Potential Protective Effects of Propolis against Hepatotoxicity and Nephrotoxicity Induced by Monosodium Glutamate in Rabbits

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ABSTRACT

Monosodium glutamate (MSG) is used to enhance the flavour in the preparation of food to improvement the palatability. However, it induces oxidative stress and causes many health complications. This work determines the effect of MSG on kidney and liver functions and to know the protective role of propolis in male rabbits. Twenty rabbits were divided into four equal groups. Group (1) used as control, group (2) received propolis (8mg/kg body weight), group (3) received MSG (50mg/kg bodyweight) and group (4) received propolis (8mg/kg body weight) plus MSG (50mg/kg bodyweight) in the same time as combination group. The doses was given every other day for 12 weeks. Monosodium glutamate significantly elevated the concentration of thiobarbituric acid reactive substances (TBARS) and significantly decreased the concentration of reduced glutathione (GSH) and antioxidant enzymes (Catalase(CAT), Superoxide dismutase (SOD), Glutathione S-transferase (GST), Glutathione peroxidase (GPx)) in plasma, kidney and liver. Activities of liver enzymes (lactate dehydrogenase (LDH), aspartate transaminase (AST), alkaline phosphatase (AlP), gama-glutamyl transferase (GGT), acid phosphatase (AcP) and alanine transaminase (ALT)), creatinine, glucose and urea were enhanced significantly, while globulin, albumin and total protein were reduced in plasma. Also, treatment with MSG resulted in the deterioration of the histological architecture in liver and kidney. The combination group alleviated its adverse effects on liver and kidney, and this protection might be due to the antioxidant properties of propolis. In addition, the histology of liver and kidney results were supported by the biochemical findings. From the obtained results, it could be concluded that propolis capable to mitigate the oxidative stress, hepatotoxicity and nephrotoxicity induced by MSG in male rabbits.

Keywords: Monosodium glutamate; Propolis; Hepatotoxicity; Nephrotoxicity; Oxidative stress; Antioxidant enzymes; Histological examination; Male rabbits.

INTRODUCTION

Several of food additives recently are used in new technology foods such as tinned foods, ready to eat, Chinese, Japanese and packaged foods (Dixit *et al*., 2014). Also, they reported that most food additives use as flavour enhancers or preservatives. Boutry *et al*., (2011) mentioned that Monosodium glutamate (MSG) used to processed food, canned vegetables, mixed with foods during preparation, soups, Chinese food and enhance the flavour by stimulating the sensory receptors, therefore improve food palatability. Also, Diniz *et al*., (2005) mentioned that MSG is a popular food enhancer, which many manufacturers believe, can be used, as the consumer likes.

In addition, Sano, (2009) mentioned that MSG dissolves in saliva or water and quickly decompose to free sodium and glutamate ions. Beyreuther *et al.,* (2007) reported that glutamate is added to food about 1 g in daily intake in European countries and about 4 g in Asia. Furthermore, Nakanishi *et al.,* (2008) reported that average daily intake of Monosodium glutamate is about 10 g and is increasing. Consumption of MSG has increased in recent decades and the average daily intake about 10 g. Onyema *et al.,* (2012) confirmed that the treated with MSG has number of adverse effects causes some alterations in hepatic glucose metabolism. Also, Geha *et al*., (2001) mentioned that some symptoms maybe resulted by use MSG such as flushing, headaches, numbness, sweating and weakness. Also, ingestion of MSG causes various complications including urticaria, asthma, neuropathy, atopic dermatitis and abdominal discomfort. Moreover, Cekic *et al*., (2005) indicated that pathological changes in hypothalamus, adrenal gland, and thymus can produce by administration of monosodium glutamate. Furthermore, rats treated with MSG showed obesity, cardiovascular dysfunction, and retinal lesions. While, diabetes mellitus, pancreatic hypertrophy and

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steatohepatitis were observed in mice treated with MSG (Sasaki *et al*., 2009; Cunha *et al.*, 2010).

Degenerative changes and lipid peroxidation are produced in kidney of rats induced by MSG (Ortiz *et al*., 2006). Also, Abass and El-Haleem (2011) confirmed that oral treatment of MSG showed morphological alterations and oxidative stress in kidney tissues. Moreover, Poli *et al.,* (2004) mentioned that cellular damage can produce from oxidative stress in tissues Thus, Havsteen (2002) confirmed that MSG causes oxidative stress and generates reactive oxygen species via the reduction of antioxidants in kidney, which leading to cellular injury and oxidation of proteins and lipids.

Oxidative stress related disorders and organ toxicity can be prevented by intake of antioxidants (Havsteen, 2002). In addition, Kamalkkannan *et al.,* (2005) suggested that many natural and synthetic antioxidants can be use to prevent lipid oxidation. Bankova *et al*., (2000) and Sforcin (2007) mentioned that propolis is a traditional herb medicine in many countries. There are more than 300 components have been found in it, most of them are composed of phenolic compounds, essential oil and terpenes. Furthermore, Bankova (2005) reported that propolis has been shown to have many vital activities that are immune regulatory, anti-tumor, antioxidative, anti-inflammatory and hepatoprotective. Digestive tract disorders, blood system, Cardiovascular, cancer, dermatological disorders and respiratory disorders can be treated by Propolis (Saleh, 2012; Nakamura *et al.,* 2013).In addition, Araujo *et al*., (2012); Mahmoud and Mahmoud, (2013) reported that propolis has many pharmacological properties like antioxidant, anti-inflammatory, antibacterial, antiviral, anticarcinogenic.

MATERIALS AND METHODS

1. Chemicals

Mono sodium glutamates, Propolis were supplied from El Dawlia for Chemicals Company and Medical Equipments, Egypt, and California Health Products, Inc. 11577W. CA90064. Los Angeles. Olympic Bivd, respectively.

