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# Measurements of chemical parameters in breeding sites of *Culex quinquefasciatus* conferring larvicide tolerance in Dogbo district in South-western Republic of Benin, West Africa

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***Abstract***
*The effective control against vector borne diseases through larva source management requires the information on the breeding sites and the chemical parameters that affect larval tolerance to larvicides. This study aims to establish the correlation between the presence of chemical parameters in breeding sites of Culex quinquefasciatus and the larva tolerance to larvicides. The study was carried out in November 2021 during the small rainy season to collect information about the visual characteristics of Culex quinquefasciatus breeding sites present in Dogbo district. Then, the measurements of chemical parameters in breeding sites were done in laboratory using a spectrophotometer DR6000. The results showed that different Culex quinquefasciatus breeding sites were found in this study. They were larval habitats near of a muck-heap and under a bridge. Different ions such as nitrates, aluminium, calcium, magnesium and iron were present in larval habitats of Culex quinquefasciatus in Dogbo district and served as nutrient composition to the larvae. It is possible that some chemical parameters like total hardness analyzed in the current study contributed to Culex quinquefasciatus tolerance to larvicide. Information on the effect of chemical parameters on the mosquito larva tolerance to larvicides is useful in assessing the menace of mosquito borne diseases.*

***Key words:*** *chemical parameters, Culex quinquefasciatus, larval tolerance, larval habitat, Benin*

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## I. Introduction

*Culex quinquefasciatus* Say known as the southern house mosquito, is a subtropical mosquito belonging to the complex *Culex pipiens*, present in the Americas, Australia, Asia, Africa, Middle East and New Zealand. In addition to the considerable discomfort caused by the nocturnal biting behavior, *Culex quinquefasciatus* is the main vector of several pathogens, especially including

the nematode *Wulchereria bancrofti* (agent of bancroftian filariasis) and the West Nile virus ([1]; [2]). As mosquitoes from the complex *Culex pipiens* feed both on human and bird blood, they may potentially transport sylvatic arboviruses from migratory birds to man in urban territories [3]. This mosquito is also a potential vector of the arboviruses responsible for the Rift Valley fever [4] and Saint Louis encephalitis [5].

Despite a growing interest in the promotion of integrated vector control strategies co-targeting different vector species, control efforts and relative entomological, epidemiological and insecticide resistance studies primarily focus on anophelines resulting in important knowledge gaps regarding *Culex* species and their control.

The amount of pollutants released by domestic or industrial activities in the natural environment has increased during the past decades [6]. Most of these compounds accumulate in rivers or stagnant water bodies. Despite the high toxicity of some of these compounds, their impact on the aquatic fauna and the natural ecosystem is poorly understood. There is actually a fear that exposure of mosquito larvae to these substances could reduce their level of susceptibility to insecticides used for vector control. A study carried out by Corbel *et al* [7] in Benin, showed a multiple insecticide resistance mechanisms in *Anopheles gambiae* and *culex quinquefasciatus*. In addition, very recently, Aïzoun and Assongba [8] showed the temephos tolerance in larvae of mosquitoes, vectors of malaria and in *Culex quinquefasciatus* in Dogbo district in south-western of Benin republic. Therefore, there is a need to search for the chemical parameters in the breeding sites that confer tolerance in mosquito vectors in this district.

Very few researches were published on the measurements of chemical parameters in breeding sites of *Culex quinquefasciatus* conferring larvicide tolerance in Republic of Benin. Therefore, there is a need to carry out new researches for this purpose.

The goal of the current study is to describe the breeding sites of the mosquito *Culex quinquefasciatus* vector population including their visual description but also the knowledge of their environmental chemical factors or parameters.

## II. Materials And Methods

### 2.1. Study area

The study area is located in Republic of Benin (West Africa) and includes the department of Couffo. Couffo department is located in the south-western Benin and the study was carried out more precisely in Dogbo district (Figure 1). The southern borders of this district are Lokossa and Bopa districts. The northern border is Djakotomey district. The eastern border is Lalo district and the western border of Dogbo district is Togo republic. Dogbo district covered 475 km$^2$ and belongs to geographic region of ADJA. The choice of the study site took into account the economic activities of populations, their usual protection practices against mosquito bites, and peasant practices to control farming pests. We took these factors into account to describe the breeding sites of the mosquito *Culex quinquefasciatus* vector population including their visual description but also the knowledge of their environmental chemical factors or parameters in Dogbo district in South-western Republic of Benin. Couffo has a climate with four seasons, two rainy seasons (March to July and August to November) and two dry seasons (November to March and July to August). The temperature ranges from 25 to 30°C with the annual mean rainfall between 900 and 1100 mm.

