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Potential ameliorative effects of *Ocimum basilicum* extract and leaves on testicular toxicity induced by sodium arsenite in male rats

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ABSTRACT

Arsenite is a major environmental chemical and a known reproductive toxicant that induced the depression of spermatogenesis and androgenesis in males. Arsenic commonly contaminates the environment via insecticides and pesticides and seepage through drinking water. The present study was designed to investigate the effect of ethanolic *Ocimum basilicum* extract and leaves against testicular toxicity induced by sodium arsenite in male rats. Thirty male albino rats were divided into two main groups: The first main group (5 rats) was kept as (G-) a negative control group. The second main group (25 rats) was injected $NaAsO_2$ (4 mg/kg body weight) in 0.9% NaCl interaperitoneally only twice. After that, the rats were divided into five subgroups as following: subgroup (1): kept as (G+) a positive group. Subgroups (2 & 3) were given ethanolic *Ocimum basilicum* extract (250 and 500mg/kg bodyweight) and Subgroups (4 & 5) were given powder leaves of *Ocimum* (equivalent doses) added to the diet for (28 days). At the end of the experiment, rats were sacrificed and biological evaluations were calculated. The weights of the reproductive organs were recorded. Sperm count, motility, progressive motility and normal form were evaluated. Serum sex hormone (luteinizing hormone, LH), follicle stimulating hormone (FSH) and testosterone were analyzed. Antioxidant enzymes were assayed in testicular tissue. Results showed that treatment groups were associated with significant increase in sperm parameters, serum sex hormone, GP_X, SOD and CAT. In contrast level of MDA were significantly ($p \leq 0.05$) decreased as compared with the positive control group. In Conclusions: ethanolic *Ocimum basilicum* extract and leaves have a potent effect in the treatment of testicular toxicity caused by sodium arsenite. This effect may be due to the presence of flavonoides and antioxidant properties of *Ocimum basilicum* which may be useful in the treatment of testicular toxicity caused by arsenite.

Keywords: Testicular toxicity, sodium arsenite, *Ocimum basilicum*, Antioxidant enzymes, Sperm parameters, LH, FSH, testosterone.

INTRODUCTION

Arsenical compounds are environmental contaminant with manifold effects in animal and human populations. Human are exposed to arsenic mainly through water, food and drugs as well as in the form of herbicides, insecticides, rodenticides and food preservatives (Mehranjani and Hemadi, 2007). Though adverse, on the other hand, reality relics that a large number of populations in some areas of the world are drinking arsenic-contaminated ground water and the number of cases torment from As-induced organ dysfunctions are increasing terrifically (Das *et al.*, 2009).

Epidemiologic studies have documented that exposure to arsenic is linked with male reproductive toxicity (Da Silva *et al.*, 2017; Zubair *et al.*, 2017). Ommati *et al.* (2019) reported the link between arsenic and male infertility. Reproductive health is a condition of complete mental, physical, and social

wellness, as referred by World Health Organization. It becomes a vital feature of general health and human development. If it is not maintained at present, it can affect the health of the next generation (Preethi *et al.,* 2020). Studies have shown that arsenic intoxication results in testicular regression in mice (Mamoun *et al.,* 2018). Testicular degeneration and tissue necrosis in mice due to exposure of arsenic have been reported (Guvvala *et al.,* 2016). A decrease in sperm count and motility has been demonstrated in a dose-dependent manner after arsenic treatment (Zhang *et al.,* 2011).

The use of medicinal plants in folk medicine is an age-long practice in various parts of the globe for both preventive and curative purposes. Today, it is estimated that about 80% of the world population relies on botanical preparations as medicine to meet their healthcare needs (Ogbera *et al.,* 2010). *Ocimum basilicum* L. (sweet basil) a member of Lamiaceae family is native throughout the old World and cultivated for religious and medicinal purposes. Basil was originated in Asia and Africa. Basil is popular for its culinary and ornamental uses. Various parts of this plant have been widely used in traditional medicine. The leaves and flowers of basil are used in folk medicine as a tonic and vermifuge. Studies showed that basil possesses central nervous system (CNS) depressant, anticancer, cardiac stimulant, hepatoprotective, hypoglycemic, hypolipidemic, immunomodulator, analgesic, anti-inflammatory, antimicrobial, antioxidant, antiulcerogenic, chemo-modulatory and larvicidal activities (Ahmed *et al.,* 2015).

