The Possible Ameliorative Effect of Propolis in Rat's Liver Treated with Monosodium Glutamate (MSG)

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Abstract: Monosodium glutamate (MSG) is a commonly used food additive and there is growing concern that excitotoxins such as MSG play a critical role in the development of several hepatic disorders. Propolis, a resinous wax-like beehive product has been used as a traditional remedy for various diseases due to a variety of biological activities of this folk medicine. The present study aimed to investigate the protective and curative effect of propolis against MSG on the rat liver. Fifty male albino rats weighting 75- 95 g. were used to study the biochemical analysis of liver function parameters, including ALAT, ASAT, ALP activities, total proteins, albumin in the blood sera, MDA, GSH and electrophoresis in liver tissue. 1) Rats received distilled water for 4 and 8 weeks (Control group); 2) rats received 200 mg propolis /kg b. w. for 8 weeks (Propolis group); 3) rats received 1 g MSG /kg. b. w. for 8 weeks (MSG group); 4) rats received 200 mg propolis /kg. b. w. for 8 weeks + 1 g MSG /kg. b. w. during the last 4 weeks (protective group); 5) rats received 1 g MSG /kg. b. w. for 8 weeks + 200 mg propolis / kg. b. w. during the last 4 weeks (therapeutic group). Rats were received their respective doses daily by oral gavage and sacrificed 24 hrs after the last dose of different treatments. The results of the present study in MSG group reveal that the mean body weight, absolute and relative liver weight was increased and a highly significant increase in ALAT, ASAT, ALP and MDA activities in serum and decrease in total proteins, albumin and GSH. In electrophoresis study, there was decrease in fractions 1, 2, 5 and fraction 6 and increase in fractions 3 and 4. In protective group, propolis extract in the protective group showed significant improvement in the activity of ALAT, ASAT, ALP, total protein, albumin, MDA, GSH and the mean body weight, absolute and liver relative weight, electrophoresis. In therapeutic group, the results indicated that propolis extract was found to be less effective in restoring MSG induced biochemical and electrophoresis alteration. It may be concluded that propolis extract possess the ability to reverse MSG induced liver oxidative injury as well as to regulate the metabolic enzymatic activities for maintaining proper functioning of the cells and may be considered as hepatoprotective agent against MSG induced toxic effects in the protective role but propolis as therapy was of only limited value.

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1. Introduction

Various environmental chemicals, industrial pollutants and food additives have been implicated as causing harmful effects. Monosodium glutamate (MSG), the sodium salt of amino acid glutamate, is a food additive, popularly used the world over as "flavor enhancer". The safety of MSG's usage has generated much controversy locally and globally ***(Zerasky, 2010)***. As a food additive, monosodium glutamate is described and listed on food labels as a "Flavouring" or "Hydrolysed vegetable protein". Through its stimulation of the Orosensory receptors and improving the palatability of meals, monosodium glutamate influences the appetite positively and induces weight gain ***(Moore, 2003)***. Despite its taste stimulation, and improved appetite enhancement, reports indicate that monosodium glutamate is toxic to humans and experimental animals ***(Biodun and Biodun, 1993)***. Alterations in the levels of thiobarbituric acid reactive substances (TBARS) and antioxidants like reduced glutathione, catalase and superoxide dismutase were reported in adult mice during MSG treatment ***(Ahluwalia et al., 1996)***. Furthermore, disruption in the levels of biochemical parameters such as carbohydrates, lipids and proteins in MSG-treated rats were also well documented ***(Ahluwalia and Malik, 1989)***.

Propolis, a resinous wax-like beehive product is collected by honey bees from plant exudates and also known as bee glue. The worker bees apply the resin to seal any cracks and fissures in the hive and they 'line their front door' with it to prevent contamination. They use it as an antiseptic in breeder cells, and they mix propolis with wax to distribute a fine varnish over every inch of the hive to protect it ***(Burdock, 1998)***. Chemical properties of propolis are not only beneficial to bees but have general pharmacological value as a natural mixture ***(Garedewa et al., 2004)***. Several empirical and clinical findings point to the fact that propolis may be more effective against

pathogenic microorganisms than conventional medications ***(Higashi and de Castro, 1994)***. The pharmacological effects of bee propolis include reduction of the blood pressure, protection of the liver tissue against carbon tetrachloride, protection against stomach ulcer formation and maintenance of serum glucose ***(Kedzia et al., 2007)***. The target of the present study is to investigate the protective and curative effects of propolis against MSG liver of rats.

2. Material and Methods

Fifty weanling male albino rats **(*Rattus norv*egicus)** weighing between 75- 95 g. were used throughout the present study. They were obtained from the Medical Research Center and Bilharzial Research Faculty of Medicine, Ain Shams University. The animals were housed in groups of five in standardized cages and were located in the same room with constant environmental conditions such as temperature (22 ± 3°C) and humidity (50-60%). They were supplied with enough rat feed and drinking water *ad-libitum*. All animals were allowed to acclimatize in the environment for one week before the commencement of the study which lasted for eight weeks.

Chemicals:

The chemicals used, monosodium glutamate (MSG) with purity 99% and propolis, were purchased from Sigma chemical company (USA).

Experimental Animal Grouping:

The animals were divided into 5 equal groups, each contains 10 male rats: **1)** The Control Group*:* Animals of this group received distilled water daily by oral gavage for eight weeks**. 2)** The Propolis-Treated Group: Rats received propolis orally in a daily dose of 200 mg/kg b. w. for eight weeks. **3)** The Monosodium Glutamate (MSG)-Treated Group: This group included rats that were administrated MSG in a daily dose of 1g/kg b. w. for eight weeks. **4)** The Protected Group: Animals of this group were first administrated propolis orally in a dose of 200 mg/kg b. w. daily for four weeks and secondly administrated daily oral doses of propolis (200 mg/kg b. w.) in association with MSG (1g/kg b. w.) for an additional four weeks. **5)** The Therapeutic Group*:* Animals of this group were first provided with oral dose of MSG (1g/kg b. w.) daily for four weeks, then were treated orally with MSG (1g/kg b. w.) in association with propolis (200 mg/kg b. w.) for an additional four weeks.

Preparation of samples: At the end of experiment, animals from control and treated groups were weighed and the mean body weight was calculated and sacrificed, by jugular decapitation, 24 hours after the end of four and eight weeks of treatment. Also the liver was weighted and the absolute and relative liver weight was calculated. Their blood samples were collected into labelled centrifuge tubes, allowed to clot and then centrifuged at 3000 r. p. m. for 10 minutes for biochemical analysis. Then the liver specimens obtained from the control and treated rats were homogenized to be examined for the oxidative stress and electrophoresis parameters.