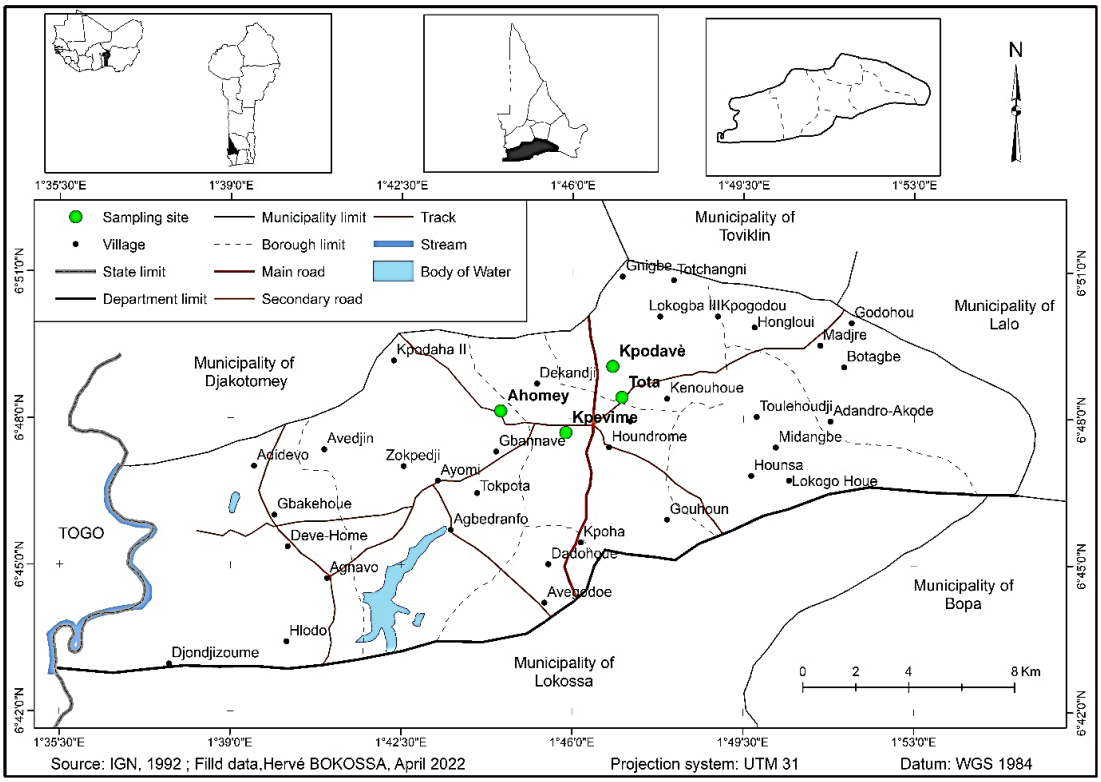


**Figure 1:** Map of Dogbo District showing sampling points of *Culex quinquefasciatus* breeding sites in Republic of Benin

**2.2. Visual characteristics of breeding sites**

The study was carried out in November 2021 during the small rainy season to collect information about the visual characteristics of *Culex quinquefasciatus* breeding sites present in Dogbo district. Photos of breeding sites were taken during our survey.

**2.3. Obtaining of the water of breeding sites of *Culex quinquefasciatus***

Water was taken from breeding sites using the dipping method [9] and kept in labeled bottles. Then, it was carried out to the Laboratory of Hygiene -Sanitation Ecotoxicology Environment Health (HECOTES) of the Interfaculty Center of Training and Research in Environment for Sustainable Development (CIFRED) for the measurements of the chemical parameters.

**2.4. Measurements of chemical parameters in breeding sites**

The measurements of chemical parameters in breeding sites of *Culex quinquefasciatus* were done using a spectrophotometer DR6000. Parameters measured were nitrates, aluminium, calcium, magnesium, total hardness and iron. These parameters were measured in distilled water as control and compared to those measured in water taken from breeding sites surveyed.

