

The effect of corona virus disinfectant, “sodium hypochlorite” (bleach) on the population of the mosquitoes (Diptera: Culicidae) in Abadan and Khorramshahr, southwest of Iran, during Covid-19 pandemic

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Abstract

The highly toxic disinfectant sodium hypochlorite may cause poisoning and even death. Due to chlorine gas emission, entry of this toxic substance into the environment might hazard the environment. To combat the COVID-19 pandemic, various disinfectants were utilized by various countries. Likewise, the substance was extensively used in Iran to deter the disease and consequently large amounts of chlorine were released into the environment which may have affected the environment and disrupted the natural balance of ecosystems possibly causing irrecoverable damage.

Sampling of larval habitats was conducted in a standardized way in March 2020 in two cities of Abadan and Khorramshahr in Iran in order to investigate the effect of sodium hypochlorite on the mosquitoes' population during the fight against COVID-19. The data were compared with that of conducted in March 2019.

The results showed that a total of 1887 mosquitoes were caught in March 2019, including *Culex*, *Aedes* and *Anopheles*, while after the bleach entered the larval habitats, only 180 mosquitoes of the genus *Culex* and *Aedes* have been caught; while, no *Anopheles* was caught.

By comparing climate data for March 2019 and 2020, it can be concluded that the most important factor influencing the reduced population of mosquitoes in larval habitats is associated with the entry of the bleach inside the relevant environment. This study attempts to identify the risks of human interference with the excessive consumption of disinfectants.

Keywords: disinfectant, mosquito, ecosystem, COVID-19, diptera: culicidae

1. Introduction

Bleach or sodium hypochlorite (NaClO), popularly known as liquid bleach, is a solution with a sharp and strong smell (Motlagh and NAZARI 2002) [19]. It is widely used at homes, offices and various industrial premises. This material is utilized in industry as a bleaching powder and also as bleach for fabric and pulp (Shabana, Elaziz *et al.* 2000) [21]. It is used domestically or otherwise to whiten laundry, disinfects surfaces and dishes in kitchens, treat water for drinking, disinfect surfaces in bathroom and pools, etc. The bleach contains a low percentage of sodium hypochlorite in water. This ratio may vary depending on different applications (Wang, Duan *et al.* 2019) [29]. Disinfectant properties of the bleach are due to the production of free chlorine. The bleach, when combined with boiling water, releases chlorine gas and is highly toxic, so that severe cases of poisoning have also been reported with the bleach or sodium hypochlorite (Craig and Powers 2002) [9]. The results of various studies by researchers indicate that exposure to high doses of sodium hypochlorite may lead to renal adenoma, cancer, and noncancerous benign prostatic hyperplasia (Zhang, Bull *et al.* 2011) [30].

Due to pandemic outbreak of COVID-19 in late 2019 and early 2020, many control measures have been taken to fight the disease including quarantine and personal protection; however, the disease is increasing globally. One of the most common measures to control the disease is the widespread consumption of chlorine-containing disinfectants in public

places. Continued consumption of these compounds, may endanger the lives of animals, including insects, which play a vital role in the food chain due to the existence of chlorine in environmental cycles (Abdollahi, Ranjbar *et al.* 2004) [2]. The life on earth depends on food chains consisting of organisms whose lives depend on each other (Brower, Van Brower *et al.* 1967) [7]. Insects, especially mosquitoes, have played a vital role in the Earth's food chain for more than 100 million years. Even insects themselves have become part of the diets of nearly 2 billion people worldwide in the current century (Halloran, Muenke *et al.* 2014) [15]. Mosquito larvae are considered as the food source of the fish in the water food chain and become prey to birds and spiders after full growth. Therefore, in the case of insect poisoning, this poisoning is transmitted to other creatures and may disturb the balance of the ecosystem (Stansley, Roscoe *et al.* 2001) [22].

