

Protective Effect of *Chlorella vulgaris* and *Spirulina platensis* against Thioacetamide-Induced Hepatorenal Toxicity in Male Rats

Mai I. Elmeleh, Taha Attia and Hanem Elgendy

Department of Pharmacology, Faculty of Veterinary Medicine, University of Sadat City, Sadat City, Egypt.

*Corresponding author: maielmeleh@gmail.com Received: 15/10/2022 Accepted: 11/12/2022

ABSTRACT

The present inquiry evaluated the possible pharmacological effects of *Chlorella vulgaris* (CV) and *Spirulina platensis* (SP) with special reference to their hepatorenal protective effect as well as their antioxidant activities against thioacetamide (TAA) acute toxicity. Thirty-six male Wister albino rats, weighing from 100 to 120 gm were applied in the present study. Rats were randomly allocated into 6 groups each of 6 animals. Group I was maintained as the control healthy group. It was administrated distilled water orally for one month and normal saline at a dose of 1 ml IP. On the last two days of the experiment. The other groups were allocated into 5 groups including A, B, C, D and E. Group A was used as a control intoxicated with thioacetamide at a dose of 300 mg/ kg b.wt. IP for two days with 24 hrs intervals before the end of the experiment. Group B was stated as a standard protected group and it was treated with silymarin at a dose of 100 mg/kg b.wt. orally for one month. Group C was given *Chlorella vulgaris* orally at a quantity of 400 mg/kg b.wt. daily, for one month. Group D was given *Spirulina platensis* at a dose of 400 mg /kg b.wt. Orally daily for one month. Group E was given CV & SP at doses of 400 mg /kg b.wt each orally daily for one month. Groups B, C, D, and E were intoxicated with thioacetamide (TAA), at an amount of 300mg/kg b.wt. IP for two days with 24 hrs intervals at the end of the month. Toxicity of rats with thioacetamide substantially elevated the levels of alanine transferase and aspartate aminotransferase, serum urea, creatinine, and uric acid in addition to increased malon-di-aldehyde concentration. However, it significantly decreased total proteins, and total antioxidant capacity concentrations and decreased blood parameters. As well as it induced histopathological alterations in hepatic and renal tissue designs (delete). On the other hand, oral administration of *Chlorella vulgaris* and *Spirulina platensis* ameliorated TAA-induced biochemical, pathological, and histopathological changes in hepatic tissues and renal tissues. This study stated that these algae attenuate thioacetamide and protect against hepatorenal toxicity, via their antioxidant properties.

Keywords: *Chlorella vulgaris*, Hepatorenal, Silymarin, *Spirulina platensis* and Thioacetamide.

INTRODUCTION

The liver is a vital organ, and it is a critical role in the metabolism and excretion of xenobiotics from the body. It also acts as a center of the metabolism of carbohydrates,

lipids, proteins and excretion waste products (Smuckler, 1975). The kidney is a vital organ, that has a critical role in animals including the excretion of waste products, Maintenance of systemic blood pressure and

production of erythropoietin (Kim and Kim 2017).

Thioacetamide (TAA) has hepatotoxicity and/or carcinogenicity (AL Hunter et al., 1977). It is one of the organosulfur compounds used in laboratories, leather handling, textile, and paper production (akhtar & Sheikh, 2013). TAA was stated to be hepatotoxic, nephrotoxic, genotoxic and carcinogenic so used in experimental models of renal toxicity and liver injury (Mansour et al., 2020). The inquiry of this work is to examine the hepatorenal defensive effect and antioxidant activity of *Chlorella vulgaris* and *Spirulina platensis* (SP). European Food Safety Authority (EFSA) *Spirulina platensis* (SP), a cyanobacterium has filaments and has different biological behaviours and nutritional importance because it contains high quantities of nutrients (proteins, vitamins, minerals, amino acids, and fatty acids like γ -linoleic acid (Belay et al., 1993). It has different therapeutic effects as antioxidant, antibacterial antiviral, anti-inflammatory, anti-allergic, anticancer, and antidiabetic effects (Archana et al., 2008). The present work estimated the defensive effect of SP against the hepatorenal toxicity occurred by thioacetamide.

Silymarin has a hepatoprotective and antioxidant effect, which is produced by its capacity to obstruct the free radicals generated from the metabolism of toxic elements (Mendoza et al., 2014). It is used for the medication of hepatic conditions, such as cirrhosis, and chronic hepatitis (Stolf et al., 2017). Silymarin has a good effect on renal glomeruli and tubular injuries (Tayawi and Ibrahim, 2019).