Biochemical Methods:-

Determination of serum alanine aminotransferase (ALAT):

ALAT activity was determined colorimetrically according to ***Reitman and Frankel (1957)*.** The color absorbance was obtained by coupling of pyruvic acid and L-Glutamic acid with 2, 4-Dinitrophenylhydrazine. The corresponding colored hydrazones was measured at wave length of 546 nm.

Determination of serum aspartate amino transferase (ASAT):

ASAT activity was determined according to ***Reitman and Frankel (1957)*.** Serum is incubated with ketoglutarate for one hour at 37°C and the reaction is stopped and dinitrophenylhydrazine was added. The color absorbs light at 505 nm.

Determination of serum alkaline phosphatase (ALP):

Estimation of ALP in serum was determined according to ***Belfield and Goldberg (1971)*.** Alkaline phosphatase, in alkaline medium, hydrolyzes a colorless substrate of disodium phenyl phosphate giving rise to phenol and phosphate. 4-aminoantipyrine and sodium arsenate are used to stop the enzymatic reaction. The liberated phenol could then be measured colorimetrically by adding potassium ferricyanide as a color developing reagent.

Determination of serum total protein levels:

Total protein in serum was determined colorimetrically according to ***Henry et al. (1974)*.** Carbonyl and amine groups of the peptides of protein molecules form a colored complex with copper which is determined photometrically and corresponds to protein content in the serum.

Determination of serum albumin levels:

Serum albumin level was estimated colorimetrically according to ***Doumas et al. (1971)*.** Determination of albumin depends on the dye binding in a buffered solution. As bromocresol green forms a green colored complex with albumin whose intensity is proportional to the amount of albumin present in serum.

Liver Tissue (Oxidative stress parameters) Methods:-

1- Determination of Glutathione (GSH): GSH was determined by ***Tietze (1969)*.**

2- Determination of lipid peroxidation

malondialdhyde (MDA): MDA was determined according to ***Botsoglou et al. (1994).***

Liver protein electrophoresis:

Aqueous extracts were prepared from equal weight of liver of rats of each group as described by ***Jay (1964).*** Ten grams of ground liver were homogenized with 30 ml of distilled water and the homogenate stirred for 15 min by a magnetic stirrer, then centrifuged at 3000 rpm for 20 min at 4ºC. Supernatants were individually filtered and kept frozen at -20 until further analyses. The method used for electrophoresis was that of ***Davis (1964)*** and ***Syn Gene, 4.01.02 – Serial No. 17292*14518*sme*mpsc.***

Statistical Analysis:-

All data were analyzed using the SPSS for windows software, version 10.0. Analysis of variance (ANOVA) which is an indication of the dispersion or difference between more than two means to the calculated standard deviation of this difference was assessed ***(Tello and Crewson, 2003)***.

3. Results:

Body Weight, Absolute and Relative Liver Weight changes:-

1-Body weight:

In the present study, the mean body weight was recorded for control and treated rats (Table 1). No remarkable changes were recorded after 4 and 8 weeks in control and propolis groups. On the other hand, the mean body weight of MSG group showed an increase and reached 177.40±3.41 g at 8 weeks. The obtained data of the protective and therapeutic groups were nearly similar to those of the control group. The mean body weights were 159.40±5.16 g and 166.00±14.90 g, respectively at 8 weeks compared with control group.

2- Liver weight:

No remarkable changes occurred in the mean liver weight of control and propolis groups after 4 and 8 weeks. On the other hand, the mean liver weight of MSG group increased and reached 5.520±0.220 g at 8 weeks compared to the control group. Furthermore, protection was shown in the mean liver weight in protective rats group. The mean liver weight recorded 4.446±0.191 g at the end of experimentation (8 weeks). Nevertheless, an increase occurred in the mean liver weight in therapeutic rats group as compared to control group. The percentage of the mean liver weight reached to 16.45 % at 8 weeks (Table 1).

3- Relative liver weight:-

No significant differences were found in the relative weight of liver to body weight in control rats and those treated with propolis. After treatment with MSG an increase in the relative liver weight of 3.113±0.118 g occurred after 8 weeks. In the fourth group, no change was reported during the experiment time where the relative liver weight recorded 2.786±0.040 g at 8 weeks. On the other hand, the relative liver weight was increased in therapeutic group and reached to 3.291±0.192 g at the end of experimentation (8 weeks) (Table 1).

Biochemical Studies:

Serum alanine aminotransferase (ALAT) level: No remarkable changes were reported in ALAT after rats were treated with control and propolis through the experimental duration (Table 2). In MSG group, a significant elevation in the level of ALAT was recorded. The percentage of increase was 82.223 % at the last interval (8 weeks). In the protective group, illustrated slight increase from 24.92±0.93 to 26.41±1.30 U/L (5.979 % increase) compared with the control group. In the therapeutic group, the level of ALAT gradually increased to 33.12±1.27 U/L at 8 weeks as compared with control group.

Serum aspartate aminotransferase (ASAT) (U/L) level: No changes were verified after the administration of propolis for 4 and 8 weeks and control group. On the other hand, in the group of rats treated with MSG a significant elevation was realized in ASAT level as compared with the control group with a percentage increase reached 121.150 % at the last study interval (8 weeks). Furthermore, protection was shown in the level of ASAT in protective rats group. The mean values of ASAT levels reached 30.41±0.94 U/L at the end of experimentation (8 weeks). In contrast, the administration of propolis 4 weeks post MSG revealed mild sign of improvement was recorded at the end of experimental duration of 8 weeks (58.843 %) (Table 2).

Serum alkaline phosphatase (ALP) (U/L.) level: No remarkable changes were noted in the level of serum ALP in control and propolis rats during the study period. In relation to the control animals, a significant increase in the serum ALP levels was reported in the MSG rats group. The percent of elevation that occurred was 47.533 % at the end of experimentation (8 weeks). The obtained data of the protective group were nearly similar to those of the control group. The mean value of ALP levels were 130.10±1.93 U/L at 8 weeks (Table 2). On the contrary, a mild improvement in ALP level took place in the therapeutic group compared with control group. The mean values of ALP levels were 155.10±1.53 U/L at the end of the experimental period (8 weeks) (Table 2).

Table (1): The protective and therapeutic role of propolis on body weight, liver weight and relative liver weight (g) in control and experimental groups.