2. Experimental groups and Animals

In the present work, Male V-line rabbits (initial weight of 3.200±0.083 Kg and age of 6-7 months) were used. Rabbits were obtained from the High Institute of Public Health, Alexandria University. Egypt. The animals were housed in cages. Water and Feed were provided ad libitum. Commercial pellets were provided for rabbits (Childs *et al.,* 2002).

Twenty rabbits were divided into four equal groups. Group (1) used as control, group (2) received propolis (8mg/kg body weight), group (3) received MSG (50mg/kg bodyweight) and group (4) received propolis (8mg/kg body weight) plus MSG (50mg/kg bodyweight) in the same time as combination group. propolis and MSG doses were calculated according to body weight of animals. Propolis and MSG was treated orally using syringe. The doses was given day after day for 12 weeks

3. Blood samples collection and tissue preparations

From the ear vein of all rabbits the blood were collected at the finale of 4th, 8th and 12th week throughout the 12-week experimental time in tubes with heparin (anti-coagulant). The centrifuge of sample sat 860Xg for 20 min was used to obtain the plasma, and were stored at -80°C until used for analyses.

Animals were sacrificed at the end of treatment period. Kidney and liver were removed; chilled saline solution was used to wash the tissue, minced, homogenized (10%, w/v), centrifuged at 10,000 Xg for 20 min at 4 °C, stored at -80 °C for the determination of tested parameters.

4. Oxidative stress markers

Plasma, kidney and liver Glutathione peroxidase (GPx), Superoxide dismutase (SOD), Glutathione S-transferase (GST), Catalase(CAT), glutathione(GSH) and thiobarbituric acid reactive substances (TBARS) were measured by Biodiagnostic Kit, Egypt.

5. Biochemical parameters

Plasma total protein, albumin, urea, creatinine and glucose were measured used kits from Barcelona; Spain, (Costa Brava 30), Biosystems S.A The activities of plasma lactate dehydrogenase (LDH), aspartate transaminase (AST), alkaline phosphatase (AlP), gama-glutamyl transferase (GGT), acid phosphatase (AcP) and alanine transaminase (ALT) were determined by kits from Barcelona; Spain, (Costa Brava 30), Biosystems S.A.

6. Histological examination

Liver and kidney tissue were dissected and the samples were fixed in 10% formalin. Paraffin was used to stabilize the tissue and stained by hematoxylin and eosin (H&E) to examine the tissue under the light microscope(Kulalou *et al.,* 2004).

7. Statistical analysis

Data were analyzed as a completely randomized design (Steel and Torrie, 1981) using the General Linear Model procedure of SAS (1986). Means were statistically compared using least significant difference (LSD) test at 0.05 significant levels (Steel and Torrie, 1981).

RESULTS

Lipid peroxidation (LPO) was assessed by measuring thiobarbituric acid-reactive substances (TBARS) levels in plasma, kidney and liver of male rabbits treated with monosodium glutamate (MSG), propolis and their combination at the finale of experimental time. Tables (1) and (2), Figure (1) showed that treatment with monosodium glutamate (group 3) significantly ($p \leq 0.05$) increased the TBARS concentration, and significantly ($p \leq 0.05$) decreased the activities of Catalase(CAT), Superoxide dismutase (SOD), Glutathione S-transferase (GST), Glutathione peroxidase (GPx) and the level of glutathione(GSH) in plasma, kidney and liver as compared to control group (group 1). Moreover, treatment with propolis in combination group (group 4) minimized effect of MSG on all of the previous parameters as compared to MSG group (group 3). Furthermore, treatment with propolis (group 2) significantly ($p \leq 0.05$) minimized TBARS concentration and enhanced GSH level and CAT, SOD, GST and GPx activities compared to control group (group 1).

Lactate dehydrogenase (LDH), aspartate transaminase (AST), alkaline phosphatase (AlP), gama-glutamyl transferase (GGT), acid phosphatase (AcP) and alanine transaminase (ALT) were determined in plasma of male rabbits treated with MSG, propolis and their combination during the 12-week trial period. Figure (2) showed that treatment with monosodium glutamate (group 3) significantly ($p \leq 0.05$) elevated plasma LDH, AST, AlP, GGT, AcP, and ALT when compared to control group (group 1). While, treatment with propolis in combination group (group 4) alleviated the effect of MSG on plasma enzymes compared to MSG group (group 3). While, treatment with Propolis (group 2) caused a decrease in plasma LDH, AST, AlP, GGT, AcP, and ALT activities.

Table 1. Mean values ± SE of liver TBARS and antioxidant enzymes of male rabbits treated with propolis (Pro), monosodium glutamate (MSG) and their combination

Parameter	Experimental groups			
	Control	Pro	MSG	MSG+ Pro
TBARS	34.37± 0.557^{c}	26.81± 0.434^{d}	50.87± 0.824^{a}	45.72± 0.74^{b}
GSH	6.37± 0.096^{b}	7.90± 0.119^{a}	3.25± 0.049^{d}	4.08± 0.061^{c}
GPx	35.28± 0.984^{b}	43.15± 0.999^{a}	16.91± 0.950^{d}	22.68± 0.961^{c}
CAT	51.42± 0.441^{b}	64.27±0.551^{a}	26.22±0.225^{d}	32.91± 0.282^{c}
GST	1.78± 0.019^{b}	2.19± 0.023^{a}	0.87± 0.009^{d}	1.09± 0.011^{c}
SOD	26.68± 0.141^{b}	33.09± 0.175^{a}	13.07± 0.069^{d}	17.34± 0.091^{c}

n = 5 for each treatment group.
Mean values were significantly different ($p \leq 0.05$) within a row not sharing a common superscript letters (a, b, c, d)
TBARS (nmole/gm tissue) = Thiobarbeturic acid reactive substances, GSH (u mole/gm tissue) = Glutathione, GPx (U/mg protein) = Glutathione peroxidase, CAT (U/mg protein) = Catalase, GST (µmole/hr /mg protein) = Glutathione S-transferase and SOD (U/mg protein) = Superoxide dismutase.