**2.5. Statistical analysis**

The chemical parameters were tested with univariate analysis. *P* values <0.05 were considered significant. All these analyses were carried using the software R.

## III. Results

**3.1. Characteristics of the different *Culex quinquefasciatus* breeding sites**

The different *Culex quinquefasciatus* breeding sites found during our survey where water of breeding sites was taken for measurements of chemical parameters were the breeding sites near of a muck-heap and under a bridge (Figure 2 and Figure 3).

**Figure 2:** A breeding site (near of a muck-heap) of *Culex quinquefasciatus* larvae surveyed in TOTA location in Dogbo district

**Figure 3:** A breeding site (under a bridge) of *Culex quinquefasciatus* larvae surveyed in AHOMEY location in Dogbo district

**3.2. Measurements of chemical parameters in larval habitat water**

The analysis of table 1 showed that there was the presence of nitrates, aluminium, calcium, magnesium, total hardness and iron in the different breeding sites surveyed in the current study. The values of nitrates ranged from 0.7 to 1.9 with the mean of 0.65. The values of aluminium ranged from 0.024 to 0.138 with the mean of 0.079. The values of calcium ranged from 0 to 0.94 with the mean of 0.292. The values of magnesium ranged from 0 to 2.58 with the mean of 1.18. The values of total hardness ranged from 0 to 3.08 with the mean of 1.47

whereas the values of iron ranged from 0.4 to 3.75 with the mean of 2.34. All these mean values are higher than those of the corresponding controls.

**Table 1: Recording of the values of chemical parameters**

| Parameters | Unities | Symboles | Used methods | Obtained values | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 3 | 4 | Distilled water (Control) |
| Nitrates | mg /L | $NO_3^-$ | Reduction to Cadmium | nd | nd | 1.9 | 0.7 | 0 |
| Aluminium | mg/L | $Al^{3+}$ | Colorimetry | 0.138 | 0.034 | 0.120 | 0.024 | 0 |
| Calcium | mg/L | $Ca^{2+}$ | Ethylene Diamine Tetra-acetic Acid | 0.23 | 0 | 0.94 | 0 | 0 |
| Magnesium | mg/L | $Mg^{2+}$ | Ethylene Diamine Tetra-acetic Acid | 2.58 | 0 | 2.14 | 0 | 0 |
| Total hardness | mg/L | TH | Ethylene Diamine Tetra-acetic Acid | 2.81 | 0 | 3.08 | 0 | 0 |
| Iron | mg /L | Fe | 1.10-Phenanthrolin | 3.5 | 1.71 | 3.75 | 0.4 | 0 |

nd = no determined ; 1 = *Culex quinquefasciatus* breeding site water taken under a bridge in AHOMEY location ; 2 = *Culex quinquefasciatus* breeding site water taken in a ditch in KPODAVE location ; 3 = *Culex quinquefasciatus* breeding site water taken in a sump in KPEVIME location ; 4 = *Culex quinquefasciatus* breeding site water taken near of a muck-heap in TOTA location

## IV. Discussion

The different *Culex quinquefasciatus* larval habitats found during our survey where water of breeding sites was taken for measurements of chemical parameters were breeding sites near of a muck-heap and under a bridge. Both were semipermanent stagnant and polluted water. Polluted breeding sites are semipermanent water collections containing domestic wastes or organic products in decomposition which could be invaded by moisture or alga. *Culex quinquefasciatus* mosquito breeding sites are often located in a variety of contaminated environments. Also, the density of these mosquito larvae were significantly influenced by several chemical environmental factors that are associated with mosquito breeding sites. The higher numbers of *Culex quinquefasciatus* larvae is an indication that the species, which was once considered as an urban mosquito is also colonizing rural pockets that were once free of this mosquito [10]. If *Culex quinquefasciatus* mosquito breeding sites are often found in areas polluted by industrial effluents, rotting vegetation, human faeces, cow urine, as well as oil and grease mostly, the most Anopheles mosquitoes traditionally breeds in clear, clean and apparently less contaminated surroundings usually around human habitation.

