International Journal of Clinical and Diagnostic Pathology

ISSN (P): 2617-7226
ISSN (E): 2617-7234
www.patholjournal.com
2025; 8(1): 50-55
Received: 22-11-2024
Accepted: 28-12-2024

Zahraa Riadh Majeed
Department of Medical Biotechnology, College of Biotechnology, AL-Qasim Green University, Iraq

Abbas Abed Sharhan
Department of Medical Biotechnology, College of Biotechnology, AL-Qasim Green University, Iraq

Corresponding Author:
Zahraa Riadh Majeed
Department of Medical Biotechnology, College of Biotechnology, AL-Qasim Green University, Iraq

Role of *Melissa officalis* leaves extract in treatment of induced hypothyroidism in male albino rats

Zahraa Riadh Majeed and Abbas Abed Sharhan

DOI: https://doi.org/10.33545/pathol.2025.v8.i1a.2053

Abstract
Study was conducted to estimation efficiency of alcoholic Leaves extract from *Melissa officinalis* in treatment of induced hypothyroidism in male albino rats. The aim of this study was to investigate the effects of oral administration of *Melissa officinalis* leaves extract on biomarkers of Thyroid hormones and lipid profile in induced hypothyroidism rats. Fifty male rats were divided into five groups, ten for each one. Group I selected as negative control and administered orally with normal saline alone, group II served as positive control and treated by carbimazole (5 mg/kg) anti-thyroid drug for six weeks. Group III treated by carbimazole to induce hypothyroidism, then treated by plant extract (75 mg/day). Group IV treated by carbimazole to induce hypothyroidism, then treated by plant extract (150 mg/day) And the group V was treated by carbimazole (5 mg/kg), then treated by thyroxin (50 µg). The results showed non-significant differences in T_3 and T_4 level in third, fourth and fifth groups when compared with the first group, while the results showed a significant increase ($p \leq 0.05$) when compared with second group. Results showed insignificant differences in the level of TSH in the third, fourth and fifth groups when compared with the first, while there was a significant decrease when compared with the second group. The results showed an insignificant differences in the concentrations of TG, TC, LDL-c, and VLDL-c in the third, fourth and fifth groups when compared with the first group, while there was a significant decrease when compared with the second group. Also, the results showed an insignificant differences in the concentrations of LDL-c in third, fourth group and fifth groups when compared with the first group, while there was a significant decrease when compared with the second group. In conclusion, *Melissa officinalis* leaves extract succeeded in amelioration of thyroid function towards normal level. *Melissa officinalis* have efficacy in improves lipid profile regulation inside the body.

Keywords: Hypothyroidism, thyroid gland, T_3, T_4 and TSH, lipid profile, cholesterol, *Melissa officinalis*, plant extract

Introduction
The thyroid gland plays a crucial role in regulating the body's metabolism by producing thyroid hormones, primarily thyroxine (T_4) and triiodothyronine (T_3). These hormones influence nearly every cell in the body, affecting growth, development, and energy expenditure [1]. Thyroid hormones enhance the oxidation of fatty acids in the liver and muscle, promoting energy production and reducing fat storage [2]. Thyroid stimulating hormone (TSH) is a glycoprotein hormone secreted from the anterior lobe of the pituitary gland. The thyroid gland produces thyroid hormones primarily in response to this stimuli. Additionally, it promotes thyroid follicular cell development, resulting in thyroid hypertrophy [3]. There are number of disorder companied with the thyroid gland functions such as hypothyroidism, hyperthyroidism and thyroid nodules [4]. Hypothyroidism is a disease means the thyroid gland cannot able to synthesis enough amount from thyroid hormone, this disease regarded as an endocrine disorder which effect numerous metabolic processes and in all tissues in body [5]. Carbimazole is a prodrug of the active structure methimazole which keeps the thyroid peroxidase enzyme from coupling and iodinating the tyrosine deposits on thyroglobulin, consequently decreasing the generation of T_3 and T_4 [6].
The standard treatment replacement therapy, in primary or central hypothyroidism. providing synthetic T_4 to normalize hormone levels [7]. In hypothyroidism, lower levels of thyroid hormones lead to decreased lipolysis (Breakdown of fats), resulting in increased levels of triglycerides and cholesterol.

