

(RESEARCH ARTICLE)



Health impact linked to the use of water of questionable microbiological quality in the town of Nkolafamba (Center, Cameroon)

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Abstract

A study was carried out in order to assess the health impact linked to the untreated use of water from the watercourse in the town of Nkolafamba by the neighboring populations. The surveys were conducted on the entire population taking into account the status of the respondent, his responsibility in the family, his level of education. In a questionnaire, after identifying the respondents, the points considered were knowledge of the management of solid and liquid household waste, the supply of drinking water, the health and environmental impact linked to the use of untreated water. The results of the surveys were codified and processed by statistical analyzes using SPSS version 16 software. In order to establish the links between the health risks recorded and the microbiological quality of the water used. It shows positive and very significant correlations ($P < 0.01$) between the type of activity carried out and the treatment of water before consumption, between the source of supply and the treatment with bleach, between monthly income and water supply, between the interviewee's neighborhood and the water treatment before consumption. Positive and significant correlations ($P < 0.05$) were observed between the source of water supply and water-borne diseases, the source of water supply and knowledge of water quality, water-borne diseases and water treatment before consumption. However, a significant but negative correlation was observed between monthly income and bleach treatment. The populations of the locality of Nkolafamba should be sensitized on water treatment techniques.

Keywords: Health impact; Microbiological quality; Water; Watercourses

1. Introduction

On the planet, only 0.014% of fresh water is usable by humans as surface water [1] In emerging countries, the massive resignation of populations to use surface water (rivers, springs, etc.) is linked to the insufficient resources of local municipalities to ensure optimal distribution of drinking water. [2] mention in this regard that these populations often face water supply problems in their distribution network. Indeed, the demographic explosion is causing a scarcity of sources of drinking water supply. The populations therefore, in the need to obtain drinking water, are obliged to resort to surface water so they ignore the microbiological quality [1]. However, this water has been qualified of dubious or contaminated quality by several studies and likely to cause many ailments [3-7]. Contamination of surface waters by pathogens is a pollution problem that goes back a long way [8]. Pollution of water due to faecal microorganisms appeared very early as soon as water was used as a vector for waste disposal [8]. Human contamination occurs either

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by consumption of drinking water, or by consumption of food contaminated by water, or even during a bath or contact with water for recreational use[9].

A preliminary study was conducted on the microbiological quality of surface water in the locality of Nkolamfamba [10]. This study showed that the waters of Nkolamfamba are unfit for human consumption without prior treatment and harbor a bacterial microflora consisting of fecal and total coliforms, fecal streptococci and BHAM beyond the standards recommended by the [8]. The contamination is predominantly animal. This contamination would occur upstream in the Afamba stream used for watering livestock. In addition, the waters of Nkolamfamba also harbor a pathogenic microflora, illustrated by the presence of *Pseudomonas aeruginosa*, *P. pasteurilla* whose abundances can sometimes reach 5.46 log units (CFU / 100ml) [10]. These waters are mineralized with slightly acidic pH. Their flow speed rarely exceeds 0.155m / s, the flow being between 0.37 and 1.76m³ / s for an average width of the stream beds which oscillates between 1 and 2m. In these waters, the biotope's pH, electrical conductivity, temperature, turbidity, nitrate content and suspended matter significantly impact ($P < 0.05$) the abundance of certain groups or certain bacterial species present [10]. Despite this information, the consideration of the health risks of the users of these waterways has not been elucidated. The objective of this study is to assess the health impact linked to the untreated use of water from Nkolamfamba by the populations.

2. Material and methods

2.1. Collection of data

2.1.1. Geographical coordinates

The town of Nkolamfamba is located in the central region, in the department of Mefou and Afamba and in the district of Nkolamfamba. This small town is about 10km from Yaoundé between 3 ° 51 ' 32 " North latitude and 11 ° 39 ' 53 " East longitude.