Many studies have reported that basil leaf extracts have potent antioxidant, anti-aging, anticancer, antiviral, and antimicrobial properties (Manosroi *et al.,* 2006). Sethi *et al.* (2003) reported that the leaves of basil possess good antioxidant and antistress potentials in experimental animals. Consumption of basil or basil oil has been associated with a reduction in total cholesterol, low-density lipoprotein and triglyceride levels (Harnafi *et al.,* 2009). Supplementation with *O. sanctum* leaf extract reduced the severity of hydropericardium, hepatitis, myocarditis accompanied with hemorrhages, lung edema, lymphocytic depletion in lymphoid organs and focal interstitial nephritis (Batra and Gupta, 2006).

The present study aims to investigate the possible beneficial effects of *Ocimum basilicum* as a source of natural antioxidants to aid the sperm parameters in rats against testicular alterations in male albino rats.

MATERIAL AND METHODS

Materials:

1- *Ocimum basilicum* was purchased from local market, 6th October City, Egypt.

2- Sodium arsenite ($NaAsO_2$): was purchased from Al-Rahma Company in Zigzag in the form of powder.

3- Casein (85% protein), choline chloride, DL-methionine, vitamins and salt mixture were obtained from El–Sharqiya Co., Sun flower oil and corn starch also were obtained from local market, Tanta, Egypt. 95% ethanol was purchase from Al-Rahma Company in Zagazig in liquid form.

4- Thirty normal male albino rats of "Sprague Dawley" Strain weighing (200 ± 10 g) were obtained from the laboratory animal colony, Ministry of Health and Population, Helwan, Cairo, Egypt.

Methods:

Preparation of leaves:

Ocimum basilicum leaves were picked fresh then cleaned. Leaves were dried by dry air at room temperature then grinded using a blinder into fine powder and were kept separately in dark glass containers in a refrigerator till use

Preparation of leaves extract:

800g of shade dried leaves powder were immersed in 4 L of 95% ethanol and

left for 24h with stirring and then filtered. This was repeated twice with 2 L of 95% ethanol. Thus, a total of 6.5 L filtrate was collected and concentrated by rotary vapor at 40°C. The yield of ethanol extract (EE) was 42 g (5.25%). The extraction of the selected plants was done by the method of (Villasenor *et al.,* 2002).

Chemical analysis:

Leaves of *O. basilicum* were subjected to chemical analysis in order to determine: Total phenolic: Phenolic compounds in dried leaves were determined by HPLC according to the method of Goupy *et al.* (1999) at Central Lab of Food Technology Research Institute Agric. Res. Cent. Egypt.

Experimental design:

Thirty healthy adult male albino rats "Sprague Dawley strain" weighing (200 ± 10 g) were kept in single wire cages with wire bottoms under hygienic conditions. Rats were divided into two main groups:

The first main group (5 rats) was fed on basal diet and administrated distilled water orally for 28 days and kept as a negative control group **(G-).**

The second main group (25 rats) was interaperitoneally injected by sodium arsenite ($NaAsO_2$) (4 mg/kg body weight) in 0.9% NaCl twice only for two consecutive days (Sharma *et al.,* 2007).After that, the rats were divided into five subgroups as following:

Subgroup (1): was fed on basal diet as a positive control group (G+).

Subgroup (2): was fed on basal diet + (250 mg /kg body weight) *O. basilicum* extract was administered orally.

Subgroup (3): was fed on basal diet + (500 mg /kg body weight) *O. basilicum* extract was administered orally.

Subgroup (4): was fed on basal diet + amount of *O. basilicum* powder which equalize extract 250mg/ body weight.

Subgroup (5): was fed on basal diet + amount of *O. basilicum* powder which equalize extract 500mg/kg body weight.

At the end of the experiment the rats were fasted overnight before sacrificed and the blood samples were collected from each rat and centrifuged to obtain the serum. The testis and prostate were collected and removed, cleaned in saline solution, dried by filter paper and weighted.

