acid and Guaiacol compounds, while compounds with low concentrations were 2-methyltetrahydrofuran compounds. The compounds in Merbau wood liquid smoke have many benefits, among others in the cell mechanism as a flavoring, flavoring in food and as a bio-oil. This study will help researchers to uncover the a critical area of the question of why fish are burned using Merbau wood, fish meat is far more savory and tastier than using other wood. Besides giving the fish its aroma, the phenol compound in Merbau wood liquid smoke and its activity in liver cells can repair damaged cells marked by a decrease in SGPT levels in the blood, these results cannot be explored by many researchers.

Thus, a new theory of the effects of Merbau liquid smoke and its role in improving liver cell regeneration and being able to reduce SGPT levels, may be arrived at.

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