Table 2. Mean values ± SE of kidney TBARS and antioxidant enzymes of male rabbits treated with propolis (Pro), monosodium glutamate (MSG) and their combination

Parameter	Experimental groups			
	Control	Pro	MSG	MSG+ Pro
TBARS	21.07± 0.581^{c}	16.43±0.435^{d}	32.03±0.883^{a}	28.87±0.796^{b}
GSH	6.10±0.148^{b}	7.23±.093^{a}	3.11±0.076^{d}	3.97±0.096^{c}
GPx	25.64±0.368^{b}	30.70±0.342^{a}	13.36±0.430^{d}	16.97±0.412^{c}
CAT	65.12±5.325^{b}	79.50±4.728^{a}	33.21±2.716^{d}	42.98±3.514^{c}
GST	5.19±0.086^{b}	6.06±0.072^{a}	2.75±0.045^{d}	3.42±0.057^{c}
SOD	24.88±0.435^{b}	29.60±0.364^{a}	13.17±0.589^{d}	16.64±1.141^{c}

n = 5 for each treatment group.
Mean values were significantly different ($p \leq 0.05$) within a row not sharing a common superscript letters (a, b, c, d)
TBARS (nmole/gm tissue) = Thiobarbeturic acid reactive substances, GSH (u mole/gm tissue) = Glutathione, GPx (U/mg protein) = Glutathione peroxidase, CAT (U/mg protein) = Catalase, GST (µmole/hr /mg protein) = Glutathione S-transferase and SOD (U/mg protein) = Superoxide dismutase.

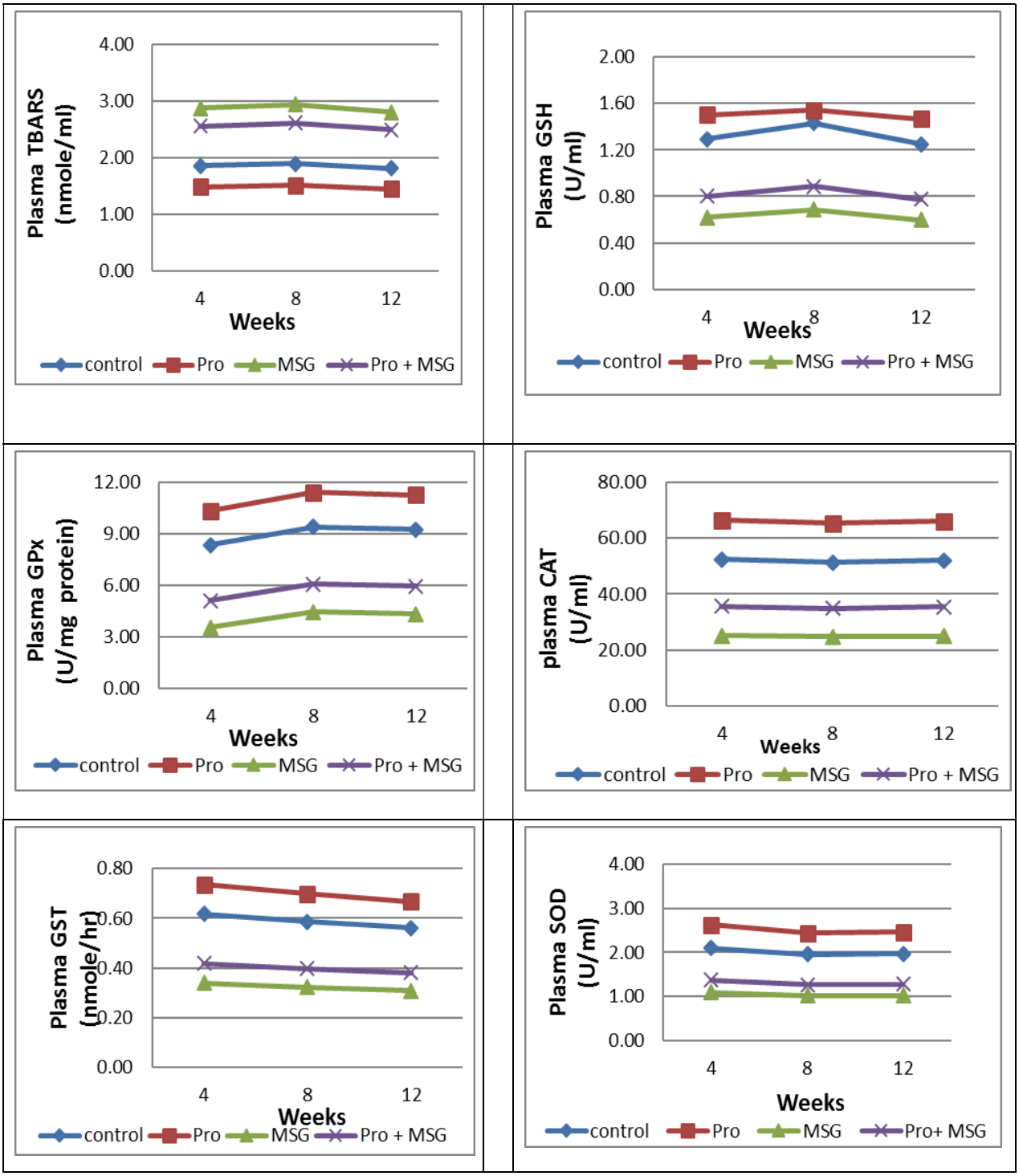


Figure 1. Changes in plasma activites of Catalase(CAT), Superoxide dismutase (SOD), Glutathione S-transferase (GST), Glutathione peroxidase (GPx) and the level of glutathione (GSH) and thiobarbituric acid reactive substances(TBARS) in male rabbits treated with monosodium glutamate (MSG), propolis (Pro) and their combination.

