

# Water Consumption Survey Used in the Largest City in Western of Côte d'Ivoire : Daloa

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**Abstract:** - This study aims to collect information on the types of water consumed in Daloa in order to understand behavior of populations of this city with respect to the different types of water consumed in this locality of Côte d'Ivoire. Thus, it called for a survey in eleven districts of Daloa. The results identified four types of water commonly used in Daloa. This is water from natural springs, wells, fountains and that distributed by the Water Distribution Company of Côte d'Ivoire called in french " Société de Distribution d'Eau de Côte d'Ivoire" (SODECI). Spring water is most popular with the populations surveyed with a percentage of 78%, unlike the water distributed by SODECI (2%). Also, well water (8%) is better appreciated by the people surveyed than water distributed by SODECI (2%) because it is qualified by the latter as unsuitable for consumption as drinking water. Well water and that distributed by SODECI are widely used for laundry, personal hygiene and cooking with respective values of 35.45%, 34.55% and 35.45% for well water and 61.82%, 58.18% and 50.91% for SODECI water. According to them, the consumption of water distributed by SODECI could be unhealthy for human consumption as drinking water without prior treatment because of the visible cloudiness of this water. A physico-chemical study followed by a microbiological analysis could better provide an answer to this concern and would at the same time make it possible to remove the fears related to the consumption of water distributed by SODECI-Daloa as human drinking water.

**Key-Words:** - Water type, Water quality, SODECI-Daloa, Daloa (Côte d'Ivoire)

Received: May 18, 2021. Revised: February 23, 2022. Accepted: March 28, 2022. Published: April 27, 2022.

## 1 Introduction

Water is essential for the life of humans, animals and plants. It therefore deserves special attention since it can be the object of serious threat due to human activities. According to Zmirou *et al.* [1], all human activities involving the mobilization of natural resources lead to the production of waste (solid and liquid) and gaseous effluents capable to causing a transfer of pollutants. Water could be a source of disease due to its contamination by household, industrial, agricultural and organic waste. It is for this reason that the quality of drinking water appears to be a worrying issue all over the world [2]. The risks of spreading water-borne diseases such as cholera, hepatitis, dysentery, and all other diseases whose vectors are mosquitoes are becoming more important [3].

In Daloa city, a large proportion of households are not connected to the Water Distribution Company of Côte d'Ivoire (SODECI) according to survey data by

Diarra *et al.* [4]. Almost the entire population obtains water from fountains, natural springs and wells. And even in connected households, the appearance (turbidity) of the water remains unsatisfactory. Thus, because of their accessibility, water from springs, wells and fountains is offered to the populations of this city at different points in the neighborhoods in often precarious conditions and is often preferred to water from SODECI despite the questionable quality and the lack of hygiene noted around these water supply areas. In principle, drinking water is water intended for human consumption and which is not likely to harm health in its everyday use. However, according to WHO, nearly 25 million people die each year due to the consumption of contaminated water in developing countries.

According to WHO-UNICEF [5], 2.1 billion people do not have access to safe drinking water in their homes and more than double do not have safe sanitation services. In addition, nearly 3.1% of deaths

worldwide are explained by poor water quality, sanitation and hygiene. The waterborne diseases that can be contracted when consuming these waters are diseases related to biological agents or diseases related to physico-chemical parameters [6].

For the acceptance of water as intended for drinking, it must meet all the quality guidelines set by the WHO. It exceeds a certain interval of physico-chemical parameter and favors a complete absence of faecal germs indicators of contamination. Sanitation and access to drinking water are therefore essential elements for improving living conditions and human health [7].

The objective of this work is to carry out a survey of consumption of water consumed in Daloa to better understand the behavior of populations of this city with respect to the different types of water consumed in this locality of Côte d'Ivoire.

## 2 Material and Methods

### 2.1 Material used for the survey

The survey carried out in the municipality of Daloa required the development of survey sheet and pen.

### 2.2 Research Methodology

The study was based on documentary research and field surveys. The documentary research made it possible to take stock of research on the different types of water consumed in Daloa and their characteristics as well as the different treatments that this water undergoes before consumption.