Hypothyroidism is often associated with lower levels of HDL (High-density lipoprotein) cholesterol, which is important for transporting cholesterol away from the arteries and back to the liver. Hypothyroidism can lead to insulin resistance, which can further increase triglyceride levels and affect overall lipid metabolism [8].

Many natural dietary agents, including vegetables, fruits, herbs, and spices have been used in traditional medicines, as non-conventional treatments, for thousands of years, but without sufficient scientific proofs. If effective, natural agents might lead to the development of natural and novel drugs with low or no side effects [9]. *Melissa officinalis* L (lemon balm, Lamiaceae family) is a medicinal plant has long been used in the Iranian traditional medicine. It is an aromatic perennial plant [10], that has a highly branched root system, which guarantees the plant excellent adaptive capabilities; the upper parts of the plant perish at the beginning of the winter, while in spring new saplings re-emerge from the roots, it is an edible medicinal herb belonging to the mint family Lamiaceae and the subfamily Nepetoideae. *Melissa Officinal* contains several phytochemicals such as phenolic acids, flavonoids, terpenoids, and many others at the basis of its pharmacological activities Indeed [11], flavonoid can help with killing free radicals [12]. Sveral clinical studies have investigated the potential pharmaceutical properties of *Melissa officinalis* consumption in patients with depression, anxiety, obesity, diabetic Type 2, and cancer [13]. This suggests a partial protective effect of leaves extract against cholesterol levels. By affecting the absorption of dietary cholesterol in the intestines or by altering the synthesis and excretion of cholesterol inhibiting enzymes involved in cholesterol absorption or enhance the excretion of bile acids, which can lead to reduced cholesterol levels [14, 15].

2. Materials and Methods

Preparation of extract

The dried leaves of plant of *Melissa Officinals* were obtained from the local market in Hilla City, Iraq. The dried plant material were coarsely powdered and subjected to extraction, extracted with ethanol (70%) by soxhlet [16] for 24 hrs, and then the extract was placed in cotainer and put in the oven at a temperature of 40 ℃ within 48 hours, the extract was stored at 4 ℃ until use [17].

Fifty (50) male rats were divided into five groups, ten for each. Group I served as negative control and administered orally with normal saline alone. The second group used as positive control was treated by carbimazole (5 mg/kg /day) anti-thyroid drug for six weeks [18]. The third group was treated with carbimazole then plant extract (75 mg /day) [19]. The fourth group was administrated by carbimazole drug then plant extract (150 mg/day) for six weeks [18], the fifth group was treated by thyroxin drug (50 µg) for six week [20]. Rats body weight were measured before and after treatment, and animals were sacrificed after 48 hours of last administration of the drugs and plant extract. The blood was collected from the left ventricle of the heart through heart puncture, and the blood samples allowed to stand for 1 hour at a room temperature and later centrifuged at 3000 rpm for 15 min to obtain serum which served in deep freez.

Hypothyroidism was stimulated by antithyroid drug called carbimazole which is using in the treatment of human hyperthyroidism disease [21]. Change in the thyroid gland functions may related to disorder in hormones synthesis was recorded. Thyroid hormones T_3, T_4 and TSH were measured by using Elisa SunLong Biotech kits (China). While lipid profile measurements were carried out using spectrophotometer. Total cholesterol was determined using Bio. Labo. S.A. kit (France).

Statistical Analysis

The statistical analysis of the obtain data was performed by using one-way (ANOVA) which include estimation of (Mean ±standard error) and comparison between means by using least significant difference (L.S.D) between groups and under probability ($p \leq 0.05$) according to Statistical Package foe Social Science (SPSS) system (version 20)(AL-Rawi and Khalafalla, 2000) [22].

3. Results

The results showed no significant differences in the concentrations of TSH in the third group (Carbimazole & plant extract 75 mg/day) when compared with the first (Normal saline alone), fourth group (Carbimazole & plant extract 150 mg/day) and fifth groups (Carbimazole & thyroxin drug), as showed in (figure-1). While there was a significant decrease when compared with the second (Carbimazole alone) group. In T3 and T4 concentrations the results showed that there was no significant difference in the third group (Carbimazole & plant extract 75 mg/day) when compared with the first group, fourth (Carbimazole & plant extract 150 mg/day), and fifth groups (Carbimazole & thyroxin) while the results showed a significant increase ($p \leq 0.05$) when compared with second group (Carbimazole alone), as showed in (Figure-2) and (Figure-3).

