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Research Article:

The Antioxidative Role of Moringa oil extract in Modulating Histological and Biochemical changes in the Salivary Glands of Rats under Oxidative Stress Induction

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Abstract

Background: Medicinal plants are a rich source of antioxidants, and attention has been drawn to them in subsequent years, as the Moringa plant is one of these sources. The aim of this work is to identify the protective role of Moringa oil versus the oxidative stress induced by H_2O_2 in the salivary glands of rats. **Materials methods:** 27 rats were divided into 3 groups. A daily dose of 1000 mg/kg of moringa oil was used for the first group. The second group received a daily dosage of 2 ml/rat of 0.5% H_2O_2. For 21 days, the third group received a daily dosage of 1000 mg/kg of moringa oil and 2 ml/rat of 0.5% H_2O_2. After 7, 14, and 21 days blood samples are drawn to measure TAC, GSH and MDA, and salivary gland samples are taken for histological examination. **Results:** There are significant differences in TAC, GSH and MDA levels between the treatment groups within each period and significant variations across different periods within the same treatment group. The histological examination suggests that the Moringa oil group generally maintained normal glandular architecture, while the H_2O_2 group exhibited signs of degeneration and necrosis. The Moringa + H_2O_2 group showed a protective effect in some instances, preserving tissue structure. **Conclusion:** the findings imply that Moringa oil could offer protection against oxidative stress by influencing TAC levels and reducing MDA levels. The combination of H_2O_2 and Moringa oil seems to counterbalance the impact of hydrogen peroxide. Moreover the group using Moringa oil generally maintained a structure while the H_2O_2 group showed signs of deterioration and cell death. The group using both Moringa oil and H_2O_2 exhibited some effects at times preserving the tissue structure of the gland.

1. Introduction

Antioxidants have a major role in maintaining public health; they reduce damage caused by free radicals, reduce inflammation in the body, improve cardiovascular health, and reduce the risk of heart disease (1). Antioxidants also assist and boost the immune system. Some evidence suggests that antioxidants may help to reduce the risk of specific kinds of cancer (2). Antioxidants aid in reducing aging, improve brain functioning, and maintain brain health (3, 4). The Moringa tree is a perennial tree originating in tropical regions. That tree is fruitful and produces the Moringa oleifera plant, from which the seeds used in extracting oil, which has various medical and cosmetic benefits, are extracted. It is high in vitamins and minerals, as well as antioxidants (4, 5). Moringa oil contains an amount of antioxidants, which are known for their ability to interact with molecules that cause oxidation, in the body (5). The antioxidant effects of Moringa oil are credited to components like vitamin E, vitamin A and other beneficial substances (5, 6). Additionally Moringa oils

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antioxidant properties play a role, in protecting the body's cells and tissues from damage. Some studies suggest that antioxidants could potentially enhance the system helping the body defend against diseases and infections (6, 7). Moringa oil is also thought to have a good effect on the skin due to its capacity to prevent oxidation and moisturize the skin (8). Hydrogen peroxide is a potent oxidant, and when used in large doses or incorrectly, it can harm the body when excessive amounts of hydrogen peroxide come into contact with the skin or eyes, it produces irritation and redness (9). Inhaling excessive amounts of hydrogen peroxide vapor may induce respiratory system discomfort, trouble breathing, and potentially lung damage (10). Ingestion of large amounts of hydrogen peroxide can cause intestinal discomfort, vomiting, and nausea, High amounts of hydrogen peroxide may cause tissue and organ corrosion (11). It also works as an oxidant and may react with living cells in the body, causing DNA and other cellular components to be damaged (12). Hydrogen peroxide should be handled with care. Excessive exposure and high concentrations should be avoided for medical or cosmetic objectives. The study's goal is to discover Moringa oil's capacity to counteract oxidative stress generated by hydrogen peroxide in rat salivary.

2. Materials and methods

2.1 Animals

The animal's were (10-12) weeks old and weighed (200-220) grams. The animals are placed in the animal house and provided with appropriate conditions in terms of light, darkness, temperature, and humidity, as is usual in scientific laboratories that work with laboratory animals(13).

2.2 Preparing seeds

Moringa seeds were bought from Mosul's local markets. Ripe seeds are enclosed by light wooden shells and are manually removed and sorted. The undamaged grains will be chosen and dried in an oven at (40) degrees Celsius for 8 hours, after which the dried grains will be ground with an electric grinder and the powder will be stored until use.

2.3 Moringa oil extraction process

The solvent extraction method was used to obtain Moringa seed oil from seed powder. Assessed the extraction period (6 hours), the solid to solvent ratio (0.20-0.50 g/mL), and the use of a Soxhlet apparatus in this investigation. A 5 g/ml volume of powdered moringa kernel powder was mixed with 200 ml of hexane extraction solvent. The extraction took 6 hours with a regulated water bath set to the boiling point. The distillation procedure was utilized at the end of the experiment to recover the solvent from the oily solvent combination (14).

2.4 Study design

The study is a randomized experimental study. which, 27 rats were separated into three groups.

• The first group receives Moringa oil 1000 mg/kg every day including 7 rats.