Parameters	Duration / Group		Control Group	Propolis group	MSG group	Protective group	Therapeutic group
Body weight	1st Day	Mean ± S. E.% of change	$86.15^{A}{}_{a}\pm1.88$	$84.25^{A}{}_{a}\pm1.45$ -2.21	$83.74^{A}{}_{a}\pm1.48$ -2.80	$82.84^{A}{}_{a}\pm0.88$ -3.84	$83.71^{A}{}_{a}\pm2.05$ -2.83
	4th week	Mean ± S. E.% of change	$130.60^{A}{}_{b}\pm2.73$	$132.60^{A}{}_{b}\pm6.47$ 1.53	$148.60^{B}{}_{b}\pm3.74$ 13.78	$128.60^{A}{}_{b}\pm5.51$ -1.53	$151.80^{B}{}_{b}\pm5.19$ 16.23
	8th week	Mean ± S. E.% of change	$167.20^{A}{}_{c}\pm10.70$	$162.40^{ACD}{}_{c}\pm3.66$ -2.87	$177.40^{B}{}_{c}\pm3.41$ 6.10	$159.40^{C}{}_{c}\pm5.16$ -4.67	$166.00^{AD}{}_{c}\pm14.90$ -0.72
Liver weight	4th week	Mean ± S. E.% of change	$4.532^{A}{}_{a}\pm0.387$	$4.484^{A}{}_{a}\pm0.290$ -1.06	$4.910^{B}{}_{a}\pm0.146$ 8.34	$4.472^{A}{}_{a}\pm0.295$ -1.32	$4.950^{B}{}_{a}\pm0.132$ 9.22
	8th week	Mean ± S. E.% of change	$4.706^{A}{}_{a}\pm0.409$	$4.374^{A}{}_{a}\pm0.102$ -7.06	$5.520^{B}{}_{b}\pm0.220$ 17.30	$4.446^{A}{}_{a}\pm0.191$ -6.40	$5.480^{B}{}_{b}\pm0.580$ 16.45
Relative liver weight	4th week	Mean ± S. E.% of change	$3.470^{A}{}_{a}\pm0.231$	$3.375^{AB}{}_{a}\pm0.096$ -2.74	$3.310^{BC}{}_{a}\pm0.107$ -4.61	$3.465^{A}{}_{a}\pm0.085$ -0.14	$3.273^{C}{}_{a}\pm0.118$ -5.68
	8th week	Mean ± S. E.% of change	$2.815^{A}{}_{b}\pm0.208$	$2.695^{A}{}_{b}\pm0.052$ -4.26	$3.113^{B}{}_{b}\pm0.118$ 10.59	$2.786^{A}{}_{b}\pm0.040$ -1.03	$3.291^{B}{}_{a}\pm0.192$ 16.91

A, B, C, D The groups in the same row with different letters are statistically significant ($p<0.05$).
a, b, c The groups in the same column with different letters are statistically significant ($p < 0.05$).

Table (2): The protective and therapeutic role of propolis on serum alanine amoinotransferase (ALAT), aspartate amoinotransferase (ASAT) and alkaline phosphatase (ALP) (U/L) in control and experimental groups.

Parameters	Duration / Group		Control Group	Propolis group	MSG Group	Protective group	Therapeutic group
ALAT	4th week	Mean ± S. E. % of change	$24.51^{A}{}_{a}\pm0.92$	$24.23^{A}{}_{a}\pm0.91$ -1.142	$40.52^{B}{}_{a}\pm1.12$ 65.320	$24.31^{A}{}_{a}\pm0.94$ -0.816	$39.63^{B}{}_{a}\pm1.16$ 61.689
	8th week	Mean ± S. E. % of change	$24.92^{A}{}_{a}\pm0.93$	$24.91^{A}{}_{a}\pm1.19$ -0.040	$45.41^{B}{}_{b}\pm1.49$ 82.223	$26.41^{A}{}_{a}\pm1.30$ 5.979	$33.12^{C}{}_{b}\pm1.27$ 32.905
ASAT	4th week	Mean ± S. E. % of change	$26.81^{A}{}_{a}\pm1.21$	$26.31^{A}{}_{a}\pm1.92$ -1.865	$49.36^{B}{}_{a}\pm1.43$ 84.110	$27.63^{A}{}_{a}\pm1.31$ 3.059	$50.21^{B}{}_{a}\pm1.19$ 87.281
	8th week	Mean ± S. E. % of change	$27.14^{A}{}_{a}\pm1.10$	$27.11^{A}{}_{a}\pm1.30$ -0.111	$60.02^{B}{}_{b}\pm0.92$ 121.150	$30.41^{A}{}_{a}\pm0.94$ 12.049	$43.11^{C}{}_{b}\pm1.05$ 58.843
ALP	4th week	Mean ± S. E. % of change	$122.41^{A}{}_{a}\pm2.41$	$123.30^{A}{}_{a}\pm2.29$ 0.727	$165.47^{B}{}_{a}\pm2.12$ 35.177	$123.93^{A}{}_{a}\pm2.12$ 1.242	$166.12^{B}{}_{a}\pm1.34$ 35.708
	8th week	Mean ± S. E. % of change	$123.22^{A}{}_{a}\pm2.10$	$124.12^{A}{}_{a}\pm1.87$ 0.730	$181.79^{B}{}_{b}\pm1.32$ 47.533	$130.10^{C}{}_{b}\pm1.93$ 5.583	$155.10^{D}{}_{b}\pm1.53$ 25.872

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a, b, The groups in the same column with different letters are statistically significant ($p < 0.05$).

Serum total protein (T. P.) (g/dl) level:

No changes were noted in the mean values of total proteins in control and propolis group during the experimental time. After the rats were treated with MSG, a significant depletion in the serum total protein level occurred. The percentage of decrease in the serum total protein level in MSG group was -48.237 % at 8 weeks. A considerable protection in the serum total protein level occurred in the rats of the protective group. The percentage of changes in the level of total proteins reached -6.571 % at 8 weeks of experimentation as compared to the control rats. On the other hand, depletion in total protein levels took place in the therapeutic group. The mean value of total protein levels were 4.74±0.08 g/dl at 8 weeks of experimentation (Table 3).

Serum albumin (g/dl) level:

The control and propolis rats designated similar levels during the study period (Table 3). In relation to the control rats a decrease in the serum albumin was reported as animals were treated with MSG. The percentage of decrease in the serum albumin level was -22.788 % at 8 weeks. Furthermore, protection was shown in the level of albumin in protective rats

group. The mean values of albumin levels recorded 182.41±2.66 g/dl at the end of experimentation (8 weeks). Nevertheless, a decrease occurred in serum albumin levels in therapeutic rats group as compared to control group. The percentage of decrease in the serum albumin level reached to -11.918 % at 8 weeks.

Table (3): The protective and therapeutic role of propolis on serum total protein (g/dl) and albumin (g/dl) in control and experimental groups.