The goal of the inquiry is to investigate the hepatorenal protective and antioxidant activities of *Spirulina platensis* and *Chlorella vulgaris* versus silymarin against TAA acute hepatorenal toxicity.

described that antioxidants have a vital role in lowering the level of thioacetamide toxicity. So, *Chlorella vulgaris* (CV), is a green eukaryotic microalga (Scheffler, 2007). *Chlorella vulgaris* contains many antioxidants, so it plays a vital role in reducing the toxic effect of thioacetamide. Treatment with CV reestablish the hepatorenal activity, and oxidant/antioxidant pathway in rats intoxicated with thioacetamide (El-Sheikh, 2018). In addition to, it was explained that *Chlorella vulgaris* chlorophylls prevent lipid peroxidation through decreasing ROS and chelating metal ions (Hsu & Yang, 2013).

MATERIAL AND METHODS

Materials:

Thioacetamide (CASR NO (62-55-5)) and purity 99% was purchased from SDFCL company, in India with sampling SOP NO.: SDFCL-TAR-SWP-GEN-007.

Chlorella vulgaris (CV) & *Spirulina platensis* (SP) were obtained as pure powder were taken from Animal Health Research Institute, Egypt then made by homogenizer in the genetic engineering & biotechnology research institute Sadat city.

The required daily dose from CV & SP are dissolved in water to be in suspension form at the day of their administration to rats by using an ultrasonic homogenizer.

Silymarin was obtained from an Arab company for the pharmaceutical and medicinal company (MEPACO-MED) in Cairo, Egypt as a sachet. NEW-FLOTAN, Sodium chloride, Formal saline 10% solution, and ethanol were obtained from Sigma-Aldrich chemical company.

Animals:

Thirty-six male albino Wistar rats weighting from 100–120 gm were purchased from Laboratory Animal Colony, Giza, Egypt. Rats were housed in polypropylene cages under basic sterile conditions and given an adequate amount of diet (AL majd

Company) and an adequate amount of water. The rats were kept under normal ventilation, a 12-hr. light/dark, and at a temperature of 20–25°C. Rats were adapted for 14 days before the start of the experiment. All experimental measures and techniques were agreed upon by the Research Ethics Committee of the Faculty of Veterinary Medicine, University of Sadat City, Egypt.

Experimental design and animal grouping:

Rats were weighed and randomly divided into 6 groups (n = 6). The Control group I (control negative) was administrated orally distilled water daily for a month. Also injected with normal saline i.p in the last two days of the month. The prophylactic groups include the following groups: Group A was used as a control intoxicated with thioacetamide at a dose of 300 mg/ kg b.wt. IP for two days with 24 hrs intervals before the end of the experiment (Wallace et al., 2015; Zargar et al., 2017 and Mousa et al., 2019). Group B was stated as a standard protected group and it was treated with silymarin at a dose of 100 mg/kg b.wt. orally for one month (Wang et al., 2017). Group (C) was administrated *Chlorella vulgaris* (CV) 400mg/ kg b.wt. orally, daily for a month. Group (D) received *Spirulina platensis* (SP) at a dose of 400mg/ kg b.wt. orally for a month (Kumar et al., 2009 and EL-Shamarka et al., 2022). Group (E) was treated with a mixture of (CV) and (SP) at a dose of 400+ 400mg/ kgb.wt. orally daily for a month (Wan et al., 2019 and YIpel et al., 2019). All groups except the control group were intoxicated with thioacetamide at a dose of 300 mg/ kg b. wt. Ip in the last two days of the month with 24 hrs intervals (Wallace et al.,2015; Zargar et al., 2017and Mousa et al.,2019).

Blood sampling:

At the end of the experiment, rats were Fastened for 12 hours and anaesthetized by NEW-FLOTAN before slaughtering. Blood samples were taken from the middle canthus

of the eye by capillary tube and other samples were taken after sacrificing the rats from the intracardiac of each rat. Two blood samples were taken from each rat. The first blood samples (2ml) were taken from rats in a dry-clean Eppendorf tube containing 0.4mg EDTA, mixed completely with an anticoagulant. This method is used for complete blood count (CBC) analysis. The second blood samples (5ml) were taken from each rat without anticoagulant and were left to clot for obtaining serum which was separated by centrifugation at 3000 rounds per minute for 10 min. The clear supernatant serum was taken with sterile automatic pipette and kept at –20°C until used for biochemical analysis. The liver and kidney of each rat were collected and fixed in a 10% buffered formalin solution for histopathological investigations.

