Physiological Impact of *Abutilon Indicum* Extract Against Heat Stress–Induced Liver Injury in Rats

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***Abstract*—** The present study evaluated the hepatoprotective action of *Abutilon indicum* aqueous extract on heat stress–induced liver damage in male Wistar albino rats. Heat stress causes oxidative stress, inflammation, and hepatocellular damage, ultimately leading to liver functional disturbance and necrosis. Twenty-four male rats were randomly assigned to 3 groups as follows (n = 8 per group): Group A, the control, was treated with normal saline (0.9% NaCl); Group B was exposed to heat stress for 3 h a day at 39-40°C for 30 days ; and Group C received heat exposure followed by oral administration of aqueous extracts of *Abutilon indicum* (100 mg/kg body weight) for one month. The results of this study revealed a significant decrease in biochemical parameters (Alanine aminotransferase (ALT), aspartate aminotransferase (AST), alkaline phosphatase (ALP), and total bilirubin (BT) in Group C, compared to Group B. Additionally, the histological analysis identified severe hepatocyte necrosis, along with inflammation and hepatocellular degeneration in Group B, while Group C showed a significant positive effect on the biochemical parameters of the rats' liver damage induced by heat stress. In conclusion, *Abutilon indicum* has hepatoprotective qualities and could be used as a natural remedy to lessen animal liver damage brought on by heat stress.

***Keywords* —** *Abutilon indicum,* heat stress, hepatoprotection, liver injury

INTRODUCTION

Heat stress (HS) establishes serious challenges to both public health and the livestock industry, resulting in substantial economic losses and adverse effects on human and animal health. These consequences are expected to intensify with the progression of global warming (1). Acute and chronic HS can lead to a wide range of physiological and behavioral disturbances in animals including metabolic oxidative stress responses, dysfunctions immune disorders, and organ impairments (2-6). The liver is a central metabolic organ that regulates numerous biological processes including nutrient storage, protein synthesis, metabolism, excretion, and detoxification of major toxins (7- 9). Owing to these critical functions, the liver is continuously exposed to a variety of internal and external stressors (10). Toxic insults including thermal stress can impair hepatic cells, tissues, and architecture, ultimately contributing to liver dysfunction or disease (11). In addition, heat stress disrupts the activity of major antioxidant enzymes such as superoxide dismutase (SOD), glutathione peroxidase (GPX), and reduced glutathione (GSH). These alterations promote mitochondrial dysfunction and excessive free radical generation, underscoring the central role of mitochondrial integrity in heat stress–related liver pathology (12,13). Elevated temperatures have been shown to reduce the activity of antioxidant enzymes in the liver and to increase the generation of reactive oxygen species (ROS) and lipid peroxidation in various tissues (13,14). Heat exposure also decreases plasma alkaline phosphatase levels, while inducing oxidative stress and inflammatory responses that may alter metabolic hormone regulation in rats (15). Hepatocytes contain high concentrations of alanine aminotransferase (ALT) and aspartate aminotransferase (AST), which are released into the bloodstream following liver cell damage or stimulation, making them reliable biomarkers of hepatic injury (16). Given these hazards, recognizing effective protective approaches against HS-induced oxidative and inflammatory damage is an expanding research priority. Herbal medicines remain a primary healthcare resource for many populations; the World Health Organization estimates that over 80% of people in low- and middle-income countries use traditional remedies for common ailments (17). The genus *Abutilon*, belonging to the family *Malvaceae*, comprises approximately 150 annual or perennial herbs and small trees, many of which display considerable morphological diversity (18,21). Historical records and oral traditions document the high vitamin and mineral content of the leaves, while the oil-rich seeds were roasted and consumed in certain cultures (19). Among these species, *Abutilon indicum* (L.) Sweet, commonly known as Indian mallow or "Aatibala," is an important medicinal plant in Ayurvedic medicine (20). *A. indicum* is characterized by oval leaves, yellow flowers, dentate comb-like fruits, and dull brown seeds (22). In recent years, increasing attention has been directed toward herbal medicines as potential protective agents against oxidative and inflammatory damage induced by

environmental stressors. Previous studies have reported its hepatoprotective properties (23) as well as its anti-inflammatory effects (24). Additionally, α-glucosidase and α-amylase inhibitory activities, antipyretic and antidiabetic effects, anti-diarrheal activity, and DNA protective properties have been documented (25,26). This study evaluates whether *Abutilon indicum* confers hepatoprotection against heat stress–induced biochemical and enzymatic disturbances in rats.