### 2.3 Determination of sample size

The size of people to be surveyed was determined using Fisher's formula :  $N = t^2 \times p \cdot (1-p)/e^2$  (1)

$N$  = expected sample size

$t = 1.96$  at 95% confidence level

$p$  = estimated proportion of the population with the characteristic studied in the study (50%)

$e$  = margin of error (fixed at 3.65%).

With a confidence rate of 95%, a margin of error of 5%, the survey covered 330 people. The sample was evenly distributed among eleven neighborhoods (30 peoples per neighborhood).

### 2.4 Field investigation

A survey sheet has been developed to obtain information on the water consumed in Daloa. The survey took place during the months of October to November 2021. It covered a sample of 330 peoples chosen at random from 11 neighborhoods at the rate of thirty people per neighborhood. The information

collected focused on socio-demographic status (sex, age and study level), type of water consumed, use, their impression of the quality of the water consumed and their preference. The information collected was used to compile a database on the water consumed in Daloa.

## 2.5 Data processing

The data set was processed using the Excel 2019 spreadsheet. The survey data, histograms, pie charts and tables were produced using the XLSTAT version 2021 software incorporated into Excel 2019.

## 3 Results

### 3.1 Gender of respondents

The survey carried out in the municipality of Daloa concerned both men and women (Figure 1). Women represent 60% of those surveyed.

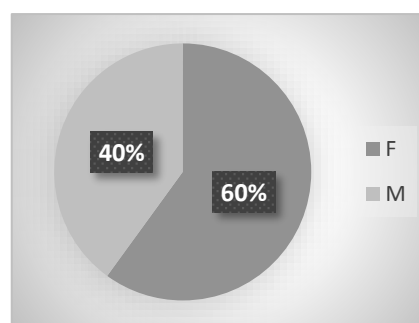


Figure 1. Distribution of people surveyed by gender

### 3.2 Age groups of respondents

The survey covered all age groups. People whose age range is between [26-35] years and [36-50] years were the most surveyed with respective values of 37.27 and 41.82%. Figure 2 shows the distribution of people surveyed by age group.

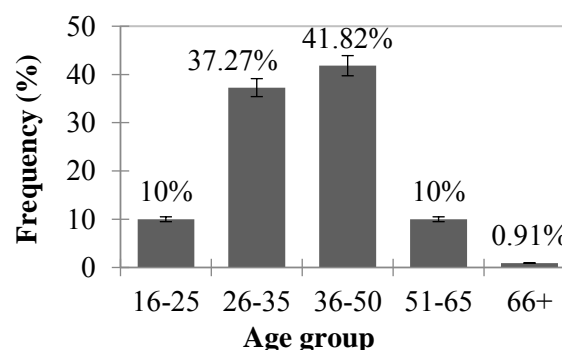
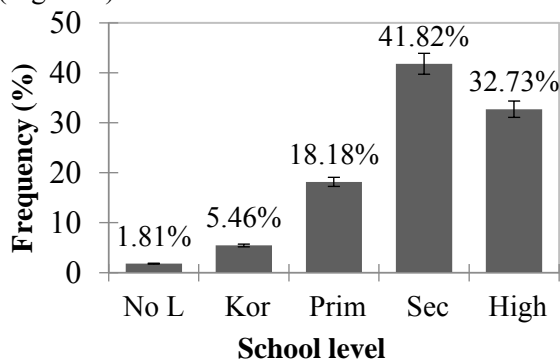


Figure 2. Distribution of people surveyed by age

### 3.3 Educational level of respondents

The results showed that people with secondary education were the most represented with a percentage of 41.82%. Then follow people with a higher education level (32.73%), then those in primary school (18.18%), koranic school (5.46%) and those with no level with a percentage of 1.81% (Figure 3).