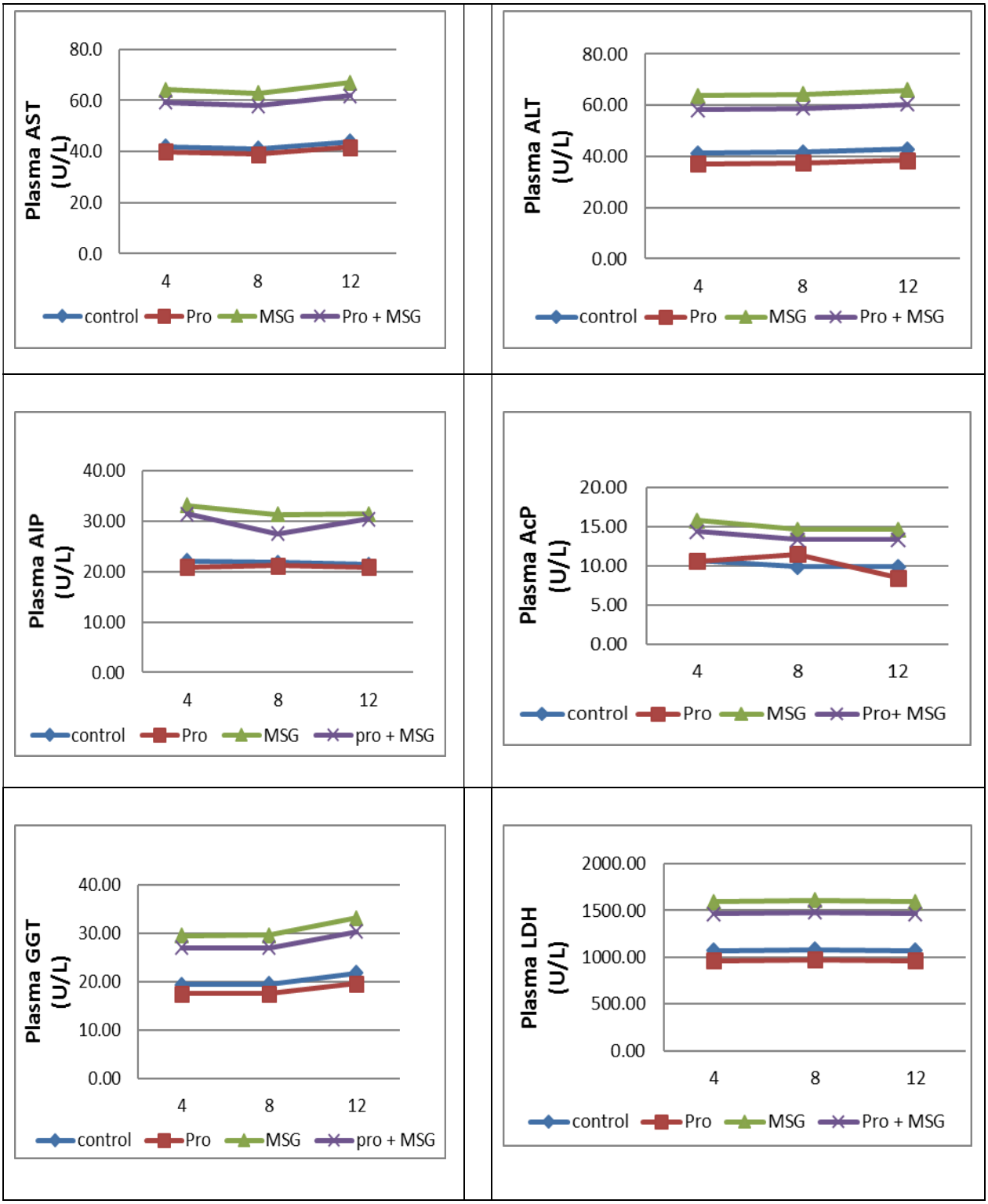


Figure 2. Changes in plasma lactate dehydrogenase (LDH), aspartate transaminase (AST), alkaline phosphatase (AlP), gama-glutamyl transferase (GGT), acid phosphatase (AcP) and alanine transaminase (ALT) in male rabbits treated with monosodium glutamate (MSG), propolis (Pro) and their combination.

Plasma glucose level of male rabbits exposed to MSG, propolis and their combination represented in figure (3).The figure showed that treatment with MSG (group 3) caused a significant ($p \leq 0.05$) elevated in the concentration of plasma glucose than control group (group 1). Moreover, propolis treatment in combination group (group 4) caused a decrease in the increase of plasma glucose level as compared to MSG group (group 3). On the other hand, treatment with propolis (group 2) decreases glucose level.

Plasma globulin (G), albumin (A), total protein (TP), creatinine and urea were determined in 4th, 8th and 12th week. The figure (3) represented treatment with MSG (group 3) caused a significant ($p \leq 0.05$) reduce in plasma G, A and TP and increased in urea and creatinine when comparing with control group (group 1). Moreover, the combination group (group 4) showed a decrease in the increase of plasma urea and creatinine. While, increase in the decrease of plasma G, A and TP as compared to MSG group (group 3). Also, treatment with propolis (group 2) elevated plasma level of G, A and TP and reduced creatinine and urea.

