JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v12i6.37311
JKD (DMJ), Volume 12, Number 6, November 2023 : 336-342

THE EFFECT OF *MORINGA OLEIFERA* EXTRACT ON HISTOPATHOLOGICAL OF MICE TESTES EXPOSED BY MONOSODIUM GLUTAMATE

Regenio Akira Handoyo[1], Indah Saraswati [2], Arufiadi Anityo Mochtar [4], Ika Pawitra Miranti [5], Hermawan Istiadi [5], Desy Armalina [3*]
[1]Undergraduate Program, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia
[2]Department of Biology, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia
[3]Department of Anatomy and Histology, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia
[4] Department of Obstetric and Gynecology, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia
[5] Department of Anatomical Pathology, Faculty of Medicine, Universitas Diponegoro, Semarang, Indonesia
*Corresponding Author: E-Mail: desy.armalina@gmail.com

ABSTRACT

Background: Monosodium glutamate (MSG) consumption in excess can have an impact on a man's fertility and lead to infertility. MSG has the potential to produce free radicals, which can harm cells. Antioxidants can fight off free radicals. Exogenous antioxidants are required to maintain equilibrium since there will be an imbalance if the body produces more free radicals than endogenous antioxidants. Exogenous antioxidants flavonoids are present in the leaves of the Moringa plant (Moringa oleifera L). It is thought that flavonoids have 4-5 times more antioxidant potential than vitamins. **Objectives:** To evaluate how moringa leaf extract affects the histopathological profile of MSG-exposed mouse testes. **Methods:** Only the posttest was used as a control group in this study. 25 male mice were used as the sample, and they were split up into five groups. The treatment group 1 (P1) received 6 g/day of MSG exposure + 300 mg/kg BW/day of moringa leaf extract, the treatment group 2 (P2) received 6 g/day of MSG exposure + 600 mg/kg BW/day of moringa leaf extract, and the treatment group 3 (P3) received 6 g/day of MSG exposure + 1200 mg/kg BW/day of moringa leaf extract. The control group (K-) received only standard feed. The mice were put to death after 30 days. The testes were removed for histological examination using hematoxylin-eosin staining, and the Johnsen scoring criteria were applied to their evaluation. **Results:** The data were not significant according to the Shapiro-Wilk test in the P3 group (MSG 6 g/day + Moringa Extract 1200 mg/kg BW/day). The Kruskal-Wallis test revealed that there was no significant difference between the seminiferous tubules according to the treatment group ($p = 0.117$). **Conclusion:** *Moringa oleifera* leaf extract protects the histopathological picture of the testes of male mice compared to the group given monosodium glutamate.
***Keywords**: Testicular histopathology, Moringa oleifera leaf, Monosodium glutamate, Free radicals, Antioxidants*

INTRODUCTION

The preference for something quick and convenient in today's society can be seen, for instance, in the use of flavorings. We frequently utilize Monosodium Glutamate (MSG) as a flavor. MSG is a popular flavor enhancer since it effectively adds a savory and tasty flavor to food. (Kurtanty,2018). However, using MSG excessively has negative effects, such as infertility. (Edward,2010). Budiman (2015) reported a study on 18 mice exposed to MSG at a dose of 6 mg/gW/day for 30 days showed that the seminiferous tubules, interstitial compartments, spermatogenic cells, Sertoli cells, Leydig cells, and visible erythrocyte cells all suffered damage to the testes' histological structure. This is due to the fact that MSG contains free radicals.

Antioxidants can help to lower these free radicals. This is due to the endogenous antioxidants that exist in the human body to combat free radicals and other reactive oxygen molecules, such as MSG. However, the body needs antioxidants from outside the body (exogenous antioxidants) to combat these free radicals and other reactive oxygen molecules if they are present in excess (Budiman, 2015). Flavonoids are an illustration of exogenous antioxidants.(Winarsi, 2011; Arifin, 2018; Parwata, 2016).