• The second group receives a daily dose of 0.5% H_2O_2, 2 ml/rat per day including 10 rats.

• The third group was given 0.5% H_2O_2 of 2 ml/rat, as well as moringa oil 1000 mg/kg per day including 10 rats. Treatment was continuous daily for 21 days, and blood sampl and salivary glands tissues were collected after 7, 14, and 21 days of the study.

2.5 Collect blood samples

The animals were anesthetized with ether before collecting blood from their eye sockets, then placed in gelatin tubes, and allowed to colt, then separate the serum using a centrifuge at 3500 rpm for 20 min. Serum deposited in the Eppendorf tubes and stored at -20 degrees Celsius in a deep freeze.

2.6 Salivary gland extraction

The salivary glands of each animal were extracted and preserved in 10% formalin until the time of the histopathological study.

2.7 Biochemical studies

The biochemical parameters measured in this study obeyed the instructions. provided with each kit used in the study which was supplied by ELABSINCSE company (USA).

• Total antioxidants Capacity (TAC) measurement kit

• Malondialdehyde (MDA) measuring kit

• Glutathione (GSH) measuring kit.

2.8 Statistical analysis

To interpret the data, the statistical program ANOVA was used, and a two-way analysis test was used to detect statistically significant differences at the probability level of 0.05.

3. Results:

Based on the information provided in **Table 1**, the analysis suggests that there are significant differences in TAC levels between the treatment groups within each period and also significant variations in TAC levels across different periods within the same treatment group. The specific interpretation would depend on the context of the experiment and the study objectives.

After Day 7: In the 7-day period, The H_2O_2 group is significantly decrease as compare to the first group.

After Day 14: In the 14-day period, the first group has a TAC level of 12.4 ± 2.0. The H_2O_2 group is significantly different from the first group.

After Day 21: During the 21 day timeframe the first group showed a TAC level of 18 ± 2.0. The H_2O_2 group displayed distinctions compared to the first group.

Table 1. levels of TAC in different groups

Treatments / Periods	First (Moringa oil)	H_2O_2 group	H_2O_2+ Moringa oil
7 days \TAC nmol\L	8.0 ± 1.0	6.4 ±1.0 acBC	15.2 ± 1 ab BC
14 days \TAC nmol\L	12.4 ± 2.0	4.5 ± 0.3 acAC	16.1 ± 1.1 ab AC
21 days\ TAC nmol\L	18 ± 2.0	2 ± 1.0 acAB	18.4 ± 2.0 bAB

Lowercase letters (ac, ab) indicate variances, among the treatment groups during the period whereas uppercase letters (BC, AC, AB) signify significant differences between periods, within the same group.

Lowercase letters indicating different between groups, uppercase Letters indicating differentiation between periods, P<0.0

Table 2 displays the data regarding the levels of (GSH), in treatment groups across three time periods.

After 7 Days: period the first group exhibited a GSH level of 0.07 ± 0.01. It was observed that there was a difference between the H_2O_2 group and the first group (a) and similarly the H_2O_2+Moringa oil group showed a difference compared to the H_2O_2 group (b).

After 14 days: period the first group recorded a GSH level of 0.08 ± 0.02.

After 21 days: it was found that the Control group had a GSH level of 0.1 ± 0.04. The comparison revealed differences between the H_2O_2 group and Control (acAB) as well as, between H_2O_2+Moringa oil compared to H_2O_2 alone (ab).

Table 2. levels of GSH nmol\L in different groups

Treatments / Periods	first (Moringa oil)	H_2O_2 group	H_2O_2+ Moringa oil
7 days GSH nmol\L	0.07 ± 0.01	0.05±0.009 a	0.07±0.01 b
14 days GSH nmol\L	0.08 ±0.02	0.04±0.01 ac C	0.08±0.01 ab
21 days GSH nmol\L	0.1 ±0.04	0.02±0.009 acAB	0.08.4±2.0 ab

Lowercase letters indicating different between groups, uppercase Letters indicating differentiation between periods, P<0.0

Notably there was a decrease in the H_2O_2 group compare to the Control group (ac) while also between the H_2O_2+Moringa oil group and the H_2O_2 group (ab).

Table 3 displays (MDA) levels, in treatment groups across three time periods (7, 14 and 21 days).

After 7 days: During the 7 day period the first group showed an MDA level of 32.0 ± 0.2. The H_2O_2 group exhibited a difference compared to the first group (ac) as well as a notable variance from the H_2O_2+Moringa oil group (BC).

After 14 days: At the end of the 14 day period the first group recorded an MDA level of 30.5 ± 0.1. The H_2O_2 group displayed a distinction from both the Control group (ac) and the H_2O_2+Moringa oil group (AC).

After 21 days: By day 21 the first group registered an MDA level of 29.9 ± 0.3. The H_2O_2 group demonstrated a deviation from the Control (ac) as well as a marked contrast, with the H_2O_2+Moringa oil group (AB).

This analysis suggests that there are significant differences in MDA levels between the treatment groups within each period also significant variations in MDA levels across different periods within the same treatment group. The specific interpretation would depend on the context of the experiment and the study objectives.

