Kuwait Research Journal of
Agriculture and Life Science (KRJALS)

ISSN Print: 2790-6485 | ISSN Online : 2790-6477 Open Access

Effect of Aqueous Extract of Senna alexandrina on some Physiological and Biochemical Parameters in Female Rats

Amal Hamdan Mohsen Al-Ziyara
Assistant. Lecturer ,Department of Biology, Ministry of Education- Najaf Education Directorate .
Hiyam Habeeb Al-Thabhawee
Assistant Lecturer , Department of Biochemistry, Ministry of Education- Najaf Education Directorate .
Wajda Mohsen Jayesh Al-mayali
Assistant.Lecturer ,Department of Biology, Ministry of Education- Najaf Education Directorate .
Dalal Abdel-Hussein Kadhim Al-Essawi
Prof, Department of Biology, College of Education for women, University of Kufa, Iraq
Lahib Sadiq Mahdi Albusayr
Lecturer, Department of Biology, College of Education for women, University of Kufa, Iraq.

*Corresponding Author

Amal Hamdan Mohsen Al-Ziyara
Assistant.Lecturer ,Department of Biology, Ministry of Education- Najaf Education Directorate .

Article History
Received: 02.10.2026
Revise : 13.11.2026
Accepted: 16.11.2026
Published: 19.11.2026

DOI:10.61705/KRJALS.5.3.2026.21.28

Keywords:
Senna alexandrina, AST, ALT, rats, RBC, PLT, WBC, MDA, GSH.

Abstract : Background: Senna alexandrina is a medicinal plant used for various therapeutic purposes; however, the use of its extracts may be associated with physiological and biochemical changes that warrant evaluation.
Objective: This study aimed to evaluate the effect of an aqueous extract of *Senna alexandrina* leaves on certain hematological parameters, liver enzymes, oxidative stress markers, and antioxidant status in female rats,
Methodology: Thirty adult female rats (Rattus rattus), weighing between 190 and 230 grams and aged 3.5 to 4.5 months, were used. The animals were divided into two main groups, each comprising three subgroups of five animals. One group served as a control, while the other groups were treated with an aqueous extract of *Senna alexandrina* leaves at doses of 200 and 300 mg/kg of body weight. The treatment lasted for 30 and 45 days, with a single daily dose administered via oral gavage. At the end of the experimental period, the animals were anesthetized, and blood samples were collected for hematological and biochemical analyses. These included total white blood cell (WBC) count, red blood cell (RBC) count, platelet (PLT) count, liver enzymes (AST, ALT, ALP), as well as malondialdehyde (MDA) and glutathione (GSH) levels.
Results: The study findings showed a significant increase ($P<0.05$) in the total white blood cell (WBC) count, platelet (PLT) count, levels of enzymes (AST, ALP), and malondialdehyde (MDA). Conversely, there was a significant decrease ($P<0.05$) in the red blood cell (RBC) count, levels of the enzyme ALT, and glutathione (GSH) in groups administered the plant extract at doses of 200 and 300 mg/kg for 30 days.
Conclusions: These observed effects on the aforementioned physiological and biochemical parameters were more pronounced in the groups treated with 200 and 300 mg/kg of the aqueous extract of *Senna alexandrina* for a duration of 45 days, when compared to their respective control groups for the 30-day and 45-day treatment periods.