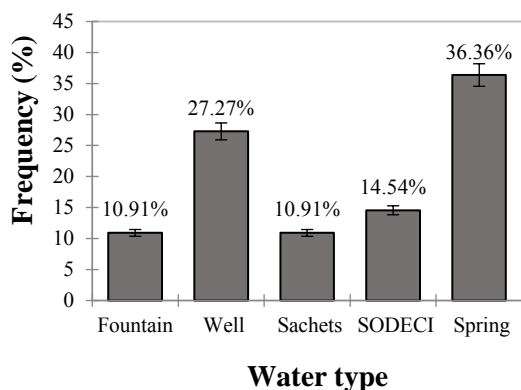


**Figure 3.** Distribution of people surveyed by level of education

No L : No level ; Kor : Koranic ; Prim : Primary ; Sec : Secondary ; High : Higher

### 3.4 Type of water consumed in Daloa

Figure 4 shows the proportion of type of water consumed in Daloa. The survey carried out in the neighborhoods revealed that more than 35% of the individuals surveyed consume spring water, more than 25% well water, 10% fountain water and water in sachets and 15% water distributed by SODECI in the municipality of Daloa.

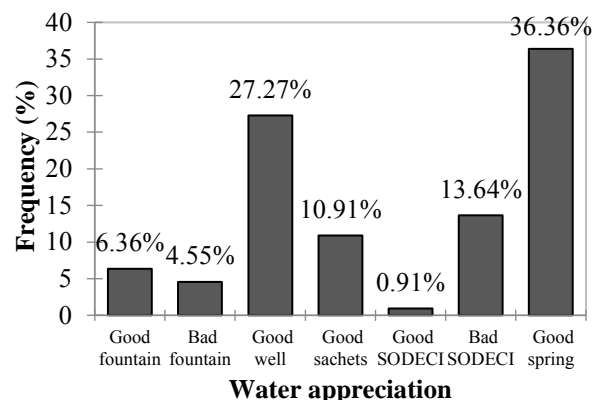


**Figure 4 :** Distribution of water type consumed in Daloa

### 3.5 Quality of water consumed according to respondent

The survey showed that 36.36% and 27.27% of those surveyed think that spring water and well water are of good quality respectively. On the other hand, 13.64% of those surveyed think that the water

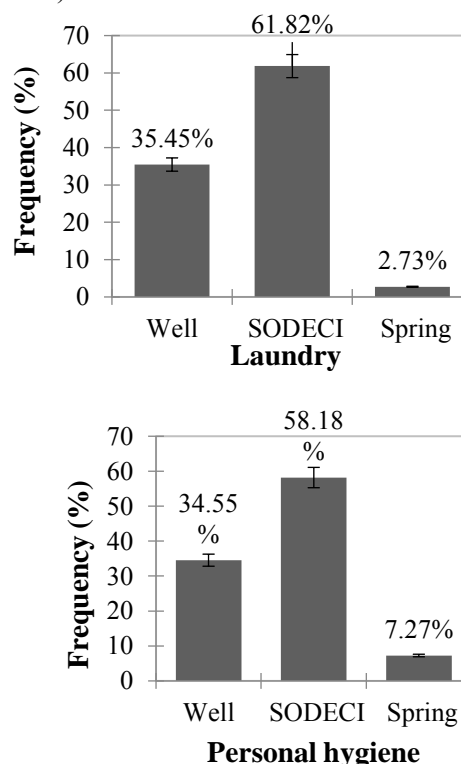
distributed by SODECI is of poor quality. Figure 5 presents the percentage of appreciation of water quality according to the person surveyed.



**Figure 5.** Appreciation of water quality according to person surveyed

### 3.6 Water used for laundry and personal hygiene

This result shows that the water distributed by SODECI is the most used for laundry (61.82%) and personal hygiene (58.18%) followed by well water (Figure 6).



**Figure 6.** Breakdown of water used for laundry and personal hygiene

### 3.7 Water used for cooking

The survey carried out in the commune of Daloa revealed that 50.91% of the individuals surveyed use

the water distributed by SODECI for cooking (Figure 7). In addition, some of the people surveyed (35.45%) also use well water for cooking.

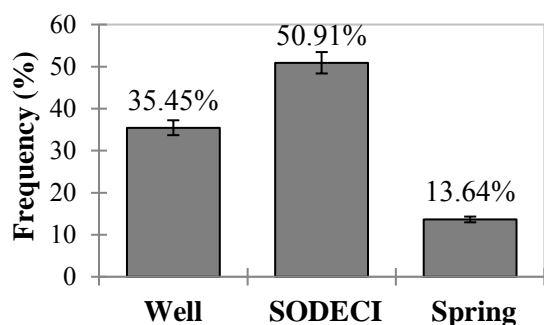


Figure 7. Distribution of water used in cooking

### 3.8 Fear of drinking water

Figure 8 presents the opinions of population surveyed according to whether they are afraid of the water they drink in Daloa. Thus, 69% do not feel fear. However, 31% of respondents have concerns about the quality of the water consumed.