Hematological examination:

Estimation of RBC count, WBCs, Hb, PCV, Total leukocytic count and differential leucocytic counts were measured according to the standard haematological measures explained by (Weiss and Wardrop, 2010). MCV was estimated as PCV divided by RBC count and multiplied by 10. MCH was assessed as Hb divided by RBC count and multiplied by 10, while MCHC was determined as Hb divided by PCV multiplied by 100.

Serum biochemical investigation:

Serum liver enzymes (ALT, AST, ALP) and total protein levels commercial kits obtained from (Bio diagnostic company, Dokki, Giza, Egypt) were used to define hepatic enzymes ALT, ALT and ALP according to (Fawcett and Scott 1960; Murray et al., 1984 and Young, 2001), respectively. Serum total protein was evaluated rendering to (Lawry et al., 1951) and the result was conveyed as g/dl. Diagnostic kits for assaying serum urea, creatinine, and uric acid were purchased from the diamond diagnostic

company, in Holliston, USA (Fawcett and Scott, 1960 and Patton and Crouch, 1977).

Serum antioxidant investigation:

Serum levels of total antioxidant capacity (TAC) and malondialdehyde (MDA) were assayed calorimetrically using commercial kits of bio diagnostics (EGYPT) according to the methods of Satoh (1978) and Koracevic et al., (2001) respectively.

Histopathological examination:

The liver samples fixed in formalin were cut and handled for paraffin sections (4 µm thick) using a microtome (LEICA RM 2135) and then usually stained with hematoxylin and eosin stain (H&E) rendering to (Bancroft and Layton, 2013). Histopathological analysis was done using a digital Leica photomicroscope (LEICA DMLB, Germany) (Bancroft and Gamble 2008).

Statistical Analysis:

Statistical analysis of all results was carried out by applying analytical software SPSS (version 8.0.) according to Snedecor and Cochran (1986).

All data were described as mean ± standard error (SE) and were evaluated for significance by applying a one-way analysis of variance (ANOVA test) and then by Tukey's test to reveal the significance of the

variations among groups. A P-value of .05 or less was studied significantly differently.

RESULTS

Results of haematological limits:

The results are presented in table (2). Group (A) which was treated with TAA only showed a significant reduction in Hb, RBCs and PCV, while they increased in groups B, C, D and E. There is a non-significant change in MCV, MCH and MCHC levels among groups. There is a significant increase in the N/L ratio in group (A) than in other groups.

Results of serum biochemical parameters:

The results are shown in table (1). Compared with a group (A) treated with TAA had a significant increase in liver functions (ALT, AST and ALP) and increase urea and creatinine while decreasing total protein. CV and/or SP before intoxication with TAA restored the level of liver and kidney enzymes. TAC had a significant rise in the control group, groups B, D and E and a significant decline in group A. MDA had a significant elevate in group A than in other groups. Groups that were treated with CV and SP had significantly decreased MDA than group (A) as shown in figure 1.

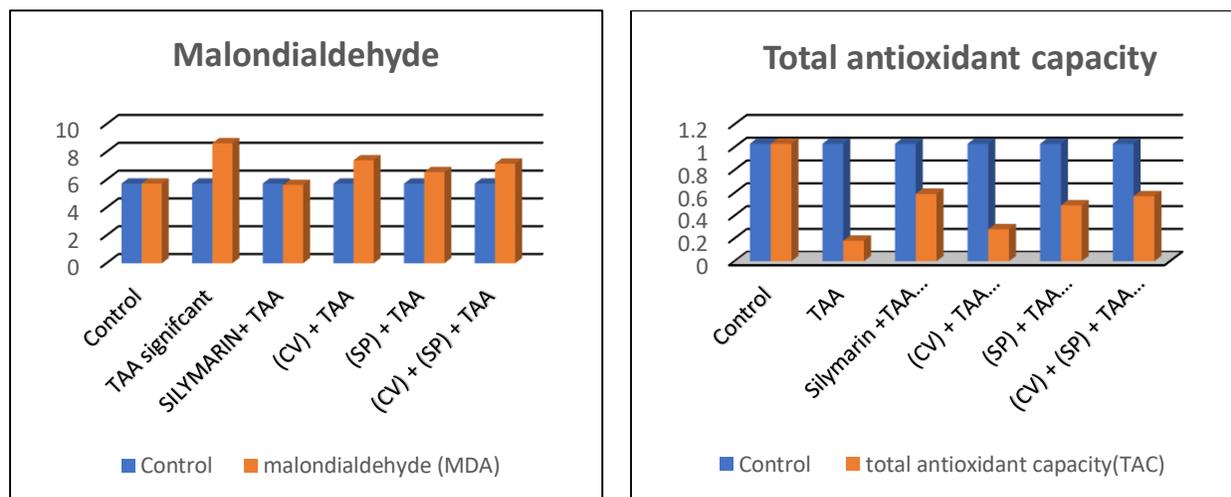


Fig (1): Level of Malondialdehyde and Total antioxidant capacity in different protected groups.