MATERIALS AND MTHODS

Preparation for Aqueous Plant Extract

The whole plant of *Abutilon indicum* (seeds, roots, and leaves) was collected from Al-Muthanna University, Iraq, and authenticated at the Department of Botany. The plant materials were thoroughly washed with tap water and rinsed three times with sterile distilled water, then air-dried at room temperature for one week. After drying, the plant parts were cut into small pieces and ground into a fine powder (27). Ten grams of the powdered plant material were dissolved in 100 mL of distilled water and heated on a hot plate at 60°C with continuous stirring overnight. The mixture was allowed to cool to room temperature and subsequently filtered using Whatman No. 1 filter paper. The filtrate was centrifuged at 3000 rpm for 10 minutes, transferred into a clean sterile bottle, and stored at 4°C until further use.

Animal Dosing Protocol

Male albino rats weighing approximately 180 ± 30 g and aged 56 days were obtained from Al-Muthanna University, Iraq. Animals were housed under standard laboratory conditions with free access to a pellet diet containing at least 16% crude protein and 8.5 MJ/kg metabolizable energy, as well as water and libitum, except during periods of heat stress exposure. A total of 24 rats were randomly divided into three groups (n = 8 per group): Group A (Control): Rats received normal saline orally every other day for 30 days. Group B (Heat Stress): Rats were exposed to heat stress at 39–40°C for 3 hours daily. Food and water were withheld only during the heat exposure period and the subsequent overnight recovery period (12 hours), after which normal feeding and watering were resumed. This protocol was repeated daily for one month. Group C (Heat Stress + Treatment): Rats were subjected to the same heat stress protocol as Group B. Immediately after the completion of each daily heat stress exposure, rats received *A. indicum* aqueous extract orally at a dose of 100 mg/kg body weight for one month (28).

Blood Collection and Biochemical Parameters

Following the experiment, chloroform vapor at a concentration of roughly 25,000 parts per million was used to put the animals to sleep for five minutes before they were killed. For histological and biochemical analyses, male rats were employed. Disposable syringes were used to draw five milliliters of blood via heart puncture, and the samples were stored in tubes without anticoagulant until a clot formed within fifteen minutes. The serum was then extracted from the coagulated blood samples by centrifugation at 5000 rpm for 15 minutes. The serum was kept in standard tubes at -20°C until it was required (27). The serum extracted from each sample was used to measure BT and transaminases (AST, ALT, and ALP).

Histological Examination (29)

After 24 hours of keeping in a 10% neutral buffered formalin solution, the liver is washed with 70% ethanol. Next, tissues were put in tiny metal caskets, folded with a magnetic stirrer, dried up with a cycle of alcohol extending from 70% to 100%, and then set in paraffin using an embedding procedure. A rotary ultra-microtome was used to slice the paraffin blocks, which were then placed on glass slides and permitted to dry overnight. Concerning staining, hematoxylin and eosin (H&E) dyes were displayed, and slides were examined under a light microscope.

STATISTICAL ANALYSIS

The least significant difference (LSD) test was conducted using ANOVA one-way by the program IBM SPSS (USA), version 20. $P \leq 0.05$ was considered statistically significant. The figures in the tables indicate the means and their standard deviations.

ETHICAL APPROVAL

This study was approved by the research and animal ethical committee in the College of Veterinary Medicine, Al-Muthanna University, Iraq, Ref: AM.VET.2025.03, Date: 13-3- 2025).

RESULT AND DISCUSSION

Serum Liver Biochemical Parameters

Hepatocytes contain large amounts of AST and ALT, which are released into the bloodstream when hepatocellular damage occurs. Serum ALT and AST activities are therefore reliable indicators for evaluating liver function. Serum levels of ALT, AST, ALP, and total bilirubin were significantly higher ($p \leq 0.05$) in the heat stress group (Group B) than in the control group (Group A), with mean values of 36.60 ±0.69, 246.50 ±1.66, 200.30±1.50, and 0.7±0.1 IU/L, indicating severe hepatic dysfunction. In contrast, the Abutilon indicum extract treatment group (Group C) had significantly lower serum ALT, AST and ALP levels ($p \leq 0.05$) than the heat stress group (22 ±0.91; 106.5±1.10 and 110.4±1.70 IU/L). Additionally, total serum bilirubin levels (0.3±0.1 mg/dl).