Secondary polyphenol metabolites with antioxidant properties are called flavonoids. Plants contain a variety of flavonoids. (Munhoz,2014). The moringa oleifera plant is a natural substance with a high antioxidant content that is thought to provide a number of advantages. (Krisnadi,2015; Hardiyanthi,2015). The nutrients calcium, potassium, magnesium, calories, and protein are abundant in the moringa leaves. (Gopalakrishnan,2016). Based on phytochemical tests by Pratama (2017), Alkaloids, flavonoids, glycosides, terpenoids, and tannins are just a few of the chemicals found in moringa oleifera

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v12i6.37311
JKD (DMJ), Volume 12, Number 6, November 2023 : 336-342

that have antioxidant properties. According to the background, the goal of this study is to demonstrate the impact of administering Moringa oleifera leaf extract on the testicular histopathology of mice exposed to monosodium glutamate (MSG).

MATERIALS AND METHODS

Materials

The conditions utilized as samples are met by a number of mice (Mus musculus). Male mice who were 6–8 weeks old, weighed 25–30 grams, were healthy, and had no obvious anatomical anomalies were required for inclusion. Using the maceration process, moringa oleifera extract was produced. MSG (monosodium glutamate) was the common MSG "ajinomoto" available at the store.

Methods

Experimental animals were utilized as the test subjects in this study, which had a posttest-only control group design. In order to care for experimental animals, research, data collection, and data processing were done at the Biology Laboratory of the Faculty of Mathematics and Natural Sciences (FMIPA) of Semarang State University. Histopathological tissue images were also read at the Satmoko Clinic Semarang and the Anatomical Pathology Laboratory of Dr. Kariadi Semarang Hospital. From June to September 2020, the study was conducted.

According to WHO recommendations for the use of experimental animals, the sample size was chosen. A minimum of 5 people made up each treatment group. In accordance with the rules, a sample of at least 25 people who met the inclusion criteria was employed. Using simple random sampling, the sample was then divided into five groups: four for the treatment and one for the control.

Before the treatment, 25 male mice were adapted to standard feed and drink for one week. Then, the group treatment was carried out for 30 days. The control group (K-) was only given standard feed, group (K +) was exposed to MSG 6 g / day (0.02 g / kg BW), treatment group 1 (P1) was given MSG exposure 6 g / day (0.02 g / kg BW) + Moringa leaf extract 300 mg/kg BW / day, treatment group 2 (P2) was given exposure to MSG 6 g / day (0.02 g / kg BW) + Moringa leaf extract 600 mg/kg BW / day, treatment group 3 (P3) was given exposure MSG 6 g / day (0.02 g / kg BW), + Moringa leaf extract 1200 mg/kg BW / day. The MSG and Moringa leaf was given orally.

After 30 days of therapy, the mice were put inside a jar with a cotton ball filled with liquid chloroform/ether so they wouldn't know what was happening, and then they were killed via cervical dislocation. The testes were removed for histological examinations with HE staining and scored between 1 and 10 using the Johnsen scoring criteria.

Table 1. Johnsen Score criteria

SCORE	EXPLANATION
10	There is a complete spermatogenesis process.
9	The spermatogenesis process is incomplete, with many late-stage spermatids.
8	Spermatozoa cells <5 per tubule and some late-stage spermatid cells.
7	Lots of early-stage spermatids, no spermatozoa or late-stage spermatids.
6	Multiple early-stage spermatids, no spermatozoa, or late spermatids.
5	Lots of spermatocytes, no spermatozoa or spermatids.
4	Few spermatocytes, no spermatozoa or spermatids.
3	There are only spermatogonia cells.
2	There are only Sertoli cells, no germ epithelial cells.
1	There is no seminiferous epithelium.

Data Analysis

SPSS for Windows is used for data analysis. To see the distribution of normality and homogeneity, testicular microscopic image data from mice were first checked for normality using the Shapiro-Wilk test with normal criteria p> 0.05. The One Way Annova test is carried out if the data is homogeneous and distributed regularly. The Kruskal-Wallis test is used to determine if the data is homogenous and regularly distributed.