Biological parameters evaluation:

During the experiment (28 days), feed intake was recorded every day, and body weight was recorded every week. Biological evaluation of the different diets was carried out by determination of body weight gain % (BWG %) feed efficiency ratio (FER) according to Chapman *et al.* (1959).

Sperm parameters:

Sperm count, sperm motility, progressive motility and normal form were calculated according to the methods of Ekaluo *et al.* (2005) and Ekaluo *et al.* (2013).

Biochemical analysis:

Hormonal assays:

The levels of hormones were measured in serum according to the principle highlighted by (Tietz, 1995) for testosterone, while the method of Uotila *et al.* (1981) was used for luteinizing and follicle stimulating hormones**.**

Antioxidant enzymes and Malondialdehyde in testes tissue:

Glutathione peroxidase (GPx), Catalase (CAT), Super Oxide Dismutase (SOD) and Malondialdehyde (MDA) were determined according to the methods of Paglia and Valentine, (1967), Ohkawa *et al* (1979), Nishikimi *et al.* (1972) and Aebi (1984), respecively.

Statistical analysis:

Statistical analysis was carried out using the programme of Statistical Package for the

Social Sciences (SPSS) and PC statistical software (Version 20; Untitled–SPSS Data Editor).The results were expressed as mean ± Standard deviation (mean ± S.D.). Data were analyzed using one way classification, analysis of variance (ANOVA) (Sendcor and Cochran, 1979).

RESULTS

Chemical analysis:

Phenolic compound of *Ocimum basilicum* leaves extract:

High-performance liquid chromate-graphy (HPLC) analyses of sweet basil (*Ocimum basilicum*) leaves extract are reported in Figure (1). HPLC analysis revealed the presence of twenty one compounds in leaves extract. The data illustrated the highest amount of phenolic compounds in *O. basilicum* recorded for Catechein, Benzoic, P-OH-benzoic, Ellagic, Salycillic and Pyrogalloi. Meanwhile, Cinnamic and Alpha-coumaric were found to be the lowest amount of phenolic compounds.

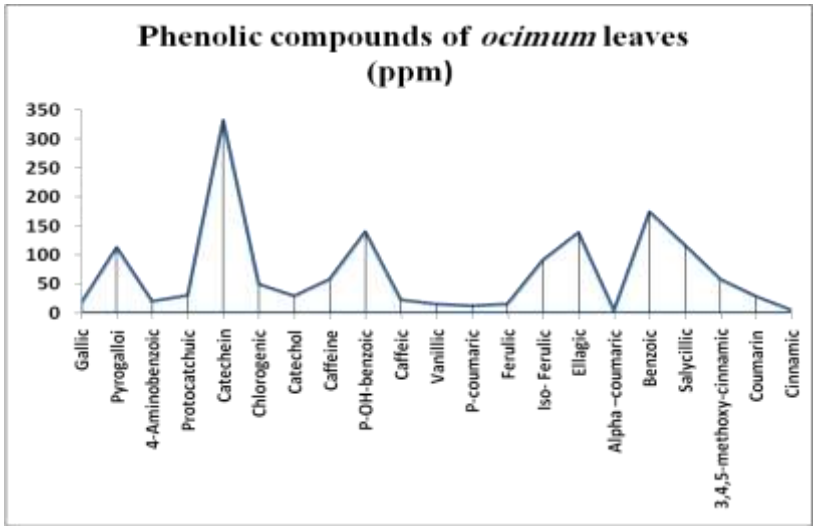

Fig (1): Phenolic compounds of *Ocimum basilicum* leaves extract (ppm) by HPLC analysis.

Effect of *Ocimum basilicum* extract and leaves on biological parameters in rats with induced testicular toxicity.

Data present in Table (1) showed the effect *O. basilicum* leaves powder and extract on feed intake, body weight gain and feed efficiency ratio. The results showed that there were a significant decrease in feed intake, body weight gain and feed efficiency ratio in sodium arsenite group (Control +ve) compared with negative group. All experimental groups treated with *O. basilicum* leaves powder and extract recorded significant increase in their FI, BWG% and FER when compared to (+ ve) control group. The best results were recorded for the groups treated with *Ocimum* extract (500mg/kg) as compared with negative control group.