Table 3. levels MDA in different groups:

Treatments / Periods	first (Moringa oil)	H_2O_2 group	H_2O_2+ Moringa oil
7 days\MDA nmol\ml	32.0 ± 0.2	60.4 ± 0.1 acBC	40.2 ± 0.2ab BC
14 days \MDA nmol\ml	30.5 ± 0.1	80.5 ± 3.0 acAC	38.1± 2.0 abAC
21 days\MDA nmol\ml	29.9 ± 0.3	150 ± 4.0 acAB	35.4 ± 1.0 abAB
Lowercase letters indicating different between groups, uppercase Letters indicating differentiation between periods, P<0.0			

3.1 Histological results

The provided figures depict photomicrographs of rat submandibular salivary glands under different treatment conditions and durations, stained with Hematoxylin and eiosin stain (H&E).

First Group (Moringa Oil):

- **7 Days (Figure 1):** Normal architecture of the Mucous acini, tortuous granular ducts, in addition to striated tubules at 100X magnification.
- **7 Days (Figure 2):** Same as above but at 400X magnification.
- **14 Days (Figures 3 and 4):** Normal architecture was observed at both 100X and 400X magnifications
- **21 Days (Figures 5 and 6):** Normal architecture was observed at both 100X and 400X magnifications.

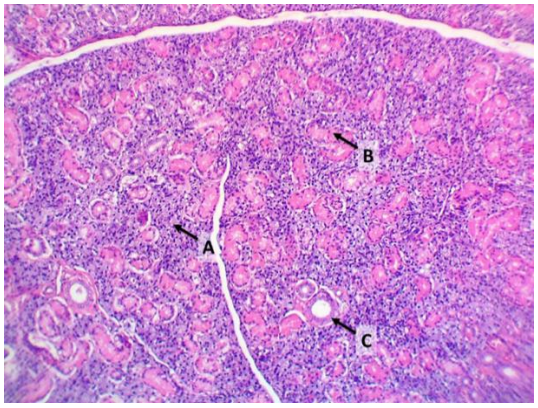

Figure 1: The control rat salivary gland of Moringa (7 days) showing normal architecture of the mucous acini (A), granular convoluted tubule (B) striated duct (C). H&E, 100X.

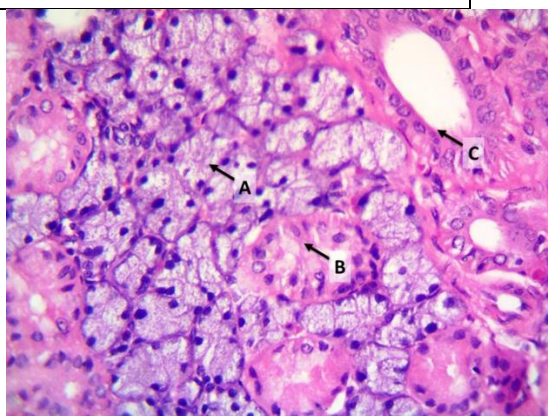

Figure 2: the rat salivary gland of the Moringa G1 (7 days) showing normal architecture of the mucous acini (A), granular convoluted tubule (B) striated duct (C).

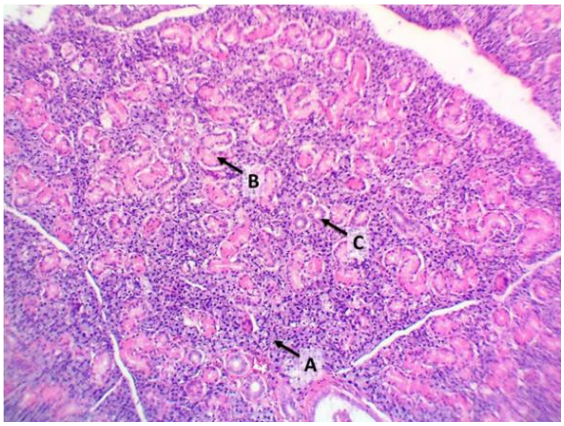

Figure 3: rat submandibular salivary gland of the Moringa G1 (14 days) showing normal architecture of the mucous acini (A), granular convoluting tubule (B) and striating ducts (C). H&E, 100X.

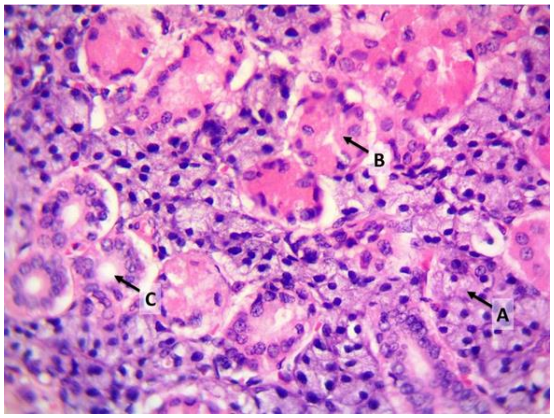

Figure 4: rat submandibular salivary gland of Moringa G1 (14 days) showing normal architecture of the mucous acini (A), the granular convoluting tubule (B) and striating duct (C).