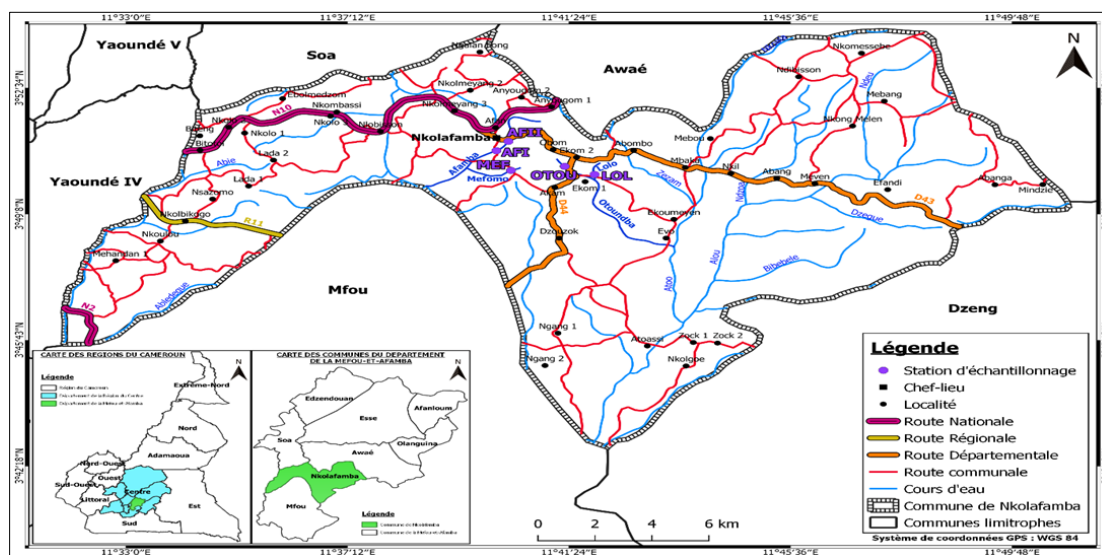


Figure 1 Positions of sampling stations in the Arrondissement of Nkolamfamba

2.2. Census among the population the main users of watercourses

The main activity carried out by this rural population is agriculture with nevertheless the young class in school. It is a cosmopolitan population coming from different regions of the country with different habits and customs. The lower level of the age group was chosen in order to survey individuals at an acceptable level of understanding. In addition, the gender aspect has been respected each time. Indeed, several methods from related scientific disciplines have been combined to operationalize the conceptual approach. Thus, two types of surveys were conducted using a quantitative approach and a qualitative approach [11].

2.3. Quantitative surveys

A once-through survey was carried out in June 2019 among the populations of the study locality [11]. The questionnaire used included the following modules among others: Sex of the interviewee, type of dwelling, socio-professional activity (main activity), average monthly income, liquid waste management, drinking water supply and quality, main source of supply in drinking water, the source of water supply for household activities, precautions taken before consuming the drinking water, the treatments applied before consuming the drinking water.

2.4. Qualitative surveys

The methods used for qualitative surveys are essentially “focus groups”, informal meetings with stakeholders and direct observations [11]. The “focus groups” were used to characterize the actors and to investigate the practices related to the supply of drinking water, the precautions taken before consuming the drinking water, and the treatments applied to the drinking water. Direct observations made it possible to identify in-situ management of liquid waste (black water in particular) and the treatment methods applied to drinking water.

2.5. Link between the water consumed and waterborne diseases in the locality

The link between the microbiological quality of the water consumed and the water-borne diseases suffered by local populations was made after a preliminary analysis of the quality of the water used by these populations and the questionnaire submitted to these populations and to health personnel.

2.6. Analysis of the microbiological quality of water

The analysis of the microbiological quality of the water was carried out to search for Mesophilic Aerobic Heterotrophic Bacteria (BHAM), and bacteria of the genus *Pseudomonas* because of their importance in public health and in monitoring the microbiological quality of water [12,13] and to verify the doubtful origin of this water. Indeed, 5 sampling points were chosen including 2 points on the Afamba river, and 1 point on each of its tributaries. Mefomo, Lolo and Otoundoumba respectively in order to follow the variation of microorganisms. BHAMs were isolated on PCA medium and bacteria of the genus *Pseudomonas* on cetrimide agar [12]. The organisms isolated were enumerated by direct counting and depletion of the agar on Petri dishes [14]. The results were expressed in CFU / 100ml then transformed into log units (CFU / 100ml) of water sample analyzed, in order to reduce the large differences obtained and maintain the same variation [13].

