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USING OF AQUATIC EXTRACTS OF *SALVIA OFFICINALIS* TO CONTROL THE SNAIL *BULINUS TRUNCATUS* THE INTERMEDIATE HOST OF SCHISTOSOMIASIS IN IRAQ (PART I)

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Key words: *Salvia officinalis,* Schistosomiasis, LD50

ABSTRACT

Samples of the snails were collected from site in Al-Rasheed distract (30 km) southern of Baghdad. Isolation, identification and acclimatization to laboratory circumstances made within the laboratory. Several toxic parameters as NOEL, Threshold, different values of ED and LD were determined in this study. The ED50 of *S. officinalis* and Copper sulfates to *B. truncatus* were (8.8 and0.04g/L) respectively. The LD50 of *S. officinalis* and Copper sulfates to *B. truncatus* were (20 and 2.2 g/L) respectively.The study showed that the extracts of *S. officinalis* were less effective than CuSO4. The results improved that the toxicity of extracts was dose and time dependent. The present work concluded to ability to use the target extracts in control of snails the middle host of urinary Schistosomiasis.

Schistosomiasis (Bilharziasis) may be a major public pathological state within the world. It affects 240 million people worldwide. Millions of people are suffering from severe morbid because of Schistosomiasis.The type parasitic worm *Schistosoma haematobium* is the causing of urogenital Schistosomiasis and the types *S. guineensis*, S. *intercalatum*, S. *mansoni*, S. *japonicum*, and S. *mekongi* are the causing of intestinal Schistosomiasis. Iraq is a one of countries suffering from urogenital Schistosomiasis. Baladruz is one of endemic distract of Diyala province with Bilharziasis. Al-Bzania River in Baladruz is considers as a foci of disease victor. According to statistics of health associations and many studies in the region, 18% of Baladruz populations affects with Schistosomiasis. Many causes were effected of distribution of Schistosomiasis in the region as authorities' factors like using of river water as a wash place and swim especially with children whereas it specialized to palms irrigation [1-3].The life cycle of the disease is depending on factors such as presenting of *Bulinus truncatus* snail and contacting with water infested with

cercariae. Cercariae are release from the snails into the water and penetrate the skin of human through bathing, swimming, fishing, and agricultural activities. Adult worms are lives in the veins draining the urinary tract and intestines [4].

Control of Bilharziasis might hap by chemical, physical, and biological. Chemical management has several disadvantages as aspect effect, non-selectivity, represent treatment not interference, and expensively. Now, the control of Bilharziasis became it doable by WHO ways. Severe morbidity because of bilharzias is often preventing by treatment with PRAZIQUANTEL, ALBENDAZOLE and IVERMECTIN or by community education [5, 6].Biological control by cutting of life cycle of unwellness, management of the vector and eradication of disease agent before put down the body is bear in mind to be higher than chemical control for previous causes. Materials utilized in biological management should studied additional details to guard the surroundings and living communities [7].

Extracts of some plant molluscicidal as *Euphorbia splendens, phytolacca dodecandra, and Tetrapleura tetraptera* had been reportable to find the toxicity towards snails. It is also reported that the n-butanol extracts of some plant molluscicidal like *Sapindus trifoliatus, Agave americana, Balanites agyptica, Jatrapha gossypifolia, and Vaccaria pyramidata* are toxic against freshly arranged eggs of *L. luteol*[8].

The Leaves of the plant *S. officinalis* are containing a giant range of chemicals, elements, and acids. For example, Cineol, Heptane, Hydroxy-olen, Epioleanolic-acid, Alpha-amyrin, Aluminum, Boron, Calcium, Iron, Chromium, Cobalt, Zinc, Copper, Magnesium, Silicon, Sodium ,Manganese, Phosphorus, Potassium, Ascorbic acid , Beta carotene, Beta sitosterol, Botulin, Camphor, Humulene, Menthol, Myrcene, Niacun, Riboflavin, Sabinene, Sabinol, Tannin, Thiamin, Tricyclene [9, 10].