Histopathological Examination

This section describes the histological alterations observed in the liver tissues of rats subjected to heat stress and treated with *Abutilon indicum* extract. Liver sections stained with hematoxylin and eosin (H&E) were examined under a light microscope. Liver sections from the control group (Figure 1) exhibited normal histological architecture, characterized by hepatocytes radially arranged around the central vein, intact cell membranes, distinct nuclei, and clear cytoplasm. In contrast, liver tissues from heat-stressed rats (Figure 2) showed marked histopathological alterations, including hepatocellular degeneration, inflammatory cell infiltration, nuclear condensation (pyknosis), sinusoidal congestion, and disruption of the normal hepatic architecture necrosis, indicating severe heat-induced liver injury. Following heat stress exposure, liver sections from rats treated with *Abutilon indicum* extract at a dose of 100 mg/kg body weight (Figure 3) demonstrated noticeable histological improvement. These

findings indicate a protective and regenerative effect of the plant extract against heat stress–induced liver damage, as evidenced by partial restoration of hepatic architecture, reduced inflammatory changes, mild sinusoidal congestion, and preservation of hepatocyte nuclei.

The present study displayed that heat stress causes hepatic injury, as signaled by elevated liver enzymes and rigorous histopathological alterations. Heightened serum ALT, AST, and ALP actions are indicative of hepatocellular membrane damage and necrosis, which are consistent with the observed histological findings. Heat stress-induced oxidative stress and inflammatory responses are expected to be responsible for these extreme changes. Treatment with *Abutilon indicum* significantly reduced liver injury, as supported by the reduction in serum liver enzymes and enhancement in hepatic histology. Preliminary phytochemical analysis of extracts of *Abutilon indicum* obtainable the presence of carbohydrate, alkaloid, anthraquinone glycoside, flavanoid, saponin, amino acid, and phenolic compound as biologically active phytoconstituent and may be accountable for their pharmacological properties (30). The reduction in BT levels supplements the protective role of the extract in continuing hepatic and biliary function. Overall, the results suggest that *Abutilon indicum* relieves heat stress–induced liver dysfunction by stabilizing hepatocyte membranes, decreasing oxidative damage, and sponsoring tissue regeneration. Acute hepatitis is defined as a marked increase in aminotransferases corresponding with Ischemic hepatitis (31). These findings are well- matched with histopathological changes that originate in the rats of both treated groups, which represented necrosis, Pyknosis, and disappearance of hepatocyte nuclei, and were established with increases in the aminotransferase serum activity (32). Bilirubin gets accumulated in plasma each time the occurrence of a liver disorder or obstruction in the biliary tract or an increased rate of hemolysis.

Table 1. Effects of heat stress and *Abutilon indicum* extract on serum liver biochemical parameters

Liver enzymes	Group A	Group B	Group C
ALT (IU/L)	21.16 ±0.35^{c}	36.60 ±0.69^{a}	22 ±0.91^{b}
AST (IU/L)	99.2 ±0.19^{c}	246.50 ±1.66^{a}	106. 5±1.10^{b}
ALP (IU/l)	100.5 ±0.77^{c}	200,30 ±1.50^{a}	110.4± 1.70^{b}
BT (mg/dl)	0.2 ±0.1^{c}	0.7 ±0.1^{a}	0.3 ±0.1^{b}

Values are expressed as mean ± standard deviation (n = 8 per group). Means within the same row with different superscript letters (a, b, c) are significantly different from each other ($P \leq 0.05$).

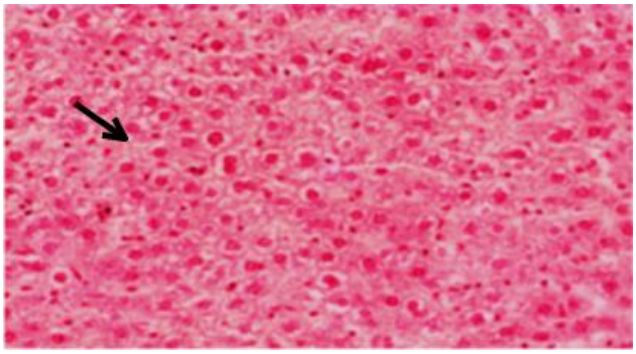

Figure 1. Histological section of the liver of the normal rats (control), showing normal hepatocytes with distinct nuclei and clear cytoplasm (H&E, 40×).