Mosquitoes have 3,500 recognized species, out of which 200 species are vectors of human pathogens. In this group, *Culex*, *Aedes* and *Anopheles* transmit various diseases to humans through biting (Caraballo and King 2014) [8]. Hence, researchers have always attempted to find methods to eradicate a mosquito, which is regarded as the disturbance of the natural balance in the ecosystem. Mosquitoes extinction, may incur an irrecoverable disruption in the food chain. For instance, there is a huge number of mosquitoes in Tundra, a region in North Pole representing the main food sources for migratory birds. Due to the extinction of

mosquitoes, number of such birds may significantly decrease owing to deprivation of their food source (Vuilleumier 1996) [28]. The fish may also lose their food source following this extinction and are forced to adapt to another source to survive, which will take a very long time to replace, and this will reduce their population. Since fish is regarded as one of the most important food sources for humans, about 20% of the world's animal protein is now supplied by fish and aquatic animals (Seyed Ali Akbar Hedayati 2017) [20]. Mosquito activity culminates at 26 C⁰ and reversely it becomes inactive at temperatures below 10 C⁰. Consequently, they are active in the tropics throughout the year (Hopp and Foley 2001) [16]. Mosquitoes are considered as the vectors of diseases such as malaria, yellow fever, dengue hemorrhagic fever, Zika, encephalitis, filariasis and West Nile fever (Gubler and Clark 1995) [14].

The species of *Aedes aegypti* and *Aedes albopictus* are vectors of dengue fever, chikungunya virus, and yellow fever, which have also been reported in Iraq (Dawood and Al-Sarray 2009). The mosquito surveillance programs in the cities of Abadan and Khorramshahr is also routinely being investigated intermittently due to having a common border with Iraq.

Following the COVID-19 pandemic, antiseptic and

bleaching agents have been widely used to stop the virus. All public places, parks, street floors, parked cars and even areas in front of people's houses were also disinfected in Abadan and Khorramshahr to control the disease by NGOs, military forces, the municipality and health centers using bleach or sodium hypochlorite, which contains chlorine compounds in different concentrations. The introduction of large amounts of such substances into the environment will certainly have an impact on aquatic animals. This study is designed and implemented in order to investigate the effect of the bleach or sodium hypochlorite as a disinfectant compound on the population of mosquitoes in Abadan and Khorramshahr cities during the COVID-19 pandemic.

2. Materials and Methods

The cities of Abadan and Khorramshahr are located in the southwest of Iran in Khuzestan province. They are limited to Iraq and Arvand River from the west. Bahmanshir Channel and the Persian Gulf are located in the southern part of the two cities. The area of Abadan is 2538 square kilometers, whereas the area of Khorramshahr is 67.5 square kilometers. Abadan's highest point is 3 meters above mean sea level and Khorramshahr's altitude is 4 m above sea level (AZEMATI and Hosseini 2013) (fig.1).