Cupper sulfates used as molluscicides to the snail of *Biomphalaria alxandry* the middle host of *Schistosoma mansoni* in Egypt and Sudan, *B. truncatus* the middle host of Schistosoma haematobium in Iraq and *Lymnaea caillaudi* the middle host of *Fasciola hepatica*[11].

The aim of study is to determine some plant molluscicides to the snail of *Bulinus truncatus* to regulate the Bilharziasis with environmental safety.The aim of present study is to determine the effects of aquatic extracts of *Salvia officinalis*comparing with cupper sulphates against *Bulinustruncatus*the vector of urinary Bilharziasis.

MATERIALS AND METHODS

Collection ofsnails

Collection of *Bulinus truncatus*snail'ssamples were from June to August 2015 weekly. Collection of samples was from Al-Rasheed district (30km) south of Baghdad. The study area is including station near of street number 37 (arrived between Al-Rasheed districts and Tigris River). The coordinates of area were (33º32'83) longitude and (44º25'37) latitude. The snails were collected from small irrigation canal beside main canal called (Muhyii Canal). Zooplankton net and steel spoon were used to collecting the snails. Aquatic plants were collect to obtain the snails attached on their surfaces. 5 L plastic containers were using to keep the samples. We are place the snails in with a quantity of water from the river. The snails were feeding with the extracts of leaves of *Alfa alfa* plant 10ml per 50L daily. The collected snails were isolate, identified according to stander keys of snails [12]. Then the snails are acclimatized to laboratory conditions (T 25± 3) before testing for two days. Snails were cultivated in laboratory.

Preparation of Aquatic Extracts and stock solution (SS)

The aquatic extract of the leaves of *S. officinalis* were prepared, concentrated,anddried. The leaves dried in a shade, shredded in a hand mill (Estrella®, model 41B) and in an electric mill (Moulinex®), then sifted through a mesh (number 30) to obtain a fine powder, and left in a cool dry place[13].A weighed amount of the extract made up to desired concentrations in water for analysis. Fifty and one hundred grams of leaf powder of both *S. officinalis* and *T. vulgaris* were macerated for 24hr in 1 L of distilled water and placed in glass flasks. The macerate was filter through cotton gauzes in a plastic funnel to get crude extracts. To prepare each extracts stock solution, 50 grams added to 1000 milliliters of distilled water to give a concentration of 5% (0.05). Fifty and one hundred grams of *S. officinalis*extracts were adding to 1L of distilled water to produce a stock solution (50,000 and 100,000 ppm). Serial of dilution made from this SS. One gram of Kuepfer sulfates (CuSo4.5H2O) (RIEDEL-DE HAEN AG SEELZE-HANNOVER) was adding to 1 L of distilled water to make a stock solution (1000 ppm) as a standard of comparators or positive control [14].

Treatmentsand Bioassays

A serial of 1-10% concentrations was prepared from each stock solution of the extracts (50g and 100g /L) for *S. officinalis*. The W.H.O. method (II) for testing for molluscicides was follow; exposure and recovery periods were 24 hours in all the tests. To monitor the susceptibility of snails and to compare its potency with the extracts while the lethal concentrations and their 95% confidence limits were determine by probit analysis [15]. Bioassays were conduct in the laboratory to evaluate by sub-acute NOEL, ED10, ED16, ED50, ED84, ED90, and ED100. Same parameters were performing to LD[16].End point of dead individuals were considered when there was no movement, no response to stimulation by glass rod, no recovery after 24 hr. of putting in clean water and lack of the ability to adhere. Dead individuals were removing after every recording. All recorded results were comparing with the control group. With the data obtained, percentage of mortality was estimate with respect to the total population of snails evaluated in this bioassay. Compering made to each period of exposure and for all concentrations [17].

Statistical Analysis

Regression analysis depending on the probit units used to calculate different levels of LD and ED by using the provider of SPSS (V. 21)and Biostat (V. 5) programs[18-20]. The results corrected by Abbott equation, calculating with two analysis methods included Log of Dose and Dose, and relationships between Logarithm of concentrations and probit units plotted [21].