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v12i6.37311
JKD (DMJ), Volume 12, Number 6, November 2023 : 336-342

RESULTS AND DISCUSSION

Descriptive analysis of the microscopic image of mice seminiferous tubules

Case Summaries

Tubulus seminiferus

ompok	N	Mean	Std. Deviation	Median	Minimum	Maximum
Kontrol normal	5	9.5580	.29995	9.4300	9.30	10.00
MSG	5	9.1980	.21253	9.1300	9.00	9.50
MSG + Kelor 300	5	9.5460	.25403	9.6000	9.27	9.90
MSG + Kelor 600	5	9.2940	.55644	9.4700	8.37	9.80
MSG + Kelor 1200	5	9.6660	.19034	9.6000	9.53	10.00
Total	25	9.4524	.35112	9.5000	8.37	10.00

The table shows that the microscopic image of seminiferous tubules in treatment group 3 (MSG + Moringa 1200) has a higher mean value (9.66) than the other four groups. Meanwhile, the lowest average calculation value was found in the K treatment group + MSG exposure (9.19).

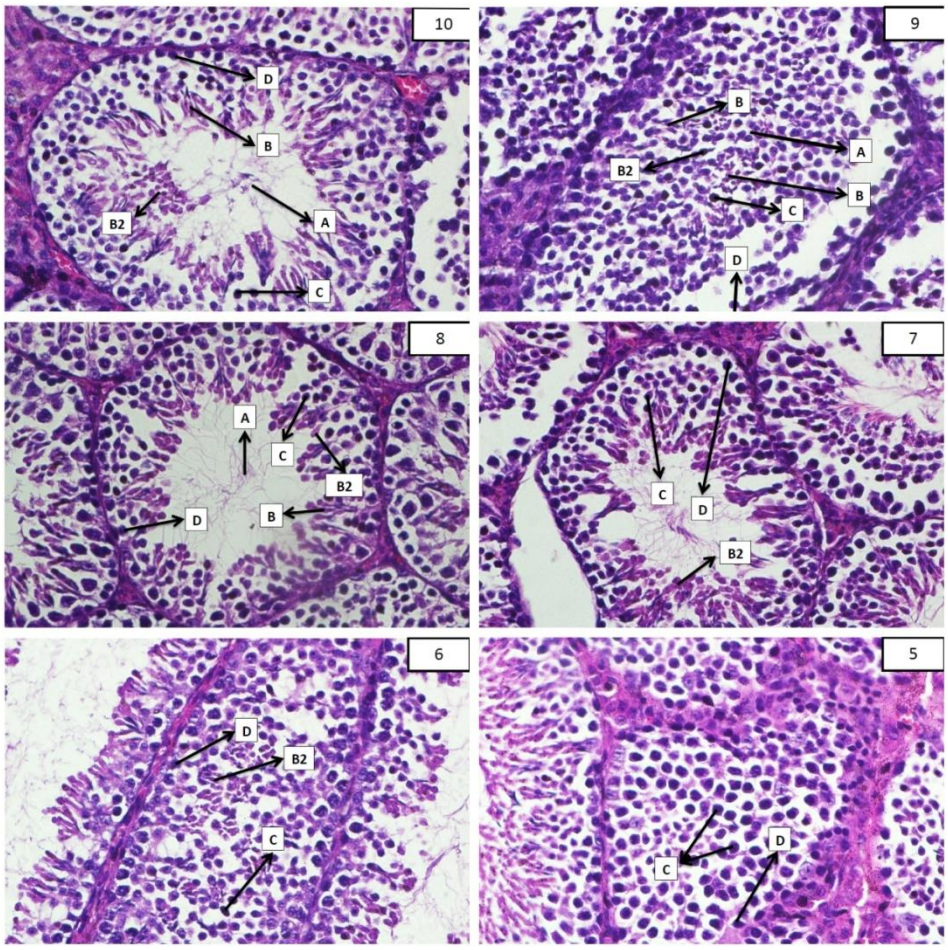

Figure 1. Seminiferous tubules are microscopic at the 400x magnification Johnsen Score criteria assessment. Score 10, 9, 8, 7, 6, 5. Spermatozoa (A), spermatids in various stages (B), spermatids in different stages (B2), spermatocytes (C), and spermatogonia (D). All the stages in spermatogenesis in score 10 appeared and were reduced with the decrease of the score**.**

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v12i6.37311
JKD (DMJ), Volume 12, Number 6, November 2023 : 336-342

The normality test used in this study was the Shapiro-Wilk test because the sample size was less than fifty. In addition, the data was normally distributed if the p-value was> 0.05.

