SGOT and SGPT level of Wistar rat after the administration of Channa micropeltes extract

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ABSTRACT
Channa micropeltes is a local peatland water species which has been utilized as an alternative of Channa striata among South Kalimantan population to anticipate the scarcity of Haruan species. Channa micropeltes originate from the same family of Channa striata in which both fishes contain albumin. Albumin is proven to accelerate wound healing, thus can be produced as capsules. The capsule form of Channa micropeltes extract will later be deployed as an alternative herbal medicine for the acceleration of mucosal wound healing. Nevertheless, a study of a hepatological profile is pivotal to assess the safety of its consumption. The present study aimed to analyze the effect of Channa micropeltes extract capsules oral administration at 0.7 g dosage on SGOT and SGPT level of Wistar rat liver. This was a real experimental study with post-test only and control group design. The samples comprised of 12 rats which were distributed into three groups namely a treatment group of 0.7 g Channa extract capsule, a positive control group of 0.7 g Channa striata extract and a negative control group without any treatment for 28 days. The level of SGOT and SGPT were 19.41 IU/L and 29.52 IU/L in Channa micropeltes treatment group, 31.95 IU/L and 28.71 IU/L in the positive control group of 0.7 g Channa striata extract, 25.07 IU/L and 18.90 IU/L in the negative control group. Hence, there is no effect of Channa micropeltes extract capsule oral administration at 0.7 g dosage on SGOT and SGPT level of Wistar rat liver.

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INTRODUCTION
Channa striata (Haruan fish) is one of the local peatland species (Huwoyon and Gustiano, 2013). Majority of South Kalimantan society believe that Channa striata consumption may accelerate wound healing process due to the albumin content. Albumin is the highest protein to be found in plasma which reaches 60%, and it may accelerate wound healing process by the presence of antioxidant property (Nicodemus et al., 2014); (Alamsjah et al., 2014); (Agustin et al., 2016). Channa striata capsule at a 0.7-gram dosage which may accelerate wound healing process has
been widely distributed (Tawali et al., 2012). However, the high price and the complexity of Channa striata cultivation emerge the necessity for alternative species such as Channa micropeltes (Toman fish) (Audina et al., 2018).

Channa striata and Channa micropeltes originate from the same family, Channidae. Channa micropeltes is notable for its albumin content which is 5.35%, while Channa striata are reported to contain 4.53% albumin only. Channa micropeltes contains omega-3 fatty acid, omega-6 fatty acid and zinc (Firlianty, 2016); (Fajriani et al., 2018). In a study conducted by (Nicodemus et al., 2014), Channa micropeltes at 16 mL/kg BW dosage may accelerate wound healing process in the absence of chronic disease with 97.21% wound healing rate (Nicodemus et al., 2014).

Channa micropeltes may be produced in the form of a capsule and be used as an alternative herbal drug to accelerate wound healing of the oral mucosa. Yet, a further study of its safety is required to analyze the toxicity prior its consumption. One of the toxicity analysis used is a sub-chronic toxicity test (Hulla et al., 2014). This test should be performed for 28-90 days to identify hepatotoxicity effect by observing the influence of a compound toward the change in Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) level of the liver (Singh et al., 2011); (Wahyuni et al., 2017). The liver is the main organ for drug metabolism. Several drugs may induce the destruction of the liver cell due to hepatotoxic property (Indahsari and Histopatologi, 2017). Hepatotoxicity term refers to liver dysfunction due to over-dosage of drugs or xenobiotic (Singh et al., 2011).

Serum Glutamic Oxaloacetic Transaminase (SGOT) is an enzyme found inside the body which immediately detected in peripheral circulation when necrosis occurred in a tissue. SGOT enzyme is commonly found in cardiac and liver, while Serum Glutamic Pyruvic Transaminase (SGPT) is frequently detected in the liver and effectively diagnosed the presence of hepatocellular destruction. This enzyme will be secreted by the liver when there is a destruction of liver cells which is depicted in the increase of SGPT level in blood plasma (Nasution et al., 2015); (Qodriyati et al., 2016). SGOT and SGPT level test should be performed to identify the presence of liver abnormality or destruction due to drug consumption. Average SGOT level is 6-30 IU/L while normal SGPT level is 6-45 IU/L (Nurminha and Gambaran, 2013); (Reza and Rachmawati, 2017). When SGOT and SGPT level is higher than normal, necrosis of hepatocytes in the liver can be detected. The increase in both enzymes level will indicate that the compound should not proceed for further production as an alternative drug (Sari et al., 2015). Based on the background above, it is pivotal to conduct this study to analyze the effect of Channa micropeltes extract capsule at 0.7 gram dosage per oral upon the level of SGOT and SGPT of Wistar rat liver.