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Table (1): Effect of *Ocimum basilicum* extract and leaves on feed intake (FI), body weight gain% (BWG) and feed efficiency ratio (FER) in rats with induced testicular toxicity. (mean±SD)

Groups	Parameters		
	FI (g/28days)	BWG (%)	FER
Control –ve	293.33±3.06^{a}	32.92±1.24^{a}	0.11±0.004^{a}
Control +ve	241.33±4.16^{d}	18.84±1.17^{d}	0.07±0.004^{e}
***Ocimum* extract (250mg/kg)**	263.67±3.79^{c}	24.24±1.27^{c}	0.09±0.004^{cd}
***Ocimum* extract (500mg/kg)**	278±6.56^{b}	28.20±1.00^{b}	0.10±0.003^{bc}
***Ocimum* powder equalize extract (250 mg /kg)**	269.67±5.51^{bc}	24.29±1.41^{c}	0.09±0.004^{d}
***Ocimum* powder equalize extract (500 mg /kg)**	272±4.58^{bc}	27.30±1.39^{b}	0.10±0.005^{b}

Data are presented as mean±SD. Values with different letters indicate significant differences among groups at $p \leq 0.05$.

Effect of *Ocimum basilicum* extract and leaves on weight of prostate and testes in rats with induced testicular toxicity

The results in the Table (2) indicated that weight of prostate and testes recorded significant decrease in positive control group compared with negative one. All treated groups had significant increase in mean values of prostate weight and testes weight when compared with (+ve) control group (0.34±0.04 & 1.65±0.08, respectively).

Table (2): Effect of *Ocimum basilicum* extract and leaves on weight of prostate and testes in rats with induced testicular toxicity.

Groups	Parameters	
	Prostate weight (g/100 g b.wt.)	Testes weight (g/100 g b.wt.)
Control –ve	0.61±0.03^{a}	2.27±0.02^{a}
Control +ve	0.34±0.04^{c}	1.65±0.08^{c}
***Ocimum* extract (250mg/kg)**	0.58±0.02^{ab}	2.23±0.01^{ab}
***Ocimum* extract (500mg/kg)**	0.63±0.03^{a}	2.26±0.01^{a}
***Ocimum* powder equalize extract (250 mg /kg)**	0.53±0.03^{b}	2.16±0.02^{b}
***Ocimum* powder equalize extract (500 mg /kg)**	0.54±0.03^{b}	2.19±0.01^{b}

Data are presented as mean±SD. Values with different letters indicate significant differences among groups at $p \leq 0.05$.

Effect of *Ocimum basilicum* extract and leaves on sperm parameters in rats with induced testicular toxicity

There was a significant reduction in sperm count, sperm motility, progressive motility and sperm normal form ($P<0.05$) after injection with sodium arsenite in comparison to the normal control group. Administrations of rats in subgroups (1-4) *O. basilicum* leaves powder and extract produced significant increase in their sperm count, sperm motility, progressive motility and normal form compared with positive group. The best results was recorded for the group treated with Ocimum extract (500mg/kg), which recorded the nearest values of sperm parameters from those of normal control group (Table 3).

Table (3): Effect of *Ocimum basilicum* extract and leaves on sperm parameters in rats with induced testicular toxicity.

Groups	Parameters			
	Sperm count (×10 6 /ml)	**Sperm motility (%)**	**Progressive motility (%)**	**Normal form (%)**
Control –ve	65.52±2.01[a]	75.33±3.51[a]	61.00±2.65[a]	71.00±2.65[a]
Control +ve	34.16±2.55[d]	39.67±3.06[e]	33.33±3.21[e]	38.00±3.00[c]
***Ocimum* extract (250mg/kg)**	52.92±3.12[c]	64.67±2.08[bc]	50.33±1.53[c]	62.67±2.52[b]
***Ocimum* extract (500mg/kg)**	58.67±2.61[b]	68.33±4.04[b]	55.00±2.65[b]	67.00±2.65[a]
***Ocimum* powder equalize extract (250 mg /kg)**	50.32±3.13[c]	53.67±3.51[d]	44.33±2.08[d]	58.33±1.53[b]
***Ocimum* powder equalize extract (500 mg /kg)**	53.10±3.10[c]	59.67±1.53[c]	47.00±3.00[cd]	61.33±1.53[b]

Data are presented as mean±SD. Values with different letters indicate significant differences among groups at p≤0.05.