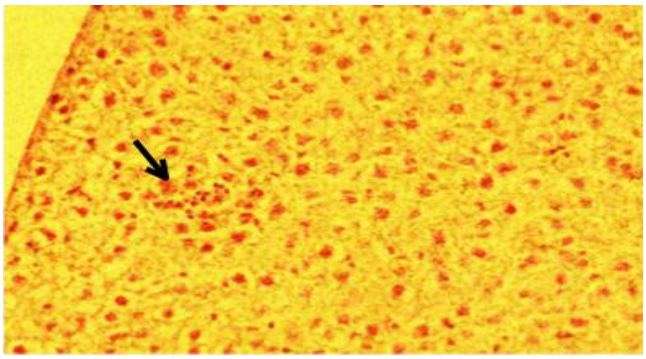

Figure 2. Histological section of the liver tissue of rat exposed to heat stress, showing severe necrosis of hepatocytes with degeneration of some nuclei and apoptosis in some cells and loss of normal hepatic architecture (H&E, 40×)

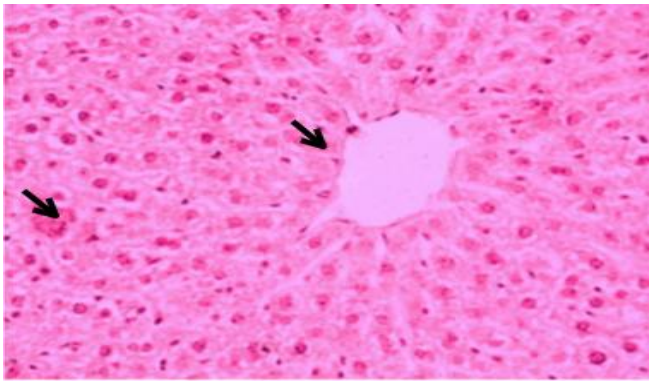

Figure 3. Histological section of the liver treated rats with *Abutilon indicum* showing few normal hepatic cells and few necrotic cells mild congestion and regeneration of hepatocytes the level of necrosis decreased in this group (H&E, 40×).

CONCLUSION

The present research indicated that heat stress affects biochemical and histopathological alterations in the rat liver, indicating hepatocellular degeneration. Processing of *Abutilon indicum* aqueous extract significantly improved these modifications, as proven by upgraded liver enzyme profiles and rebuilding of hepatic architecture. The hepatoprotective effects of *Abutilon indicum* are prospectively reconciled by its valuable phytochemical components with antioxidant and anti-

inflammatory properties. Therefore, *Abutilon indicum* may be an appreciated natural hepatoprotective mediator for mitigating heat stress–induced liver injury in animals.