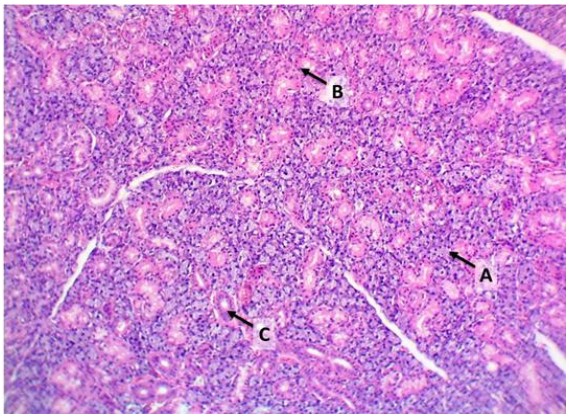

Figure 5: rat submandibular salivary gland of the Moringa G1 (21 days) showing normal architecture of the mucous acini (A), granular convoluting tubule (B) striating duct (C). 100X.

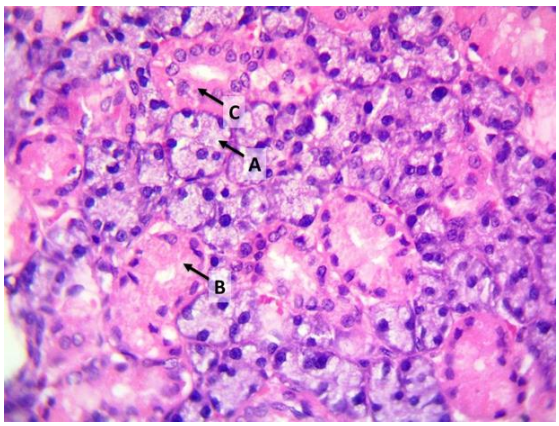

Figure 6: rat submandibular salivary gland of the Moringa G1 (21 days) showing normal architecture of the mucous acini (A), granular convoluting tubule (B) and striated duct (C). 100X.

H_2O_2 Group

- **7 Days (Figures 7 and 8):** Necrosis of striated duct, degeneration of the granular convoluted tubules and the mucous acini cells, with edema and congestion observed at 100X and 400X magnifications.

- **14 Days (Figures 9 and 10):** Degeneration, necrosis, and atrophy of cells, decreased granular convoluted tubules, increased fibrous tissue, and blood vessel congestion at 400X and 100X magnifications

- **21 Days (Figures 11 and 12):** Increased fibrous tissue, congestion of blood vessels, and degeneration of cells at 400X magnification

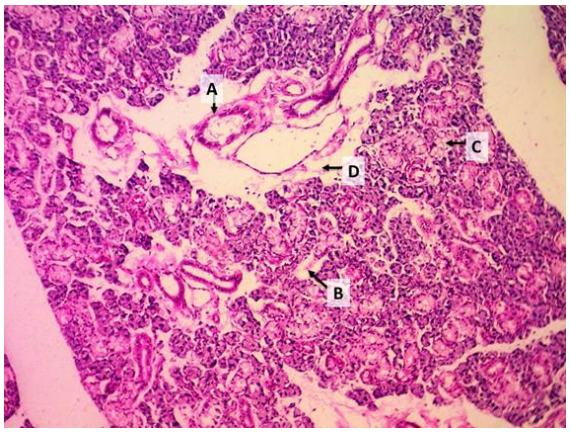

Figure 7 : rat submandibular salivary gland of the H2O2 (7 days) showing the necrosis of striating duct (A), granular convoluting tubule epithelial cell (B) the mucous acini (C) edema surrounded the striating duct (D)..

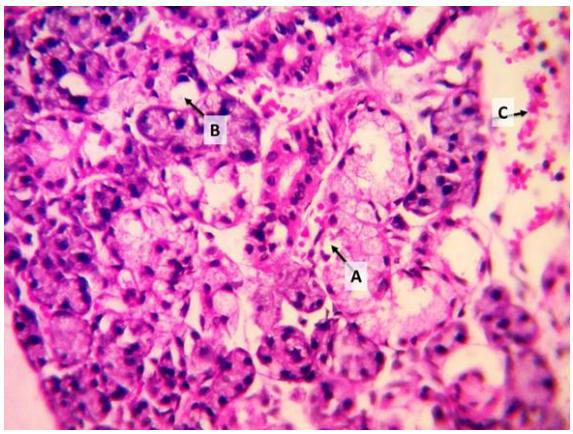

Figure 8: rat submandibular salivary gland of the H2O2 (7 days) shows degenerate of the granular convoluting tubule epithelial cell (A) the mucous acini cell (B) with congestion of blood vessels (C).