Effect of *Ocimum basilicum* extract and leaves on testes hormone's (FSH, LH and testosterone) in rats with induced testicular toxicity

FSH, LH and testosterone levels in plasma of different investigated groups were illustrated in Table (4). In arsenic treated rats (Control +ve) the levels of FSH, LH and testosterone were significantly (P<0.05) decreased when compared with the negative control group. The other treated groups showed significant increase in their FSH, LH and testosterone hormones compared with the positive control group. The best result in tests hormone's was shown in rats treated with *Ocimum* extract (500mg/kg), which recorded the nearest values from those of the normal control group.

Table (4): Effect of *Ocimum basilicum* extract and leaves on testes hormone's in rats with induced testicular toxicity.

Groups	Parameters		
	FSH (ng/ml)	LH (ng/ml)	Testosterone H. (ng/ml)
Control –ve	1.36±0.03[a]	1.87±0.08[a]	3.61±0.03[a]
Control +ve	0.19±0.01[f]	0.42±0.04[e]	1.12±0.03[f]
***Ocimum* extract (250mg/kg)**	1.08±0.03[c]	1.34±0.06[c]	2.62±0.02[d]
***Ocimum* extract (500mg/kg)**	1.21±0.02[b]	1.55±0.07[b]	3.08±0.03[b]
***Ocimum* powder equalize extract (250 mg /kg)**	0.88±0.03[e]	1.23±0.02[d]	2.48±0.03[e]
***Ocimum* powder equalize extract (500 mg /kg)**	1.01±0.02[d]	1.35±0.05[c]	2.73±0.03[c]

Data are presented as mean±SD. Values with different letters indicate significant differences among groups at p≤0.05.

Effect of *Ocimum basilicum* extract and leaves on antioxidant enzymes (GPX, SOD and CAT) and malondialdehyde (MDA) in rats with induced testicular toxicity

Glutathione peroxidase (GPx), Superoxide dismutase (SOD) and catalase (CAT) were determined as important endogenous antioxidant enzymes in the testis tissue of the investigated rats. It was obvious from Table (5) that sodium arsenite -treated rats group has MDA levels that were substantially increased ($p < 0.05$), and their GPx, SOD and CAT levels were significantly reduced ($p < 0.05$). Results of GPx, SOD and CAT showed that all treated groups recorded high significant increase when compared with the positive control group. On the other hand, all treated groups recorded significant decrease in MDA when compared with the positive control group.

Table (5): Effect of *Ocimum basilicum* extract and leaves on antioxidant enzymes and malondialdehyde in rats with induced testicular toxicity.

Groups	Parameters			
	GPX (ng/mg protein)	SOD (U/min/mg protein)	CAT (U/min/mg protein)	MDA (nmol/mg protein)
Control –ve	0.45 ± 0.02^{a}	0.35 ± 0.02^{a}	0.33 ± 0.01^{a}	0.13 ± 0.01^{e}
Control +ve	0.19 ± 0.02^{e}	0.13 ± 0.02^{e}	0.15 ± 0.02^{e}	0.32 ± 0.01^{a}
***Ocimum* extract (250mg/kg)**	0.32 ± 0.01^{c}	0.27 ± 0.008^{cd}	0.26 ± 0.01^{c}	0.20 ± 0.02^{bc}
***Ocimum* extract (500mg/kg)**	0.37 ± 0.01^{b}	0.33 ± 0.01^{ab}	0.30 ± 0.01^{b}	0.16 ± 0.02^{d}
***Ocimum* powder equalize extract (250 mg /kg)**	0.27 ± 0.02^{d}	0.26 ± 0.02^{d}	0.22 ± 0.01^{d}	0.22 ± 0.02^{b}
***Ocimum* powder equalize extract (500 mg /kg)**	0.31 ± 0.02^{c}	0.30 ± 0.02^{bc}	0.25 ± 0.01^{c}	0.17 ± 0.02^{cd}

Data are presented as mean±SD. Values with different letters indicate significant differences among groups at $p\leq0.05$.