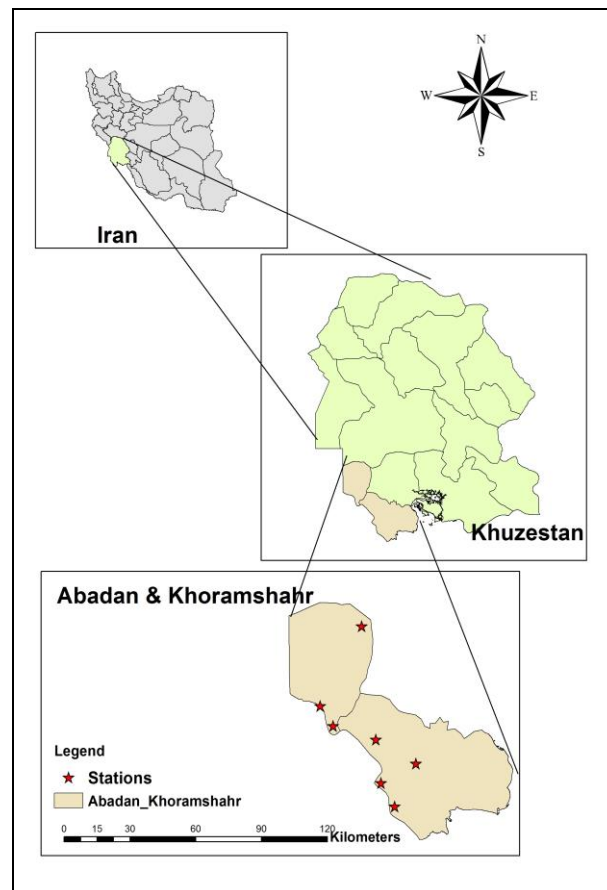


Fig 1: Study area and collection sites of Culicidae in Abadan and Khorramshahr counties, Khuzestan Province, Iran, 2019-2020

Sampling was conducted in March 2019 and 2020 and was individually performed from 7 areas in Abadan and Khorramshahr counties. Sampling sites were selected based on Geographical and climate conditions. Mosquito's larvae collection was carried out using the standard Dipper as 300 cm³ capacities. Each habitat was dipped 5 times by medical entomology and vector control experts of Abadan and Khorramshahr health centers, annually. The distribution of

sampling-sites is shown in fig1.

The collected specimens were transferred to the entomological laboratory and were placed in 70% ethanol. After death, the larvae were placed 24 hours in a lacto phenol solution for transparency. Some slides were prepared from the samples in order to observe all morphological characters. Samples were identified using valid identification keys (Azari-Hamidian and Harbach 2009) [3].

All samples were kept in the Museum of Entomology Laboratory, Health Deputy of Abadan. The data entry was conducted by SPSS software and the data were then compared. It is noteworthy that the entire collection, transparency and identification process were carried out by the same experts in both 2019 and 2020 and all sampling conditions were the same. Due to the impact of climatic conditions on the mosquito population, climate data were obtained from the Abadan Meteorological Department and compared accordingly (Bagheri, Terenius *et al.* 2015 [5]).

3. Results

In March 2020, a total of 120 Culicidae larvae, including *Culex* and *Aedes*, and 60 Culicidae larvae, including *Culex* and *Aedes*, were caught and identified in Abadan and Khorramshahr Counties, respectively. Based on data acquired in March 2019, 1157 Culicidae larvae were collected from Abadan County including *Culex*, *Aedes* and *Anopheles* as well as 730 Culicidae larvae from Khorramshahr County including *Culex*, *Aedes* and *Anopheles*. Collected specimens based on species, county and year of collection can be observed in Table 1.

Table 1: Frequency of mosquitoes (Diptera: Culicidae) collected in Abadan and Khorramshahr counties by species, 2019 – 2020

City	Year	Gender and species			Total
		<i>Anopheles stephensi</i>	<i>Aedes vittatus</i>	<i>Culex Sp.</i>	
Abadan	2019	65	228	864	1157
	2020	0	18	102	120
Khorramshahr	2019	78	69	583	730
	2020	0	25	35	60
Total	2019	143	297	1447	1887
	2020	0	43	137	180

The metrological data provided from Abadan Meteorological Department including; average relative humidity, average temperature and average rainfall in Khorramshahr and Abadan counties are shown in table 2. It is worth mentioning that climate variables do not differ due to the small size of the two cities and climatic and geographical similarities.

Table 2: Climate data in Abadan and Khorramshahr cities, 2019 and 2020

Year	2019	2020
Relative humidity	48	47
Average temperature	24.3	24.3
Average rainfall	15.08	11.4

4. Discussion

According to the results of this study, the number of mosquitoes caught in March 2020 has decreased significantly compared to 2019. The first issue we should take into consideration during alteration of the insects' population is the change in climatic conditions. According to the experts of Abadan Meteorological Department and the available statistics, there has been no change in relative humidity and average temperature over the last two years covered by the study, and only a slight decrease in rainfall was recorded in 2020. In this case, it is expected that there should not be remarkable difference between the samples caught in the two sampling processes. However, considering the similarity of sampling methods and climate variables,

the results of this study showed that the rate of insect abundance in 2020 has decreased significantly (one fourth at least) compared to 2019.