| Table 1: Formulas of Channa striata Extract Capsule at 0.7 gram dosage | Composition | Unit | Total |
| --- | --- | --- | --- |
| Protein | % | 85.85 |
| Total lipid | % | 4.48 |
| Water level | % | 4.61 |
| Ash level | % | 4.47 |
| Calsium | Mg/100g | 178.91 |
| Phosphor | ppm | 7584.68 |
| Magnesium | Mg/100g | 137.35 |
| Zinc | ppm | 26.06 |
| Iron | ppm | 154.39 |
| Vitamin A | Mcg/100g | 30.1 |
| Vitamin B2 | Mcg/100g | 0.69 |
| Vitamin E | Mg/100g | 2.52 |
| Vitamin D3 | Mcg/100g | 14.92 |
| Vitamin B12 | Mcg/100g | 1.08 |
| Aspartat | ppm | 76625.61 |
| Glumat | ppm | 104485.93 |
| Serine | ppm | 27022.51 |
| Glisine | ppm | 59350.12 |
| Histidine | ppm | 36982.73 |
| Arginine | ppm | 93522.03 |
| Threonine | ppm | 45575.86 |
| Alanine | ppm | 39367.7 |
| Proline | ppm | 39031.92 |
| Valine | ppm | 43852.14 |
| Methyonine | ppm | 28142.51 |
| Isoleusine | ppm | 39383.8 |
| Leusine | ppm | 70774.16 |
| Phenylalanine | ppm | 48371.51 |
| Lysine(Lysine HCl) | ppm | 66262.24 |
| Tyrosine | ppm | 32376.36 |
| Triptophane | ppm | 6358.88 |
| Oleicacid/Ω9 | % | 0.8567 |
| Linoleic acid/Ω6 | % | 0.1417 |
| Ω3 | % | 0.0092 |
| (Doxosahexaenoic acid) |
Figure 1: Graphic of SGOT dan SGPT level mean value in Wistar rat (A: Negative control; B: Positive control of Channa striata extract capsule at 0.7 gram dosage; C: Treatment group of Channa micropeltes extract capsule at 0.7 gram dosage)

Table 2: Formulas of Channa micropeltes extract capsule at 0.7 gram dosage

| Component             | Formula | Function     |
|-----------------------|---------|--------------|
| Channa micropeltes    | 700 mg  | Active compound |
| dried extract         |         |              |
| Aerosil               | 30 mg   | Adsorbent    |
| Talk                  | 20 mg   | Gidlan       |
| Mg. Stearat           | 10 mg   | Lubricant    |
| Amilum                | 260 mg  | Filler       |
| Total weight          | 1000 mg |              |

MATERIALS AND METHODS

This was an actual experimental study with post-test only and control group design. The ethical clearance was obtained from the Ethics Committee of Health Research, Faculty of Dentistry, Universitas Lambung Mangkurat No 160/KEPKG-FKGULM/EC/1/2019. The study sample comprised of male Wistar rat age 6-8 weeks with 200-300 gram BW.

At the beginning of the study, the experimental animal was adapted at the animal laboratory of Veterinary Centre (BVET) Regional V Banjarbaru for seven days by feeding them with BR2 and aqua dest ad libitum. A total of 12 rats were divided into three treatment groups, with four rats presented in each group. The groups comprised of negative control without given any treatment, positive control with the administration of Channa striata extract at 0.7 gram dosage and treatment group with the administration of Channa micropeltes extract capsule at 0.7 gram dosage. The administration of drugs was performed for 28 days each morning and noon per oral using a nasogastric tube.