DISCUSSION

The role of nutritional and biochemical factors in reproduction and sub fertility treatment is very important. Oxidants and antioxidants have attracted widespread interest in nutrition research, biology and medicine. Several conditions can interfere with spermatogenesis and reduce sperm quality and production. Earlier studies have shown that exposure to arsenic caused male reproductive toxicity when administered by means of drinking water (Souza *et al.,* 2016; Momeni and Eskandari, 2012). Male germ cells may be susceptible to oxidative stress because of high concentration of polyunsaturated fatty acids and low antioxidant capacity. It may also reduce the epididymal sperm count, viability, motility and the activity of antioxidant defense system (Momeni and Najmeh, 2012).

In the present investigation feed intake, body weight gain, feed efficiency ratio and organ-body weight were decreased in rats with testicular toxicity and this was in accordance with the result of Muthumani and Miltonprabu (2012) on rats. The significant decrease of body weight in arsenic rats group was in agreement with previous findings of Sharma *et al.* (2007).

In the current study the decrease in sperm count, sperm motility and form may be related to the fact that arsenic exposure causes increased production of free radicals, thus affecting the sperm production in the testes and its retention in seminiferous tubules (Kumar *et al.*, 2015; Adedara *et al.*, 2017).Sharma and Kumar (2011) mentioned that arsenic exerts its toxicity by generating reactive oxygen species (ROS) during redox cycling and metabolic activation processes that causes tissue damages. Free radicals damage biomembrane, reflected by increased lipid peroxidation oxidation of nucleic acid and protein, thereby compromising cellular integrity and function. Compounds containing arsenic were reported to cause DNA damage by reactions involving free radicals resulting in defective sperms (Momeni and Eskandari, 2012). On the other hand, Guvvala *et al.* (2016) found that the seminiferous tubules' diameter and the sperm quality were suppressed by arsenic. Significant decrease in sperm counts was also observed in arsenic exposed rats in the present study. Arsenic is a well-known thiolinhibiting metalloid necessary to maintain sperm mortality and stability. The decrease in sperm motility in the present study may be due to accumulation of arsenic in the epididymis where the sperm matures and acquires motility and due to low availability of testosterone in arsenic treated rats

(Muthumani and Miltonprabu, 2012; Ali *et al.,* 2013).

Also, the current results showed that sodium arsenite induced significant decrease in testes hermon's (FSH, LH and testesteron), GPX, SOD and CAT. A significant decrease in the weights of testis and accessory sex organs was observed in arsenic exposed rats, which may be due to the inhibition of spermatogenesis and decreased steroidogenesis. Arsenic has been found to have an inhibitory effect on the activity of testicular steroidogenic and reduces the weight of the testes, accessory sex glands in rats and suppress the sensitivity of gonadotroph cells to GnRH (Gonodotropin releasing hormone) (Ali *et al.,* 2013). It is well known that the testosterone stimulates normal growth and function of male reproductive system (Dohle *et al.,* 2003). The weight of the testis is also largely dependent on the mass of the differentiated spermatogenic cells and reduction in the testicular weight indicates germ cell loss (Sarkar *et al.,* 2003). Mukhopadhyay *et al.* (2013) had observed a decrease in serum testosterone levels along with significant diminution in testicular glutathione S-transferase activity and reduced glutathione level. Samir *et al.* (2016) mentioned that Arsenic decreases the levels of testicular superoxide dismutase (SOD), catalase (CAT), reduced glutathione, and zinc. Moreover, arsenic significantly decreased plasma testosterone, luteinizing hormone (LH), sperm motility and sperm count. Arsenic also reduces the levels of follicle-stimulatinghormone (FSH) and luteinizing hormone (LH), leading to decreased testosterone production. Arsenic has a high affinity for sulfhydryl-containing glutathione. Binding of arsenic with sulfhydryl groups of glutathione (Flora *et al.,*2007) leads to the depletion of glutathione (Lawley *et al.,* 2014; Reddy *et al.,* 2011) resulting in inhibition of glutathione reductase, thus producing excessive reactive oxygen species in the testis. Increased production of free radicals leads to lipid peroxidation in the cell membranes and finally damage to the cell. Increased free radical production interferes with the functioning of the antioxidant defense system, and this result in tissue injury (Díaz-Villaseñor *et al.,* 2007). In the current study arsenic (AS) led to a significant increase in testicular malondialdehyde (MDA) which in agreement with the observation of Manna *et al.* (2008).