Table 2. Normality test (Saphiro-Wilk test)

Group	Mean ± SD	Median (min-max)	Shapiro-Wilk	
			p	Transf. p
Normal Control	9,56 ± 0,30	9,43 (9,3 – 10)	0,296*	0,306*
MSG	9,20 ± 0,21	9,13 (9 – 9,5)	0,447*	0,456*
MSG + Moringa 300	9,55 ± 0,25	9,6 (9,27 – 9,9)	0,627*	0,632*
MSG + Moringa 600	9,29 ± 0,56	9,47 (8,37 – 9,8)	0,278*	0,225*
MSG + Moringa 1200	9,67 ± 0,19	9,6 (9,53 – 10)	0,023	0,024

Based on the normality test data, it was found that the data were not normally distributed p <0.05 because the MSG + Moringa 1200 group obtained a p-value of 0.023, so a non-parametric test was carried out in the form of the Kruskal Wallis test.

Table 3. Kruskal Wallis test

Group	Seminiferous Tubules	p
Normal Control	9,43 (9,3 – 10)	0,117
MSG	9,13 (9 – 9,5)	
MSG + Moringa 300	9,6 (9,27 – 9,9)	
MSG + Moringa 600	9,47 (8,37 – 9,8)	
MSG + Moringa 1200	9,6 (9,53 – 10)	

The non-parametric Kruskal Wallis test had a p-value of 0.117. Because the p-value > 0.05, there was no significant difference between the seminiferous tubules based on the treatment group. The value could be insignificant from these data, so there was no need for an analysis test.

The findings of this study suggest that the histological testicular tissue exposed to MSG can be shielded by moringa leaf extract. This was demonstrated by the lower Johnsen score (9.20) in the MSG-exposed K + group compared to the other three treatment groups, namely the P1, P2, and P3 groups (MSG + Moringa at various dosage levels), which received scores of 9,55, 9.29, and 9.67 respectively. Additionally, it is demonstrated from this score that long-term MSG exposure can lower the testes' histopathological quality.

This supports the hypothesis that MSG supplementation alters the testes' histological characteristics in male mice. When the amount of MSG in the body exceeds the number of antioxidants, it produces reactive oxygen species (ROS), which damage DNA and circulate in the circulation throughout the body, including the testes. (Susantiningsih,2015; Arief,2018; Christijanti,2011). Monosodium glutamate interferes with spermatogenesis in three different ways: pre-testicular, testicular, and post-testicular. Pre-testicular processes disrupt spermatogenesis by suppressing it in the hypothalamus, pituitary, and testes. Reduced intratesticular testosterone and FSH as a result of decreased LH in the serum will impede sperm generation. (Sukmaningsih,2011). According to Das and Ghosh (2010), Disorders of the hypothalamus, pituitary, and adrenal glands, which result in low levels of serum LH and testosterone, can affect spermatogenesis. The activity of the LDH enzyme, which converts NADH to NAD + as a lactate-forming substance through pyruvate synthesis, will be affected if testosterone levels are consistently reduced. This will then alter the metabolism of the Sertoli cells, which will have an effect on spermatogenesis. In the process of spermatogenesis in the Sertoli cells, lactate serves as a nutritional intake for spermatozoa. Inadequate dietary intake leads to the generation of sperm of low quality. (Daiber, 2017; Stefani, 2015; Schieber, 2014; Celino, 2011).

Additionally, oxidative stress can harm the mitochondrial membrane and render it useless, leading to membrane leakage, membrane depolarization, and the activation of apoptotic proteins, which trigger the process of cell deterioration. Seminiferous tubule degeneration, interstitial vacuolization, diminished seminiferous basal epithelial cells resulting in basement membrane release, and hypo-spermatozoa production are the hallmarks of this injury. Infertility issues could result from testicular damage since it will interfere with the production of spermatozoa and disturb the process of sperm spermatogenesis. (Akunna,2013,2017; Akingbade,2014).

According to Andrew's research, female Wistar rats given MSG doses of 0.04 mg/kg BW and 0.08 mg/kg BW had hypertrophy and degenerative

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v12i6.37311
JKD (DMJ), Volume 12, Number 6, November 2023 : 336-342

alterations in their histological image. issues with infertility (Eweka,2010). Previous studies showed that the MSG dose that can cause death 50 % (LD50) is between 15000 - 18000 mg/kg BW in mice and rats (Bera,2017; Husarova,2013).