Channa micropeltes extraction

Channa micropeltes was obtained from traditional market Martapura, Kalimantan Selatan, and used in this study had a total weight of 11 kg. The part utilized for the study was the flesh of Channa micropeltes. The extract was made at Pharmaceutical Laboratory, Faculty of Mathematics and Science ULM. Fish was cleaned from scale, blood, head and guts.

Table 3: The results of Bonferroni test on SGOT and SGPT level of Wistar rat

| GROUP | A   | B     | C     |
|-------|-----|-------|-------|
| SGOT  |     |       |       |
| A     | -   | 0,011*| 1,000 |
| B     | 0,011*| -      | 0,017*|
| C     | 1,000 | 0,017*| -     |
| SGPT  |     |       |       |
| A     | -   | 0,421 | 0,968 |
| B     | 0,421| -      | 1,000 |
| C     | 0,968| 1,000  | -     |

*: Significantly different (p<0.05)
A : Negative control  
B : Positive control of Channa striata extract capsule at 0.7 gram dosage  
C : Treatment group of Channa micropeltes extract capsule at 0.7 gram dosage
and the flesh were later weighed at 9.84 kg. The flesh was steamed inside a pan for 30 minutes under 70-80°C temperature. Light yellow liquid was secreted from the flesh to be collected and separated in a total of 750 ml. Channa micropeltes flesh was later covered with flannel fabric and Whatman paper no 1 to be inserted into a hydraulic press for pressing. Channa micropeltes extract was then put into a reaction tube as much as 7.5 ml and centrifuged for 15 minutes on 6000 rpm speed. The supernatant liquid was collected from the centrifuged extract. A total of 700 ml of liquid was obtained to be separated from 50 mL sedimentation. Further, Channa micropeltes extract was evaporated in a rotary evaporator for 8 hours until thickened. The extract was evaporated a second time in a water bath until dried in the form of granules.

**Channa striata extract capsule**

In this study, the capsule of 0.7 gram Channa striata extract distributed in the market was employed. Below presents the formulation of 0.7 gram Channa striata extract capsule is shown in Table 1.

**Formulation of Channa micropeltes extract capsule**

Dried Channa micropeltes extract was inserted into a mortar and mixed with aerosol, talk, Mg stearate and amyllum. All compounds were crushed using stamper until homogenous. Granules were then weighed using an analytical scale and put on a parchment to be inserted inside a gelatinous capsule shell. The capsule was then stored inside dark bottle glass. Formulas of Channa micropeltes extract capsule are presented in Table 2 (Nurani et al., 2017).

**Animal treatment**

Experimental rats were randomly selected and were administered with standard dosage given orally for 28 days every morning and noon. Calculation of the dosage was obtained from human dose, which is converted by multiplying it with 0.018 (Togubu et al., 2013). The capsule of Channa micropeltes extract was divided into two in which one capsule contained 500 mg granules. Thus, a dosage conversion for rat obtained: 500 mg x 0.018 = 9 mg/g BW. One capsule of 0.7 gram Channa striata extract in a weight of 750 mg might present a conversion of dosage as 750 mg x 0.018 = 13.5 mg/g BW.

These were the treatment given for each group: Group A (negative control) in which four rats given BR2 feed for 28 days each morning and noon; Group B (positive control) in which four rats given Channa striata extract capsule at 13.5 mg/g BW dosage dissolved in aqua dest for 28 days every morning and noon using nasogastric tube; Group C (treatment group) in which four rats given Channa micropeltes extract capsule at 9 mg/g BW dosage dissolved in aqua dest for 28 days every morning and noon using nasogastric tube.

**Collection of blood plasma**

On day 29, rats were sacrificed to collect their blood. Each rat was sacrificed by putting it in a container of cotton fumed with 5 ml diethyl ether. The container was covered tightly so that the diethyl ether would not evaporate. After waiting for several minutes until the rat was unconscious, blood was then obtained by an intracardial technique using a syringe. Blood was centrifuged until blood plasma was secreted. Plasma was then separated into a microtube.