The most important change occurred in the two sampling times is the COVID-19 pandemic and the widespread utilization of sodium hypochlorite mainly in the form of bleaches and disinfectants used in COVID-19 control operations. Due to the fact that chlorine is one of the most important compounds in disease control and also organochlorine compounds are an important group of insecticides as well as pesticides, it seems that the widespread use of compounds containing chlorine and its application into the environment of mosquito larvae considerably reduced the population of mosquitoes.

In a study conducted by Kim *et al.* on 162 samples that were exposed to various toxins, including organophosphates, organochlorines and carbamates insecticides, the stomach contents of 26 species were analyzed in this exposure. The results of the study demonstrated that the insects were destroyed in different concentrations of toxins. Insecticide poisoning has also massively been observed in wildlife. In addition, insecticide poisoning has occurred and been reported throughout the world and creatures may unintentionally and accidentally exposed to toxins under different conditions and die (Kim, Kim *et al.*).

Another study by Kim *et al.* from the Department of Veterinary Medicine on the residual effects of drugs and toxins on the meat of slaughtered animals indicated that pesticide residues are stored in animal tissues such as muscle, kidney and liver. Finally, the researchers of this study suggested that a control system should be prepared and used for chemical waste and environmental pollutants (Kim, hee Kim *et al.* 2015).

Comparison of the collected samples in Abadan and Khorramshahr cities shows that the widespread use of chlorine compounds and their entry into insect larval habitats may have affected their population and caused tremendous changes in the number of caught samples during the relevant two years. Although the reduction of Culicidae population may seem hygienically desirable, there is a fact conveying that these compounds may affect all aquatic animals, and the chlorine compounds entering the aquatic environment may get into the food chain and become concentrated throughout the chain, its concentration may increase and thus, it might have irrecoverable effects on the environment and ultimately human health. Due to the fact that bleaching product emits chlorine gas, the release of this toxic substance into the environment can be very dangerous (Shabana, Elaziz *et al.* 2000) [21]. The entry of large amounts of chlorine into the environment in the fight against the COVID-19 pandemic might have devastating effects on the environment and disrupt the natural balance of ecosystems, ultimately causing irreparable damage (Abdollahi, Ranjbar *et al.* 2004, Halloran, Muenke *et al.* 2014) [22].

Out of the samples caught during the two years under study, the elimination of the *Anopheles stephensi* species in 2020 is quite noteworthy. Numerous cases of *An. stephensi* resistance to organochlorine compounds have been reported from different countries so far. Insecticide resistance in Iran began in late 1958, the first year of the malaria eradication plan in Iran, with the onset of *An. stephensi* resistance against DDT (Dichloro diphenyl trichloroethane) in southern Iran, including Khuzestan and Abadan suburban areas. It seems that the volume of chlorine entering the

environment has been so high that the entire population of this species has been destroyed. There are newly reports about indication of tolerance/resistance of *An.stephensi* to different insecticides (Vatandoosta, Mashayekhib *et al.*, Motlagh and NAZARI 2002, Borhani 2004, Vatandoost and Hanafi—Bojd 2005, Vatandoost, Oshaghi *et al.* 2006, Davari, Vatandoost *et al.* 2007, Vatandoost and Hanafi-Bojd 2012, Fathian, Vatandoost *et al.* 2015, Gorouhi, Vatandoost *et al.* 2016, Abbasi, Hanafi-Bojd *et al.* 2019, Vatandoost, Raeisi *et al.* 2019)^[27, 19, 6, 11, 12, 10, 13, 1, 26].

According to the results of this study, and despite the fact that all countries of the world are in a critical situation to combat COVID-19 disease, it is necessary to be more careful in using disinfectant compounds, so that the environment suffers less damage from control measures for the disease. It is also necessary to conduct further studies on the impact of control measures used to control COVID-19 in terms of environment as well as terrestrial and aquatic animals.

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6. References

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