2.7. Health impact assessment following the use of untreated water

A survey questionnaire submitted to the attention of populations using the waters of the watercourses considered was carried out according to the recommendations of [6]. This questionnaire took into account the resurgence of water-related diseases due to the microorganisms considered, the frequency of complaints. The same questionnaire was submitted to the health personnel of the District Medical Center (CMA) of Nkolafamba. The risk is above all microbiological, the transmission of microorganisms can occur by ingestion of water or by direct contact with the skin or mucous membrane [8]. Contamination of surface water is frequent, whether by urban wastewater, by point sources of pollution (septic tanks) or wild. These sources are associated with an increase in the frequency of enteric diseases,

2.8. Data analysis

2.8.1. Assessment of the socioeconomic impacts linked to the use of waterways in the city of Nkolafamba

The data from surveys carried out among the populations was processed using SPSS 20.0 software and an Excel spreadsheet. The aim was to assess the socioeconomic impacts linked to the use of the rivers analyzed. This impact assessment also took into consideration the type of activity of the people questioned, their level of knowledge of water treatment methods and the main water-borne diseases that they suffer on a daily basis among others. The processing of the recorded information was codified and then processed using SPSS software.

3. Results

3.1. Socio-economic characteristics of households

Of all the individuals questioned during the survey carried out in the locality of Nkolafamba, 65.0% were female. Most of them were traders (60.0%), civil servants (10%) fishermen (5%) resourceful (15%) and unemployed (5%). All the data on the socio-economic aspect of the respondents is presented in Figure 2.



Figure 2 Gender distribution and socio-economic characteristics of households in the locality of Nkolafamba

3.2. Health risks associated with water consumption

3.2.1. Source of water supply in the town of Nkolafamba

Following the survey, most of the individuals questioned do not carry out any control relating to the quality (microbiological and physicochemical) of the water. Indeed, out of 100 households getting water 20% use well water, 50% spring water, 3% protected well water 20% unprotected well water, 2% CAMWATER water and finally 5 % of other origins namely mineral water.

3.3. Water use by the population of Nkolafamba

The target population uses these local waters for drinking, washing up, bathing, washing clothes and cooking, respectively. The majority of individuals questioned replied that they did not know the microbiological quality of their drinking water and that they had not treated the water before consumption (85%). Indeed, almost all households do not really master the drinking water treatment processes and go back to treatment by chlorination (10%) and very few of them to the filtration method (5%). All the data on the methods of water treatment by the respondents are presented in Figure 3.

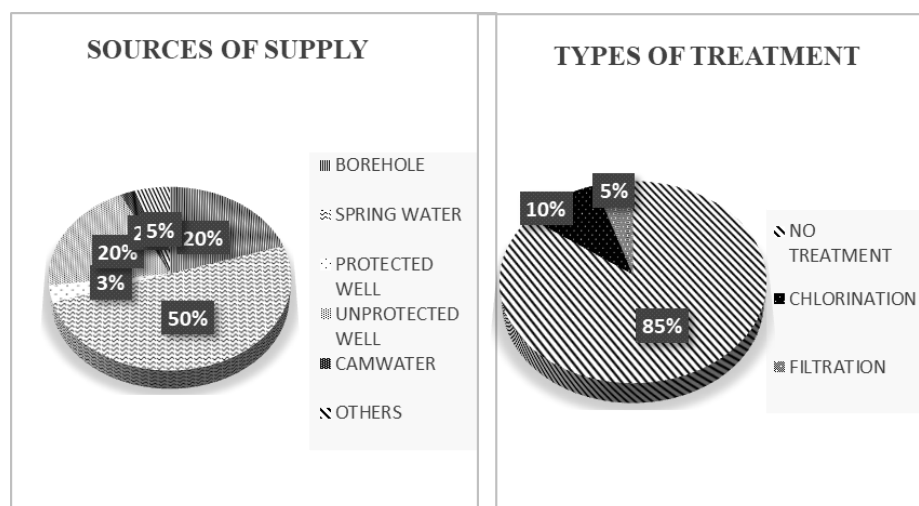


Figure 3 Source of water supply and water treatment processes by the population of Nkolafamba

3.4. Wastewater discharge sites in Nkolafamba

Wastewater discharges in Nkolafamba are made into the environment without any prior treatment. Indeed, it was recorded 60% of the respondents discharged their wastewater directly into the gutters; 35% in the yard and 5% in the septic tanks (Figure 4).