Table (1): Different Biochemical and antioxidant parameters in prophylactic groups:

GROUP	I (control)	Group(A)	Group(B)	Group (C)	Group (D)	Group (E)
Urea	49.50 ±1.28 ^d	68.66 ±3.16 ^a	63.86 ±1.98 ^{ab}	59.16 ±2.45 ^{bc}	57.36 ±2.28 ^{bcd}	53.26 ±3.93 ^{cd}
Creatinine	0.53 ±0.06 ^c	1.36 ±0.08 ^a	0.93 ±0.08 ^b	1.06 ±0.08 ^b	1.03 ±0.03 ^b	0.86 ±0.03 ^b
Uric acid	2.47 ±0.00 ^{cd}	3.91 ±0.32 ^a	2.23 ±0.23 ^d	2.87 ±0.06 ^{bc}	3.28 ±0.11 ^b	3.34 ±0.17 ^b
Albumin	3.69 ±0.18	3.18 ±0.18	2.74 ±0.17	3.41 ±0.62	3.38 ±0.36	3.16 ±0.19
TP	7.40 ±0.27 ^a	6.11 ±0.11 ^b	5.64 ±0.26 ^b	6.26 ±0.80 ^b	8.74 ±2.36 ^a	7.05 ±0.36 ^a
A/G ratio	1.00 ±0.11 ^{ab}	1.09 ±0.11 ^{ab}	0.94 ±0.12 ^{ab}	1.19 ±0.26 ^a	0.63 ±0.12 ^b	0.82 ±0.02 ^{ab}
AST	135.33 ±12.34 ^{ab}	213.33 ±35.25 ^a	116.33 ±13.34 ^b	17.66 ±2.96 ^c	23.66 ±5.69 ^c	112.67 ±15.25 ^b
ALT	51.36 ±8.33 ^b	191.77 ±13.30 ^a	60.83 ±19.66 ^{ab}	17.66 ±2.90 ^b	15.66 ±1.85 ^b	2.3540 ±1.15 ^{ab}
ALP	193.67 ±3.84 ^c	488.00 ±16.38 ^a	476.33 ±19.41 ^{ab}	331.67 ±23.80 ^{bc}	500.67 ±21.36 ^{ab}	570.33 ±1.33 ^a
TAC	1.03 ±0.09 ^a	0.18 ±0.06 ^b	0.59 ±0.39 ^{ab}	0.28 ±0.003 ^b	0.49 ±0.04 ^{ab}	0.57 ±0.01 ^{ab}
MDA	5.73 ±0.06 ^c	8.63 ±0.62 ^a	5.63 ±0.17 ^c	7.40 ±0.20 ^b	6.56 ±0.20 ^{bc}	7.16 ±0.72 ^b

Table (2): Level of blood parameters in various prophylactic groups:

GROUP	I (control)	Group(A)	Group(B)	Group(C)	Group(D)	Group(E)
Hb	13.23 ±0.12^b	12.10 ±0.05^b	15.73 ±0.28^a	15.20 ±1.98^a	14.93 ±0.28^a	15.26 ±0.56^a
RBCs	5.89 ±0.16^b	6.15 ±0.45^b	7.71 ±0.29^a	7.12 ±0.95^a	7.08 ±0.36^a	7.46 ±0.40^a
PCV	32.16 ±0.54^b	29.76 ±0.57^c	40.36 ±2.16^a	36.73 ±4.98^{ab}	37.06 ±0.85^{ab}	38.00 ±1.92^{ab}
MCV	54.13 ±1.32	52.83 ±1.44	52.33 ±1.21	51.63 ±0.21	51.36 ±0.57	51.00 ±0.37
MCH	22.16 ±0.33	21.93 ±0.72	20.40 ±0.96	21.33 ±0.14	20.60 ±0.35	20.43 ±0.48
MCHC	41.10 ±0.50	41.56 ±0.66	39.16 ±2.14	41.30 ±0.17	40.23 ±0.23	40.16 ±0.63
PTS	630.67 ±61.48^a	284.00 ±1.03^b	417.33 ±1.58^a	401.00 ±29.54^a	459.00 ±77.94^a	506.67 ±33.34^a
WBCs	1900.0 ±4.16^a	1156.7 ±3.24^b	1780.0 ±9.86^a	7966.7 ±2.99^b	1010.0 ±7.54^b	8900.0 ±1.16^b
N	15.00 ±0.57^{ab}	18.66 ±1.66^a	13.33 ±2.40^{ab}	14.00 ±3.46^{ab}	11.33 ±0.33^b	10.00 ±0.57^b
L	80.66 ±0.66^{ab}	75.33 ±1.33^b	82.33 ±1.66^{ab}	82.33 ±4.97^{ab}	84.33 ±1.33^a	84.66 ±1.45^a
M	2.66 ±0.33	3.00 ±0.00	2.66 ±0.66	2.00 ±1.00	2.33 ±0.66	3.00 ±0.57
E	1.33 ±0.33	1.33 ±0.33	1.66 ±0.33	1.33 ±0.33	1.66 ±0.66	2.00 ±0.57
B	0.33 ±0.33	0.33 ±0.33	0.33 ±0.33	0.33 ±0.33	0.33 ±0.33	0.33 ±0.33
N/L ratio	0.18 ±0.008^b	0.25 ±0.04^a	0.163 ±0.03^b	0.17 ±0.05^b	0.13 ±0.005^c	0.12 ±0.15^c