Kuwait Research Journal of
Agriculture and Life Science (KRJALS)

ISSN Print: 2790-6485 | ISSN Online : 2790-6477 Open Access

INTRODUCTION

Senna alexandrina belongs to Fabaceae family, it is native to Egypt and is now cultivated worldwide(1). It is a medicinal plant found in many regions of the world such as India, Africa, Saudi Arabia, and others and plant is known by many names such as Cassia angustiofia (Indian senna), Caccia alexandrina (Alexandrian senna), Cassia fistula, Caccia obovata, Caccia dentate, Caccia alata and Caccia sofara (2), senna has been used as laxatives and stimulants in traditional herbal medicine and their leaves can be used as plant extracts or tea which has a bitter taste and is therefore combined with a number of other herbal teas to improve the taste (3), This plant is one of the active and important plants in various laxative medications that are commonly used and do not require prescriptions. It is a natural treatment because it contains compounds known as sennosides, which are derived from the leaves of the plant and are the most important active substances found in the plant. Therefore, senna is used to treat short-term constipation and hemorrhoids resulting from constipation. It has benefits for hair, and the plant is also used to treat type 2 diabetes (4) and to lower cholesterol levels, as for the benefits of senna related to weight loss, there is not enough scientific evidence for that, but the use of senna is accompanied by many effects such as colic, cramps, severe diarrhea that leads to fainting as a result of loss of body fluids, nausea, abdominal cramps, and black stools (5),long-term use of laxatives, especially senna, may cause severe constipation because without them the intestines do not move as a result of the body becoming accustomed to them, disturbances in mineral and salt levels due to their increased excretion from the body, which stimulates serious harm to heart patients and liver damage (6).

Materials and Methods

- Plant Extract

Senna leaves were used and purchased from herbal stores in Najaf Governorate, leaves were then cleaned of foreign matter and ground using an electric grinder to obtain leaves powder. 30 grams of plant leaf powder was then taken and 1000 ml of distilled water was added. The mixture was then placed in a heating device for three consecutive hours. Then it was centrifuged for (10) minutes at a speed of (3000) rpm, and the extract was then filtered using filter papers and clear solution was taken and dried after placing it in sterilized dishes using an electric oven at a temperature of (40 degrees Celsius), and this step was repeated several times until the required amount of dry extract was obtained which was kept in refrigerator in sterile glass containers until use (7).

-Experimental Animals

(30) adult female rats, aged between (3-3.5) months and weighing between (250-200) grams, were used. The animals were placed in special plastic breeding cages with a mesh iron cover in the animal house. The animals were exposed to similar laboratory conditions in terms of temperature, which ranged between (22-20) degrees Celsius, and the lighting cycle was (12 hours light/12 hours dark), and ventilation was good. The animals were given water and feed freely throughout the experiment period.

-Animal Treatment

(30) adult female rats were divided into two large groups, each containing 15 f rats and each large group then divided as follows:

- The first large group (15 females): was divided into three small groups, each containing five female rats, and received:

1- The first group: Control group: was treated with the physiological solution only.

2- The second group: was treated with the aqueous extract of senna at a dose of 200 mg/kg.

3- The third group: was treated with an aqueous extract of senna at a dose of 300 mg/kg.

The animals in the first large group were treated for 30 days , sacrificed and blood was drawn on day 31.

- The second large group (15 females): was divided into three small groups, each containing five female rats, and treated as follows:

1- The fourth group: a control group: was treated with the normal saline solution only.

2- Group 5: was treated with 200 mg/kg of senna aqueous extract.

3- Group 6: was treated with 300 mg/kg of senna aqueous extract.

ISSN Print: 2790-6485 | ISSN Online : 2790-6477 Open Access

Animals in the second large group were treated for 45 days, sacrificed, and blood was drawn on day 46.

-Blood Collection

Blood was collected from rats after the animals were anesthetized with chloroform. A medical syringe was then used to puncture the heart in order to extract blood directly from it Five milliliters of blood were extracted. After that, three milliliters of blood were put into sterile test tubes (Gel tubes) devoid of any anticoagulant, After allowing the blood to clot for 20 minutes at room temperature, the tubes were placed in a centrifuge set to 3000 rpm for 15 minutes to extract the serum, which was then transferred to tiny, sterile, and labeled Eppendorf tubes. The serum was then stored in a refrigerator at -20 degrees Celsius until the biochemical tests were performed on it, which include liver enzymes (AST, ALT, ALP) and antioxidants(GSH,MDA), while about (2) ml were placed in tubes containing the anticoagulant (EDAT), then the blood was mixed with the substance well to estimate the physiological standards which included numbers of (WBC, RBC, PLT).