RESULTS AND DISCUSSION

1. *S. officinalis*Extracts (Escaping activity, Dose 50 and 100g/L)

Theresults of the study showed that the escaping activity of snails is marketing in 24hr. of exposure at stock solution (50g/L) and (100g/L) experiments. The lowest and highest recorded number of escaping activity with their probit values showing in the table below.The results of probit analysis of log of dose normal distribution cleared the little differences between the really value of escaping number (R) that recorded in study and expected number E (R) calculated according to the analysis. According to Chi-square values, there is a confidence of recorded results. No significant differences between the effects of concentrations for 50 and 100g/L on escaping activity (p-value 0.9 and 1) respectively (Table1).

Table 1. Escaping activity of *B. truncatus* exposed to 50 and 100g/L *S. officinalis*for 96hr with Probit analysis - Finney Method [Lognormal Distribution].

Log10Dose	Actual (%)	Probit (%)	N	R	E(R)	Difference	Chi-square

Dose of *S. officinalis*extracts 50g/L							
0.	0.0667	0.028	30	**2.**	0.8396	1.1604	1.6037
1.	0.5667	0.508	30	**17.**	15.2386	1.7614	0.2036
Dose of *S. officinalis*extracts 100g/L							
0.	0.2	0.1786	30	**6.**	5.3582	0.6418	0.0769
1.	0.3333	0.3332	30	**10.**	9.9969	0.0031	0.

Parameters	**50g/L**	**100g/L**
Chi-square	3.4001	0.2136
Degrees of Freedom	8	8
p-level	0.9068	1
Alpha value (for confidence interval)	0.001	0.001

The study recorded different values to ED of*S. officinalis* extracts to snail *B. truncatus*for 50 and 100g/L Doses, lower and upperconfidant level, Beta value and SE (Table2).

Table 2. Different ED levels of escaping activity of *B. truncatus* exposed to *S. officinalis* (Dose-Response analysis)

Dose of *S. officinalis*extracts 50g/L			
ED10	2.0023	*Beta*	0.1883
ED16	3.4981	*Beta Standard Error*	0.0598
ED50	**8.8076**	*ED50 LCL*	7.2872
ED84	14.117	*ED50 UCL*	10.3279
ED90	15.6128	*Intercept*	3.3411
ED100	16.7717	**ED50 Standard Error**	**0.457**
Dose of *S. officinalis*extracts 100g/L			
ED10	-7.964	*Beta*	0.0507
ED16	-2.4112	*Beta Standard Error*	0.0537
ED50	**17.2986**	*ED50 LCL*	11.9503
ED84	37.0084	*ED50 UCL*	22.6469
ED90	42.5612	*Intercept*	4.1223
ED100	46.8633	**ED50 Standard Error**	**1.6093**

The study concluded that the Dose (SS-50and 100 g/L) were in the rage target for achieved the ED50. Clear significant relationship between *S. officinalis* extracts and *B.truncatus* response. This relationshiprepresented by increasing of Dose and log Dose followed by increasing the response of snails. According to the least squares of escaping activity numbers, the actual percent,

probit and weight of Dose used in the experiments were suitable for determine the ED50 of extracts to target snail.Marketing of escaping rates in 24hr. of exposure with the lowest tested concentrations indicate that the NOEL values are lying in the concentrations less than 1% or in the first hours of exposure. THRESHOLD of effect of *S. officinalis* expected to be marketing in the range of concentrations (0-1%). Abstractly, Marketing of escaping rates in the experiments of stock solution (50g/L) with percent higher than in the experiments of stock solution (100g/L) is due to the mortality rate.Absence of dose-response relationship at 72 &96hr. of exposure indicate that the tested concentrations considered as NOEL values and all tested snails were killing.