Histopathological examination results:

Liver and kidney units stained with hematoxylin-eosin stain revealed that tissues of control rats and rats that received CV and SP showed regular histological structure, standard lobular architecture with central veins, and normal glomeruli, especially in group E which administrated a mixture of algae together. TAA group showed severe

damage and haemorrhage as marked congestion in the central vein and hepatic sinusoids, most hepatocytes presented severe damage and necrosis in liver tissues. kidney tissues showed shrunken glomeruli, renal tubular epithelial cell degeneration and necrosis and marked haemorrhage and congestion in the interstitial tissue.

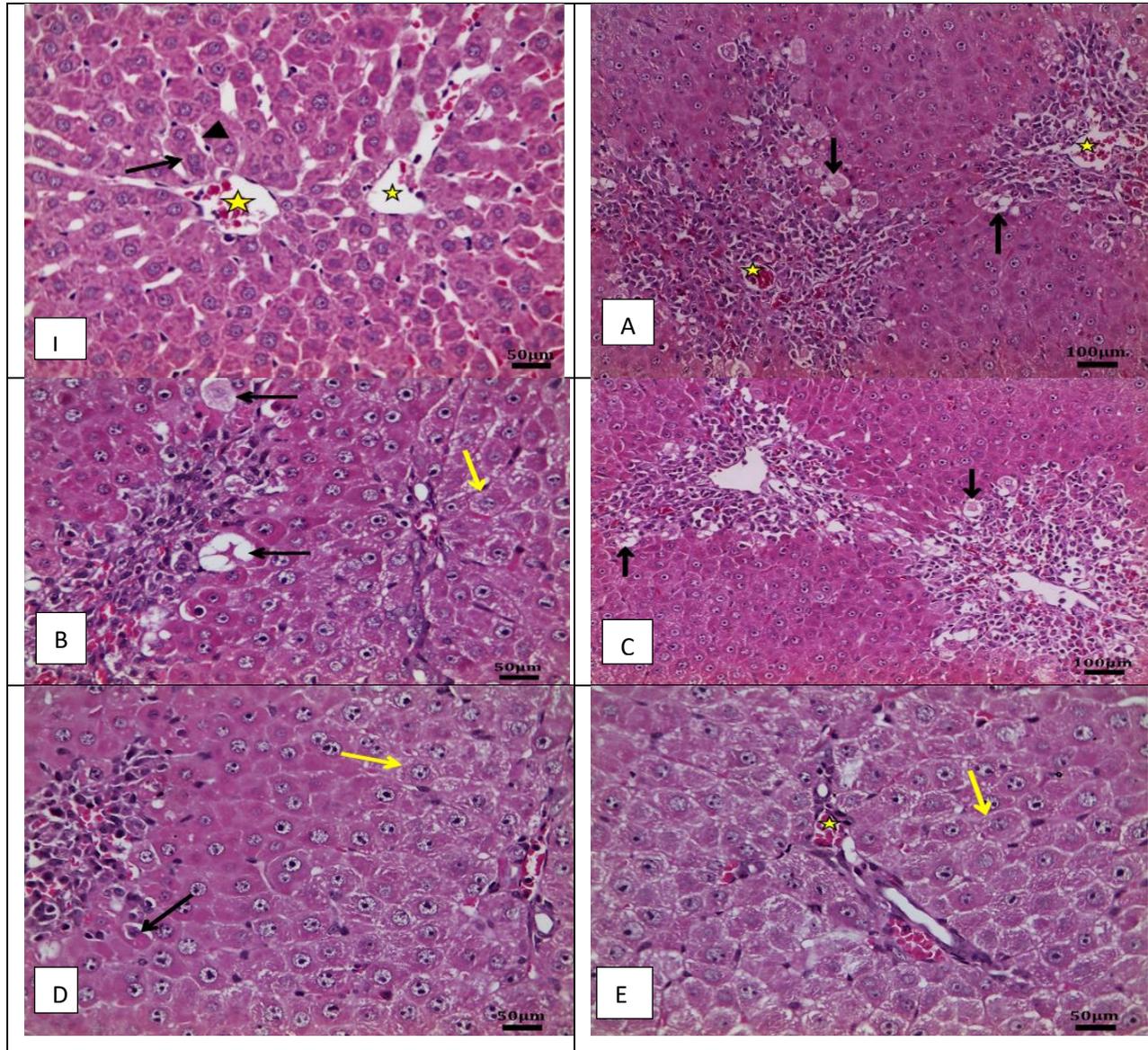


Figure 2: Effect of *Spirulina* and *Chlorella* on thioacetamide-induced hepatic toxicity.

- I) Control liver showed Normal histological appearance.
- A) Group A showed: Marked congestion in the central vein and hepatic sinusoids hepatocytes around the central vein presented severe damage.

- B) Group B showed: Centri-lobular necrosis, and hepatocytes around the central vein presented severe damage.
- C) Group C showed: Mild centrilobular necrosis, some hepatocytes presented severe damage & necrosis presented severe damage.
- D) Group D showed: Very mild centrilobular necrosis.
- E) Group E showed: Mild congestion in portal area, somewhat normal histological appearance.