-Evaluation of physiological parameters

Physiological blood parameters (WBC total count , RBC count, PLT count) were estimated using an automated complete blood count (CBC) machine.

-Evaluation of biochemical parameters

The method of (8) was applied to detect the ALT enzyme. ALP enzyme activity was estimated based on the method (9) using a ready-made kit and an enzyme-based method which is a colorimetric method based on the substrate on which alkaline phosphatase (ALP) acts. The technique was used to measure the AST enzyme activity (8).

-Statistical Data Analysis

The Social Package Statistical System (SPSS) software was used to statistically analyze the data, and one-way analysis of variance (ANOVA) was used to test for differences between mean values (10). The data were presented as mean and standard error (Mean± SD), with a significance threshold of P <0.05 and the least significant difference (LSD) applied (11).

Results

The results of the statistical analysis of this study showed a significant increase (P<0.05) in count of white blood cells (WBC) and platelets(PLT), while a significant decrease (P<0.05) in count of red blood cells (RBC) for the group of females dosed with the aqueous extract of *Senna alexandrina* at concentrations of (300, 200) mg/kg for (30, 45) days, compared with the control groups for same treatment periods (table 1,2) respectively.

Table (1): Effect of hot aqueous extract of *Senna alexandrina* leaves on levels of some physiological parameters in blood serum of female rats for (30) days.

Groups	physiological parameters(M±SD)		
	WBC(10^9/L)	RBC (10^{12}/L)	PLT(10^9/L)
Control	1.25±4.52	0.61±4.30	303.0±40.80
Plant extract at a level of 200 mg/kg	5.72±0.81 A	3.46±0.28 A	688.50 ±51.93 A
Plant extract at a level of 300 mg/kg	6.21 ±2.65 AB	2.6 2 ±0.39 AB	800.0 ±104.77 AB
L.S.D	0.52	0.71	10.36

Data as/ mean and standard deviation
L.S.D/ Least significant difference at a probability level(p<0.05).
A/ Significant difference compared to the control group.
B/Significant difference between the groups.

ISSN Print: 2790-6485 | ISSN Online : 2790-6477 Open Access

Table (2): Effect of hot aqueous extract of *Senna alexandrina* leaves on levels of some physiological parameters in blood serum of female rats for (45) days.

Groups	physiological parameters(M±SD)		
	WBC(10^9/L)	RBC (10^{12}/L)	PLT(10^9/L)
Control	1.25± 4.89	0.61±4.49	303.0±40.80
Plant extract at a level of 200 mg/kg	6.17 ±0.78 A	3.00 ±0.81 A	688.50 ±51.93 A
Plant extract at a level of 300 mg/kg	6.88 ±2.15 A	2.25 ±1.35 AB	800.0 ±104.77 AB
L.S.D	2.424	0.564	11.36

Data as/ mean and standard deviation
L.S.D/ Least significant difference at a probability level($p<0.05$).
A/ Significant difference compared to the control group.
B/Significant difference between the groups.

Data pointed to a significant increase ($P<0.05$) in liver enzymes (AST, ALP) , while there is a significant decrease ($P<0.05$) in liver enzyme (ALT) of group of females dosed with the aqueous extract of *Senna alexandrina* at concentrations of (300, 200) mg/kg for (30, 45) days, compared with control groups for same treatment periods, and according to the current study's findings, there was a significant increase ($P<0.05$) in malondialdehyde (MDA) levels in female rats given the extract at doses of 300 and 200 mg/kg for two treatment periods of 45 and 30 days while levels of glutathione (GSH) ($P<0.05$) had significantly lower than the control animals for 30 and 45 days, as shown in tables (3,4) respectively .