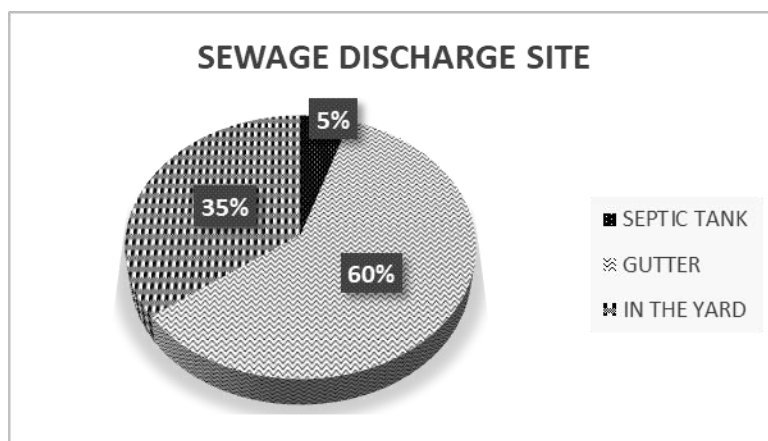


Figure 4 Places of wastewater discharges by the populations of the city of Nkolafamba

3.5. Assessment of the microbiological quality of the water used

The results of the microbiological analyzes showed that the waters of the analyzed water points were all contaminated by most of the germs sought. They were heavily contaminated by the total mesophilic flora of which 25% of this mesophilic flora are represented by the germs of the genus *Pseudomonas*. An average value of 5.17 units (log CFU / 100mL) was recorded for BHAM. In general, BHAMs were most abundant at all stations throughout the study period. BHAM densities fluctuated between 4.36 and 6.03 units (log CFU / 100mL of water). The waters of Nkolafamba also harbor a pathogenic microflora, including bacteria such as *P. aeruginosa*, *P. pasteurella*, the abundances of which can sometimes reach 5.462 units (log CFU / 100mL) (Figure 5).