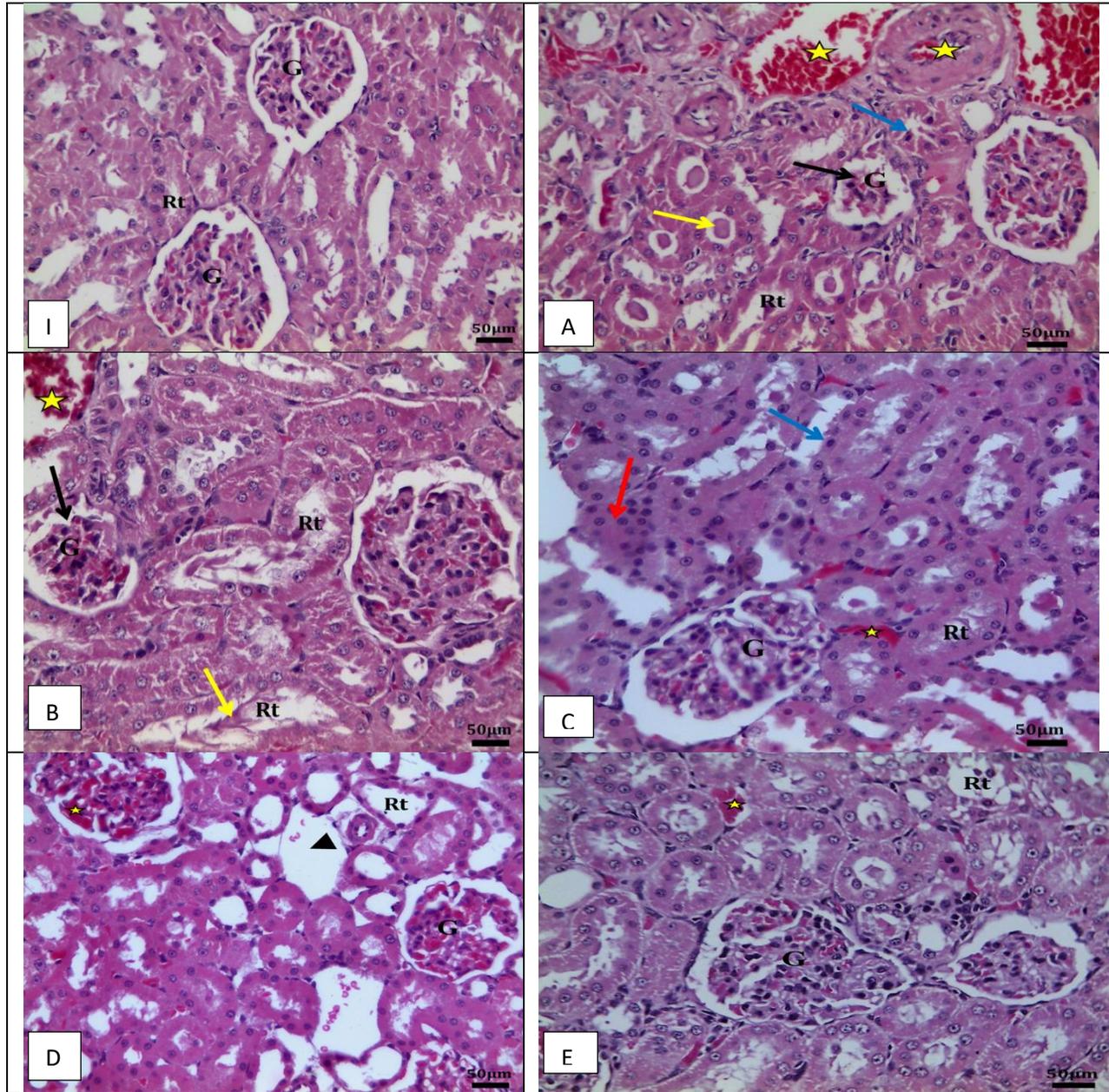


Figure 3: Effect of *Spirulina* and *Chlorella* on thioacetamide-induced kidney toxicity

- I) Control group exposed Normal histological appearance of kidney tissue.
- A) Group A showed shrunken glomeruli (G) with dilated capsular spaces (black arrow), renal tubular epithelial cell degeneration and necrosis associated with pyknotic nuclei.
- B) Group B showed atrophy of glomerular tuft and dilatation of renal tubules.

- C) Group C showed necrosis in the renal tubular epithelial cell associated with pyknotic nuclei, some renal tubules with marked cloudy swelling.
- D) Group D showed mild congestion in the glomeruli (star) and oedema in the interstitial tissue.
- E) Group E showed normal glomeruli and renal tubules, mild congestion in the interstitial tissue.

DISCUSSION

Microalgae are considered protective nutrients and are used for many therapeutic effects. *Chlorella Vulgaris* and *Spirulina platensis* supplementation had great pharmacological effects in animal models (Wan et al., 2019). In the present study, some pharmacological aspects especially hepatorenal protective, haematological, antioxidative and histopathological activities of *Chlorella Vulgaris* and *spirulina platensis* were investigated in intoxicated male rats with thioacetamide.

Thioacetamide-treated rats during the month of the experiment could be explained by hepatic and renal dysfunction (Mansour et al., 2020). In this inquiry, intraperitoneal injection of TAA (300 mg/kg b.wt)for two days with 24 hrs intervals induced acute toxicity with a statistical decrease in the value of RBCs, Hb and PCV, this agreed with (Raji et al., 2014) and also agree with (Al-Attar, 2022).The decrease in RBCs value may be attributed to the effect of TAA on the hematopoietic system which is damaged by exposure to TAA and decreasing in Hb concentration