Table (3): Effect of hot aqueous extract of *Senna alexandrina* leaves on levels of some biochemical parameters in blood serum of female rats for (30) days.

Groups	Biochemical parameters(M±SD)				
	AST (U/L)	ALT (U/L)	ALP (U/L)	GSH (µmol/ml)	MDA (Con.nmol/ml)
Control	157.50±55.73	73.50±45.99	63.0±15.43	33.91±7.67	2.30±0.65
Plant extract at a level of 200 mg/kg	174.00±19.78 B	62.75±17.19 A	182.75±6.95 A	16.78± 2.16 A	0.92 ±3.25 B
Plant extract at a level of 300 mg/kg	182.50±55.55 B	56.25±19.29 AB	188.0±7.91 AB	13.98 ± 1.97 AB	5.05±0.77 AB
L.S.D	6.92	4.71	5.24	4.00	1.23

Data as/ mean and standard deviation
L.S.D/ Least significant difference at a probability level($p<0.05$).
A/ Significant difference compared to the control group.
B/Significant difference between the groups.

Table (4): Effect of hot aqueous extract of *Senna alexandrina* leaves on levels of some biochemical parameters in blood serum of female rats for (45) days.

Groups	Biochemical parameters(M±SD)

ISSN Print: 2790-6485 | ISSN Online : 2790-6477 Open Access

	AST (U/L)	ALT (U/L)	ALP (U/L)	GSH (µmol/ml)	MDA (Con.nmol/ml)
Control	187.50±9.73	72.50±4.99	73.0±15.43	33.91±7.67	2.30±0.56
Plant extract at a level of 200 mg/kg	218.50±10.83 A	49.75±13.18 A	162.25±11.03 A	20. 86± 5.13 A	5.18±0.87 A
Plant extract at a level of 300 mg/kg	252.75±13.46 AB	35.75±9.22 AB	208.50±6.80 AB	11.08± 2.72 AB	5.35±1.03 AB
L.S.D	16.37	10.10	20.23	7.27	1.44

Data as/ mean and standard deviation
L.S.D/ Least significant difference at a probability level($p<0.05$).
A/ Significant difference compared to the control group.
B/Significant difference between the groups.

Discussion

Results of this study showed a significant increase in count of white blood cells (WBC) and platelets(PLT), while a significant decrease in count of red blood cells (RBC) for the group of females dosed with the aqueous extract of *Senna alexandrina* at concentrations of (300, 200) mg/kg for (30, 45) days, compared with the control groups for same treatment periods, laxative use hinders the absorption of iron, a necessary component of hemoglobin, the molecule that carries oxygen inside red blood cells. This can result in iron deficiency anemia, which lowers the number of red blood cells and impairs their capacity to carry oxygen. This could be the cause of the decreased red blood cell count. The plant also contains saponins or some phenolic compounds which can have properties blood condition and *Senna alexandrina* may cause dehydration, especially with prolonged or excessive use and dehydration can in turn, affect blood volume and possibly red blood cell concentration. Although severe dehydration is not a direct cellular effect, it may stress the circulatory system and indirectly affect red blood cell function by changing blood viscosity and oxygen delivery (12). Anemia can develop as a result of malnutrition and malabsorption Which leads to a deficiency of iron and other nutrients, such as folic acid or vitamin B12 (13), the increase in white blood cell count may be due to increased intestinal motility and the possibility of diarrhea caused by *Senna alexandrina* which may in turn indirectly affect the white blood cell count, as some cytokines released during inflammation can stimulate the production and release of white blood cells from the bone marrow leading to a temporary increase in the white blood cell count. Conversely, prolonged or excessive inflammation can lead to weaken the immune system and suppress the function of white blood cells. The increase in blood platelets is due to dehydration and fluid loss leading to blood viscosity and an increase in the number of platelets. The study by (14) confirmed that the use of low concentrations (50 mg/kg) of *Senna alexandrina* for a short dosage period reduces the negative effects on the count of red blood cells, white blood cells, and platelets, and vice versa when using a high concentration of the plant extract, and results pointed to a significant increase ($P<0.05$) in liver enzymes (AST, ALP) *Senna alexandrina*, while there is a significant decrease ($P<0.05$) in liver enzyme (ALT) of group of females dosed with the aqueous extract of *Senna alexandrina* at concentrations of (300, 200) mg/kg for (30, 45) days, compared with control groups for same treatment periods, the reason for the increase in the level of liver enzymes (AST, ALP) may be due to the increase in the level of liver enzymes which are highly toxic substances that have an oxidative effect causing liver toxicity as a result of oxidative stress and an increase in the level of free radicals (ROS) including hydroxyl radicals and oxygen radicals which cause membrane destruction or a malfunction in its working mechanism which causes these enzymes to exit the cells, thus increasing their level in the serum (15), or the