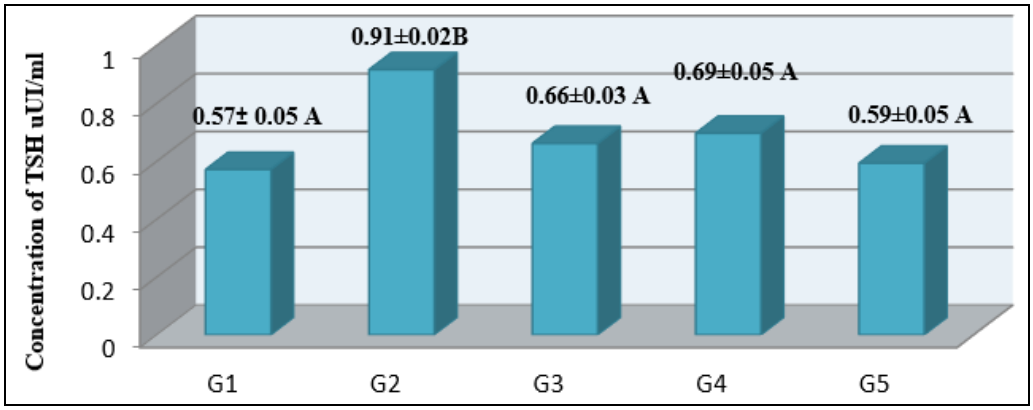

Fig 1: Effects of alcoholic extract *of Melissa officinalis* leaves on the serum TSH level (Mean ± S.E), the different letters are a significant differences at $p \leq 0.05$.

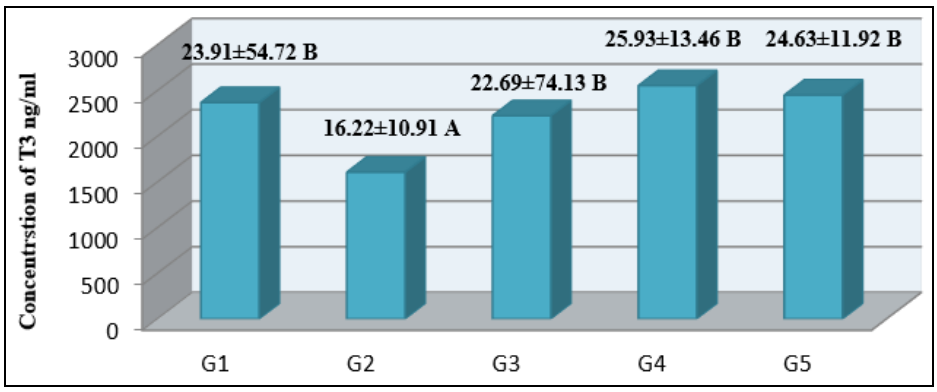

Fig 2: Effects of alcoholic extract of *Melissa officinalis* leaves on the serum T3 level (Mean ± S.E), the different letters are a significant differences at $p \leq 0.05$.