In group P, giving Moringa leaf extract could help damage histopathological tissue in male mice testes due to MSG exposure. This is because the results obtained are different from the control group. This study showed that administering Moringa leaf extract at 300 mg/kg BW, 600 mg/kg BW and 1200 mg/kg BW affected the Johnsen score. This can be seen with an increase in the Johnsen score in the P group, which was given Moringa leaf extract in stratified doses (P1 is 9.55, P2 is 9.29, P3 is 9.67) compared to the group (K +), which is only exposed to MSG.

The results of this study are in line with the findings of research conducted by Jannah (2018), that the oral administration of Moringa leaf extract at a dose of 100 mg/kg BW, 200 mg/kg BW, 300 mg/kg BW, 400 mg/kg BW and 500 mg. / KgBW for five weeks of testicular histopathological examination of white male rats with Diabetes Mellitus showed an improvement in the histopathological picture of the testes after giving Moringa leaf extract (Jannah,2018). This is because Moringa leaf extract contains antioxidants that can help prevent damage caused by free radicals.

The antioxidant components found in moringa leaves, a well-known superfood, include tannins, steroids, triterpenoids, flavonoids, saponins, interquinones, and alkaloids. They also contain vitamin C. (Krinadi,2015; Gopalakrishnan,2016; Kasolo,2010). One of the active elements in Moringa leaves that contributes to their antioxidant activity is flavonoids. Flavonoid groups are some of the primary bioactive components of its phenolics. The majority of phenolics are antioxidants that prevent free radicals from oxidizing, which can harm cell structure. (Cahyani,2017). By stopping free radical oxidative chain reactions or capturing them, flavonoids protect cells and tissues from oxidative stress brought on by an excess of free radicals. This prevents free radicals from reacting with cellular components and causing free radical stability in the body. (Winarsi,2011; Parwata,2016)

Vitamins, macroelements, and microelements can function as antioxidants to guard against DNA damage, stop lipid peroxidation, and stop the chain reactions that free radicals cause. For instance, the antioxidants in Moringa leaves inhibit the oxidation of most biomolecules and offer significant protection against oxidative damage by neutralizing free radicals. (Cahyani,2017).

In comparison to the P1 and P3 groups, the results of the Johnsen score in the P2 group revealed a decrease after the administration of 600 mg/kg BW of moringa leaf extract. The lack of a pre-test on the mice may have contributed to the lower Johnsen's score in the P2 group because it was unknown how well-trained the mice were prior to the study's execution. One drawback of study using the posttest-only design type is that the degree of function of a sample group before and after treatment cannot be assessed, as well as the degree of change between before and after treatment. (Baldwin,2018). Another possibility is the occurrence of hormonal fluctuations in mice during the study, which stress conditions may cause during treatment.

In a study by Moodley (2017), the administration of Moringa leaf extract at a dose of more than 2000 mg/kg BW in mice showed no change in clinical signs or histopathological features (Moodley,2017). In addition, in research conducted by Widowati, it was stated that giving Moringa leaf extract at a dose of More than 4000 mg/kg BW in Wistar rats are included in the practically non-toxic (PNT) material group so that they still show normal conditions in liver and kidney function (Widowati,2014). According to the research that has been done, the dosage of Moringa leaf extract can cause death by up to 50% (LD50) in mice at a dose of 6616.67 mg/kg BW (Osman,2015). So the dosage of moringa leaf extract of 300 mg/kg BW, 600 mg/kg BW, and 1200 mg/kg BW that has been done in this study is a dose that is still safe for consumption.

The research found that Moringa leaves protect the histopathological testicular tissue of mice exposed to monosodium glutamate.

CONCLUSION

The testes of mice subjected to monosodium glutamate show a protective effect of Moringa leaf extract on the histological appearance. If Moringa leaf extract is administered at doses of 300 mg/kg BW, 600 mg/kg BW, and 1200 mg/kg BW, it may have a protective effect against exposure to

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v12i6.37311
JKD (DMJ), Volume 12, Number 6, November 2023 : 336-342

monosodium glutamate. Furthermore, compared to the group of male mice administered monosodium glutamate, the flavonoids in Moringa leaf extract can offer histological protection of the testes.