The histological examination of rabbits livers are represented in figure (4). The figure showed that liver formed of tubules of hepatocytes formed of bile duct, hepatic artery and portal vein separated by sinusoidal blood vessels in the control group (Figure 4 A) and propolis treated group (Figure 4 B). Liver section taken from rabbits after treated with MSG represented in figure (4C1) and (4C2), showed hepatocytes damage was manifested by marked disturbance in hepatic architecture with hydropic change with dilation of sinusoidal blood vessels, the portal tract showed moderate portal inflammation precemeal necrosis and lytic necrosis, and congestion.

Liver section taken from MSG with propolis group appeared in figure (4D1) and (4D2), showed that improvement in hepatic architecture with mild hydropic change, mild sinusoidal dilation and mild portal inflammation.

The light micrographs of kidney tissues demonstrated in figure (5). Kidney section taken from control group (Figure 5A) and propolis treated group (Figure 5B) showed normal tubules and glomeruli. Kidney section taken from rabbits after treated with MSG represented in figure (5C1) and (5C2), revealed degeneration changes in tubular epithelium with flattening of epithelial lining. Presence of propolis with MSG showed improvement of glomeruli and tubules appeared in figure (5D1) and (5D2), showed mild glomerular capillary swelling and mild degeneration change in tubules.

DISCUSSION

Monosodium glutamate significantly elevated the concentration of TBARS and significantly decreased the concentration of reduced glutathione (GSH) and antioxidant enzymes. This result is comparable and confirmed by Selvakumar *et al*., (2006) who reported that high concentration of lipid peroxidation could be return to generation of ROS due to induces MSG, leading to injury of membrane function. Also, Gupta *et al.,* (1992) mentioned that the high level of lipid peroxidation causes functional and structural inflammation of cellular membranes. Furthermore, Fadillioglu *et al.,* (2004) suggested that accumulation of lipid peroxidation causes inflammation of tissue. Moreover, treatment with propolis in combination group minimized bad effect of MSG on antioxidants enzymes and TBARS, this result confirmed by Fadillioglu *et al.,* (2004) who reported that propolis treatment accelerated repair mechanism of damaged cell membranes.

In addition, low concentration of glutathione S-transferase activity and glutathione level following MSG administration is similar to the finding by Andersen, (2004) who reported that MSG treatment caused depletion of tissue glutathione. Also, the reduction in GSH levels are in agreement with Onyema *et al*., (2006) who reported that low tissue levels of GSH occur due to lipid peroxidation resulting from MSG treatment. In our study, MSG group showed decreased activities of SOD and CAT enzymes, in MSG treated rabbits which is comparable with previous study of Singh *et al.,* (2003) who mentioned that the decrease in the activity of these enzymes could result from their stop by ROS. Also, this result is comparable and confirmed by Abdel Baky *et al*., (2009) who mentioned that MSG causes the induction of oxidative stress in the liver.

The present results showed that MSG caused elevation in plasma AST and ALT. Mansour *et al*., (2002) confirmed this result and referred that the elevation of these enzymes in plasma due to the leakage of ALT and AST from the liver cystol into the blood. Moreover, Al-Mamary *et al*., (2002) reported that the high concentration activity of serum ALT probably be a marker of hepatic damage. This elevation might be mainly to the production of free radical caused damage of plasma membranes and mitochondrial resulting in release of this enzyme (Poli *et al.,* 1990). The high concentration activity of GGT in MSG group is corroborated with previous study of Onyema *et al*., (2006) who reported that MSG caused oxidative stress resulting in liver damage.