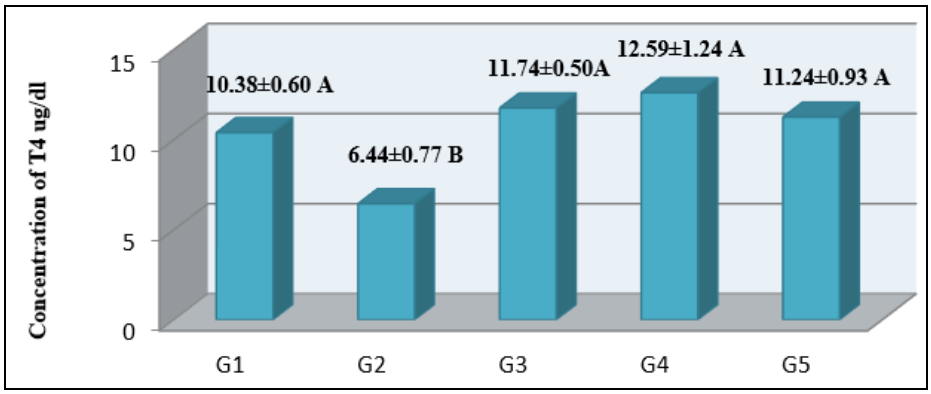

Fig 3: Effects of alcoholic extract of *Melissa officinalis* leaves on the serum T4 level (Mean ± S.E), the different letters are a significant differences at $p \leq 0.05$.

Serum levels of Lipid profile

In table- 1 The results showed an insignificant differences in the concentrations of TG in the third group (Carbimazole & plant extract 75 mg/day), fourth group (Carbimazole & plant extract 150 mg/day) and fifth groups (Carbimazole & thyroxin drug) when compared with the first (normal saline alone), while there was a significant decrease when compared with the second (Carbimazole alone) group. The results showed an insignificant differences in the concentrations of TC in the third group (CARBIMAZOLE & plant extract 75 mg/day, fourth group (Carbimazole & plant extract 150 mg/day) and fifth groups (Carbimazole & thyroxin drug) when compared with the first (normal saline alone), while there was a significant decrease when compared with the second (Carbimazole alone) group. The results showed an insignificant differences in the concentrations of HDL-c in the third group (Carbimazole & plant extract 75 mg/day), fourth group (Carbimazole & plant extract 150 mg/day) and fifth groups (Carbimazole & thyroxin drug) when compared with the first (Normal saline alone), while there was a significant increase when compared with the second (Carbimazole alone) group. The results showed an insignificant differences in the concentrations of LDL-c in the third group (Carbimazole & plant extract 75 mg/day) when compared with the first (normal saline alone), fourth group (Carbimazole & plant extract 150 mg/day) and fifth groups (Carbimazole & thyroxin drug), while there was a significant decrease when compared with the second (Carbimazole alone) group. The results showed an insignificant differences in the concentrations of VLDL in the third group (Carbimazole & plant extract 75 mg/day) when compared with the first (Normal saline alone), fourth group (Carbimazole & plant extract 150 mg/day) and fifth groups (Carbimazole & thyroxin drug), while there was a significant decrease when compared with the second (Carbimazole alone) group. Effect of MO on serum thyroid function in different experimental groups.

Table 1: The effect of ethanolic extract of *Melissa officinalis* leaves on the sera levels of TG, TC, HDL-c, LDL-c and VLDL. (Mean ± S.E)

Parameters / Groups	Triglycerides (mg/dl)	Cholesterol (mg/dl)	HDL (mg/dl)	LDL (mg/dl)	VLDL (mg/dl)
GroupI (normal saline)	83.23±3.92 B	69.4±2.42 B	30.44±0.52 A	58.97±1.62C	16.64±0.78 B
GroupII (carbimazole)	125.28±12.25 A	94.18±5.25 A	24.88±1.70 B	78.14±2.71 B	25.07±2.57 A
GroupIII (carbimazole &plant extract 75 mg/day)	86.8±2.18 B	73.8±4.61 B	32.54±3.03 A	61.31±3.06 C	17.4±1.21 B
GroupV (carbimazole & plant extract15 mg/day)	81.77±7.87B	68.7±5.46B	32.75±0.67 A	55.26±6.48 C	16.35±0.65 B
GroupVI (carbimazole& thyroxin)	79.34±5.04 B	67.35±2.89 B	30.86±1.70A	56.98±3.84 C	15.86±1.0 B

Note: Different letters indicate the presence of a significantly differences ($p \leq 0.05$).