ISSN Print: 2790-6485 | ISSN Online : 2790-6477 Open Access

increased activity of these enzymes may be due to a dysregulation of the liver caused by free radicals. Liver enzyme dysfunction occurs in addition to changes in the permeability of the liver cell membrane. Significant increases in liver enzymes have been found to be accompanied by tissue and cellular damage (16). Elevated liver enzymes may also be due to oxidative stress and this study confirmed the results (17;18). As for the liver enzyme (ALT), this enzyme is an important and accurate indicator to accumulate fat in the liver, as low ALT activity leads to high blood cholesterol levels as is the case in cases of hepatic anemia (19), and according to the current study's findings, there was a significant increase ($P<0.05$) in malondialdehyde (MDA) levels ,while levels of glutathione (GSH) had significantly reduced ($P<0.05$) infemale rats given the extract at doses of 300 and 200 mg/kg for two treatment periods of 45 and 30 days compared with control animals for 30 and 45 days, free radicals in particular are considered strong oxidizing agents that cause oxidative stress and stimulate oxidative destruction of various cells and tissues in the body, as they interact strongly with lipids in cell membranes and this causes oxidation and interaction with important molecules such as nucleic acids, proteins, and other intracellular molecules. It also stimulates the breakdown of proteins and other intracellular molecules, leading to the destruction of various body cells and causing elevated levels of malondialdehyde (MDA), a clear indicator of tissue damage caused by free radicals in the body. High concentrations of free radicals deplete antioxidants and it results in the depletion of antioxidants such as glutathione (GSH) which is the first line of defense against these free radicals (20-22). On the other hand, there is no significant difference ($P<0.05$) in the level of dimalonaldehyde (MDA) in female rats treated with the extract at a concentration of (200,300) mg/kg for (30,45) days compared with control groups for (30,45)days(tables3,4), the presence of antioxidant enzymes in vivo protects cells from oxidative damage and maintains the balance between oxidative processes and the antioxidant defense system, but when the balance is disturbed as a result of the increase of oxidizing agents that cause oxidation of phospholipids that induce oxidative stress, the activity of free radicals increases significantly and the efficiency of the antioxidant defense system decreases, resulting in increased lipid peroxidation and increased production of MDA (23-25). Stress may be the cause of increased activity of the enzyme fatty acetyl CoA oxidase (FACO) which catalyzes the peroxidation of fatty acids and increases the formation of H_2O_2, thus increasing the superoxide dismutase of lipids and the production of malondialdehyde (MDA) (26-28) and free radicals (ROS) attack fatty acids in cell membranes causing significant cellular damage and resulting in the production of reactive aldehydes (MDA), the end product of lipid peroxidation (23,29).