REFERENCES

1. Kurtanty D, Faqih DM, Upa NP. Review Monosodium Glutamat How to Understand it Properly? Vol. 4, Katalog dalam Penerbitan (KDT) Primer Koperasi Ikatan Dokter Indonesia. 2018.
2. Edward Z. Pengaruh Pemberian Monosodium Glutamat (MSG) Pada Tikus Jantan (Rattus norvergicus) Terhadap FSH dan LH. Maj Kedokt Andalas. 2010;34(2):160.
3. Budiman J, Istiadi H, Amarwati S. Pengaruh madu terhadap gambaran mikroskopis testis pada tikus wistar yang diinduksi monosodium glutamat. Media Med muda. 2015;4(4):723–31.
4. Winarsi H. Antioksidan Alami dan Radikal Bebas, Potensi dan Aplikasinya dalam Kesehatan [Internet]. 5th ed. Yogyakarta: KANISIUS (Anggota IKAPI); 2011. Available from: https://books.google.co.id/books?id=AlC1KQ2Oaj0C&printsec=copyright#v=onepage&q&f=false
5. Arifin B, Ibrahim S. Struktur, Bioaktivitas Dan Antioksidan Flavonoid. J Zarah. 2018;6(1):21–9.
6. Parwata MOA. Bahan Ajar Antioksidan. Kim Terap. 2016;(April):1–54.
7. Munhoz VM, Longhini R, Souza JRP, Zequi JAC, Mello EVSL, Lopes GC, et al. Extraction of flavonoids from Tagetes patula: Process optimization and screening for biological activity. Brazilian J Pharmacogn. 2014;24(5):576–83.
8. A Dudi Krisnadi. KELOR, Super Nutrisi. Morindo. Pusat Informasi dan Pengembangan Tanaman Kelor Indonesia. 2015. 160 p.
9. Hardiyanthi F. Pemanfaatan Aktivitas Antioksidan Ekstrak Daun Kelor (Moringa oleifera) Dalam Sediaan Hand and Body Cream. Fak Sains dan Teknol UIN Syarif Hidayatullah. 2015;
10. Gopalakrishnan L, Doriya K, Kumar DS. Moringa oleifera: A review on nutritive importance and its medicinal application. Food Sci Hum Wellness [Internet]. 2016;5(2):49–56. Available from: http://dx.doi.org/10.1016/j.fshw.2016.04.001
11. Pratama Putra I, Dharmayudha A, Sudimartini L. Identifikasi Senyawa Kimia Ekstrak Etanol Daun Kelor (Moringa oleifera L) di Bali. Indones Med Veterinus. 2017;5(5):464–73.
12. Susantiningsih T. Obesitas dan Stress Oksidatif. J Biokimia, Fak Kedokteran, Univ Lampung. 2015;1.
13. Arief H, Widodo MA. Peranan Stres Oksidatif pada Proses Penyembuhan Luka. J Ilm Kedokt Wijaya Kusuma. 2018;5(2):22.
14. Christijanti W, Utami NR. Efek Pemberian Antioksidan Vitamin C dan E terhadap Kualitas Spermatozoa Tikus Putih Terpapar Allethrin. J Biol Biol Educ. 2011;2(1):18–26.
15. Sukmaningsih a. a. S., Ermayanti IGAM, Wiratmini NI, Sudatri NW. Gangguan Spermatogenesis Setelah Pemberian Monosodium Glutamat Pada Mencit(Mus musculus L .). J Biol. 2011;XV(2):49–52.
16. Das RS, Ghosh SK. Long term effects of monosodium glutamate on spermatogenesis following neonatal exposure in albino mice--a histological study. Nepal Med Coll J. 2010;12(3):149–53.
17. Daiber A, Di Lisa F, Oelze M, Kröller-Schön S, Steven S, Schulz E, et al. Crosstalk of mitochondria with NADPH oxidase via reactive oxygen and nitrogen species signalling and its role for vascular function. Br J Pharmacol. 2017;174(12):1670–89.
18. Stefani GP, Baldissera G, Nunes RB, Heck TG, Rhoden CR. Metabolic Syndrome and DNA Damage: The Interplay of Environmental and Lifestyle Factors in the Development of Metabolic Dysfunction. Open J Endocr Metab Dis. 2015;05(07):65–76.
19. Schieber M, Chandel NS. ROS function in redox signaling and oxidative stress. Curr Biol [Internet]. 2014;24(10):R453–62. Available from: http://dx.doi.org/10.1016/j.cub.2014.03.034
20. Celino FT, Yamaguchi S, Miura C, Ohta T, Tozawa Y, Iwai T, et al. Tolerance of spermatogonia to oxidative stress is due to high levels of Zn and Cu/Zn superoxide dismutase. PLoS One. 2011;6(2):1–11.