4. Discussion

The result in the study revealed that TSH level in second group animals (Carbimazole alone) was elevated significantly, while T_3 & T_4 level were reduced when compared with first group (normal saline alone), this result may be due to thyroid activity which mainly regulated by TSH, the defect in function of pituitary gland would result in hypothyroidism [23]. Carbimazole is an anti-thyroid drug has ability to block the T_3 and T_4 production pathways *in vivo*, or may reduce binding rate of T_3 and T_4 with the carrier proteins such as TBG [24]. The ability of plant extract to increasing concentrations of thyroid hormone may due to ability of leaf extract to induce increase T_4 concentration in the blood as a result of direct stimulation of T_4 synthesis in the follicles and release in blood stream [25]. Thyroid hormones are essential for normal body functions including metabolism, growth, maturation, and reproduction. Thyroid hormone levels are controlled by feedback regulation to the pituitary and hypothalamus, which has a primary role for integrating thyroid function with body requirements. When the blood level of thyroid hormone falls the hypothalamus senses the change and secretes thyroid–releasing hormone (TRH) [26, 27].

However, increase in serum T_3 concentration in third and fourth may be due to the stimulation in monodeiodination of T_4 in peripheral cells, which is regarded to be the major process of its synthesis. Another possibility of *Melissa officinalis* leaves extract can induce increase in thyroid hormone concentrations by decrease of utilization the thyroid hormones by the body [28]. As T_4 is synthesized in animals treated by *Melissa officinalis* plant extract increased the concentrations of this hormone, it appears that the leaf extract induced increase in T_4 concentration which could either be the result of direct stimulation of T_4 synthesis. Some studies suggest that *Melissa officinalis* phytochemicals in the extract, such as Caffic acid, which can positively influence thyroid hormone production. may stimulate an increase in T_4 concentrations, potentially through direct stimulation of T_4 synthesis or by supporting overall thyroid function [19, 29]. The mechanism, of action of thyroregulatory role of *Melissa officinalis* leaf extract, and the present findings clearly indicated that this extract is stimulant to thyroid functions [29]. Phenolic compounds and flavonoids found in *Melissa officinalis* may help reduce stress and support general thyroid health. Some studies suggest that flavonoids can positively influence hormonal balance, which may support thyroid function, The mechanisms by which they might help include promoting overall hormonal balance and improving metabolic health [30, 31].

The regulation of lipid profiles in the body involves complex interactions between various hormones, enzymes, and pathways. The liver produces and secretes lipoproteins, which they are broken down in the mitochondria for energy, influenced by hormonal signals and the availability of substrates [32]. The thyroid gland plays a critical role in the synthesis of fatty acids and the degragation of lipids; therefore thyroid dysfunction is often associated with weight gain. With that results which indicate an increase in body weight [33].

The result in the study showed a significant increase in second group (Carbimazole alone) in lipid profile (TG, TC, LDL-c, and VLDL-c) and significant decrease in (HDL-c) when compared to others groups. Carbimazole an antithyroid medication, it suppresses thyroid hormone production. As thyroid hormones play a crucial role in lipid metabolism. Reduced thyroid function can lead to changes in how the liver processes lipoproteins, potentially resulting in lower HDL and in elevated cholesterol levels in inducing hypothyroidism levels [34, 35]. Thyroid hormones, particularly thyroxine (T_4), stimulate the expression of LDL receptors in the liver that promote the breakdown of lipids. The reduced levels of these hormones associated with reduced hepatic clearance of LDL-c, which help clear LDL from the bloodstream. LDL receptor activity declines, leading to elevated LDL-c levels. This causes an increasing in accumulation of TG and TC, while the HDL-c decreased [36, 37], elevated triglyceride levels, which can contribute to increased VLDL production [38]. Hypothyroidism can lead to decreased HDL, which is often referred to as “good” cholesterol because it helps remove other forms of cholesterol from the bloodstream. Decreased in HDL-c level might be due to increased activity of CETP (Cholesterol ester transport protein) and lipoprotein lipase [39]. The result in the study showe a significant dicrease in third and fourth groups in lipid profile (TG, TC, LDL-c, and VLDL-c) and significant increase in (HDL-c) when compared to others groups, *Melissa officinalis* leaf extract can regulate LDL-c, TG and TC in humans. In addition, the potential effect *of Melissa officinalis* may suppress hypercholesterolemia, hyperlipidemia, and lipid peroxidation in the liver of rats. These results may be related to the hepatoprotective effect of *Melissa officinalis* of its phenolic compounds owing antioxidant properties which increase the level of thyroid hormone or the quercetin compounds in the plant, which possess inhibitory effect on lipid peroxidation) [40, 30].