can be due to an elevated rate of destruction of RBCs or decreasing in the rate of RBCs formation. Lymphocytopenia and neutrophilia were observed in the TAA-treated group, which may be attributed to the TAA exposure group and may be stated as a simulation of the immune system due to acute toxicity and tissue damage by TAA.

The results of the present study showed that *Chlorella vulgaris* and *Spirulina platensis* supplementation significantly decreased the changes in haematological parameters

induced by acute toxicity with TAA. This was agreed with (Abd el- Aziz et al., 2022) who reported that oral administration of *Chlorella vulgaris* and *Spirulina platensis* increased RBCs, Hb, hematocrit and platelet count. This may be attributed to spirulina playing an important role in the erythropoiesis process (Badawy et al., 2022) and on the same side, *Chlorella vulgaris* improved heamato-biochemical parameters (Sayed et al., 2021) and also may attribute to feed with protein can improve the number of RBCs. CV and SP are rich in proteins and other nutrients, similar to that reported by Siman Juntak et al. (2022). In addition to this may also refer to *Chlorella vulgaris* and *Spirulina platensis* are rich in iron, so they increase the level of blood parameters this agrees with Emami and Olfati (2017).

Administration of TAA intraperitoneal increases the level of liver enzymes (AST, ALT and ALP). These liver enzymes are used as a biochemical indicator for hepatic injury in damaged liver cells, these enzymes elevated into the bloodstream, leading to an increase in the plasma levels of hepatic enzymes, and TAA had a toxic effect on liver cells leading to hepatic injury and TAA produced oxidative stress with the accumulation of free radicals, as shown by the significant increase in MDA level and decrease in TAC (Barhoma, 2018) and (Ra et al., 2019).