**Identification of SGOT and SGPT level**

SGOT and SGPT analysis was conducted at Toxicology Laboratory of Veterinary Centre (BVET) Regional V Banjarbaru with IFCC methods and interpreted using Genesis 20 spectrophotometry with 365 nm wavelength. Blood plasma mixed with reagent kit under 37°C room temperature. Blood plasma was mixed in a total of 100 μL with a reagent kit in a total of 1000uL. After mixed homogenously, absorbency was observed in minute 1, 2 and 3. Data were presented in the result of absorbance (A). Thus, the result of SGOT and SGPT level activity (IU/L) should be obtained by multiplying the average subtraction from absorbance (A) minute 1, 2 and 3 with 3235 factors. The measurement of activity employed this formula:

\[
\left\{ \frac{((\Delta A \text{ minute 1 and 2}) + (\Delta A \text{ minute 2 and 3}))}{2} \right\} \times 3235
\]

The result then would be input to computer software SPSS 23.0 for Windows.21

**Statistical analysis**

Data were analyzed using Saphiro-Wilk test and then proceeded into variance homogeneity test of Levene’s. It was revealed that the data were normally distributed and homogenous (p>0.05) thus Oneway ANOVA parametric test with a 95% confidence level (α=0.05) was performed. Data analysis was then followed by Post-Hoc Bonferroni test.

**RESULTS AND DISCUSSION**

Average SGOT level is 6-30 IU/L, while normal SGOT level is 6-45 IU/L. Graphic of SGOT dan SGPT level mean value in Wistar rat is presented in Figure 1. Based on Figure 1, it can be concluded that the average value for SGOT and SGPT level in group A, B and C are at a normal level. Data were then examined using Saphiro-Wilk and Levene’s Test,
which resulted in normal distribution and homogeneity among three groups (p>0.05). Data were further analyzed using one-way ANOVA test and a significant value obtained for SGOT level was 0.006 (p<0.05) while SGPT level was 0.308 (p>0.05) thus presenting a significant difference between each treatment. Data were then continued with Post-hoc Bonferroni analysis which can be observed in Table 3.

Serum Glutamic Oxaloacetic Transaminase (SGOT) and Serum Glutamic Pyruvic Transaminase (SGPT) enzyme are two enzymes which may detect the destruction of liver cell (Nasution et al., 2015). In this research, there is no significant difference between the SGOT level of negative control and Channa micropeltes extract treatment group. Hence, as between positive control of Channa striata extract group and Channa micropeltes extract treatment group. This reveals that Channa striata extract may increase the SGOT level but still in the normal range; thus, no toxicity effect resulted in the liver. No significant difference was observed on the impact of Channa striata, and Channa micropeltes extract toward SGPT level among all groups, which describes that Channa striata and Channa micropeltes extract do not induce hepatocellular destruction.

Channa micropeltes (Channa micropeltes) contains omega-3 fatty acids, omega-6 fatty acid, zinc, vitamin C and albumin (Nicodemus et al., 2014; (Firlianty, 2016); (Irwanda et al., 2015). Albumin content in Channa micropeltes reaches 5.35% (Fajriani et al., 2018). This albumin content will undergo distribution and metabolism (Throop et al., 2004). At a metabolic stage, albumin is synthesized at the liver cell, specifically hepatocytes, and it is converted into preproalbumin (Arroyo et al., 2014). Preproalbumin will then be imported into the endoplasmic reticulum, and fission of N-terminal prepropeptide will present as it is assisted by serine protease to be released into interstitial of the liver; sinusoid and liver vein (Arroyo et al., 2014); (Kebamo and Tesema, 2015). The aerobe route of albumin metabolism in the liver cell will form a by product of oxygen molecules which is classified as Reactive Oxygen Species (ROS) (Lee and Wu, 2015); (Li et al., 2015). Albumin possesses the antioxidant property to bind free radical produced by ROS and stimulate antioxidant enzyme such as superoxide dismutase (SOD) through the activation of nuclear factor-erythroid-2 related factor 2 (NRF2) (Widayati et al., 2012); (Ma, 2013); (Cahyani and Rustanti, 2015). NRF2 functions as the first defence against oxidative stress in the cytoplasm. Unless induced by the presence of oxidant and electrophile, NRF2 will be presented in the inactive form (Vriend and Reiter, 2015); (Layal, 2016). It will bind with receptor molecule such as Kelch like ECH association protein 1 (Keap1) and later formulate NRF2-Keap1 complex. In the presence of an oxidant, Nrf2 will be translocated to the nucleus and will form Antioxidants Response Element (ARE) and will be able to stimulate antioxidant enzyme activity such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GPx) which can neutralize ROS component (Widayati et al., 2012); (Vriend and Reiter, 2015).