Melissa officinalis has been shown to support liver function, which is crucial for maintaining the balance between HDL and LDL cholesterol. A healthy liver can efficiently process and eliminate excess cholesterol, promoting higher HDL levels. Improved liver function also enhances the body’s ability to clear bad cholesterol [41, 42]. This suggests a partial protective effect of *Melissa officinalis* leaves extract against cholesterol levels. By affecting the absorption of dietary cholesterol in the intestines or by altering the synthesis and excretion of cholesterol inhibiting enzymes involved in cholesterol absorption or enhance the excretion of bile acids, which can lead to reduced cholesterol levels [14, 15], helping in prevent LDL cholesterol from becoming oxidized, aiding the conversion of LDL to HDL, positively influence HDL levels [43].

Studies have indicated that *Melissa officinalis* may have an inhibitory effect on enzymes involved in cholesterol synthesis, particularly HMG-CoA reductase, the same enzyme targeted by statin drugs used to lower cholesterol. By inhibiting this enzyme, *Melissa officinalis* may reduce the overall production of cholesterol in the liver, lowering LDL levels in the bloodstream [44]. Also, *Melissa officinalis* may support the body's ability to metabolize lipids, which is crucial for maintaining healthy cholesterol levels. By improving lipid metabolism, the body can more effectively remove excess cholesterol from the bloodstream, which may help raise HDL levels. HDL cholesterol helps transport excess cholesterol from the arteries back to the liver, where it can be excreted or reused, thus protecting the cardiovascular system [45, 46].

5. Conclusion

From the present data can be concluded that alcoholic extract of *Melissa officinalis* leaves has a biochemical role

in ability to succeeded in amelioration of thyroid function towards normal level. MO possesses anti-hypothyroidism efficacy and improves regulation of lipid profile, in hypothyroidism disease.