JURNAL KEDOKTERAN DIPONEGORO
(*DIPONEGORO MEDICAL JOURNAL*)
Online : http://ejournal3.undip.ac.id/index.php/medico
E-ISSN : 2540-8844
DOI : 10.14710/dmj.v12i6.37311
JKD (DMJ), Volume 12, Number 6, November 2023 : 336-342

21. Akunna G, Saalu L, Ogunlade B, Ogunmodede O, Akingbade A. Anti-Fertility Role of Allethrin Based-Mosquito Coil on Animal Models. Int J Biol Pharm Allied Sci. 2013;2(2):192–207.
22. Akunna G, Nwafor J, Egwu O A, Akingbade A M, Olasehinde O R, O FC, et al. Follicular counts and biochemical evaluation in ovary of Wistar Rats exposed to Esbiothrin-based mosquito repellant . SAS J Med [Internet]. 2017;3(6):103–11. Available from: http://sassociety.com/sasjm/
23. Akingbade A M; Saalu L C; Oyebanji O O; Oyeniran D A; Akande O O; Akuma G G. Rhodinol-based Incense Testiculotoxicity in Albino Rats: Testicular Histology, Spermatogenic and Biochemical Evaluations. J Pharmacol Toxicol. 2014;2:68–81.
24. Eweka A, Eweka A, Om'Iniabohs F. Histological studies of the effects of monosodium glutamate on the fallopian tubes of adult female wistar rats. Ann Biomed Sci. 2010;2(3):146–9.
25. Bera TK, Kar SK, Yadav PK, Mukherjee P, Yadav S, Joshi B. Effects of monosodium glutamate on human health: A systematic review Tushar. World J Pharm Sci. 2017;5(May):139–44.
26. Husarova V, Ostatnikova D. Monosodium Glutamate Toxic Effects and Their Implications for Human Intake: A Review. JMED Res. 2013;(March 2014):1–12.
27. Jannah R, Setiasih NLE, Suastika P. Histopathological of Diabetes Mellitus White Rat Testicle After Given Moringa Leaf Extract. Bul Vet Udayana. 2018;10(2):176.
28. Kasolo JN, Bimenya GS, Ojok L, Ochieng J, Ogwal-Okeng JW. Phytochemicals and uses of Moringa oleifera leaves in Ugandan rural communities. J Med Plants Res. 2010;4(9):753–7.
29. Cahyani S L. Skrining Fitokimia dan Aktivitas Penangkapan Radikal Bebas DPPH Ekstrak Etanol Daun Kelor (Moringa Oleifera) di Ende. J Kedokt Udayana. 2017;410–6.
30. Baldwin L. Research Concepts for the Practitioner of Educational Leadership. The Library of Congress Cataloging in Publication Data. The Library of Congress Cataloging-in-Publication Data; 2018. 74 p.
31. Moodley I. Evaluation of Sub Chronic Toxicity of Moringa Oleifera Leaf Powder in Mice. J Toxicol Pharmacol Res Artic [Internet]. 2017; Available from: www.oecd.org/test/monos/htm]
32. Widowati L, Winarno MW, Intan PR, Teknologi P, Kesehatan T. Toksisitas Akut dan Subkronis Ramuan Ekstrak Kelor dan Klabet sebagai Pelancar ASI dan Penambah Gizi Lucie. J Kefarmasian Indones. 2014;4(2):51–66.
33. Osman H., Shayoub M., Babiker E., Faiza A., Munzir ME., Bashier O, et al. Assessment of acute toxicity and LD 50 of Moringa oleifera ethanolic leave extract in albino rats and rabbits. J Med Biol Sci Res. 2015;1(4):38–43.