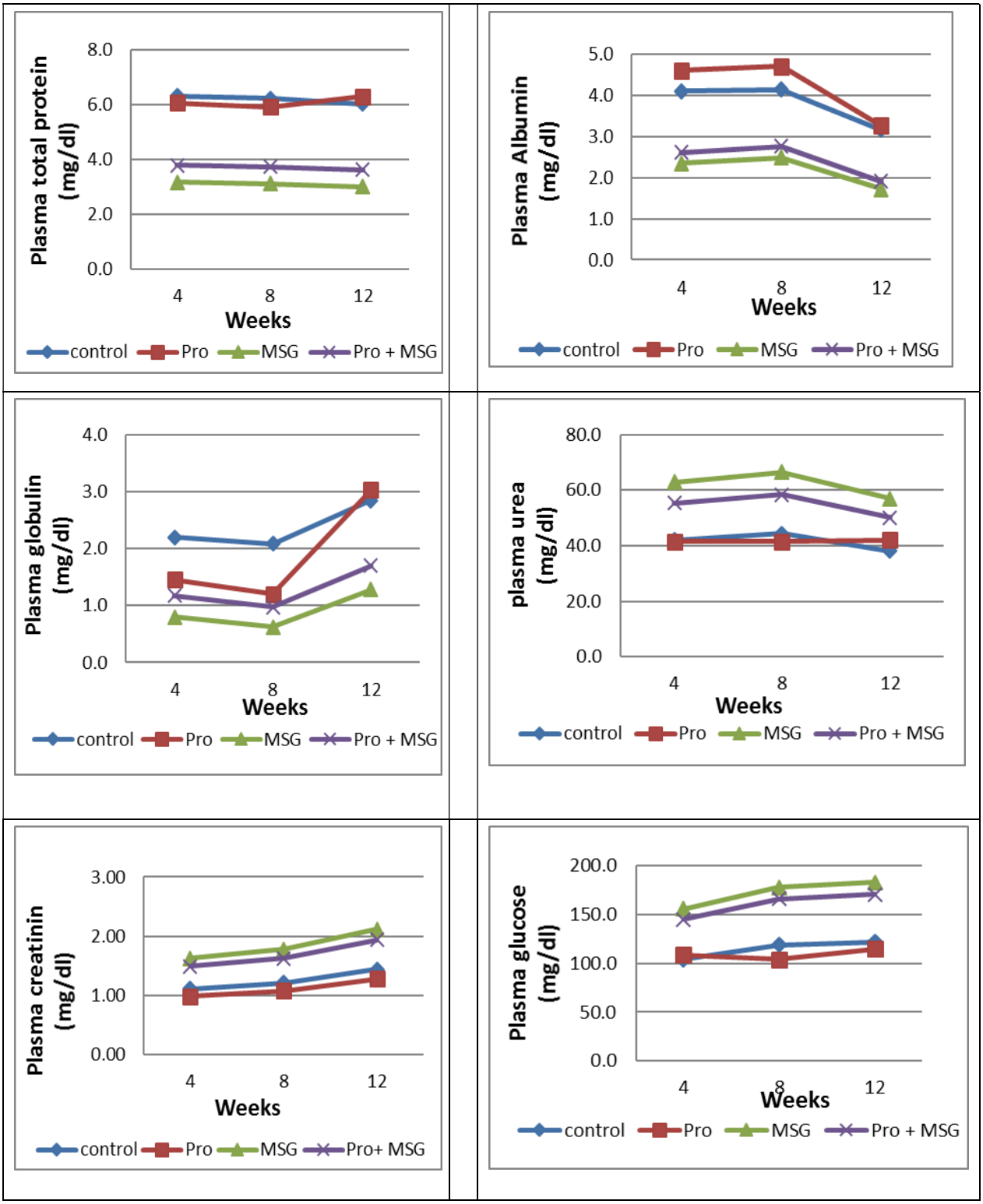
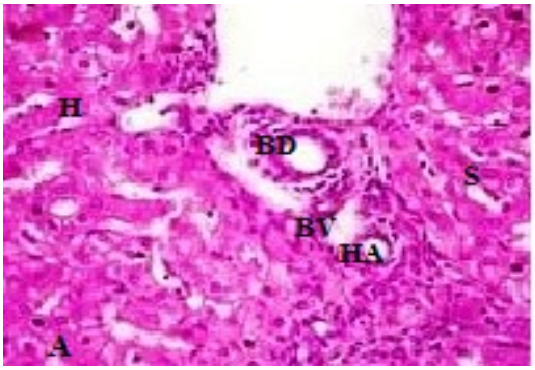
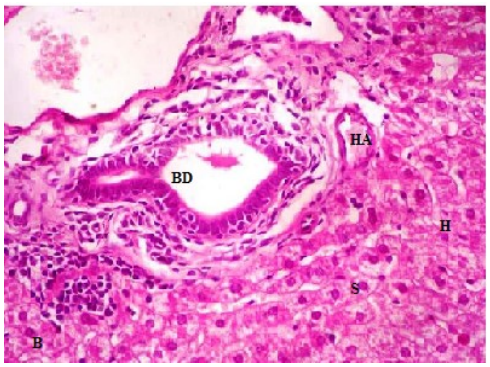


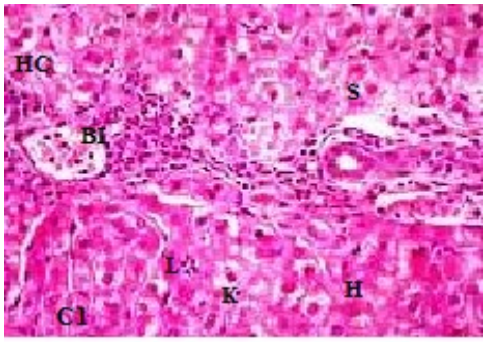
Figure 3. Changes in Plasma globulin (G), albumin (A), total protein (TP), creatinine, glucose and urea in male rabbits treated with monosodium glutamate (MSG), propolis (Pro), and their combination.



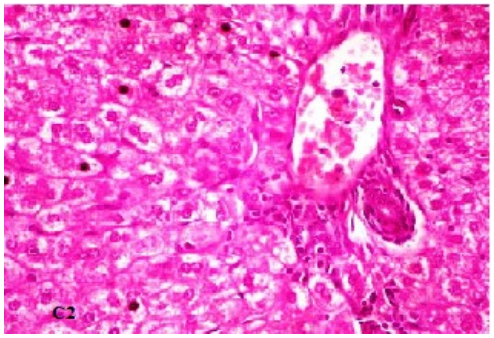
(A) Liver section of control group (group 1), showing liver formed of tubules of normal hepatocytes (H) formed of bile duct (BD), hepatic artery (HA) and portal vein (BV) separated by sinusoidal (S) blood vessels.



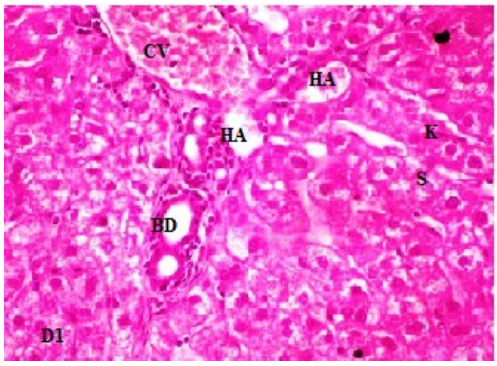
(B) Section in the liver of propolis (group 2), showing tubules of hepatocytes separated by sinusoidal blood vessels, there is portal tnets formed of bile duct (BD), hepatic artery (HA) and portal vein (BV).