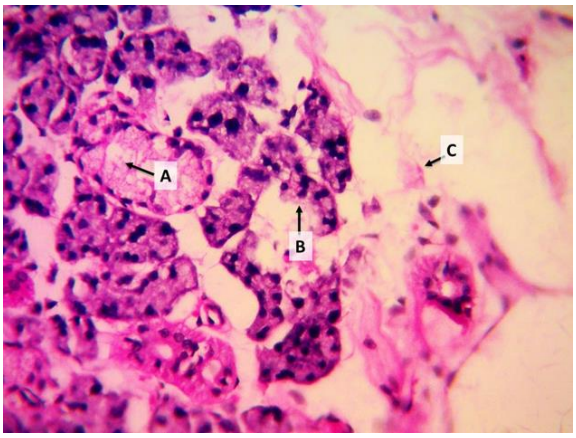

Figure 9 : rat salivary gland of the H2O2 (14 days) shows degenerate of the granular convoluting tubule epithelial cell (A), the necrosis and atrophy of mucous acini cell (B) edema surrounded it(C). H&E, 400X.

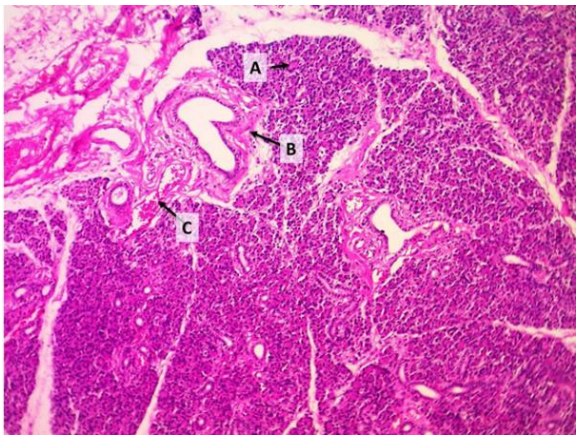

Figure 10: rat submandibular salivary gland of the H2O2 (14 days) and group shows decreasung number of the granular convoluting tubule (A), increasing fibrous tissue surrounded interlobular duct (B) and congestion of blood vessels (C). H&E, 100X.

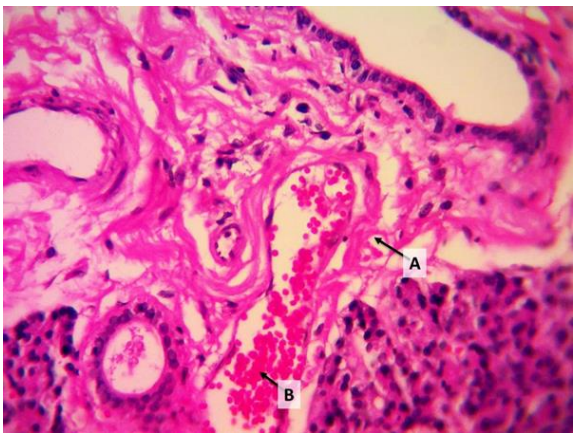

Figure11 : rat submandibular salivary gland of the H2O2 (21 days) shows increase fibr tissue surrounding interlobular ducts (A) congested of the blood vessel (B), 400X.

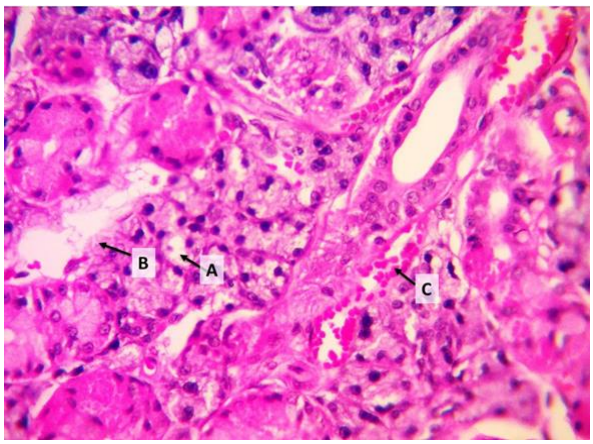

Figure 12 : rat submandibular salivary gland of the H2O2 (21 day) showing degenerated of mucous acini cells (A), necrosis and atrophy of granular convoluting tubule (B) and congested of the blood vessel (C).

Moringa + H_2O_2 Group

- **7 Days (Figures 13 and 14):** Intact structures with congestion of blood vessels and hemorrhage at 100X and 400X magnifications.
- **14 Days (Figures 15 and 16):** Mild vacuolar degeneration with congestion of blood vessels and hemorrhage at 100X and 400X magnifications.
- **21 Days (Figures 17 and 18):** Normal structure observed at both 100X and 400X magnifications.

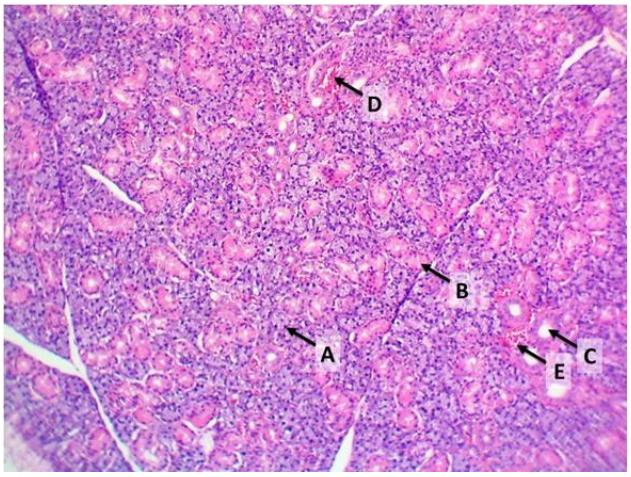

Figure 13: rat salivary gland of Moringa+ H2O2 (7 days) show intacting mucous acini (A), granular convoluting tubule (B) striating duct (C) with congested of the blood vessels (D) hemorrhage (E). H&E, 100X.