***S. officinalis*Extracts (Mortality Rate, Dose 50 and 100g/L)**

Probit analysis of log Dose, and Dose normal distribution in this study showed that the mortality rate of snails were marketing in 48hr. of exposure at stock solution (50g/L) and (100g/L) experiments. The lowest and highestmortality values with their probit percent were recorded in the table below. The results found significant differences between effects of concentrations on mortality rates (Table3).

Table 3. Mortality rates of *B. truncatus* exposed to 50g/L *S. officinalis*for 96hr with Probit analys Method [Lognormal Distribution].

Log10[Dose (Stimulus)]	Actual (%)	Probit (%)	N	R	E(R)	Difference	Chi-square
Dose of *S. officinalis*extracts 50g/L							
0.	0.0083	0.	30	**0.25**	0.	0.25	25,224.2471
1.	0.1	0.0977	30	**3.**	2.9297	0.0703	0.0017
Dose of *S. officinalis*extracts 100g/L							
0.	0.0083	0.0001	30	**0.25**	0.0027	0.2473	23.0799
1.	0.2	0.216	30	**6.**	6.4798	-0.4798	0.0355

	50g/L	**100g/L**
Chi-square	25,310.8	26.13
Degrees of Freedom	8	8
P-level	0.	0.001
Alpha value (for confidence interval) 0.001		

The study recorded a serial of doses with their percentile needs to use to achieve the percentile of mortality. Clear significant relationship between *S. officinalis* extracts and *B.truncatus* response by escaping activity affect. According to the least squares of escaping

activity numbers, the actual percent, probit and weight of Dose used in the experiments were suitable for determine the LD50 of extracts to target snail.

The study recorded different values to LD of*S. officinalis* extracts to snail *B. truncatus*for 50 and 100g/L Doses, lower and upperconfidant level, Beta value and SE (Table 4).

Table 4. Different LD levels of mortality rates of *B. truncatus* exposed to *S. officinalis* (Dose-Response analysis)

Dose of *S. officinalis*extracts 50g/L			
LD10	10.7685	*Beta*	0.138
LD16	12.8094	*Beta Standard Error*	0.0914
LD50	**20.0533**	*LD50 LCL*	13.2088
LD84	27.2973	*LD50 UCL*	26.8978
LD90	29.3381	*Intercept*	2.2317
LD100	30.9192	**LD50 Standard Error**	**1.8704**
Dose of *S. officinalis*extracts 100g/L			
LD10	7.0803	*Beta*	0.184
LD16	8.6116	*Beta Standard Error*	0.0816
LD50	**14.0472**	*LD50 LCL*	12.1302
LD84	19.4827	*LD50 UCL*	15.9641
LD90	21.014	*Intercept*	2.4157
LD100	22.2004	**LD50 Standard Error**	**0.573**

Generally, the study reported that the increasing of stock solution concentration laid to increasing of mortality rates. As well as, the increasing of period of exposure laid to increasing of mortality rates too. The study reported that the complete death of snails did not marked in stock solution (50g/L) experiments but the complete death was marked in stock solution (100g/L) experiments. Therefor we can say there was a significant increase in the mortality rates of snails exposed to tested extracts comparatively with the control group. This finding agrees with finding which showed marked reduction in the survival rate of snails treated with concentrations of different plant extracts compared to control [22].The study found that these extracts were cause effect and death to snail of *B. truncatus* and dose and time dependent. These results agreed with applied study of water extract of *T. tetraptera* that used a concentration of 15, 20, and 25mg/liter in Nigeria [23-26]. Absence of dose-response relationship between the tested extracts and tested snails at 50g/L for 24hr. of exposure indicate that the tested concentrations considered as NOEL values. Absence of dose-response relationship between the tested extracts and tested snails at 100g/L for 96hr. of exposure indicate that all tested snails were killing.

The snail *B. truncatus* exposed to CuSO4

SS-1g/L CuSO4

EC50 (Escaping activity)

The study recorded lowest and highest escaping activity with their probit in the table below.Little differences between the really value of escaping number (R) that recorded in study and expected number E (R) calculated according to the analysis were recorded. According to Chi-square values, there is a confidence of recorded results. No significant differences between the effects of concentrations on escaping activity (p-value 0.02) (Table5).