The results of the present work indicated that administration of *O. basilicum* leaves and extract protects the testis from sodium arsenite toxicity as indicated by increase in sperm count, sperm motility, Progressive motility, Normal form, testes hermon's (FSH, LH and testesteron), prostate weight, tests weight, weight gain , SOD, CAT and also showed significant decrease in MDA compared with sodium arsenite rats. In accordance with these results, Khaki *et al.* (2011a) reported that *O. basilicum* extract protected rats from testicular damage and reduced apoptosis after exposure to an electromagnetic field. Asuquo *et al.* (2010) found that *O. gratissimum* extract improved the testicular histopathological alterations in diabetic rats. The present study showed an increase in the body weight of treated rats with *O. basilicum* leaves and extract which in agreement with Bayomy *et al.* (2016) who found that administration of *Ocimum basilicum* and adriamycin (ADR) caused significant increase in body weight of rats.

The present study confirmed that *O. basilicum* had beneficial effects on male reproductive activity and testes hermon's. Male rats received *O. basilicum* extract showed significantly increased in total testosterone serum, sperm concentration, percentage of sperm viability and sperm

motility which support the results of Khaki *et al,* (2011b) who mentioned that *O. basilicum* extract may be a promising treatment for enhancing healthy sperm parameters. On the other hand, Umar *et al.* (2012) found that leaves of *O. basilicum* have increased sperm motility, viability, sperm count, and total antioxidant capacity but decrease malondialdehyde in HFD-induced obese mice. Moreover, Mohammed (2016) found that the extract of *O. basilicum* dry leaves enhanced the serum FSH and LH levels and increased fertility in rabbit.

The current findings reported that *O. basilicum* had beneficial effects on antioxidant activities and maintenance of antioxidant enzymes. The leaves of *O. basilicum* are a rich source of flavonoids which possess various biological properties related to antioxidant mechanisms (Zhang *et al.,* 2009). Polyphenolic compounds are most abundant natural antioxidants and their radical scavenging capabilities play an important role in preventing many chronic diseases (Garcia-Lafuente *et al.,* 2009; Rathee *et al.,* 2009). The antioxidant activity of the plant may be due to flavonoids which have shown to possess various biological properties related to antioxidant mechanism (Marzouk, 2009). Caffeic acid is another component in the leaf of the *O. basilicum* that has antioxidant, anti-inflammatory, and cancer chemopreventive activities (Neradil *et al.,* 2003). Another constituent of *O. basilicum* is A p-coumaric acid possess radical scavenging and antioxidant activity at high concentration (Yeh and Yen, 2003). Recent studies reported that the antioxidant activity of Basil (*Ocimum basilicum* leaves) could be attributed to its bioactive phenolic compounds in leaves and flowers (Prinsi *et al.,* 2020). In addition, other researchers (Noor *et al.,* 2019; Eftekha *et al.,* 2019) reported that *O. basilicum* has high antioxidant activity against oxidative stress. It also has immunomodulatory, anti-nflammatory, antiapoptotic and cell regeneration effects (Ibrahim *et al.,* 2020).

The protective effect of *O. basilicum* extract on doxorubicin/irradiation-induced testicular injury was studied in rats; the extract elevated testicular total antioxidant capacity, nuclear erythroid-related factor-2 and testosterone contents. These changes were also accompanied by restoration of testicular architecture (Ibrahim *et al.,* 2020).