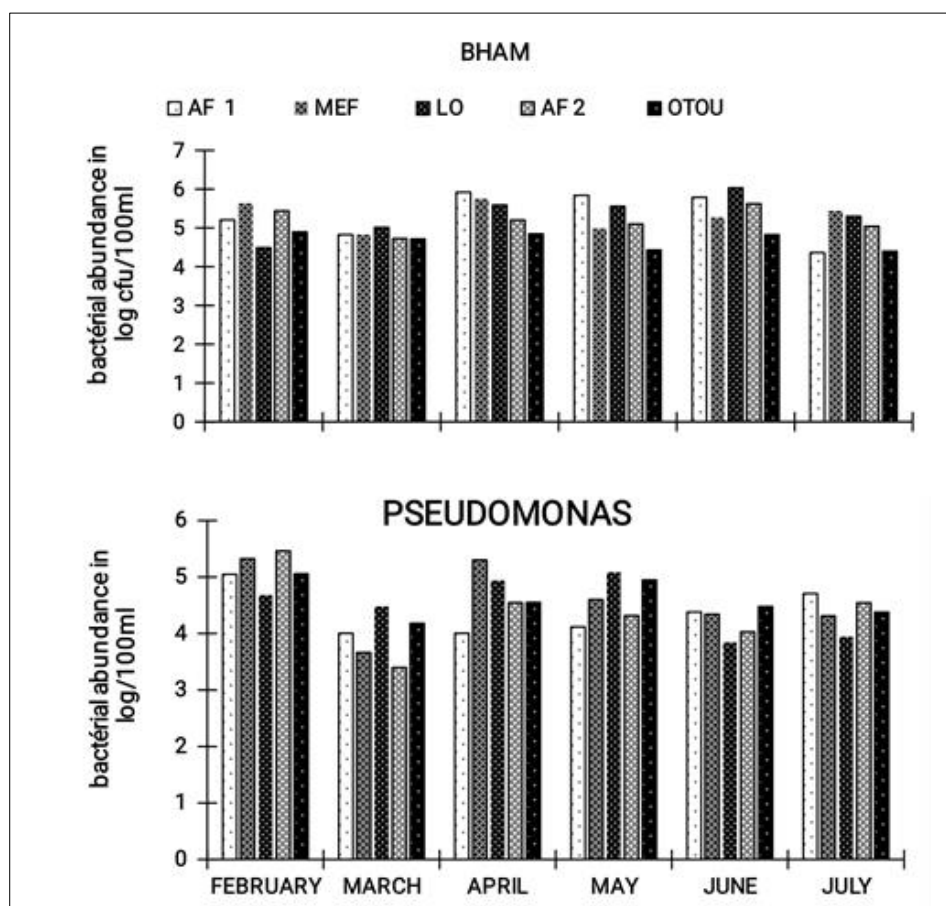


Figure 5 Spatio-temporal variations in the abundances of BHAM and bacteria of the genus *Pseudomonas* during the study period

3.6. Health impact following the use of untreated water

The direct health impact linked to the use of water by the populations of Nkolamfamba is perceived by the recurrent water-related or water-related diseases identified in the locality. In fact, the water-borne diseases identified were typhoid, diarrhea (cholera) and gastritis. Most of the time, water-related diseases have been malaria. The rates of occurrence of these diseases are presented as follows, typhoid fever (45%), malaria (25%), diarrheal diseases (cholera and gastritis) (10%), eye infections (15%) and other diseases such as parasitosis (5%) (figure 6). Diarrheal diseases (cholera and gastritis) being classified together because of the difficulty of the respondents to establish a difference between them.

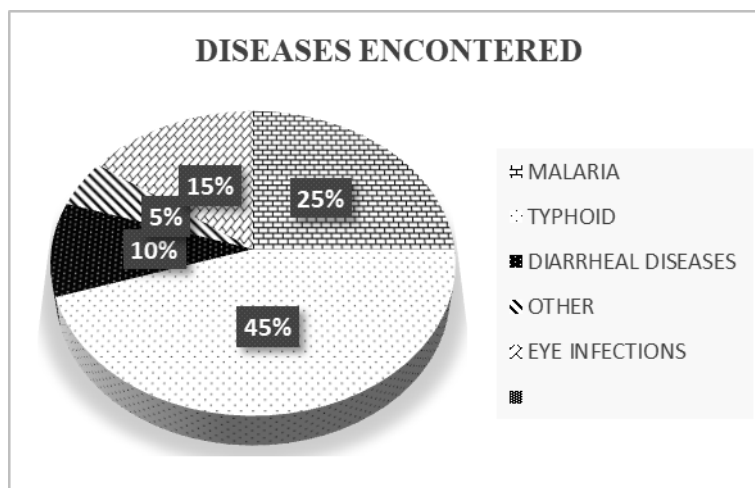


Figure 6 Diseases encountered in the populations of the locality of Nkolafamba

3.7. Socioeconomic impacts linked to the use of waterways in the city of Nkolafamba

A socio-economic study related to water consumption was carried out among the populations of the district of Nkolafamba. A correlation between the results of this study was performed (Table 1). It shows positive and very significant correlations ($P < 0.01$) between the type of activity carried out and the treatment of water before consumption, between the source of supply and the treatment with bleach, between monthly income and water supply, between the interviewee's neighborhood and the water treatment before consumption. Positive and significant correlations ($P < 0.05$) were observed between the source of water supply and water-borne diseases, between the source of water supply and knowledge of water quality, between water-borne diseases and water treatment before consumption. However, a significant but negative correlation was observed between monthly income and bleach treatment.

Table 1 Correlations resulting from the study of socioeconomic impacts

	TA	TL	SAP	CQE	MH	TAEJ	RM	QE	TEAC
TA	1,000	0.013	-0.283	-0.277	0.182	0.163	-0.155	0.279	0.494 **
TL	-	1,000	-0.313	-0.257	-0.097	-0.184	0.053	-0.137	-0.129
SAP	-	-	1,000	0.377 *	0.394 *	0.272 **	0.512 **	-0.030	0.151
CQE	-	-	-	1,000	0.621 *	0.039	0.099	-0.327	0.051
MH	-	-	-	-	1,000	0.181	-0.193	0.377 *	0.373 *
TAEJ	-	-	-	-	-	1,000	-0.448 *	-0.048	0.202
RM	-	-	-	-	-	-	1,000	-0.269	-0.255
QE	-	-	-	-	-	-	-	1,000	0.533 **
TEAC	-	-	-	-	-	-	-	-	1,000

*: $P < 0.05$ **: $P < 0.01$ P = degree of significance dof = 44; TA = types of activity; TL = types of latrines; SAP = sources of water supply; CQE = knowledge of water quality; MH = water-borne diseases; TAEJ = treatment applied with bleach; RM = average income; QE = district of the respondent; TEAC = treatment of water before consumption.