REFERENCES

1) Chen, S., Yong, Y., & Ju, X. (2021). Effect of heat stress on growth and production performance of livestock and poultry: Mechanism to prevention. *Journal of Thermal Biology*, 99, 103019. https://doi.org/10.1016/j.jtherbio.2021.103019
2) Collier, R. J., Baumgard, L. H., Zimbelman, R. B., & Xiao, Y. (2019). Heat stress: Physiology of acclimation and adaptation. *Animal Frontiers*, 9(1), 12–19. https://doi.org/10.1093/af/vfy031
3) Chauhan, S. S., Rashamol, V. P., Bagath, M., Sejian, V., & Dunshea, F. R. (2021). Impacts of heat stress on immune responses and oxidative stress in farm animals and nutritional strategies for amelioration. *International Journal of Biometeorology*, 65(7), 1231–1244. https://doi.org/10.1007/s00484-021-02083-3
4) Mündel, T. (2008). Exercise heat stress and metabolism. *Medical and Sport Sciences*, 53, 121–129. https://doi.org/10.1159/000151554
5) Bouchama, A., Abuyassin, B., Lehe, C., Laitano, O., Jay, O., O., O'Connor, F. G., & Leon, L. R. (2022). Classic and exertional heatstroke. *Nature Reviews Disease Primers*, 8(1), 8. https://doi.org/10.1038/s41572-021-00334-6
6) Yang, X., Wang, H., Shen, C., Dong, X., Li, J., & Liu, J. (2024). Effects of isorhamnetin on liver injury in heat stroke-affected rats under dry-heat environments via oxidative stress and inflammatory response. *Scientific Reports*, 14(1), 7476. https://doi.org/10.1038/s41598-024-57852-y
7) Hubbard, A. H., Zhang, X., Jastrebski, S., Singh, A., & Schmidt, C. (2019). Understanding the liver under heat stress with statistical learning: An integrated metabolomics and transcriptomics computational approach. *BMC Genomics*, 20(1), 502. https://doi.org/10.1186/s12864-019-5823-x
8) Zhang, F., Dou, J., Zhao, X., Luo, H., Ma, L., Wang, L., & Wang, Y. (2023). Identification of key genes associated with heat stress in rats by weighted gene co-expression network analysis. *Animals*, 13(10), 1618. https://doi.org/10.3390/ani13101618
9) Gupta, A., Chauhan, N. R., Singh, A., Chowdhury, D., Meena, R. C., Chakrabarti, A., … & Singh, S. B. (2018). Heat-induced oxidative stress and aberrations in liver function leading to hepatic injury in rats. *Defence Life Sciences Journal*, 4(1), 21–32. https://doi.org/10.14429/dlsj.4.13174
10) Ishikawa, J., Takeo, M., Iwadate, A., Koya, J., Kihira, M., Oshima, M., … & Tsuji, T. (2021). Mechanical homeostasis of liver sinusoid is involved in the initiation and termination of liver regeneration. *Communications Biology*, 4(1), 409. https://doi.org/10.1038/s42003-021-01936-2
11) Ilyas, U., Katare, D. P., Aeri, V., & Naseef, P. P. (2016). A review on hepatoprotective and immunomodulatory herbal plants. *Pharmacognosy Reviews*, 10(19), 66. https://doi.org/10.4103/0973-7847.176544
12) Gaber, E., & Hassan, E. H. (2024). Fasting as a therapeutic strategy to alleviate heat-induced liver and kidney damage in mice: A physiological and histological investigation. *Journal of Bioscience and Applied Research*, 10(3), 466–483. https://doi.org/10.21608/jbaar.2024.379968
13) Ding, X., & Gao, B. (2025). Heat stress-mediated multi-organ injury: Pathophysiology and treatment strategies. *Comprehensive Physiology*, 15(3), e70012. https://doi.org/10.1002/cph4.70012
14) Habashy, W. S., Milfort, M. C., Rekaya, R., & Aggrey, S. E. (2019). Cellular antioxidant enzyme activity and biomarkers for oxidative stress are affected by heat stress. *International journal of biometeorology*, 63(12), 1569-1584. https://doi.org/10.1007/s00484-019-01769-z
15) Ojo, P. O., Rotimi, D., & Adeyemi, O. S. (2025). Heat exposure raised oxido-inflammatory indices and altered metabolic hormones in rats. *International Journal of Environmental Health Research*, 1–14. https://doi.org/10.1080/09603123.2025.2555981
16) Zhang, M., Xue, Y., Zheng, B., Li, L., Chu, X., Zhao, Y., … & Chu, L. (2021). Liquiritigenin protects against arsenic trioxide-induced liver injury by inhibiting oxidative stress and enhancing mTOR-mediated autophagy. *Biomedicine & Pharmacotherapy*, 143, 112167. https://doi.org/10.1016/j.biopha.2021.112167
17) Agidew, M. G. (2022). Phytochemical analysis of some selected traditional medicinal plants in Ethiopia. *Bulletin of the National Research Centre*, 46(1), 87. https://doi.org/10.1186/s42269-022-00770-8
18) Jamil, I., Kousar, S., & Abid, R. (2025). Chloroplast DNA region based phylogenetic relationships within genus Abutilon Mill. *Pakistan Journal of Botany*, 57(4), 1529–1535. http://dx.doi.org/10.30848/PJB2025-4(39)
19) Pandey, V., Saxena, H. O., Parihar, S., Yadav, A. K., & Pawar, G. (2025). Genus Abutilon: A comprehensive review of phytochemistry, traditional medicinal applications, botany and pharmacological effects. *Vegetos*, 1–17. https://doi.org/10.1007/s42535-025-01386-9
20) Banerjee, S., Phuneerub, P., Jaidee, W., Rujanapun, N., Duangyod, T., Malee, K., … & Charoensup, R. (2025). Abutilon indicum (L.) Sweet extracts inhibit key glucose metabolic enzymes while enhancing glucose transport in L6 myotubes and 3T3-L1 adipocytes. *Journal of Food Biochemistry*, 2025(1), 8252812. https://doi.org/10.1155/jfbc/8252812
21) Saleem, H., Sarfraz, M., Ahsan, H. M., Khurshid, U., Kazmi, S. A. J., Zengin, G., … & Ahemad, N.