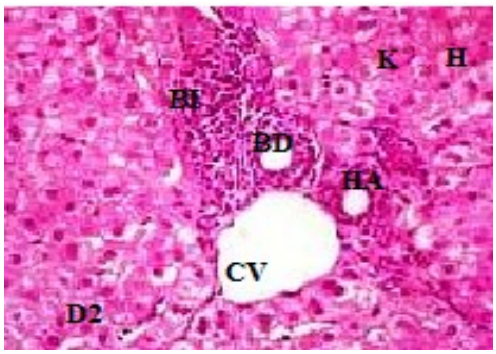
(C1) Liver section of MSG group (group 3), showing disturbance in hepatic architecture showing hydropic change (HC) with dilation of sinusoidal blood vessels, and the portal tract shows moderate portal inflammation (BI) precemeal necrosis and lytic necrosis (L).



(C2) Liver section of MSG group (group 3), showing disturbance in hepatic architecture showing hydropic change (HC) with dilation of sinusoidal blood vessels, the portal tract shows moderate portal inflammation (BI) and congestion.

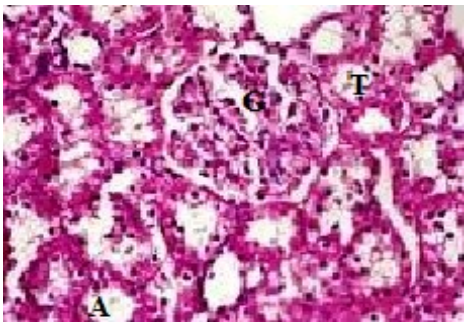


(D1) Section in the liver of propolis with MSG group (group 4), showing improvement in hepatic architecture showing mild hydropic change, mild sinusoidal dilation and mild portal inflammation.

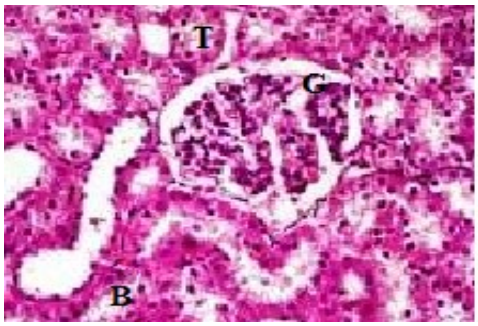


(D2) Section in the liver of propolis with MSG group (group 4), showing improvement in hepatic architecture showing mild hydropic change, sinusoidal dilation and moderate portal inflammation.

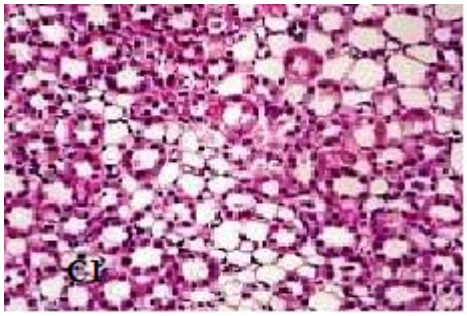
Figure 4. Photomicrograph of liver sections stained with H&E.



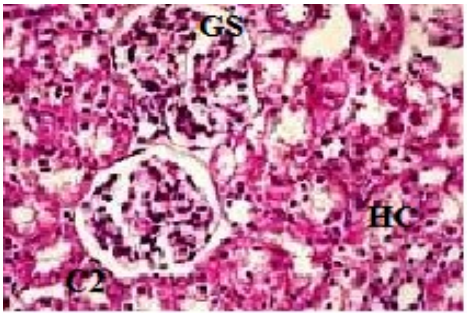
(A) Kidney tissue of control group (group 1), showing normal tubules (T) and glomeruli (G).



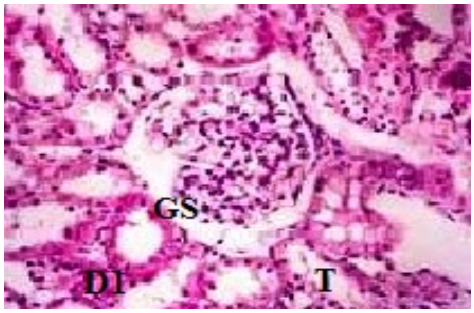
(B) Section in the kidney of propolis (group 2), showing normal glomeruli (G) and tubules (T).



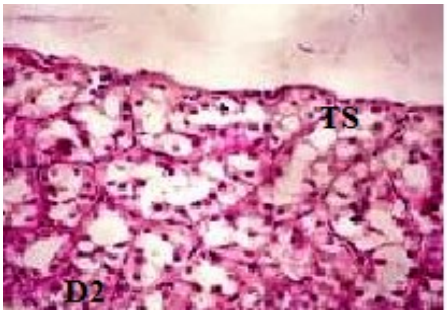
(C1) Kidney tissue of MSG group (group 3), showing degeneration changes in tubular epithelium with flattening of epithelial lining.



(C2) Kidney tissue of MSG group (group 3), showing glomerular capillary well swelling (GS) and dilation. The tubules showing hydropic change (HC).



(D1) Section in the kidney of propolis with MSG group (group 4), showing mild glomerular capillary swelling (GS) and mild degeneration change in tubules (T).



(D2) Section in the kidney of propolis with MSG group (group 4), showing tubular cloudy swelling (TS).

Figure 5. Photomicrograph of kidney sections stained with H&E

The reduction of albumin in the MSG treated rabbits is similar to the finding by Tawfik and Al-Badr (2012) who reported that MSG group showed reduced in serum albumin levels lower than control group. In addition, Vinodini *et al*., (2010) reported that treatment of MSG increase the concentration of urea and creatinine due to the kidney functional capacity, total or partial damage of kidney function of tubular excretion due to MSG could have interference with creatinine metabolism.