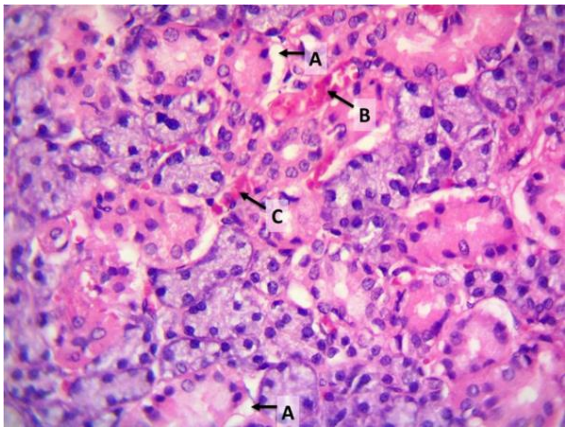

Figure 14: rat salivary gland of G3 (7 days) show mild vacuolar degenerated of cells lining granular convoluted tubules (A) with congestion of the blood vessel (B) hemorrhaging (C).

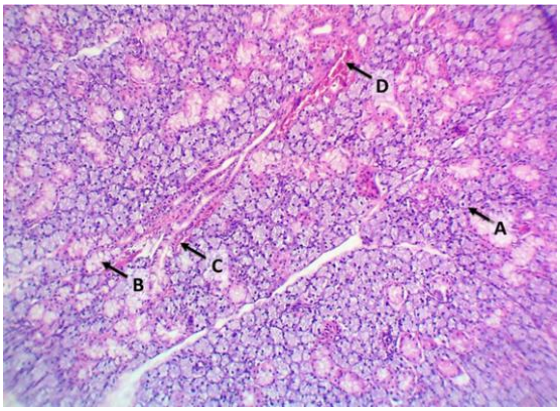

Figure 15: rat salivary gland of the Moringa+ H2O2 (14 days) show mild vacuolar degenerated of cells line the mucous acini (A) and granular convoluted tubules (B) congested of the blood vessel (C) hemorrhaging (D), 100X.

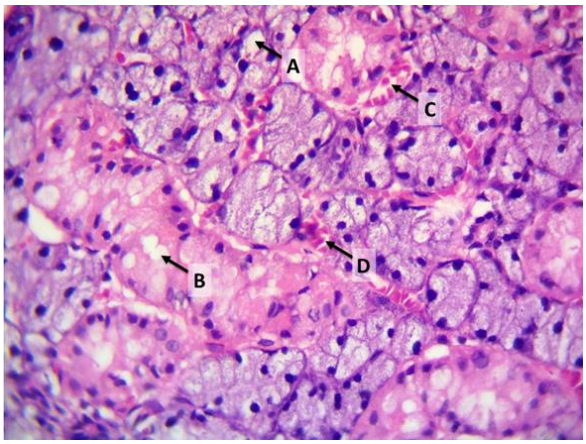

Figure 16: rat salivary gland of Moringa+ H2O2 (14 days) show mild vacuolar degenerated of the cell line mucous acini (A) granular convoluting tubule (B) with congested of the blood vessels (C) and hemorrhage (D), 400X.

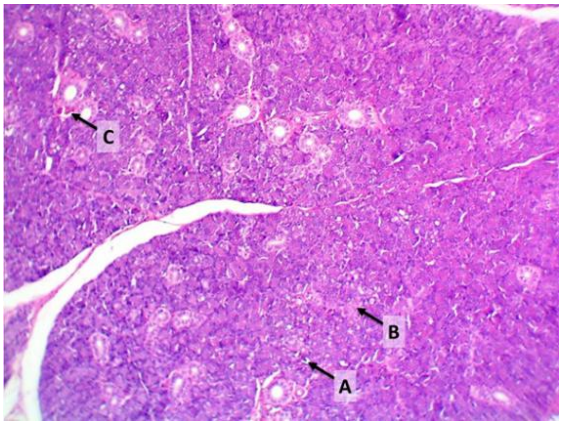

Figure 17: rat submandibular salivary gland of Moringa+ H2O2 (21 days) show normal stracture stain, 100X.