4. Discussion

Among the respondents, traders represented 60% of the respondents. This high proportion of traders is explained by the fact that the study area is located near the fresh food market. In addition, the study area being a suburb of the capital of Cameroon (Central Africa), the land is heavily agricultural. The main economic activity is the trade which is carried out by supplying food products and liquidation from potential travelers (buy and sell).

It has been reported that the populations of the town of Nkolafamba discharge domestic wastewater into the environment without prior treatment. This bitter observation had already been made in most of the metropolises of emerging countries because of the absence or dysfunction of existing wastewater treatment plants, and the ignorance of the neighboring populations who tend to use the watercourses as a dumping ground for black water, gray water and various other wastes. This wastewater is however likely to pollute the soil, the subsoil and subsequently the groundwater due to the high levels of organic matter and of microorganisms of fecal origin sometimes reaching respectively 531mg.l^{-1} and 6×10^7 CFU / 100ml [15]. In addition, households mainly obtain water from springs, wells, drilling, because the study area does not have a water supply network from the drinking water distribution company. In these suburbs in general, the installation of underground water points is often carried out by village techniques. This situation poses the problem of vulnerability to pollution of these water resources [16]. Thus, the resurgence of contamination of surface and groundwater should lead populations to adopt various methods of water treatment before consumption [17, 18].

The low rate of households that carry out water quality control is partly explained by the lack of financial means of the populations but also by ignorance of the need to carry out water quality control [19]. A small proportion of the population is aware of the short-term health risks associated with the consumption of water of poor microbiological quality, while the majority consider that they are already accustomed to this water of poor bacteriological quality, and that these are children who suffer a lot from water-borne illnesses, possibly due to their immature immune systems. On the other hand, it is this class of the population that spends the most for the treatment of diseases of various origins.

The results of the microbiological analyzes showed the recrudescence of the bacteria sought. BHAMs were present in all stations throughout the study period and dominate the identified bacterial community. Indeed, according to [20], the enumeration of the aerobic bacterial flora aims to estimate the density of the general bacterial population. The high abundance could be due to the fact that the environment of these stations is favorable to their development. In addition, the high bacterial load of BHAMs recorded could also be due to contaminated runoff. According to [21], this factor favors the contamination of surface and groundwater, leading bacteria in their movement.

The waters of Nkolafamba also harbor a pathogenic microflora, with in particular bacteria such as *P. aeruginosa*, *P. pasteurella*, the abundances of which can sometimes reach 5.462 units (log CFU / 100mL). These germs can be the cause of eye infections or sepsis in users of these waters [1]. The permanent presence of these pathogenic bacteria and their high abundance reflect the degree of pollution of these waters. Similar results have been obtained in particular by [22] in Bafoussam where many pathogens such as *Escherichia coli*, *Salmonella*, *Shigella* and many other bacteria witnessing faecal contamination have been observed there. The same is true of the results obtained by [23] in Yaoundé and [23] in Douala. These authors.

5. Conclusion

This study evaluated the health impact linked to the untreated use of water by the populations of Nkolafamba during the study period. The household survey made it possible to identify the main factors of pollution in the event of poor management of household waste, excreta and wastewater. The assessment of the bacteriological quality of these waters showed contamination to varying degrees by the desired germs. Thus, these waters are mostly contaminated by total mesophilic aerobic flora and germs due to breaches of hygiene rules. In addition, the contamination of these waters by these bacteria constitutes a major risk of gastroenteritis for consumers. Respect for hygiene rules and the treatment of water before use by the population should be encouraged to avoid the occurrence of water-borne diseases.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

Contributions from authors

The co-authors helped plan the fieldwork. SDB, OVNE, EK, AAT, CSM, YPY performed the analyzes under the supervision of OVNE, MN. OVNE, SDB, YYP, RPTK, LMM and UKB participated in the drafting of the manuscript. All authors have approved the final version of the manuscript.

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