The increase of superoxide dismutase (SOD) level has a role against free radical inside mitochondria by inducing or changing anion peroxide (O2−) into hydrogen peroxide (H2O2), a form of free radical (Widayati et al., 2012); (Fukai and Ushio-Fukai, 2011). Hydrogen peroxide (H2O2) will then be transformed into water (H2O) and oxygen (O2) by GPx and CAT (Tsutsui et al., 2011); Werdhasari, 2014; (Qu et al., 2016). The decrease of intracellular or extracellular ROS level will affect the biochemical process, including the protection against microorganisms and the function of the liver cell. When ROS decrease, the occurrence of oxidative stress can be prevented. Thus liver cell remained living and freed from radical (Hardiningtyas et al., 2014). Liver cells which are free from radical will halt cell destruction. Thus, SGOT and SGPT enzyme as identifying marker for cytoplasm and mitochondria destruction in the liver cell will be presented in the normal level (Rachmawati and Ulfa, 2018); (Giannini, 2005).

Channa micropeltes contains several hepatoprotective compounds other than albumins, such as zinc, omega-3 fatty acid and vitamin C. Omega-3 fatty acid is proven to heal liver injury, stabilize and also decrease SGOT and SGPT level (Sukarsa and Studi, 2004); (Chavan et al., 2013). Zinc is shown to reduce SGOT and SGPT level, thus deflate liver cell destruction effect (Unsal et al., 2008). Vitamin C possesses an antioxidant property which depicts a hepatoprotective effect by binding free radical, which decrease oxidative stress in the liver cell (Sabiu et al., 2015).

CONCLUSIONS

It can be concluded from this study that there is no effect of Channa micropeltes extract capsule at 0.7-gram dosage per oral upon SGOT and SGPT level changes in Wistar rat liver. This result should be deployed as the foundation of Channa micropeltes extract capsule development as an alternative herbal drug to accelerate wound healing of the oral mucosa with no destructive effect upon the liver.
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Conflict of Interest

The authors declare that they have no conflict of interest for this study.

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REFERENCES

Agustin, R., Dewi, N., Rahardja, S. D. 2016. Efektivitas Ekstrak Ikan Haruan (Channa striata) dan Ibuprofen Terhadap Jumlah Sel Neutrofil Pada Proses Penyembuhan Luka Studi in Vivo pada Mukosa Bukal Tikus (Rattus norvegicus) Wistar. Dentino Jurnal Kedokteran Gigi, I(1):68–74.

Alamsjah, M. A., Kusumaningrum, G. A., Masitah, E. D. 2014. Albumin level test and Snakehead fish (Channa striata) growth with different commercial feed protein level. *Albumin level test and Snakehead fish (Channa striata)* growth , 6:25–29.

Arroyo, V., García-Martinez, R., Salvatella, X. 2014. Human serum albumin, systemic inflammation, and cirrhosis. *Journal of Hepatology*, 61(2):396–407.

Audina, N., Carabelly, A. N., Aspriyanto, D. 2018. The Effect of Toman (Channa micropeltes) Fish Extract on Epithelial Thickness In Diabetes Mellitus Wound Healing (In Vivo Study on the back of male Wistar rat (Rattus novergicus)). *Dentino Jurnal Kedokteran Gigi*, III(1):22–28.

Cahyani, D. I., Rustanti, N. 2015. Pengaruh Penambahan Teh Hijau Terhadap Aktivitas Antioksidan dan Kadar Protein Minuman Fungsional Susu Kedelai dan Madu. *Journal of Nutrition College*, 4(4):394–399.

Chavan, T., Khadke, S., Harke, S., Ghadge, A., Karandikar, M., Pandit, V. 2013. Hepatoprotective Effect of Polysaturated Fatty Acids Against Repeated Subacute Acetaminophen Dosing in Rats. *International Journal of Pharma and Bio Sciences*, 4(2):286–295.

Fajriani, N., Carabelly, A. N., Apriasari, M. A. 2018. The Effect of Channa micropeltes Extract (Channa micropeltes) On Neutrophil In Diabetes Mellitus Wound Healing. *Dentino Jurnal Kedokteran Gigi*, 3(1):15–21.