6. References

1. Salman AG, Mahdi IAJ, Mukhlef AK, Abd Alsattar Mohammad R, Zaghir MSH, *et al*. Physiological aspects of thyroid disorders: Anatomy, Hormones, Diagnosis and Management. Curr Clin Med Educ. 2024;2(5):17-32.
2. Wang X, Wu Z, Liu Y, Wu C, Jiang J, Hashimoto K, *et al*. The role of thyroid-stimulating hormone in regulating lipid metabolism: Implications for body–brain communication. Neurobiol Dis. 2024;106658.
3. Al Shukri SAAJ, Al-Janabi HT, Ali RA. Fluctuation of Thyroid Stimulating Hormone (TSH) During Pregnancy. Curr Clin Med Educ. 2024;2(03):16-23.
4. Falgoos NS, Abdulredha WS. Thyroid dysfunction effect on lipids profile in some women of Al-Nasiriyah city. Biochem Cell Arch. 2020, 20(2).
5. Olanrewaju OA, Asghar R, Makwana S, Yahya M, Kumar N, Khawar MH, *et al*. Thyroid and Its Ripple Effect: Impact on Cardiac Structure, Function, and Outcomes. Cureus. 2024;16(1).
6. Hossain AO. Carbimazole and its effects on thyroid gland of female rabbits. Indian J Forensic Med Toxicol. 2019;13(3):305-311.
7. Jonklaas J. Optimal thyroid hormone replacement. Endocr Rev. 2022;43(2):366-404.
8. Nandi K, Sen DJ, Saha D. Hormones are the Masterkey in Chemical co-ordination system of body. Int. J Pharm Life Sci. 2020, 11(10).
9. AlAli M, Alqubaisy M, Aljaafari MN, AlAli AO, Baqais L, Molouki A, *et al*. Nutraceuticals: Transformation of conventional foods into health promoters/disease preventers and safety considerations. Molecules. 2021;26(9):2540.
10. Shahrajabian MH, Sun W. Survey on medicinal plants and herbs in traditional Iranian medicine with anti-oxidant, anti-viral, anti-microbial, and anti-inflammation properties. Lett Drug Des Discov. 2023;20(11):1707-1743.
11. Zam W, Quispe C, Sharifi-Rad J, López MD, Schoebitz M, Martorell M, *et al*. An updated review on the properties of *Melissa officinalis* L.: Not exclusively anti-anxiety. Front Biosci Scholar. 2022;14(2):16.
12. Ghafil JS, Al-Taee NSN. Effect of Garlic and Celery Extracts on Lead Toxicity in Male Mice. Medico-legal Update. 2020, 20(2).
13. Osaili TM, Dhanasekaran DK, Zeb F, Faris ME, Naja F, Radwan H, *et al*. A status review on health-promoting properties and global regulation of essential oils. Molecules. 2023;28(4):1809.
14. Bahr T, Butler G, Rock C, Welburn K, Allred K, Rodriguez D. Cholesterol-lowering activity of natural mono- and sesquiterpenoid compounds in essential oils: A review and investigation of mechanisms using in silico protein–ligand docking. Phytother Res. 2021;35(8):4215-4245.
15. Al-Snafi AE. Blood lipids lowering effect of medicinal plants. GSC Biol Pharm Sci. 2022;19(3):015-043.
16. Soxhlet F. Dinglers' Polyt J. 1879;232:461.
17. Shakeri A, Sahebkar A, Javadi B. *Melissa officinalis* L.–A review of its traditional uses, phytochemistry and pharmacology. J Ethnopharmacol. 2016;188:204-28.
18. Abdel-Fattah ME, Mohammed SM, Mohammed IH. Experimentally-induced thyroid dysfunctions on cardiac contractility in adult male albino rats. Al-Azhar Assuit Med J. 2015;13(3):143-151.
19. Abdel-Aziz M. Study on the therapeutic potential of *Melissa officinalis* (Lemon Balm) on male Wistar albino rats with induced-hypothyroidism. Al-Azhar J Pharm Sci. 2018;57(1):1-17.
20. Alva-Sánchez C, Sánchez-Huerta K, Arroyo-Helguera O, Anguiano B, Aceves C, Pacheco-Rosado J. The maintenance of hippocampal pyramidal neuron populations is dependent on the modulation of specific cell cycle regulators by thyroid hormones. Brain Res. 2009;1271:27-35.
21. Hussein SA, Abdel Aal S, Marzouk M, Darweish M, Hussein AH. Spirulina platensis and Grape Seed Proanthocyanidin Extract ameliorates hepatic impairment in Carbimazole-induced hypothyroidism in male rats via caspase 8/Bcl-2 signaling pathway. Benha Vet Med J. 2022;42(2):43-49.
22. Al-Rawi KM, KhalafAllah AM. Design and Analysis of Experiments. National of Higher Education and Scientific Research, Iraq; c2000.
23. Leung AK, Leung AA. Evaluation and management of the child with hypothyroidism. World J Pediatr. 2019;15:124-134.
24. Kerrigan LB, Stewart SA, Domínguez-Robles J, Brady AJ, Ammar AA, Donnelly RF, *et al*. Drug delivery systems for thyroid disease treatment: a mini review on current therapies and alternative approaches. J Drug Deliv Sci Technol. 2023;87:104861.
25. Hameed SI, Al-Shahwany AW, Salih SJ. Evaluation of the activity of some plants extracts on thyroid gland regulation in female albino rats. Iraqi J Sci. 2020;254-265.
26. Chaker L, Peeters RP. Thyroid-Stimulating Hormone. In: The Pituitary. Academic Press; c2022. p. 173-207.
27. Alamoudi MO. Pituitary glands and hormonal disorders: A focus on thyroid stimulating hormone disorders. Int J Pharm Res. 2020;09752366.
28. Taïbi K, Abderrahim LA, Helal F, Hadji K. Ethnopharmacological study of herbal remedies used for the management of thyroid disorders in Algeria. Saudi Pharm J. 2021;29(1):43-52.
29. Abo-Zaid OA, Moawed FS, Taha EF, Ahmed ES, Kawara RS. *Melissa officinalis* extract suppresses endoplasmic reticulum stress-induced apoptosis in the brain of hypothyroidism-induced rats exposed to γ-radiation. Cell Stress Chaperones. 2023;28(6):709-720.
30. Mahitab EK, Salama A, Mourad H, Abdel-Wahhab K. Effect of lemon balm (*Melissa officinalis*) aqueous extract on streptozotocin-induced diabetic rats. Egypt Pharm J. 2019;18(4):296-296.
31. Karajgi S, Gavit PR, Babasaheb JS, Rout DS, Chakrapani IS, Bhattacharya S, *et al*. A Comprehensive Review of the effects of Toxicity and Prevailing conditions on the Thyroid Gland and its Herbal Medicament. J Pharm Negative Results. 2023;696-703.
32. Kloska A, Węsierska M, Malinowska M, Gabig-Cimińska M, Jakóbkiewicz-Banecka J. Lipophagy and lipolysis status in lipid storage and lipid metabolism diseases. Int J Mol Sci. 2020;21(17):6113.
33. Macvanin MT, Gluvic Z, Zafirovic S, Gao X, Essack M, Isenovic ER. The protective role of nutritional