Parameters	Group / Duration		Control group	Propolis group	MSG group	Protective group	Therapeutic group
Total protein	4th week	Mean ± S. E. % of change	6.21^{A}_{a}±0.13	6.19^{A}_{a}±0.10 -0.322	4.51^{B}_{a}±0.04 -27.375	6.21^{A}_{a}±0.06 0.000	4.31^{B}_{a}±0.07 -30.596
	8th week	Mean ± S. E. % of change	6.24^{A}_{a}±0.12	6.27^{A}_{a}±0.11 0.481	3.23^{B}_{b}±0.13 -48.237	5.83^{A}_{a}±0.07 -6.571	4.74^{C}_{a}±0.08 -24.039
Albumin	4th week	Mean ± S. E. % of change	186.31^{A}_{a}±2.41	187.92^{A}_{a}±2.56 0.864	153.73^{B}_{a}±2.01 -17.487	185.21^{A}_{a}±2.39 -0.590	155.22^{B}_{a}±2.73 -16.687
	8th week	Mean ± S. E. % of change	188.70^{A}_{a}±2.94	190.42^{A}_{a}±2.39 0.912	145.70^{B}_{b}±2.71 -22.788	182.41^{C}_{a}±2.66 -3.333	166.21^{D}_{b}±2.37 -11.918

A, B, C, D The groups in the same row with different letters are statistically significant ($p < 0.05$).

a, b, The groups in the same column with different letters are statistically significant ($p < 0.05$).

Liver Tissue (Oxidative stress parameters):-

Tissue Glutathione (GSH) (µg/g protein) levels: Normal rats showed more or less constant levels during the course of the study. Moreover, no remarkable changes were reported after rats were treated with propolis through the experimental duration (Table 4). In MSG treated group of rats, a significant depletion in the content of tissue GSH was recorded. The mean value of GSH content was 8.10±0.60 µg/g protein (-56.615 %) at the last interval (8 weeks). In the protective group, were nearly similar to that of the control group and reached to 18.61±0.47 µg/g protein (-0.312 %). In therapeutic rats group, a decrease in the tissue GSH content of 14.84±0.54 µg/g protein (-20.514 %) occurred after 8 weeks of experimentation as compared with control group.

Tissue lipid peroxidation malondialdhyde (MDA) (mM/100g protein) level: No changes were verified after the administration of propolis for 4 and 8 weeks. On the other hand, in MSG rats group a significant elevation was realized in tissue MDA content as compared with the control group with a percentage increase of 81.579 % from control at 4 weeks. These were later recorded highly significant increase with lapse of time reaching 265.000 % at the last interval (8 weeks). In the protective group, MDA content were nearly similar to those of the control group. The mean values of MDA content recorded 0.47±0.21 mM/100g protein at the end of experimentation (8 weeks). A slightly improvement in MDA content in therapeutic rats group recording 65.000 % at 8 weeks, as compared with the control and propolis groups (Table 4).

Liver protein electrophoresis:-

Electrophoretic pattern showed significant alterations in most of the studied fractions between groups. Effect of treated group on the protein fractions which were electrophoretically separated are shown in table (5) and graphically represented in figure (1). There was no significant change in differential fractions of proteins in the control and fractions 1, 2, 5 and 6 in the group treated with propolis for 8 weeks, while there was decrease in the mean value in fraction 3. This decrease reached to 19.542 g/100g protein and slight increase in fraction 4 reached to 29.553 g/100g protein compared with control group. In contrast, the treatment with MSG for 8 weeks resulted in several discomfitures abnormality represented by reduction or elevation in the factions of the different liver protein fractions. There was a decrease of fractions 1, 2, 5 and fraction 6 in MSG group. The percentage of decrease was 6.060, 14.958, 8.064 and 1.020 g/100g protein, respectively. Also there was increase in fractions 3 and 4 and reached 35.768 and 34.129 g/100g protein, respectively as compared with control group. In the protective group, the data indicated protection in all protein fractions. The percentage of changes recorded 11.223, 19.143, 26.726, 30.491, 10.221 and 2.195 g/100g protein, respectively. On the contrary, in the therapeutic group, fractions 1, 2, 5 and 6 showed decreases 5.057, 13.962, 9.058 and 1.019 g/100g protein, respectively, while there was increase in fractions 3 and 4 as compared with control group. The mean value of the increase in liver protein fractions were 35.772 and 35.132 g/100g protein respectively.

Table (4): The protective and ‹mM/100g) in control and experimental groups.

Parameters	Duration / Group		Control group	Propolis group	MSG group	Protective group	Therapeutic group
GSH	4th week	Mean ± S. E. % of change	$20.23^{A}{}_{a}\pm0.82$	$19.21^{A}{}_{a}\pm0.75$ -5.042	$12.51^{B}{}_{a}\pm0.53$ -38.161	$19.82^{A}{}_{a}\pm0.56$ -2.027	$12.20^{B}{}_{a}\pm0.71$ -38.694
	8th week	Mean ± S. E. % of change	$18.67^{A}{}_{a}\pm0.71$	$18.50^{A}{}_{a}\pm0.81$ -0.911	$8.10^{B}{}_{b}\pm0.60$ -56.615	$18.61^{A}{}_{a}\pm0.47$ -0.312	$14.84^{C}{}_{b}\pm0.54$ -20.514
MDA	4th week	Mean ± S. E. % of change	$0.38^{A}{}_{a}\pm0.12$	$0.40^{A}{}_{a}\pm0.13$ 5.263	$0.69^{B}{}_{a}\pm0.22$ 81.579	$0.36^{A}{}_{a}\pm0.20$ -5.263	$0.72^{B}{}_{a}\pm0.26$ 89.474
	8th week	Mean ± S. E. % of change	$0.40^{A}{}_{a}\pm 0.14$	$0.41^{A}{}_{a}\pm0.15$ 2.500	$1.46^{B}{}_{b}\pm0.25$ 265.000	$0.47^{C}{}_{b}\pm0.21$ 17.500	$0.66^{D}{}_{b}\pm0.31$ 65.000

A, B, C, D The groups in the same row with different letters are statistically significant ($p < 0.05$).

a, b, The groups in the same column with different letters are statistically significant ($p < 0.05$).

Table (5): The protective and therapeutic role of propolis on protein fractions of Liver extract (g/100g protein) in control and experimental groups.