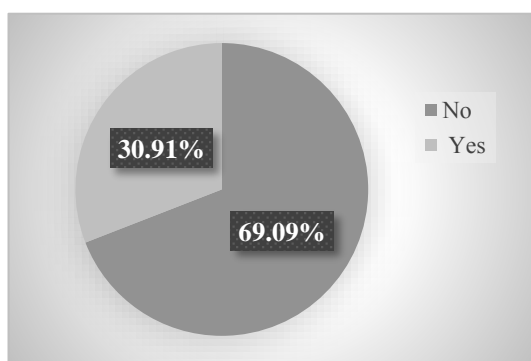


Figure 8. Opinion of respondents on a fear expressed due to the use of water

### 3.9 Best water in Daloa

The results of the survey presented in Figure 9 showed that in Daloa, spring water is most popular for human consumption as drinking water with a percentage of 78%. After this type of water, fountain water and well water are consumed as drinking water with a rate of 8%. The water sold in sachets and the water distributed by SODECI are little consumed by the populations surveyed with a rate of 2.73%.

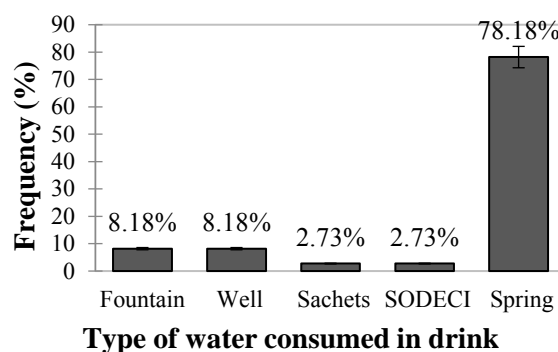


Figure 9. Distribution of water type appreciated in Daloa

### 3.10 Notice on pre-drink water treatment

The majority of respondents say they do not treat the water before use (75.45%) against 24.55% who do a treatment before use. Figure 10 shows the distribution of people who treat water before use.

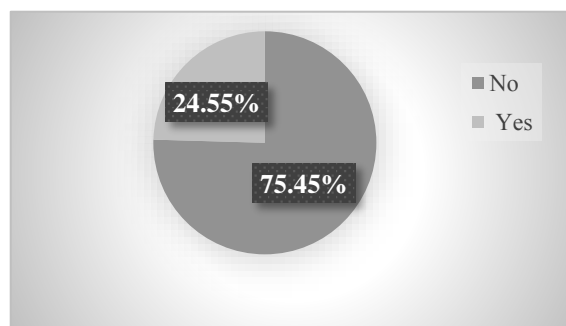


Figure 10. Distribution of people who treat water before consumption

### 3.11 Type of water consumed in drink at Daloa according to the district

The results recorded in Table 1 show that spring water is consumed the most in the neighborhoods where it is present. Spring water is consumed at 90% in ARCHIVES district, 60% in COMMERCE, GBOKORA and TAZIBOUO 1 districts, 50% in OLIVIVIERS and SOLEIL 1 districts by the populations surveyed. SODECI water is not used as drinking water in the COMMERCE, OLIVIERS, ORLY 1, TAZIBOUO 1 and TEXAS districts by the people questioned. Also, it is practically not used as drinking water in the ARCHIVES and GBOKORA districts with respective rates of 10%. In the TEXAS, LIBERIA and ABATTOIR 2 districts, it is rather well water that is consumed the most in drink with respective percentages of 100%, 60% and 40%.