Treatment with propolis lead to significant reduction in lipid peroxides levels and increase in antioxidant enzymes GPx, GST, CAT and SOD than control group, indicating the protection of the liver tissues from the damaging effect of MSG. This result confirmed by Yagi (1987) who indicated that propolis group showed higher concentration of GSH, CAT and SOD than control group of mice. This is due to the ability of propolis to protect tissues from oxidative stress. In addition, Oktem *et al.*, (2005) confirmed this result and mentioned that propolis is capable to improvement of antioxidant system by preventing oxidative damage. Also, this result is comparable with Banskota *et al*., (2000); Bhadauria, (2012) and Saleh, (2012) who indicated that propolis has high concentration of total phenolic compounds resulting in protective effect from hepatotoxicity. Moreover, this result confirmed by Newairy and Abdou, (2013) who reported that propolis considered lipid peroxidation inhibitor and free-radical scavenger because it has antioxidant property resulting in protected effect, increase antioxidant enzymes and elevation the intracellular concentration of glutathione.

Liver section taken from rabbits after treated with MSG showed hepatocytes damage was manifested by marked disturbance in hepatic architecture. This result is comparable and confirmed by Inuwa *et al.*, (2011) who suggested that the change in the structure of the liver cells occurs through oral treatment with MSG. Presence of propolis showed improvement in hepatic architecture. This result is in agreement and confirmed by Araujo *et al*., (2012) who mentioned that propoils has antioxidant properties resulting in ameliorate fibrosis in hepatic architecture. The obtained result of kidney section from MSG group is corroborated with earlier study by Thomas *et al.*, (2010) and Paul *et al.*, (2012) who supported that MSG supplementation by oral intake induced kidney damage. Furthermore, Stajn *et al.*, (1997) mentioned that MSG produces reactive oxygen substances resulting in cellular injury and oxidative stress, leading to lipid peroxidation which results in disintegration and destabilization of cell membrane.

Moreover, Eweka (2007) confirmed that treated with MSG leading to cellular necrosis of the renal glomerulus. In addition, Vinodini *et al*., (2010) recommended that oral treatment of MSG showed morphological alterations and oxidative stress in renal tissues. Presence of propolis with MSG showed improvement of glomeruli and tubules. This result confirmed by Araujo *et al.*, (2012) who reported that propoils has antioxidant properties resulting in ameliorate fibrosis in kidney. Also, El-Kott and Owayss, (2008) and El-kott *et al*., (2012) mentioned that the propolis had anti proliferative and anticarcinogenic activity.

CONCLUSION

The results obtained showed deterioration in blood biochemical measurements, activities of antioxidant enzymes, liver and kidney functions and deterioration of liver and kidney tissues due to treatment with MSG. Also, the result showed that propolis has ability to improving the biochemical measurements and has the capacity as antioxidant by increases the activities of antioxidant enzymes and restore liver and kidney cells near their normal shape.

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الملخص العربي

التأثيرات الوقائية المحتملة للبروبوليس تجاه السمية الكبدية والكلوية المستحثة بأحادى جلوتامات الصوديوم في الأرانب

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تستخدم مادة أحادى جلوتامات الصوديوم (MSG) كمادة مضافة للطعام محسنة للنكهة لزيادة قدرة الطعام على الاستساغة. ومع ذلك فإنها تؤدى إلى الاجهاد التأكسدي وتسبب العديد من المضاعفات الصحية. فى هذه الدراسة تم التحقق من تأثيرمادة أحادى جلوتامات الصوديوم على وظائف الكبد والكلى والتأثيرالوقائي للبروبوليس في ذكورالأرانب. تمت الدراسة باستخدام عشرون من ذكورالأرانب تم تقسيمهم إلى أربع مجموعات متساوية. المجموعة الأولى استخدمت كمجموعة ضابطة، المجموعة الثانية تم معاملتها بالبروبوليس (٨ ملجم/ كجم من وزن الجسم)، المجموعة الثالثة تم معاملتها بمادة أحادى جلوتامات الصوديوم (50 ملجم / كجم من وزن الجسم)، المجموعة الرابعة تم معاملتها بمزيج من البروبوليس (٨ ملجم / كجم من وزن الجسم) مع مادة أحادى جلوتامات الصوديوم (50 ملجم / كجم من وزن الجسم) فى نفس الوقت، وتم اعطاء الجرعات يوم بعد يوم لمدة ١٢ أسبوع. المعاملة بمادة MSG أظهرت زيادة معنوية فى مستوى TBARS وانخفاض معنوى في مستوي الجلوتاثيون ونشاط الإنزيمات المضادة للأكسدة (GPx، GST، CAT وSOD) في البلازما والكبد والكلى. كذلك أظهرت المعاملة زيادة معنوية فى نشاط إنزيمات الكبد (AST، ALT، AlP، AcP ، GGT و LDH) و مستوى الجلوكوز واليوريا والكرياتينين بينما ظهر انخفاض معنوى فى البروتين الكلي والألبيومين والجلوبيولين في البلازما، كذلك أدت المعاملة بمادة MSG إلى تدهور فى التركيب البنائى لنسيج الكبد والكلى. وجود البروبوليس مع مادة أحادى جلوتامات الصوديوم خفف من الآثارالسامة لمادة MSG على الكبد والكلى، وهذه الحماية قد تكون بسبب وجود الخصائص المضادة للأكسدة فى البروبوليس، وقد تم دعم النتائج البيوكيميائية بواسطة النتائج المتحصل عليها من خلال فحص نسيج الكبد والكلى. نستنتج من خلال النتائج السابقة أن البروبوليس قادرعلى التخفيف من الإجهاد التأكسدي، السمية الكبدية والكلوية الناتجة عن مادة أحادى جلوتامات الصوديوم MSG في ذكورالأرانب.

الكلمات المفتاحية: أحادى جلوتامات الصوديوم، البروبوليس، السمية الكبدية، السمية الكلوية، الإجهاد التأكسدي، الانزيمات المضادة للأكسدة، الفحص النسيجي، ذكور الارانب.