Fractions / Groups		Control group	Propolis group	MSG group	Protective group	Therapeutic group
Fraction 1	% Raw vol.	15.761	15.811	6.060	11.223	5.057
Fraction 2	% Raw vol.	17.984	22.246	14.958	19.143	13.962
Fraction 3	% Raw vol.	29.624	19.542	35.768	26.726	35.772
Fraction 4	% Raw vol.	24.151	29.553	34.129	30.491	35.132
Fraction 5	% Raw vol.	9.885	10.327	8.064	10.221	9.058
Fraction 6	% Raw vol.	2.595	2.520	1.020	2.195	1.019

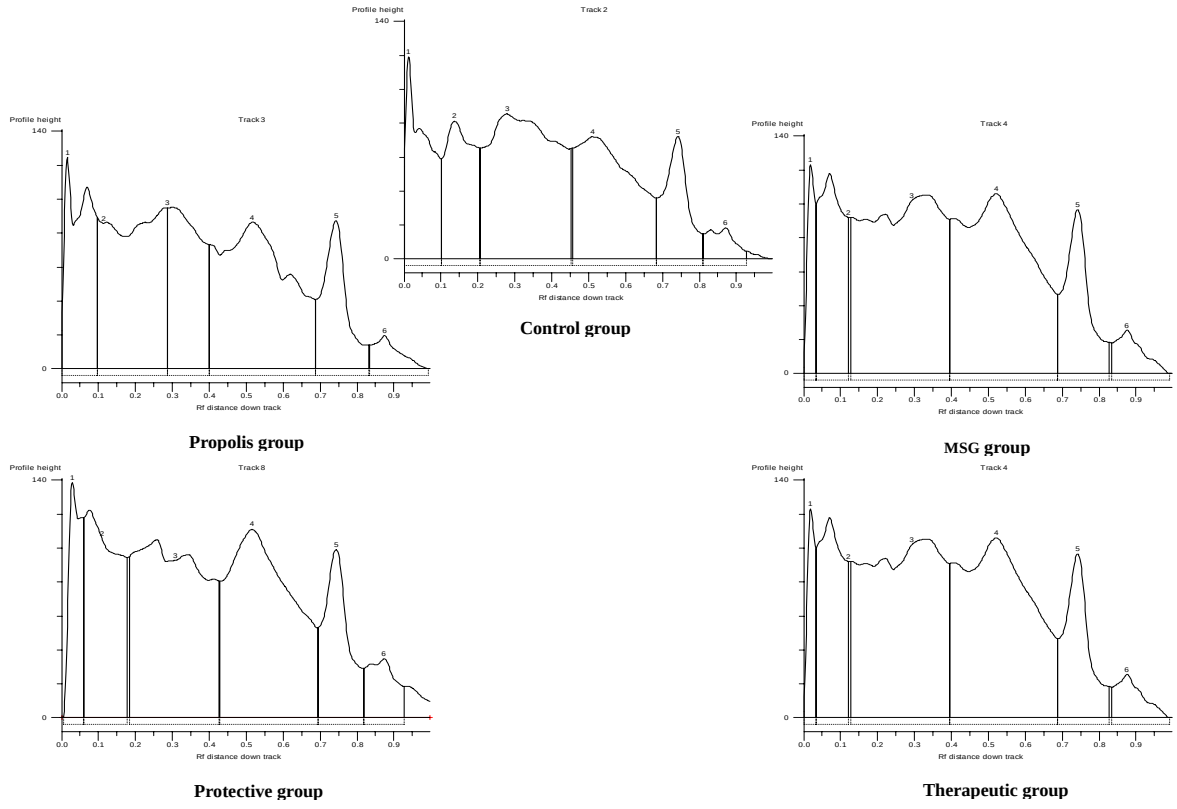

Figure (1): The protective and therapeutic role of propolis on kinds of protein fraction of Liver extract (g/100g protein) against MSG treated male albino rat

4.Discussion:

The present study showed that, there was an increase in the body weight, absolute and relative liver weight of rats that treated with MSG as compared with control rats. The presently reported results are compatible with previous findings obtained by *Oluba et al. (2011)* after administration of MSG, where treated rats showed significant increase in body weight which led to obesity, as they showed that consumption of MSG increases body weight gain. Earlier report by *Kawakita et al., (2005)* explained that the potential for MSG-obesity link lies in the alteration of regulatory mechanism that affect fat metabolism. Further finding is highly recommended to rule out the possible interference. Also, these findings are in agreement with the results observed by different authors under the effect of MSG, i. e., *Onyema et al.(2006)* recorded a significant increase in the liver weight of the animals post MSG treatment, which could be attributed to an increase in the activity of inflammatory agents that could have led to inflammation of liver tissue, also *Thomas and George (2010)* showed that administration of MSG of rats caused a significant increase in liver weight and body weight and this increase could be attributed to oxidative damage and resultant inflammation of liver tissues. The present data revealed that there were no abnormal changes as regards the body weight, absolute and relative liver weight in protective group. Similar results were demonstrated by *El-Sayed et al. (2009)* who revealed that propolis plays a hepatoprotective role against STZ-induced diabetic rats in body weight which may be due to that propolis has a strong antioxidant and free radical scavenging effect *(Valadares et al., 2008).* The present investigation showed that the group that was administered MSG followed by propolis in association with MSG revealed minimal improvement where there was an increase in the mean absolute and relative liver weight in therapeutic rats group. On the contrarily *Abo-Salem et al. (2009)* revealed that treatment with propolis showed a significant amelioration in both body and kidney weights in a dose-dependent manner.

In view of the present data, it could be assumed that MSG administration at dose of 1g/kg b. w. and for different periods (4 and 8 weeks) to the rat causes a hepatic potency, which may lead to highly significant increase in ASAT, ALAT and ALP activities in serum. Therefore, the elevated transaminases activities in rat serum might reflect the hepatic damage due to the cytotoxic effect of MSG *(Ortiz et al., 2006)*. Also, *Thomas et al. (2009)* mentioned marked elevation of serum transaminases activities. The increased ALP activity in the present study after 4 weeks and 8 weeks of MSG supplementation may be due to increased synthesis in the presence of increasing biliary pressure *(Moss and Butterworth, 1974).* Again, *Rocek et al. (2001)* demonstrated that MSG administration could alter the intestinal function and releases the intestinal ALP. There is a much evidence that important stimulus for the control of food intake and energy balance are produced by the circulating energy pool that consists mainly of glucose and lipids *(Scharrer, 1999)*.

The inhibitory effect of MSG on protein profile is in agreement with the finding of *Newairy et al. (2009) and Yousef (2004)*. Although the intestine regulates the uptake of amino acids, the liver is of major importance because it regulates protein metabolism. So, the significant decrease in the concentrations of total proteins in rats treated with MSG particularly the albumin could be attributed on one hand to an under nutrition and on the other hand to a reduction of the protein synthesis in the liver *(Cherroret et al., 1995)*. Also, the observed decrease in plasma proteins could be attributed in part to the damaging effect of MSG on liver cells as confirmed by the increase in the activities of plasma ASAT, ALAT and ALP. In this regard, also, *Yaqub et al. (2008)* mentioned that serum albumin level showed significant decrease as compared to normal control group. The synthetic function of liver was altered by MSG, so albumin level was decreased.