Firlianty 2016. Vacuum drying albumin powder of snakehead (Channa micropeltes) potential for wound healing from Central Kalimantan. *Indonesia. International Journal of ChemTech Research*, 9(5):263–269.

Fukai, T., Ushio-Fukai, M. 2011. Superoxide Dismutases: Role in Redox Signaling, Vascular Function, and Diseases. *Antioxidants & Redox Signaling*, 15:1583–1606.

Giannini, E. G. 2005. Liver enzyme alteration: a guide for clinicians. *Canadian Medical Association Journal*, 172(3):367–379.

Hardiningsya, S. D., Purwaningrisih, S., Handharyani, E. 2014. Aktivitas Antiksidan Dan Efek Hepatoprotektif Daun Bakau Api-Api Putih. *Jurnal Pengolahan Hasil Perikanan Indonesia*, 17(1):80–91.

Hulla, J. E., Navarro, L., Kruger, C. L., Hayes, A. W., Toxicity 2014. Subchronic and Chronic. *Subchronic and Chronic. Encyclopedia of Toxicology*, 4:626–633.

Huwoyono, G. H., Gustiano, R. 2013. Peningkatan Produktivitas Budidaya Ikan di Lahan Gambut. Media Akuakultur Gleni Hasan Huwoyono dan Rudhy Gustiano. *Media Akuakultur*, 8(1):13–13.

Indahsari, N. K., Histopatologi 2017. Hepar Tikus Putih (Rattus Novergicus) Yang Diinduksi Dengan Parasetamol Dosis Toksik Pasca Pemberian Ekstrak Etanol Daun Kelor (Moringa Oleifera). *Jurnal Kimia Riset*, 2(2):123–130.

Irwanda, W. F., Andrie, M., Luliana, S. 2015. Uji Efek Penyembuhan Luka Fase Air Ekstrak Ikan Toman (Channa micropeltes) Pada Tikus Putih Jantan Wistar yang Diberi Luka Sayat. *Jurnal Mahasiswa Farmasi Fakultas Kedokteran UNTAN*, 3(1):1–14.

Kebamo, S., Tesema, S. 2015. The Role of Bio- transformation in Drug Discovery and Development. *Journal of Drug Metabolism & Toxicology*, 06(05):1–13.

Layal, K. 2016. Peran Nrf2 Dalam Patogenesis Stres Oksidatif dan Infamasi pada Penyakit Ginjal Kronik. *Syifa’ MEDIKA: Jurnal Kedokteran dan Kesehatan*, 7(1):16–16.

Lee, P., Wu, X. 2015. Review: Modification of Human Serum Albumin and Their Binding Effect. *Curr Pharm Des*, 21(4):1862–1865.

Li, S., Tan, H. Y., Wang, N., Zhang, Z. J., Lao, L., Wong, C. W., Feng, Y. 2015. The Role of Oxidative Stress and Antioxidant in Liver Diseases. *International Journal of Molecular Sciences*, 16(11):26087–26124.

Ma, Q. 2013. Role of Nrf2 in Oxidative Stress and Toxicity. *Annual Review of Pharmacology and Toxicology*, 53:401–426.
Nasution, A. P., Adi, P., Santosa, P. A. 2015. Pengaruh Ekstrak Propolis terhadap Kadar SGOT (Serum Glutamic Oxaloacetic Transaminase) dan SGPT (Serum Glutamic Pyruvic Transaminase) pada Tikus Putih (Rattus norvegicus) Galur Wis- tar dengan Diet Tinggi Lemak. Majalah Kesehatan FKUB, 2(3):120–126.

Nicodemus, Andrie, M., Luliana, S. 2014. Uji Efek Penyembuhan Luka Sayat Ekstrak Ikan Toman (Channa micropeltes) Secara Oral Pada Tikus Putih Jantan Wistar. Jurnal Mahasiswa Farmasi Fakultas Kedokteran UNTAN, 1(1):1–14.