**Table 1.** Breakdown of type of water consumed by district

DIST	Water type consumed				
	Fountain	Well	Sachets	SODECI	Spring
ABA	10%	40%	10%	40%	0.0%
ARC	0.0%	0.0%	0.0%	10%	90%
COM	40%	0.0%	0.0%	0.0%	60%
GBO	0.0%	20%	10%	10%	60%
LIB	0.0%	60%	0.0%	40%	0.0%
MAR	0.0%	30%	10%	30%	30%
OLI	0.0%	20%	30%	0.0%	50%
OR1	30%	30%	40%	0.0%	0.0%
SOL1	0.0%	0.0%	20%	30%	50%
TAZ1	40%	0.0%	0.0%	0.0%	60%
TEX	0.0%	100%	0.0%	0.0%	0.0%

*DIST* : DISTRICT, *ABA* : ABATTOIR 2, *ARC* : ARCHIVES, *COM* : COMMERCE, *GBO* : GBOKORA, *LIB* : LIBERIA, *MAR* : MARRAIS, *OLI* : OLIVIERS, *OR1* : ORLY 1, *SOL1* : SOLEIL 1, *TAZ1* : TAZIBOUO 1, *TEX* : TEXAS

### 3.12 Treatment of drinking water according to the district

The results of survey showed that water treatment is linked to the place of residence. The data showed that in MARRAIS and LIBERIA districts, there are more people who treat water (40% each) before drinking it. On the other hand, in the commercial district, there are few people who do it and in the TEXAS district no preliminary treatment is done before use (Table 2).

**Table 2.** Relationship between neighborhood and pre-use water treatment

DISTRICT	Water treatment	
	YES	NO
ABATTOIR 2	30%	70%
ARCHIVES	20%	80%
COMMERCE	10%	90%
GBOKORA	30%	70%
LIBERIA	40%	60%
MARRAIS	40%	60%
OLIVIER	20%	80%
ORLY 1	30%	70%
SOLEIL 1	20%	80%
TAZIBOUO 1	30%	70%
TEXAS	100%	0.0%

## 4 Discussion

The survey on the water consumed in the districts of the municipality of Daloa concerned both men and women of various age groups. The majority of people surveyed are in the age brackets of [26-35] and [36-50] years. This observation could be explained by the

fact that the active population is between 25 and 65 years old. Regarding the type of water most consumed in the surveyed area, spring water is the most popular. This choice could be explained by the lack of consumer confidence in other water sources. Indeed, for some consumers, spring water is natural water that is clear and pleasant to drink. On the other hand, the water distributed by SODECI is almost always colored (yellowish in color) and has a strong smell of bleach. The work carried out by Diarra *et al.* [4] showed that the water produced and distributed by SODECI-Daloa is microbiologically and physico-chemically unsuitable for consumption. This would mean that this water does not meet the standards of the World Health Organization (WHO). This idea corroborates those obtained by Otchoumare [8] and Allassane [9] in the municipality of Parakou (Benin) who questioned the potability of the water distributed by the National Water Company of Benin (SONEB) due to deposits blackish they contain and because of certain environmental constraints. Also, the water sold in sachets is rejected by the population of Daloa because most producers use the water distributed by SODECI to fill these sachets. Indeed, the work carried out by Kouadio *et al.* [10] showed that the population uses SODECI water to fill the water bags sold in the cities. This idea is supported by the work of Hoteyi *et al.* [11], according to these authors, 46% of the population of the city of Porto-Novo in southern Benin uses water from SONEB to fill the bags. The work of Akiyo *et al.* [12] also showed that SONEB water is used to fill water sachets sold in the city of Parakou. In Côte d'Ivoire, specifically in Abidjan, the work carried out by Manizan *et al.* [13] showed that water sold in plastic bags, regardless of the semi-industrial or artisanal type, is unfit for consumption, in accordance with the drinking water quality criterion, with a contamination rate of 79.4%. After natural spring water, well water is the second most used type. The almost exclusive use of water from traditional wells in the districts of Daloa could result from the insufficient coverage of the water network and the very high cost price for any possible connection to the drinking water network. Indeed, the work of Koukougnon [14] showed that the applicant for a subscription connection will have to pay 167,356 CFA francs, for connection costs beyond the 12 meters granted after the main pipeline. The applicant will have to pay an additional fee. Sometimes even homes are far from drinking water pipes. This idea is consistent with that of Awomon *et al.* [15] who showed that in the ORLY 1, ORLY 2, ORLY 3 and ORLY 4 districts of Daloa, there is a crucial lack of water distributed by SODECI due to the high cost of connection to the water network

drinkable. Moreover, the work carried out by Diarra *et al.* [4] also showed that the city of Daloa is experiencing a drinking water crisis in an urban environment due to strong urbanization.