Farombi and Onyema (2006) reported that the toxic effects of MSG in the liver were caused mainly by generation of ROS and resulting oxidative stress. Induction of oxidative stress as a consequence of MSG treatment has been reported previously *(Onyema et al., 2006).* Accordingly, the malondialdehyde (MDA) concentration in tissue of liver, a marker of lipid peroxidation (LPO), increased in MSG-treated rats in the present study, probably due to the generation of reactive oxygen species as previously suggested by *Tomita and Okuyama (1994)*. The observed increase in the MDA in liver tissue by MSG appears to confirm an earlier report by *Diniz et al. (2004)* that the administration of MSG induced oxidative stress in experimental animals, thus the significant increase of MDA level indicates the possibility of increased radical production and higher rate of lipid peroxidation. However, this result confirms the earlier investigation of *Ahluwalia et al. (1996).* Also earlier studies by *Younes and Seigers (1981)* have reported that once the GSH concentration is depleted to 20% of its original content, lipid peroxidation is initiated and an inverse relationship exists between GSH and lipid peroxidation. GSH can diminish oxidative stress either by protecting the detoxifying enzymes by increasing the efficacy of nicotine amide dinucleated phosphate (NADPH), or by helping in the elimination

of compounds which produce peroxidation in the cell membranes *(Machlin and Bandich, 1987)*. This could be one of the reasons for the decreased level of hepatic GSH in the present study. Decrease in GSH level might be due to its increased utilization by the hepatocytes in scavenging toxic radicals of MSG. In consonance with the present result, several investigators reported increase in MDA and decrease in GSH subsequent to MSG administration *(Yaqub et al., 2008 and Soliman, 2011)*.

In the present study in the propolis group, no significant difference was determined in the activities of ASAT and ALAT. Similarly, in a study carried out in rats, *Mani et al. (2006)* have determined that the administration of the ethanolic and water extracts of propolis for a period of 150 days do not cause any change in the indicated parameters. Also, in this investigastion, the authors observed the absence of any signiffcant difference in the level of ALP, total protein and albumin, as well as MDA and GSH in the group that were administered propolis alone. Some authors have underlined the occurrence of alterations in enzyme activities and MDA levels upon the administration of propolis. Thus, *Jasprica et al. (2007)* have reported propolis to cause reduction in MDA levels.

The present results in the protective group indicated that propolis reduces injurious effects or to preserve the normal hepatic physiologic mechanism when it has been disturbed by a hepatotoxicant is the index of its hepatoprotective effect. In the present study, with respect to enzymes related to the liver, the ASAT, ALAT and ALP activities determined to be high in the group that was administered MSG alone. In the groups that were administered propolis for 4 weeks then treated with propolis in association with MSG (prophylactic group) compared with the group that treated with MSG alone, decreased enzyme activity supports the hepatoprotective effect of propolis. Similar results were obtained by *Sugimoto et al. (1999)* and these researchers have reported propolis to cause decrease in ASAT activity when administered to rats exposed to D-galactosamine. This result is in accordance with the findings that propolis induced reduction of the increased activity of ASAT and ALAT concentrations in plasma of rats treated with galactoseamine *(Nirala et al., 2008)*. Finally, Prophylactic treatment with propolis succeeded to protect against the hepatotoxicity induced by MSG, as evidenced by the reduction in the level of lipid peroxide, the maintenance of intracellular level of GSH Albumin and total protein and the decreased leakage of ALAT, ASAT and ALP. These effects could be, at least partly, explained by the anti-oxidant capability of the extract *(Merino et al., 1996 and Basnet et al., 1997).*

The present investigation in the therapeutic group minimal improvement in biochemical parameters where there was an increase in ALAT, ASAT, ALP and MDA and decrease in Albumin, total protein and GSH. This indicates that propolis was not efficient for use as a therapeutic agent. The previously reported treatment dependent (prophylactic/ curative *(Shukla et al., 2004),* dose dependent *(Shukla et al., 2005)* and duration dependent *(Bhadauria et al., 2007)* hepatoprotective effects of propolis against acute single administration of CCl_4 is confirmed by studies reported by *Mahran et al. (1996)* who found that a dose-related protection against the induced cell injury was conferred by aqueous propolis extract (APE) as evidenced by its inhibitory influence on the changes induced by CCl4 on the measured parameters.

In the present study, MSG group showed reduction in fractions 1, 2, 5 and 6 and elevation in the factions 3 and 4 of the different liver protein fractions as compared with control group. This result is in agreement with *Madbouly (2005)* in her study on electrophoresis of liver proteins fractions, she showed that treatment of infected mice with mirazid caused decrease of Gamma-globulin of infected group, while induced increases in Beta, Albumin, Prealbumin and Alpha fractions. This decrease and increase in particular in protein fractions may be related to the effect of MSG on the specific genes encoding for these fractions as study demonstrated by *Radwan (2005)* revealed that coumarin caused qualitative and quantitative changes in tissues (brain, liver and kidney) protein fractionation pattern of chicken. The changes (decrease or increase) in particular protein fractions may be related to the effect of xenobiotic (coumarin) on the specific genes encoding for these fractions. Furthermore, protection was shown in the mean fractions of liver proteins in protective rats group. Propolis is apicultural products which is composed of nutritionally valuable substances and contain considerable amounts of polyphenol substances which may act as potent antioxidant *(Teixeira et al., 2008)*. Flavonoids and phenolic acids are major classes of polyphenolic compounds, whose structure-antioxidant activity *(Gardjeva et al., 2007)*. On the contrary, a significant increase and decrease in the fractions took place in the therapeutic group compared with control group. The results confirm improvement and hepatoprotective effect of propolis against MSG، especially when it was administrated as a protective substance than therapeutic. Aqueous extract of propolis has prophylactic hepatoprotective effect against CCl4 induced injury *(El-Khatib et al., 2002)*. It has been previously reported that the treatment is dependent on (prophylactic/ curative; (*Shukla et al., 2004)*, dose dependent *(Shukla et al.,*

2005) and duration dependent *(Bhadauria et al., 2007).*

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Reference:

Abo-Salem, O. M.; El-Edel, H. R.; Harisa, G. E. I.; El-Halawany, N. and Ghonaim, M. M. (2009): Experimental diabetic nephropathy can be prevented by propolis: Effect on metabolic disturbances and renal oxidative parameters. *Pak. J. Pharm. Sci.*, 22 (2): 205-210.