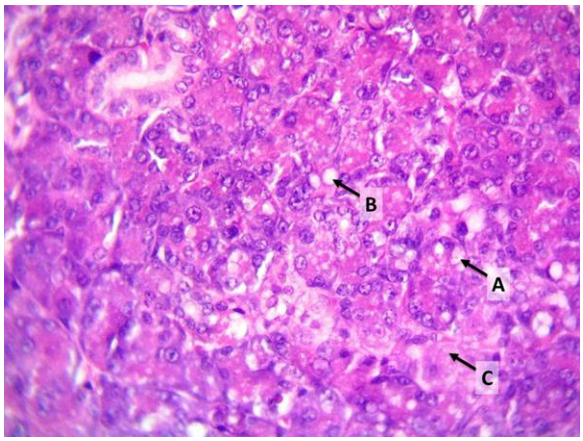

Figure 18: rat submandibular salivary gland of Moringa+ H2O2 (21 days) show normal stracture H&E stain, 400X.

The histological examination suggests that the Moringa oil group generally maintained normal glandular architecture, while the H_2O_2 group exhibited signs of degeneration and necrosis. The Moringa + H_2O_2 group showed a protective effect in some instances, preserving tissue structure. Further detailed analysis and quantitative assessments would be necessary for a comprehensive understanding of the observed effects.

4. Discussion

4.1 Biochemical variables

Levels of antioxidants such as glutathione and total antioxidant status are considered biochemical indicators that have a direct role in protecting the body from oxidative stress generated by malondialdehyde or other oxidants. The frequent application of hydrogen peroxide for medical purposes and wound sterilization may results in the occurrence of oxidative stress, which necessitates the use of an accompanying natural antioxidant substance to

counteract the effects of oxidative stress (15). The importance of measuring TAC, MDA, and GSH levels for evaluated the oxidant and antioxidant capacity of moringa. The provided **Table 1** presents the levels of (TAC) in different experimental groups subjected to various treatments over 3 different periods (7 , 14, and 21 days). Treatments include a control group treated with Moringa oil, a group treated with hydrogen peroxide (H_2O_2), and a group treated with a combination of both H_2O_2 and Moringa. The TAC levels in the first group treated with Moringa oil show an increasing trend over the three periods. The marked increase in its antioxidant capacity can be attributed to its content of linalool and caryophyllene oxide, with the presence of n-hexadecane., carvacrol, and jaerin (16). The H_2O_2 group demonstrates a decreasing in TAC levels over the three periods. H_2O_2 is considered the most reactive type of oxygen present in cells, and its concentration is considered critical, as small amounts of it are beneficial to the cell becuses, it acts as a second messenger for the cell, while increasing it concentration causes degenerative effects in cells and cell death (17).

The group treated with both H_2O_2 and Moringa oil shows an interesting pattern. the TAC levels in are higher in Moringa oil group compared to both the first and H_2O_2 groups.There is another study on dietary activities on polyphenols limited to degenerative diseases (18, 19).

In all groups, there is a significant increase in TAC and GSH levels from 7 to 14 days, and then a further increase from 14 days to 21 days. This suggests a cumulative effect over time. The presented table 3 displays levels of (MDA) in various experimental groups subjected to different treatments over three distinct periods (7, 14 , and 21 days). MDA levels in the first group, treated with Moringa oil, exhibit a decrease over the three periods, this decline suggests that Moringa oil may play a role in reducing MDA formation while MDA have oxidative effect on cell membrane. The Moringa compounds are capable to flow through the blood-brain barrier then reach their drug target (20). Gallic acid is one of most rich phenolic formulation determined in moringa extract, Gallic acid treatments have been protect SH-SY5Y cell from 6-hydroxydopamine damage by preventing the mitochondrial dysfunction, reduce intracellular ROS, and preventing apoptosis (21).

Gallic acid treatment also provides protection against H_2O_2 induce oxidative stress in SH-SY5Y cell by reduce ROS in the cells, increase REDOX activity, and inhibit caspase-3 activity(22). Loss of gallic acid and its derivatives prevents the accumulation of some amyloid proteins associated with neurodegenerative diseases (23) . The H_2O_2 group shows a significant increase in MDA levels across the three periods, this substantial elevation in MDA is attributed to the negative impact of hydrogen peroxide in inducing oxidative stress. The combination of H_2O_2 and Moringa oil appears to mitigate the increase in MDA levels. This suggests the potential of Moringa oil to attenuate the impact of hydrogen peroxide and reduce MDA formation.

4.2 Histological results:

The presented histological figures provide histological rat's submandibular salivary glands under various treatment conditions and durations, as observed through Hematoxylin and Eosin (H&E) staining

At 7, 14, and 21 days, the photomicrographs (**Figures 1-6**) depict the normal architecture of mucous acini, the granular convoluting tubule , and striated ducts. This means Moringa oil maintained the structural integrity of the salivary glands over the observed periods.

At 7 days (**Figures 7** and **8**), the H_2O_2 group exhibited necrosis of the striated duct, degeneration of granular convoluting tubule , and mucous acini cells, along with edema and congestion at both 100X and 400X magnifications. The detrimental effects persisted at 14 days (**Figures 9** and **10**) and 21 days (**Figures 11** and **12**), with observable degeneration, necrosis, atrophy of cells, increased fibrous tissue, and blood vessel congestion. These findings indicate that hydrogen peroxide induced significant damage and structural changes in the submandibular salivary glands. A study found that giving poultry feed containing plant phenols, including Moringa, led to improved production and improved microflora in the intestines, as well as regulating gene expression and amino acid synthesis (24).