Table 5. Escaping activity of *B. truncatus* exposed to CuSo4for 96hr with Probit analysis - Finney Method [Lognormal Distribution].

Log10[Dose (Stimulus)]	Actual Percent (%)	Probit Percent (%)	N	R	E(R)	Difference	Chi-square
0.	0.3	0.4829	30	**9.**	14.4859	-5.4859	2.0776
1.	0.0083	0.0062	30	**0.25**	0.1858	0.0642	0.0222
Chi-square			24.0143				
Degrees of Freedom			8				
p-level			0.0023				
Alpha value (for confidence interval)			0.001				

The study recorded a serial of doses and their percentile needs to use to achieve the percentile of escaping activity. These doses limited in range (0.1-8.4 g/L) of the Dose 1g/L. Clear significant relationship between CuSO4 and *B.truncatus* response by escaping activity affect. The study showed decreasing of extracts Dose follow by decreasing the response represented by escaping activity. In addition, we noticed decreasing of log of Dose led to decreasing of the percent of Response. As well as decreasing of Dose, follow by decreasing the response represented by escaping activity. The study found that the Dose SS-1 g/L CuSO4, which used in the experiments, was in the rage target for achieved the ED50. According to the least squares of escaping activity numbers, the actual percent, probit and weight of Dose used in the experiments were suitable for determine the ED50 of extracts to target snail.

The study recorded different values of ED, lower confidant,upper confidantlevel,Beta value and SE with intercept(Table 6).

Table 6. Different ED levels of escaping activity of *B. truncatus* exposed to CuSO4(Dose-Response analysis)

ED10	4.341	*Beta*	-0.2925
ED16	3.3777	*Beta Standard Error*	0.0811
ED50	**-0.0416**	*ED50 LCL*	1.6931
ED84	-3.4608	*ED50 UCL*	-1.7762
ED90	-4.4241	*Intercept*	4.9878
ED100	-5.1704	**ED50 Standard Error**	**-0.5097**

NOEL values of exposure the *B. truncatus* snail to CuSO4 were marked in concentration (>0.01). The Threshold value is marketing in concentrations less than 0.01g/L.half-treated snails appeared to be able to escape from the exposure media in the concentrations 0.04 at 24hr. of exposure. No ability of escaping marketing in the concentrations more than 0.03 (at 24 and 48hr), and 0.02 (at 72hr) of exposure respectively. Absence of marketing of escaping ability is due to complete death that event to all treated individuals of snails

Mortality rates

The study showed that the expose of *B. truncatus* to stock solution of (1g/L)CuSO4, mortality rate was marked in the lowest concentration 0.1% continue increasing to complete death100% in 0.6% after 24hr. of exposure. After 48hr. of exposure, the mortality rate was marked in concentration 0.1% continue increasing to complete death 100% in 0.5%. After 72hr. of exposure, the mortality rate was marked in concentration 0.1% continue increasing to complete death 100% in 0.4%. After 96hr. of exposure, the mortality rate was marked in concentration 0.1% continue increasing to complete death 100% in 0.3% (Table 7).

Table7: Mortality rates of *B. truncatus* exposed to CuSO4for 96hr with Probit Analysis - Finney Method [Lognormal Distribution].

Log10[Dose (Stimulus)]	Actual Percent (%)	Probit Percent (%)	N	R	E(R)	Difference	Chi-square
0.	0.0667	0.0319	30	2.	0.9575	1.0425	1.135
1.	0.9917	0.9999	30	29.75	29.9972	-0.2472	0.002

Chi-square

Chi-square	1.8575
Degrees of Freedom	8
p-level	0.9851

The study recorded different values of LD,lower confidant, upper confidant, Beta value and SEof *T.vulgaris* extracts to snail *B. truncatus* in the table below (Table8).