Conclusion: This study concludes that consuming hot aqueous extract of senna leaves at high concentrations and for long periods leads to increased levels of white blood cells (WBC), the number of platelets (PLT), and the levels of enzymes (AST, ALP), malondialdehyde (MAD), while the number of red blood cells and the levels of enzymes (ALT) and glutathione (GSH) decreased, the activity of free radicals increases significantly and the efficiency of the antioxidant defense system decreases, resulting in increased lipid peroxidation and increased production of MDA

Recommendation: Plant extracts should not be used randomly. The use of aqueous extract of senna leaves in high concentrations for long periods should be avoided because it causes harmful side effects.

References

1. SĂVULESCU, Elena, et al. Morphological and anatomical properties of the Senna alexandrina Mill.(Cassia angustifolia Vahl.). Sciendo, 2018, 1.1: 305-310.
2. BARI, Kaniz Fatima, et al. Serum zinc and calcium level in patients with psoriasis. Journal of Knowledge Learning and Science Technology ISSN: 2959-6386 (online), 2023, 2.3: 7-14.
3. ALI, Md Yousof; PARK, Seongkyu; CHANG, Munseog. Phytochemistry, ethnopharmacological uses, biological activities, and therapeutic applications of Cassia obtusifolia L.: a comprehensive review. Molecules, 2021, 26.20: 6252.
4. FARAG, Mohamed A., et al. Integrated

ISSN Print: 2790-6485 | ISSN Online : 2790-6477 Open Access

comparative metabolite profiling via MS and NMR techniques for Senna drug quality control analysis. Analytical and bioanalytical chemistry, 2015, 407: 1937-1949.

5. GEORGE, Philomena. Concerns regarding the safety and toxicity of medicinal plants-An overview. Journal of applied pharmaceutical science, 2011, Issue: 40-44.
6. BALLOTIN, Vinícius Remus, et al. Herb-induced liver injury: Systematic review and meta-analysis. World Journal of Clinical Cases, 2021, 9.20: 5490.
7. Hiyam Habeeb Al-Thabhawee, Elham Abed Mahdi ,Amal Hamdan Mohson, Aseel Abdulrahman Hussein. Investigating The Roles of FGF21 and VEGF-A as Metabolic and Vascular Mediators in Graves' Disease Progression.; Al-Harf Journal., No. 25., Vol. 2, May 2026
8. HERNÁNDEZ, I.; NIELL, F. X.; FERNÁNDEZ, J. A. Alkaline phosphatase activity in marine macrophytes: histochemical localization in some widespread species in southern Spain. Marine Biology, 1994, 120: 501-509.
9. AL-MASHHADANI, Z. I.; MUKHLIS, A. J. A.; AL-FARAJI, AS A.-Razaq. Estimation of ALP, GPT and GOT Activities in Iraqi Patients Female With Breast Cancer. Ibn AL-Haitham Journal For Pure and Applied Science, 2017, 25.1.
10. ENGVALL, E.; PERLMAN, P. Enzyme-Linked Immunosorbent Assay, ELISA. Peeters. H., ed. Protides of the Biological Fluids, 1971, 553-556.
11. ALMUNDARIJ, Tariq I., et al. Evaluation of the anti-diabetic activities of colored rice varieties in streptozotocin-induced diabetic rats. Systematic Reviews in Pharmacy, 2020, 11.11: 1424-1433.
12. A Jawad Alabbasy. Evolution The antibacterial and Antioxidants Activity of Garlic Extracts. Kuwait Research Journal of Agriculture and Life Science. 2026 Oct;5(3):1-12
13. CHEN, Li-Na, et al. Erythropoietin improves glucose metabolism and pancreatic β-cell damage in experimental diabetic rats. Molecular medicine reports, 2015, 12.4: 5391-5398.
14. KHAN, Rafay, et al. Increased erythropoietin levels as a biomarker of pancreatic adenocarcinoma: A case report. Molecular and Clinical Oncology, 2016, 4.1: 134-136.
15. Zainab Jawad Naqi, Widad Hashim Yahya, Aseel Kamel Abdulhussain, Buthaina Abdulhasan Nasir. (2025). A study of The effect of Alcoholic Extract of Celery Seeds on The Concentration of Sex Hormones in Male White Rats Treated with Depakine., Al-Harf Journal., No. 24., Vol. 1,March 2025
16. BUSTI, Fabiana, et al. Anemia and iron deficiency in cancer patients: role of iron replacement therapy. Pharmaceuticals, 2018, 11.4: 94.
17. OLUGBENGA, Olufunke; OKPUZOR, Joy. Effects of Senna alata Extract on the Hematological and Biochemical Alterations in Rats Exposed to Carcinogen. 2023.
18. ADEBAYO, Olayinka A.; AKINLOYE, Oluyemi; ADARAMOYE, Oluwatosin A. Cerium oxide nanoparticles attenuate oxidative stress and inflammation in the liver of diethylnitrosamine-treated mice. Biological trace element research, 2020, 193: 214-225.
19. Eelaf Kareem Abdali Hussein Al-Ibrahimi, Widad Hashim Yahya Almuhana. Evaluation of the Protective Role of Epimedium Grandiflorum Leaf Nano-Extract in Prostate Histological Changes in Male Albino Rats Treated with Amlodipine.; Al-Harf Journal., No. 25., Vol. 2, May 2026
20. PUNVITTAYAGUL, Charatda, et al. Augmentation of diethylnitrosamine–induced early stages of rat hepatocarcinogenesis by 1, 2-dimethylhydrazine. Drug and Chemical Toxicology, 2019, 42.6: 641-648.
21. YUAN, Ye, et al. Protective effects of polysaccharides on hepatic injury: A review. International journal of biological macromolecules, 2019, 141: 822-830.
22. HONG-WEI, Y. I., et al. Selenium-enriched Bifidobacterium longum protected alcohol and high fat diet induced hepatic