The combined treatment group displayed varying responses. At 7 days (**Figures 13** and **14**), intact structures were observed with congestion of blood vessels and hemorrhage at both magnifications. At 14 days (**Figures 15** and **16**), mild vacuolar degeneration with congestion of blood vessels and hemorrhage was noted. Interestingly, at 21 days (**Figures 17** and **18**), the Moringa + H_2O_2 group showed a return to normal structure at both magnifications. This indicates that Moringa oil may have an effect, against the harmful effects of hydrogen peroxide (25). The examination of tissue samples shows that the group treated with Moringa oil generally maintained a structure throughout the study. This corresponds to the trends observed in antioxidant capacity levels (26) . The properties of Moringa oil contribute to combating oxidation resulting from free radicals that harm cells and tissues in the body and lead to various diseases (27) .

The antioxidant effect plays a significant role By shielding cells from damage caused by radicals, which can result in cell damage and various diseases (28). One of the factors attributed to reducing inflammation in the body may be the effect as of Moringa oil (.29). In contrast the group treated with hydrogen peroxide exhibited signs of degeneration, necrosis and structural damage to oxidative stress .(30).

the Moringa oil and hydrogen peroxide groups showed some instances where a protective effect was observed, such as evident by a return, to structure after 21 days. This indicates that Moringa oil might help lessen the effects caused by hydrogen peroxide as our result indicate (31).

5. Conclusion

In conclusion, the findings imply that Moringa oil could offer protection, against oxidative stress by influencing TAC levels and reducing MDA levels. The combination of H_2O_2 and Moringa oil seems to counterbalance the impact of hydrogen peroxide. Moreover the group using Moringa oil generally maintained a structure while the H_2O_2 group showed signs of deterioration and cell death. The group using both Moringa oil and H_2O_2 exhibited some effects at times preserving the tissue structure of the gland.

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Conflicted interest

None

Ethics approval

This study followed instructions and Guidelines of Ethical Committee and had ethical approval no. (UoM.Dent/A.L.20/22) in the university of Mosul/College of Dentistry

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الدور المضاد للأكسدة لمستخلص زيت المورينجا في تعديل التغيرات النسيجية والكيميائية الحيوية في الغدد اللعابية لدى الجرذان تحت تأثير الإجهاد التأكسدي

المقدمة: تعتبر النباتات الطبية مصدراً غنياً بمضادات الأكسدة، وقد تم لفت الانتباه إليها في السنوات اللاحقة، حيث يعتبر نبات المورينكا أحد هذه النباتات. **الهدف من الدراسة:** التعرف على الدور الوقائي لزيت المورينجا ضد الإجهاد التأكسدي الناجم عن بيروكسيد الهيدروجين في الغدد اللعابية للجرذان. **المواد وطرائق العمل**: تم تقسيم 27 جرذاً إلى 3 مجموعات. تم إعطاء مجموعة الاولى زيت المورينجا بجرعة 1000 ملغم/كغم يومياً. المجموعة الثانية جرعت بجرعة 0.5% H_2O_2 بواقع 2 مل/ جرذ يوميا. المجموعة الثالثة جرعت بـ 0.5% H_2O_2 بكمية 2 مل/ جرذ وجرعت أيضاً بزيت المورينجا 1000 ملجم/كجم. استمرت المعاملة يومياً لمدة 21 يوماً، وتم قتل 3 حيوانات من كل مجموعة مع أخذ عينات الدم والأعضاء بعد 7، 14، و21 يوماً. **النتائج:** هناك اختلافات كبيرة في مستويات TAC، GSH وMDA بين مجموعات العلاج داخل كل فترة وأيضا اختلافات كبيرة عبر فترات مختلفة داخل نفس مجموعة العلاج. يشير الفحص النسيجي إلى أن مجموعة زيت المورينجا حافظت عمومًا على بنية غدية طبيعية، بينما أظهرت مجموعة H_2O_2 علامات الانحطاط والنخر. أظهرت مجموعة Moringa + H_2O_2 تأثيرًا وقائيًا لزيت المورينكا في بعض الحالات، حيث حافظت على بنية الأنسجة. **الخلاصة:** تشير النتائج إلى أن زيت المورينجا يمكن أن يوفر الحماية ضد الإجهاد التأكسدي من خلال التأثير على مستويات TAC وتقليل مستويات MDA. يبدو أن مزيج H_2O_2 وزيت المورينغا يوازن تأثير بيروكسيد الهيدروجين. علاوة على ذلك، حافظت المجموعة التي تستخدم زيت المورينغا بشكل عام على هيكلها بينما أظهرت مجموعة H_2O_2 علامات التدهور وموت الخلايا. أظهرت المجموعة التي تستخدم زيت المورينجا وH_2O_2 بعض التأثيرات في بعض الأحيان للحفاظ على بنية أنسجة الغدة.

الكلمات المفتاحية: مضادات الأكسدة، المورينجا، H_2O_2, التشريح المرضي، الغدد اللعابية.