Table 8. Different LD levels of mortality rates of *B. truncatus* exposed to CuSO4(Dose-Response analysis)

LD10	-0.652	*Beta*	0.4429
LD16	-0.0158	*Beta Standard Error*	0.0873
LD50	**2.2423**	*LD50 LCL*	0.8145
LD84	4.5003	*LD50 UCL*	3.67
LD90	5.1365	*Intercept*	4.007
LD100	5.6294	**LD50 Standard Error**	**0.4123**

The study recorded a serial of doses and their percentile needs to use to achieve the percentile of mortality. Clear significant relationship between CuSO4 and *B.truncatus* response by mortality rates affect. According to the least squares of escaping activity numbers, the actual percent, probit and weight of Dose used in the experiments were suitable for determine the LD50 of extracts to target snail.The study showed that the complete death of snails exposed to CuSO4 was marked in all periods of exposure. Compete death was contagiously decreased through increasing of exposure time.

The current study was supported with other study which found that the LC50 values of CuSO4·5H2O treatment for 24h, 48h, 72h and 96h were 2.596, 1.037, 0.690 and 0.400 mg/L respectively.That means increasing of death with increasing of concentrations from one side and increasing of death with increasing of time of exposure from other side.Clear liner and Semi S-shape relationship between the doses of CuSo4 and mortality of tested snails was appearing at exposure with high correlation. In a summary of arrangement, the effect of tested materials, the study found the scale: CuSO4>*S. officinalis*. The EC50 of CuSO4and *S. officinalis* to *B. truncatus* were 9.7 and 0.9respectively.In addition, in a summary of arrangement the toxicity of tested material, the study found the scale: CuSO4>*S. officinalis*. The LC50 of CuSO4 *S. officinalis* to *B. truncatus* were 21.3 and 2.2 respectively (Figure 1, 2).

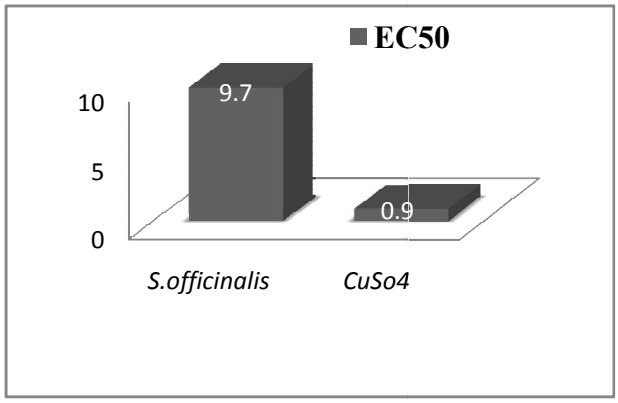

Figure1-Effectsummary of*S. officinalis*& CuSO4 extract against the snail *B.truncatus*.

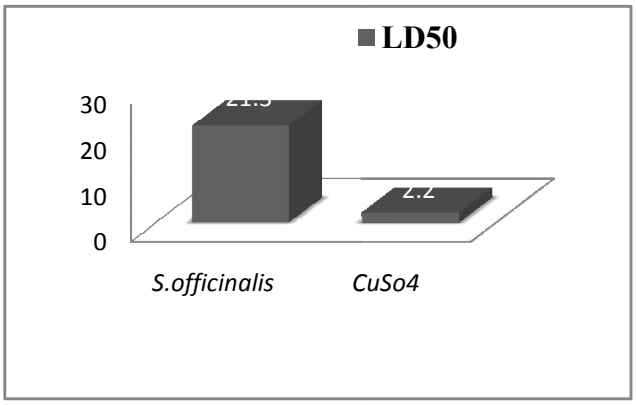

Figure2-Mortality summary of *S. officinalis*& CuSO4 extract toxicity the snail *B.truncatus*.