Mohan *et al.* (2011) found that the aqueous extracts of various parts of *O. basilicum* increased antioxidant enzymes such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GP_X) and glutathione transferase (GT). These findings in line with El-Nahal *et al.* (2012) reported that sweet basil (*Ocimum basilicum*) leaves extract may play a role in improving the activity of antioxidant enzymes and decrease the lipid peroxidation (malondialdehyde, (MDA) and level of H_20_2 in serum.

CONCLUSIONS

The beneficial actions of *Ocimum basilicum* against arsenic are believed to originate from its free radical scavenging, antioxidant activities, maintenance of antioxidant enzymes, and a decrease in the production of inflammatory mediators that are implicated in the pathogenesis of arsenic-induced testicular injury. Therefore, *Ocimum basilicum* represents a potential agent to prevent testicular injury and dysfunction induced by arsenic exposure.

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التأثيرات التحسينية المحتملة لمستخلص الريحان وأوراقه على سمية الخصية المحدثة بزرنيخ الصوديوم في ذكور الجرذان

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المستخلص

يعرف الزرنيخ بانه مادة كيميائية بيئية ذات تأثيرانجابى سام وذلك من خلال تثبيط تكوين الحيوانات المنوية والذكورة عند الذكور. وعادة ما يلوث الزرنيخ البيئة عن طريق المبيدات الحشرية والتسرب من مياه الشرب. صممت هذه الدراسة لمعرفة تأثير مستخلص الريحان الايثانولى واوراقة ضد سمية الخصية المحدثة بزرنيخ الصوديوم في ذكور الجرذان. تم تقسيم عدد ثلاثين من ذكور الجرذان الألبينو إلى مجموعتين رئيسيتين: المجموعة الرئيسية الأولى (5 جرذان) تم الاحتفاظ بها كمجموعة ضابطة سالبة. المجموعة الرئيسية الثانية (25 جرذ) تم حقنها بجرعتين من زرنيخ الصوديوم $NaAsO_2$ فى الغشاء البريتونى وكانت الجرعه الواحده (4ملجم / كجم من وزن الجسم) في 0.9٪ كلوريد الصوديوم. بعد ذلك تم تقسيم الفئران إلى خمس مجموعات فرعية على النحو التالي: المجموعة الفرعية (1): تم الاحتفاظ بها على أنها مجموعة ضابطة موجبة. المجموعات الفرعية (2 ، 3) تم إعطائهما مستخلص الريحان الايثانولى بتركيزين (250 و 500 ملجم / كجم من وزن الجسم) والمجموعات الفرعية (4 ، 5) تم اعطائهما ما يكافىء هذين التركيزين فى صوره مسحوق أوراق الريحان يضاف إلى النظام الغذائي لمدة (28 يومًا). في نهاية التجربة ، تم ذبح الفئران ، وحساب التقييم البيولوجي وتسجيل أوزان الأعضاء الجنسية. وتقييم عدد الحيوانات المنوية وحركتها وحركتها التقدمية وشكلها الطبيعي. و تحليل الهرمونات الجنسية (الهرمون الملوتن (LH) ، الهرمون المنبه للحويصلة (FSH) والتستوستيرون). كما تم تقدير الأنزيمات المضادة للأكسدة في أنسجة الخصية. وقد أوضحت النتائج أن المجموعات المعالجة أظهرت زيادة معنوية في مؤشرات الحيوانات المنوية والهرمونات الجنسية و GPX و SOD و CAT. بينما انخفض مستوى MDA ($p\leq0.05$) بالمقارنة مع المجموعة الضابطة الموجبة. خلصت الدراسة الى أن المستخلص الايثانولى للريحان وأوراقة لهما تأثير قوي في علاج سمية الخصية التي يسببها زرنيخ الصوديوم. وقد يكون هذا التأثير راجع الى وجود مركبات الفلافونويد والخصائص المضادة للأكسدة في الريحان والتي قد تكون مفيدة في علاج سمية الخصية التي يسببها الزرنيخ.

الكلمات المفتاحية : سمية الخصية, زرنيخ الصوديوم, الريحان, إنزيمات مضادات الأكسدة, مؤشرات الحيوانات المنوية, الهرمون الملوتن ، الهرمون المنبه للحويصلة ، التستوستيرون.