Nurani, L. H., Kumalasari, E., Rahman, A., Widyarini, S. 2017. Formulasi Kapsul Ekstrak Etanol Akar Pasak Bumi (Eurycoma longifolia Jack,) dan Pengaruhnya terhadap Vital Sign Manusia Sehat. Traditional Medicine Journal, 22(2):91–96.

Nurminha, Gambaran 2013. Aktifitas Enzim SGOT dan SGPT pada Penderita Demam Berdarah Dengue di RSUD Dr. Hi. Abdel Moedoeck Bandar Lampung. Jurnal Analis Kesehatan, 2(2):276–281.

Qodriyati, N. L. Y., Sulistyani, E., Yuwono, B. 2016. Kadar Serum Glutamic Oxaloacetic Transaminase (SGOT) pada Tikus Wistar (Rattus norvegicus) Jantan yang Dipapar Stresor Rasa Sakit Electrical Foot Shock selama 28 Hari. E-Jurnal Pustaka Kesehatan, 4(1):73–77.

Reza, A., Rachmawati, B. 2017. Perbedaan Kadar SGOT dan SGPT Antara Subyek Dengan dan Tanpa Diabetes Mellitus. Jurnal Kedokteran Diponegoro, 6(2):158–166.

Sabiu, S., Sunmonu, T. O., Ajani, E. O., Ajiboye, T. O. 2015. Combined administration of silymarin and vitamin C stalls acetaminophen-mediated hepatic oxidative insults in Wistar rats. Revista Brasileira de Farmacognosia, 25(1):29–34.

Sari, H. K., Budirahardjo, R., Sulistiyani, E. 2015. Kadar Serum Glutamat Piruvat Transaminase (SGOT) Jantan yang Dipapar Stresor Rasa Sakit berupa Electrical Foot Shock selama 28 Hari. E-Jurnal Pustaka Kesehatan, 3(2):205–211.

Singh, A., Bhat, T. K., Sharma, O. P. 2011. Clinical Biochemistry of Hepatotoxicity. Journal of Clinical Toxicology, 2(4):1–19.

Sukarsa, D. R., Studi 2004. Aktivitas Asam Lemak Omega-3 Ikan Laut Pada Mencit Sebagai Model Hewan Percobaan. Buletin Teknologi Hasil Perikanan, 2(1):68–79.

Tawali, A. B., Roreng, M. K., Mahendradatta, M., Suryani 2012. Difusi TeknologiProduksi Konsentrat Protein Dari Ikan Gabus Sebagai Food Supplement di Jayapura. Prosiding Seminar Nasional Insentif Riset Sinas (Insinas), pages 243–247.

Throop, J. L., Kerl, M. E., Cohn, L. A. 2004. Protein Metabolism and Function Compendium. Albumin in Health and Disease, 26(12):932–939.

Togubu, S., Momuat, L. I., Paendong, J. E., Salma, N. 2013. Aktivitas Antihiperglikemik dari Ekstrak Etanol dan Heksana Tumbuhan Suruhan (Peperomia pellucida [L.] Kunth) pada Tikus Wistar (Rattus norvegicus L.) yang Hiperglikemik. Jurnal MIPA, 2(2):109–109.

Tsutsui, H., Kinugawa, S., Matsushima, S. 2011. Oxidative stress and heart failure. American Journal of Physiology-Heart and Circulatory Physiology, 301(6):H2181–H2190.

Unsal, C., Celik, J. B., Toy, H., Esen, H., Otelcioglu, S. 2008. Protective role of zinc pretreatment in hepatotoxicity induced by halothane. European Journal of Anaesthesiology, 25(10):810–815.

Vriend, J., Reiter, R. J. 2015. The Keap1-Nrf2-antioxidant response element pathway: A review of its regulation by melatonin and the proteasome. Molecular and Cellular Endocrinology, 401:213–220.

Wahyuni, F. S., Putri, I. N., Arisanti, D. 2017. Uji Toksisitas Subkronis Fraksi Etil Asetat Kulit Buah Asam Kandis (Garcinia cowa Roxb.) terhadap Fungsi Hati dan Ginjal Mencit Putih Betina. Jurnal Sains Farmasi & Klinis, 3(2):202–202.

Widayati, E. O., Biologi, R., Bebas, Dan, A. 2012. Neliti. Majalah Ilmiah Sultan Agung, 50(128):1–8.