Finally, the results of this study agreed with a histopathological study of *T. tetraptera* extract on *Bulinus* (Phyopsis) *globosus, Biomphalaria glabrata,* and *Physa waterlotti*. The effect of the extract on various snail tissues found to be time and concentration dependent [27]. The death of snails which marked in this study may explained by the mechanism of activity of these extracts that demonstrated by produced significant reductions on the glycogen and protein content and molluscicides action on the carbohydrate metabolism of the snail. As well as mechanism ofactivity of extracts on the snails was included registration in many organs as kidney, hepatopancreas, and gastro-intestinal tract.Further effects of T. *tetraptera* extracts to *B. glabrata* and *Lymnaea columella* snail as growth and egg production recorded in some studies[4].The molluscicides effect of tested material in this study agreed with study about molluscicides effect of nicotinanilide that evaluated and compared with niclosamide against different stages of the fresh water snail *Lymnaea luteola* eggs, immature, young mature, and adults and the calculated values of lethal concentration (LC_{50} and LC_{90})[28].

Furthermore, the extracts of *S. officinalis* and *T. vulgaris* are known previously for their antioxidant, anti-inflammatory, antimicrobial, antileishmanial, antimalarial, antiprotozoal, insecticidal and molluscicides activities [29, 30]. The subject of study was around the control of snails which depending on elimination or reduction of their population density under an explicit essential threshold, laid to reduce transmission to a new people infection[31]. The study used the molluscicides plant origin because the disadvantages of use synthetic molluscicides as NICLOSAMIDE which represented by highly costs, has toxic effect to non-target organism, and need complex organized at application [32].Therefore, we needs to natural molluscicides from plants characterized with cheaper, environmentally friendly, biodegradable and immediately

offered. Advantages of using the molluscicides plant origin are exhibiting low toxicity for snails' embryos [33].The study was targeted the vector because the snail vector of Bilharzias is characteristic by protective behavior pattern, hermaphroditic, capable of both sexual and asexual and capable of self-fertilization give it an epidemiological importance[34, 35]. Some studies mentions different protective behavioral patterns of snails such ability to escaping of from the exposure media, avoid high doses of toxicant , and inter into the shell [36]. In addition, semis of these behavioral patterns were noticing in present study such as attempting to climb the piker wall, pulling the body into the shell, secreting a protective slime over the aperture, and floating to top of the containers. Thus, survival of a few individuals of snail can produce a large number of offspring. The study was chosen for these plants because *S. officinalis* leave extracts contains saponins, which produce a foam in water causing a coating of the respiratory surfaces like lung and secondary gills which will impair respiration [37].

We recommended to use extractsof *S. officinalis* or their derivative as molluscicidesby applying in the fieldas well as to determine the method of application and its biodegradability.Moreover, continuous through surveillance is important to assess both the density of the snail hosts and the prevalence of Schistosomiasis and using of other plant origin.

CONCLUSION

The present work showed that the*S. officinalis* extracts were potent to snail of *B. truncatus*. From other side view, the target snail was sensitive to CuSO4. The target extracts are often able to use as a molluscicides.

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تاثير المستخلص المائي لنبات المرميه للسيطره على القوقع المضيف للبلهارزيا الدمويه

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الخلاصة

جمعت عينات القواقع من موقع في ناحية الرشيد (30كم) جنوب بغداد. تم عمل العزل والتشخيص والاقلمة لظروف المختبر في المختبر. تم تحديد عدة مقاييس للسمية مثل مستوى التأثيرات غير المشاهد وحد العتبة وقيم مختلفة من متوسط الجرع المؤثرة والمميتة. متوسط الجرعة المؤثرة لمستخلص المرمية *S. officinalis* وكبريتات النحاس للقوقع *B. truncatus* كانت (9.7 و0.9 غم/لتر) على التوالي. ومتوسط الجرعة المميتة لمستخلص المرمية *S. officinalis* وكبريتات النحاس للقوقع *B. truncatus* كانت (21.3 و2.2 غم/لتر) على التوالي. الدراسة لاحظت ان مستخلصات المرمية كانت اقل تأثيرا من كبريتات النحاس. النتائج برهنت ان سمية المستخلصات تعتمد على الجرعة والوقت. العمل الحالي استنتج ان هناك امكانية لاستخدام المستخلصات المستهدفة في السيطرة على القوقع المضيف الوسطي للبلهارزيا الدموية.

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