(2020). Secondary metabolites profiling, biological activities and computational studies of Abutilon figarianum Webb (Malvaceae). *Processes*, 8(3), 336. https://doi.org/10.3390/pr8030336

22) 22)Krisanapun, C., Lee, S. H., Peungvicha, P., Temsiririrkkul, R., & Baek, S. J. (2011). Antidiabetic activities of Abutilon indicum (L.) Sweet are mediated by enhancement of adipocyte differentiation and activation of the GLUT1 promoter. *Evidence-Based Complementary and Alternative Medicine*, 2011(1), 167684. https://doi.org/10.1155/2011/167684

23) Rajeshwari, S., & Sevarkodiyone, S. P. (2018). Medicinal properties of Abutilon indicum. *Open Journal of Plant Sciences*, 3(1), 022–025. https://www.peertechz.com

24) Tian, C., Zhang, P., Yang, C., Gao, X., Wang, H., Guo, Y., & Liu, M. (2018). Extraction process, component analysis, and in vitro antioxidant, antibacterial, and anti-inflammatory activities of total flavonoid extracts from Abutilon theophrasti leaves. *Mediators of Inflammation*, 2018, 3508506. https://doi.org/10.1155/2018/3508506

25) Thengyai, S., Thiantongin, P., Sontimuang, C., Ovatlarnporn, C., & Puttarak, P. (2020). α-Glucosidase and α-amylase inhibitory activities of medicinal plants in Thai antidiabetic recipes and bioactive compounds from Vitex glabrata R. Br. stem bark. *Journal of Herbal Medicine*, 19, 100302. https://doi.org/10.1016/j.hermed.2019.100302

26) Islam, R., Deb, A., Ghosh, A. J., Dutta, D., Ray, A., Dutta, A., … & Saha, T. (2024). Toxicological profiling of methanolic seed extract of Abutilon indicum (L.) Sweet: In-vitro and in-vivo analysis. *Journal of Ethnopharmacology*, 335, 118655. https://doi.org/10.1016/j.jep.2024.118655

27) Mshary, G. S., Abd, M., & Jassim, B. A. (2023). Curative potential of Abutilon indicum extract against heat stress-induced kidney damage in adult male rats. *Journal of Veterinary Physiology and Pathology*, 2(4), 52–56. https://doi.org/10.58803/jvpp.v2i4.33

28) Mshary, G. S., & Kadhim, Z. Y. (2017). Evaluation of hematological and biochemical parameters of heat-stress rats treated with Abutilon indicum aqueous extract. *Mirror of Research in Veterinary Sciences and Animals*, 6(3), 25–31. https://doi.org/10.22428/mrvsa-2016-00633

29) Palipoch, S., & Punsawad, C. (2013). Biochemical and histological study of rat liver and kidney injury induced by cisplatin. *Journal of Toxicologic Pathology*, 26(3), 293–299. https://doi.org/10.1293/tox.26.293

30) Dhanesh, P. V., & Ajithkumar, T. G. (2025). In vitro Anti-inflammatory and Antitubercular studies of various extracts of Abutilon indicum (L.) Sweet Leaves. *Journal of Pharmaceutical Sciences*, 1(10). https://doi.org/10.33545/26647613.2025.v7.i2d.116

31) Allam, J., Ibrahim, A., & Rockey, D. C. (2024). The primary cause of markedly elevated aminotransferases in hospitalized patients with cirrhosis: Ischemic hepatitis. *European Journal of Gastroenterology & Hepatology*, 36(11), 1346–1351. https://doi.org/10.1097/MEG.0000000000002861

32) Al-Rikabi, F. M. K. (2012). Evaluation of selected parameters of rat liver injury following repeated administration of oseltamivir for different periods. *The Iraqi Journal of Veterinary Medicine*, 36(1), 145–156. https://doi.org/10.30539/iraqijvm.v36i1.32