Physicochemical parameters are the products of the changes that take place in the water ecosystem. These parameters affect the composition of local fauna [11]. In the current study, the results obtained regarding the measurements of chemical parameters present in breeding sites of *Culex quinquefasciatus* showed that there was the presence of nitrates, aluminium, calcium, magnesium, total hardness and iron in the different breeding sites surveyed. All these chemical parameters except total hardness are called ions and profited as nutrient composition to larvae of *culex quinquefasciatus* present in the different larval habitats surveyed. Similar results were observed by Oyewole *et al* [12] with Anopheles mosquitoes. In addition, the presence of nitrates ($NO3^-$) could also be explained by the use of nitrate base fertilizers as well as agro-allied pesticides in farmlands located around these mosquito breeding sites. They could also be carried out by stream rain water into these breeding sites.

The chemical larvicides or polystyrene granules applied to water collections in mosquito larvae control could induce resistance in mosquito species. It is also possible that some chemical parameters like total hardness analyzed in the current study contributed to *Culex quinquefasciatus* tolerance to larvicide. Therefore, there is a correlation between some chemical parameters and larval insecticide tolerance. It is for this reason that the

current study was carried out to identify these parameters influencing larvae susceptibility to insecticides or larvicides.

## V. Conclusion

The current study clearly shows that information on the effect of chemical parameters on the mosquito larva tolerance to larvicides is useful in assessing the menace of mosquito borne diseases.

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## References

[1]. Brasil. Guia de vigilância do *Culex quinquefasciatus*. Ministério da Saúde, Secretaria de Vigilância em Saúde, Departamento de Vigilância Epidemiológica, Coordenação Francisco Anilton Alves Araújo, Marcelo Santalucia. 3rd ed. Brasília: Ministério da Saúde. 2011.
[2]. Lima-Camara TN. Emerging arboviruses and public health challenges in Brazil. Rev Saude Publica. 2016; 50:36.
[3]. Fonseca DM, Keyghobadi N, Malcolm CA, Mehmet C, Schaffner F, Mogi M, *et al.* Emerging vectors in the *Culex pipiens* complex. Science. 2004; 303:1535–1538.
[4]. Meegan JN. The Rift Valley fever epizootic in Egypt 1977-78. Description of the epizootic and virological studies. Trans R Soc Trop Med Hyg. 1979; 73: 618–623.
[5]. Monath TP, Tsai TF. St Louis encephalitis: lessons from the last decade. Am J Trop Med Hyg. 1987; 37: 40S–59S.
[6]. Biney C, Amuzu AT, Calamari D *et al.* "Review of heavy metals in the African aquatic environment," Ecotoxicology and Environmental Safety. 1994; 28(2):134–159.
[7]. Corbel V, N'Guessan R, Brengues C, Chandre F, Djogbenou L, Martin T, Akogbeto M, Hougard JM, Rowland M. Multiple insecticide resistance mechanisms in *Anopheles gambiae* and *Culex quinquefasciatus* from Benin, West Africa. *Acta Trop.* 2007; 101: 207–16.
[8]. Aïzoun N and Assongba F. Temephos tolerance in larvae of mosquitoes, vectors of malaria and in *Culex Quinquefasciatus* in Dogbo district in south-western of Benin republic, West Africa. IJISR. 2022; 11(03): 1671-1675.
[9]. O'Malley C. Seven ways to a succesful dipping carrer. Wing beats.1995; 6: 23-24.
[10]. Okiwelu SN and Noutcha MAE. Breeding sites of *Culex quinquefasciatus* (Say) during the Rainy season in rural lowland rainforest, rivers state, Nigeria. Public Health Res. 2012; 2: 64-68.
[11]. Moses M and Alfred S. The effect of total dissolved solids, salinity and electrical conductivity parameters of water on abundance of Anopheles mosquito larvae in different breeding sites of Kapiri Mposhi District of Zambia. Int. J. Sci. Technol. Res. 2019; 8: 70-75.
[12]. Oyewole IO, Momoh OO, Anyasor GN, Ogunnowo AA, Ibidapo CA, Oduola OA, Obansa JB and Awolola TS. Physico-chemical characteristics of Anopheles breeding sites: Impact on fecundity and progeny development. AJEST. 2009; 3(12): 447-452.

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