ISSN Print: 2790-6485 | ISSN Online : 2790-6477 Open Access

injury in mice. Chinese Journal of Natural Medicines, 2020, 18.3: 169-177.

23. S S Abdul-Hur Al-Jassas, S M Jwad. (2024). A physiological, Histological Evaluation Study of Erythropoietin Hormone Levels and some other Biomarkers in Male Albino Rats Treated with Acetaminophen Drug and Alcoholic Extract of Malus domestica Peels., Al-Harf Journal., Vol. 21., Issue. June 2024

24. WASHINGTON, Ida M.; VAN HOOSIER, Gerald. Clinical biochemistry and hematology. In: The laboratory rabbit, guinea pig, hamster, and other rodents. Academic Press, 2012. p. 57-116.

25. Zahraa Lateef Al-Khaqani., Rouaida Kadhim A.Al- Hussein., Zainab Hameed Al-Ziyadee, Zahraa Hussam Assarraf., Hawraa Salih Aljaefari .(2026). Evaluation of the Anti-Obesity Drug Orlistat on Liver Enzymes in Male Albino Rats. Al-Harf Journal., No. 25., Vol.3, August 2026

26. AKHZARI, Morteza, et al. Berberine attenuated oxidative stress induced by sodium nitrite in rat liver. Jundishapur Journal of Natural Pharmaceutical Products, 2019, 14.1.

27. RAHAL, Anu, et al. Oxidative stress, prooxidants, and antioxidants: the interplay. BioMed research international, 2014, 2014.1: 761264.

28. AJU, B. Y.; RAJALAKSHMI, R.; MINI, S. Protective role of Moringa oleifera leaf extract on cardiac antioxidant status and lipid peroxidation in streptozotocin induced diabetic rats. Heliyon, 2019, 5.12.

29. VENMATHI MARAN, Balu Alagar, et al. Hepatoprotective potential of Malaysian medicinal plants: a review on phytochemicals, oxidative stress, and antioxidant mechanisms. Molecules, 2022, 27.5: 1533.