antioxidants against oxidative stress in thyroid disorders. Front Endocrinol. 2023;13:1092837.
34. Nasser EK, Majeed KR, Ali HI. Effect of some strains of lactic acid bacteria and their mixture on the level of fats and cholesterol in albino rats (*Rattus norvegicus*) male with hypothyroidism induced using carbimazole. Basrah J Agric Sci. 2021;34(1):139-46.
35. Farag EA, Filobbos SA, Afifi NM, Mahmoud ST, Alghandour SM. Thyroxine restores hippocampal neurogenesis and synaptogenesis in a male rat model of carbimazole-induced hypothyroidism: a histological study. Beni-Suef Univ J Basic Appl Sci. 2023;12(1):57.
36. Al-Janabi G, Hassan HN, Al-Fahham A. Biochemical changes in patients during hypothyroid phase after thyroidectomy. J Med Life. 2022;15(1):104.
37. Brenta G, Schreier L. Thyroid, Lipids, and Risk of Atherosclerosis. In: Thyroid and Heart: A Comprehensive Translational Essay. 2020, 245-62.
38. Ofori EK. Lipids and Lipoprotein Metabolism, Dyslipidemias, and Management. In: Current Trends in the Diagnosis and Management of Metabolic Disorders. CRC Press; c2023. p. 150-70.
39. Kim HK, Song J. Hypothyroidism and diabetes-related dementia: Focused on neuronal dysfunction, insulin resistance, and dyslipidemia. Int. J Mol Sci. 2022;23(6):2982.
40. Ebrahimi Y, Hasanvand A, Valibeik A, Ebrahimi F, Abbaszadeh S. Natural antioxidants and medicinal plants effective on hyperlipidemia. Res J Pharm Technol. 2019;12(3):1457-1462.
41. Jacquier EF, Kassis A, Marcu D, Contractor N, Hong J, Hu C, *et al*. Phytonutrients in the promotion of healthspan: A new perspective. Front Nutr. 2024;11:1409339.
42. Barbhuiya PA, Dey J, Saikia K, Ishtiyak ST, Aqib AB, Marshillong KL, *et al*. Herbal tea used globally targeting metabolic syndrome: A systematic review. Int J Diabetes Developing Countries. 2024;1-16.
43. García-Oliveira P, Fraga-Corral M, Pereira AG, Lourenço-Lopes C, Jimenez-Lopez C, Prieto MA, *et al*. Scientific basis for the industrialization of traditionally used plants of the Rosaceae family. Food Chem. 2020;330:127197.
44. Shrivastav D, Kumbhakar SK, Srivastava S, Singh DD. Natural product-based treatment potential for type 2 diabetes mellitus and cardiovascular disease. World J Diabetes. 2024;15(7):1603.
45. Luo L, Guo Y, Chen L, Zhu J, Li C. Crosstalk between cholesterol metabolism and psoriatic inflammation. Front Immunol. 2023;14:1124786.
46. Upadhyay RK. High cholesterol disorders, myocardial infarction and its therapeutics. World J Cardiovasc Dis. 2023;13(8):433-469.

How to Cite This Article
Majeed ZR, Sharhan AA. Role of *Melissa officalis* leaves extract in treatment of induced hypothyroidism in male albino rats. International Journal of Clinical and Diagnostic Pathology. 2025; 8(1): 50-55.