Ahluwalia, P. and Malik, V. B. T. (1989): Effect of monosodium glutamate on serum lipids, blood glucose and cholesterol in adult male mice. *Toxicol. Lett*., 45: 195-198.

Ahluwalia, P.; Tewari, K. and Choudhary, P. (1996): Studies on the effect of monosodium glutamate (MSG) on oxidative stress in erythrocyte of adult male mice. *Toxicol. Lett*., 84: 161-165.

Basnet, P.; Matsuno, M. and Neidlein, R. (1997): Potent free radical scavenging activity of propolis isolated from Brazilian propolis. *Z. Naturforsch [C]*. 52: 828–833.

Belfield, A. and Goldberg, D. M. (1971): Colorimetric determination of alkaline phosphatase activity. *Enzyme*, 2: 561-568.

Bhadauria, M.; Nirala, S. K. and Shukla, S. (2007): Duration-Dependent hepatoprotective effects of propolis extract against carbon tetrachloride–induced acute liver damage in rats. *Adv. Natur. Ther.*, 24 (5): 1136-1145.

Biodun, D. and Biodun, A. (1993): A Spice or Poison? Is Monosodium Glutamate Safe for Human Consumption?. *National Concord Newspaper*, pp: 5.

Botsoglou, N. A.; Fletouris, D. J.; Papageorgiou, G. E.; Vassilopoulos, V. N.; Mantis, A. J. and A.G. Trakatellis, A. G. (1994): Rapid sensitive and specific thiobarbituric acid method for measuring lipid peroxidation in animal tissue, food and feed stuff samples. *J. Agric. Food Chem*., 42: 1931-1937.

Burdock, G. A. (1998): Review of the biological properties and toxicity of bee propolis. *Food Chem. Toxicol.*, 36: 347–363.

Cherroret, G.; Capolaghi, B.; Hutin, M. F.; Burnel, D.; Desor, D. and Lehr, P. R. (1995): Effects of postnatal aluminum exposure on biological parameters in the rat plasma. *Toxicol. Lett.*, 78: 119-125.

Davis, B. Z. (1964): Disc electrophoresis. II–Method and application to human serum proteins. *Ann. N. Y. Acad. Sci*., 121:404.

Diniz, Y. S.; Fernandes, A. A.; Campos, K. E.; Mani, F.; Ribas, B. O. and Novelli, E. L. (2004): Toxicity of hypercaloric diet and monosodium glutamate: oxidative stress and metabolic shifting in hepatic tissue. *Food Chem. Toxicol*., 42: 319-325.

Doumas, B. T.; Watson, W. A. and Biggs, H. G. (1971): Albumin standard and the measurement of serum albumin with bromocresol green. *Clin. Chem. Acta.*, 31: 87-95.

El-Khatib, A. S.; Agha, A. M.; Mahran, L.G. and Khayyal, M.T. (2002): Prophylactic effect of aqueous propolis extract against acute experimental hepatotoxicity in vivo. *Z. Naturforschung*. 57c: 379–385.

EL-Sayed, E. M.; Abo-Salem, O. M.; Aly, A. H. and Mansour, A. M. (2009): Potential antidiabetic and hypolipidemic effects of propolis extract in streptozotocin- induced diabetic rats. *Pak. J. Pharmol. Sci.*, 22 (2): 168-174.

Farombi, E. O. and Onyema, O. O. (2006): Monosodium glutamate – induced oxidative damage and genotoxicity in the rat: modulatory role of vitamin C, vitamin E and quercetin. *Hum. Exp. Toxicol*., 25: 251-259.

Gardjeva, P. A.; Dimitrova, S. Z.; Kostadinov, I. D.; Murdjeva, M. A.; Peyche, L. P.; Lukanov, L. K.; Stanimirova, I. V. and Alexandrov, A. S. (2007): A study of chemical composition and antimicrobial activity of Bulgarian propolis. *Falia Med*., (Plovdiv) 49(3-4): 63-69.

Garedewa, A.; Schmolza, E. and Lamprecht, I. (2004): Microbiological and calorimetric investigations on the antimicrobial actions of different propolis extracts: an in vitro approach. *Thermochim. Acta.*, 422 (1-2): 115-124.

Henry, R. J., Cannon, D. C. and Winkelman J. W. (1974): Quantitative colorimetric determination of total protein in serum. Clinic. Chem. Prin. Tech., 2nd edition, New, York, Harper and Row, P. 411-421.

Higashi, K. O. and De-Castro, S. L. (1994): Propolis extracts are effective against Trypanosoma cruzi and have an impact on its interaction with host cells. *J. Ethnopharmacol.*, 43: 149.

Jasprica, D.; Mornar, A.; Debelijak, Z.; Smolcic-Bubalo, A.; Medic-Saric, M.; Mayer, L.; Romic, Z.; Bucan, K.; Balog, T.; Sobocanec, S. and Sverko, V. (2007): *In vivo* study of propolis supplementation effects on antioxidative status and red blood cells. *J. Ethnopharmacol*. 110: 548-554.

Jay, J. M. (1964): Release of aqueous extract by beef homogenates and factors affecting release volume. *Food Technol*., 18: 1633-1636.

Kawakita, T., Chiaki, S.; Shigeru, S.; Masahiro, T. and Shizuko, Y. (2005): Monosodium Glutamate. Ullmann's Encyclopedia of Industrial Chemistry.

Kedzia, B.; Iwaszkiewicz, J. and Geppert, B. (2007): Pharmacological investigations on ethanolic extract of propolis. *J. Ocul. Pharmacol. Ther.,* 23 (1): 40-5.

Machlin, L. and Bandich, A. (1987): Free radical tissue damage: Protective role of antioxidant nutrients. *FASEB. J*., 1: 441-445.

Madbouly, S. M. (2005): Electrophoretic and Histological Studies on Hepatic Schistosomiasis and its Treatment with Certain Drugs. *Egypt. J. Histol.,* 28 (2): 291-306.

Mahran, L. G.; El-Khatib, A. S.; Agha, A. M. and Khayyal, M. T. (1996): The protective effect of aqueous propolis extract on isolated rat hepatocytes against carbon tetrachloride toxicity. *Drugs Exp. Clin. Res.,* 22 (6): 309-316.

Mani, F.; Damasceno, H. C. R.; Novelli, E. L. B.; Martins, E. A. M. and Sforcin, J. M. (2006): Propolis: effect of different concentrations, extracts and intake period on seric biochemical variables. *J. Ethnopharmacol.,* 105: 95-98.