In this study oral administration of CV and SP for one month produced protection to the rat liver & kidney through ameliorated serum chemical parameters such as AST, and ALT which were decreased in the groups treated with CV and SP compared to

the intoxicated group. The reason is not clearly defined but it is likely that exert their protective effect by reducing hepatic enzymes, MDA and elevating TAC. This finding was reliable to those earlier noted by Elsheikh et al. (2018), Mazokopakis et al. (2014) and Yarmohammadi et al. (2021) explained that CV significantly reduced serum aspartate aminotransferase (AST) levels rather than alanine aminotransferase (ALT) or alkaline phosphatase (ALP) levels. In addition, Eissa et al., 2020 reported that CV extract administration adjusted TAA-induced inflammation, oxidative stress, and variation in hepatic tissue work and architecture so, CV can attenuate the increased levels of the plasma enzymes (AST & ALT). Also, Yipel et al. (2019) and Yun et al. (2011) reported that the treated CV group showed significantly lower levels of (ALT&AST) compared to the control group. SP decreased the level of liver functions and urea in groups treated with it compared to the intoxicated group. This was agreed with Viswanath et al. (2011); Abdel-Daim et al. (2013); Abu Aita (2014) and Abdel-Daim et al. (2016).

Serum biochemical parameters such as kidney enzymes such as urea and creatinine increased when occurring damaged in the kidney so leading to an increase in urea and creatinine in plasma, this damage in the kidney was observed in histopathology. TAA produced oxidative stress and accumulation of free radicals and leads to kidney damage. This agrees with Mansour et al. (2020).

CV and SP administration prevents oxidative stress and cellular damage in the kidneys, so groups treated with CV explained the decreased level of urea and creatinine, this may be attributed to the protective effect of algae by reducing urea

and creatinine, and reducing oxidative stress explained by decrease MDA levels and elevating TAC. This agrees with (Zakaria et al., 2019) and (Blas-Valdivia et al., 2010). They showed a Renoprotective effect of CV (Senthilkumar et al., 2012).

Serum total antioxidant capacity (TAC) enzyme declined in thioacetamide treated group while the CV and SP-treated groups increased the level of (TAC) due to CV containing many molecules showing in vitro antioxidant capacity, and their food consumption can protect cells from oxidative insults (Napolitano et al., 2020) noted these results. Yun et al., 2011 explained the decreased level of MDA was approximately 47%-71% due to CV and SP containing various bioactive substances with antioxidants for the prevention of oxidative stress. This result was consistent with those previously noted by Aizzat et al. (2010); PANAHI et al. (2013); Zahran & Risha (2014); Abdelhamid et al. (2020) and Azlan et al. (2020). Spirulina is based on its defensive effect against cell death induced by free radicals reported by Chu et al. (2010) so, Malondialdehyde (MDA) was decreased in all groups compared to the intoxicated group this result was explained by EL- Shamarka et al. (2022).

SP enhanced serum biochemical markers by rising serum albumin and globulins compared to the intoxicated group. This was agreed with Abdelkhalek et al. (2017) and Kumar et al. (2009) that explained increased serum albumin and serum alkaline phosphatase.

In this study thioacetamide-induced oxidative stress altered the architecture of hepatic and renal tissues, as confirmed by histopathological investigations and increased lesion scores. TAA treated causes vascular degenerative and alternative

changes in rat hepatic tissues and degenerative, necrosis, and congestion in rat renal injury. This agrees with Ghosh et al. (2016) and Schyman et al. (2017). They reported that TAA generated oxidative stress that lead to these changes in a histopathological investigation as necrosis and fibrosis in tissues of the liver and kidney.

In the present inquiry *Spirulina platensis* and *Chlorella vulgaris* ameliorated TAA-induced hepatorenal cellular injuries. This agrees with Abass et al. (2016) who reported that *Spirulina* protected against tacrolimus-induced hepatic and renal toxicity in rats. The alternative effect of microalgae as *Chlorella* and *Spirulina* prevention of morphological and histopathological

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changes in renal and hepatic tissues might be referred to microalgae as CV contains growth factor, which activates cellular proliferation and tissue repair and also activates the macrophage centre that activates the immune system which affirmed the protective effect (Aly et al., 2022 and Sayed et al., 2022).

CONCLUSION

A recent study revealed the protective and treatment effects of *Chlorella vulgaris* (CV) & *Spirulina platensis* (SP) against thioacetamide-induced hepatorenal damage. CV & SP mainly achieved protective function by restoring the antioxidative/oxidative equilibrium, Liver functions, and kidney functions.

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