Merino, N.; González, R.; González, A. and Remirez, D. (1996): Histopathological evaluation on the effect of red propolis on liver damage induced by CCl_4 in rats. Arch. Med. Res., *27 (3): 285-289.*

Moore, K. L. (2003): Congenital malformations due to environmental factors. In: Developing Humans 2nd ed. Philadelphia: W.B. Saunders Co. *Ltd,* 173-183.

Moss, D. W. and Butterworth, P. J. (1974): Enzymology and Medicine. Pitman Medical, *London,* 139.

Nagasawa, H.; Yanai, R. and Kikuyama, S. (1974): Irreversible inhibition of pituitary prolactin and growth hormone secretion and of mammary gland development in mice by monosodium glutamate administered neonatally. *Acta Endocrinol.,* 75: 249-259.

Newairy, A. A.; Salama, A. F.; Hussien, H. M. and Yousef, M. I. (2009): Propolis alleviates aluminium-induced lipid peroxidation and biochemical parameters in male rats. *Food Chem. Toxicol.,* 47: 1093-1098.

Nirala, S. K.; Bhadauria, M.; Shukla, S.; Agrawal, O. P.; Mathur, A.; Li, P. Q. and Mathur, R. (2008): Pharmacological intervention of tiferron and propolis to alleviate beryllium-induced hepatorenal toxicity. *Fundam. Clin. Pharmacol*., 22: 403-415.

Oluba, O. M.; Onyeneke, E. C.; Idonije, B. O. and Eidangbe, G. O. (2011): Effect of Soy Protein on Monosodium Glutamate (MSG)-induced Obesity in Rats. *Asian J. Pharm. Biol. Res.,* 1 (1): 8-14.

Onyema, O. O.; Farombi, E. O.; Emerole, G. O.; Ukoha, A. I. and Onyeze, G. O. (2006): Effect of vitamin E on monosodium glutamate induced hepatotoxicity and oxidative stress in rats. *Ind. J. Biochem. Biophys.,* 43: 20-24.

Ortiz, G. G.; Bitzer-Quintero, O. K.; Zarate, C. B.; Rodriguez-Reynoso, S.; Larios-Arceo, F.; Velázquez-Brizuela, I. E.; Pacheco-Moisés, F. and Rosales-Corral, S. A. (2006): Monosodium glutamate- induced damage in liver and kidney: a morphological and biochemical approach. *Biomed. Pharmacol*., 60: 86-91.

Radwan, S. A. (2005): Evoked alterations in some biochemical parameters and protein electrophoretic pattern of some tissues of broiler chicken treated with coumarin. *Egypt. J. Hospit. Med.,* 21: 176-190.

Reitman, S and Frankel, S. (1957): A colorimetric method for determination of serum glutamic oxaloacetic and glutamic pyruvic transaminases. *Am. J. Clin. Pathol.*, 28: 56-63.

Rocek, L.; Lenharalt, L. and Mozes, S. (2001): Effect of feeding and refeeding on duodenal alkaline phosphatase activity in monosodium glutamate obese rats. *Physiol. Res.,* 50: 365-372.

Scharrer, E. (1999): Control of food intake by fatty acid oxidation and ketogenesis. *Nutrition,* 15: 704-714.

Shukla, S.; Bhadauria, M. and Jadon, A. (2004): Effect of propolis extract on acute carbon tetrachloride induced hepatotoxicity. *Ind. J. Exp. Biol.,* 42 (10): 993-997.

Shukla, S.; Bhadauria, M. and Jadon, A., (2005): Evaluation of hepatoprotective potential of propolis extract in carbon tetrachloride induced liver injury in rats. *Ind. J. Biochem. Biophys.,* 42: 321-325.

Soliman, A. M. (2011): Extract of *Coelatura aegyptiaca*, a freshwater clam, ameliorates hepatic oxidative stress induced by monosodium glutamate in rats. *Afr. J. Pharm. Pharmacol*., 5 (3): 398-408.

Sugimoto, Y.; Tarumi, T.; Kaneko, Y.; Isayama, S.; Kawai, N.; Sugimoto, H.; Yamada, H. and Kamei, C. (1999): Effect of propolis extract on D-galactosamine-induced hepatic injury in rats. Biol. Pharmacol. Bull., *22 (11): 1237-1239.*

Syn Gene GeneTools-File version*: 4.01.02 – Serial No. 17292*14518*sme*mpsc.*

Teixeira, E. W.; Message, D.; Negri, G.; Salatino, A. and Stringheta, P. C. (2008): Seasonal variation, chemical composition and antioxidant activity of Brazilian propolis samples. *ECAM/nem.,* 177:

1-9.

Tello, R. and Crewson, P. E. (2003): Hypothesis testing II: means. *Radiol.,* 227 (1): 1-4.

Thomas, M. and George, S. (2010): Effect of *Piper Longum* Linn. In monosodium glutamate toxicity in rats. *Indian of animal science.* 80 (9): Retrieved from http://epubs.icar.org.in/ejournal/index.php/IJAnS/article/view/852.

Thomas, M.; Sujatha, K. S. and George, S. (2009): Protective effects of *Piper Longum* Linn. On monosodium glutamate induced oxidative stress in rats. *Ind. J. Exp. Biol*., 47 (3): 186-192.

Tietze, F. (1969): Enzymic method for quantitative determination of nanogram amounts of total and oxidized glutathione: Applications to mammalian blood and other tissues. *Anal. Biochem.,* 27: 502-522.

Tomita, M. and Okuyama, T. (1994): Effect of paraquat on the malondialdehyde level in rats liver microsome (*in vitro*). *Arch. Toxicol.* 68: 187-192.

Valadares, B. L.; Graf, U. and Span A. M. A. (2008): Inhibitory effects of water extract of propolis on doxorubicin induced somatic mutation and recombination in Drosophila melanogaster *Food Chem. Toxicol*., 46(3): 1103-1110.

Yaqub, H.; Abdel Baky, N. A.; Attia, H. A. and Faddah, L. M. (2008): Hepatoprotective Effect of N-acetyl Cysteine and/or â-Carotene onMonosodium Glutamate-Induced Toxicity in Rats. *Res. J. Medicine & Med. Sci.,* 3 (2): 206-215.

Younes, M. and Seigers, C. P. (1981): Mechanistic aspects of enhanced lipid peroxidation following glutathione depletion *in vivo*. *Chem. Biol. Interact*., 34: 257-266.

Yousef, M. I. (2004): Aluminium-induced changes in hemato-biochemical parameters, lipid peroxidation and enzyme activities of male rabbits: Protective role of ascorbic acid. *Toxicol.,* 199: 47-57.

Zerasky K. (2010): Nutrition and healthy eating; monosodium glutamate: Is it harmful?. *Available @ mayo clinic.com*.

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