The results also showed that the type of water consumed depends on the neighborhood. The survey revealed that spring water is the most consumed as drinking water in the ARCHIVES, COMMERCE, GBOKORA, TAZIBOUO 1, OLIVIERS and SOLEIL1 districts. These neighborhoods considered as residential neighborhoods contain populations of a certain standard of living who systematically reject other types of water considered unfit for consumption as drinking water.

As for well water, it is the only one used by the surveyed populations of TEXAS (100%). In addition, well water is also used by 60% of people surveyed in LIBERIA and 40% of people questioned in ABATTOIR 2. The populations of the TEXAS, LIBERIA and ABATTOIR 2 neighborhoods are considered less well off. This is probably why the populations of these neighborhoods get their supplies directly from the locally available water source. The presence of wells and natural water sources in these neighborhoods would be an asset for their use.

Regarding quality of water consumed in Daloa, opinions are divided. The survey showed that 36.36% of those surveyed gave an opinion of "good quality" for spring water, 27.27% of respondents maintain that well water is "good quality" against 13.64% who maintain that SODECI water is "poor quality". This last opinion is shared by Diarra *et al.* [4]. The work of the latter has shown that the water distributed by SODECI Daloa is unreliable because of the water retention of LOBO, a eutrophic area.

Indeed, the LOBO dam located 26 km northwest of the city of Daloa built in 1977 is the only source of supply for the production of drinking water for the city of Daloa and the surrounding villages connected to the water supply network. The reservoir has been subjected to the phenomenon of very advanced eutrophication since the beginning of 1980s. The rejection by populations of SODECI water could be explained by the fact that this water has a bad color followed by formation of rest and an aftertaste. This reality leads almost all connected households to doubt its potability.

Also, according to the results obtained, the water distributed by SODECI and well water are most used for laundry, personal hygiene and cooking. The high use of SODECI water by population for laundry, personal hygiene and cooking could be explained by the rejection of this water by population. With regard to well water, it would be used much more in neighborhoods where the connection to SODECI

distribution circuit is lacking. Indeed, in the absence of an abundant source of water, well water is the most available source of water.

With regard to the opinions of populations surveyed about a possible fear in relation to drinking water, a fraction of people questioned (31%) have fears. This opinion could be explained by the cloudiness and the deposits observed after leaving these waters at rest. Moreover, according to Koukougnon [14] and Diarra *et al.* [4], the water produced and consumed in Daloa is generally microbiologically and physico-chemically unsuitable for consumption. This is probably why some populations treat the water before any drink consumption.

The survey data revealed that the type of water consumed for drinking depends on the neighbourhood. Indeed, in residential areas such as ARCHIVES, COMMERCE, GBOKORA and TAZIBOUO 1 spring water is the most consumed. These populations prefer to refuel in this type of water. According to them, this type of water is healthy and safe for the consumer. Studies by Awomon *et al.* [15] also showed that spring water is consumed a lot by the populations of residential areas of Daloa. On the other hand, in so-called precarious neighborhoods such as ORLY 1, TEXAS and LIBERIA, well water is the most used.

Regarding the populations who treat the water before use, they maintain that the water distributed in Daloa represents a danger for the users, hence the health risk. This would mean that water distributed in Daloa does not always meet the standards of the World Health Organization (WHO). WHO [16] guidelines state that water safety and quality are fundamental to human development and well-being. Furthermore, the results also showed that water treatment is linked to the place of residence.

## 5 Conclusion

This work first made it possible to list four types of water consumed by population of Daloa (SODECI, wells, springs and fountains) and to collect information on the socio-demographic status of the people interviewed in eleven (11) districts of Daloa. Thus, the most popular source of water in Daloa is spring water. The water distributed by SODECI is preferentially used for laundry, personal hygiene and cooking. The majority of people surveyed said that water distributed by SODECI in Daloa is cloudy, sometimes even colored. This study therefore confirms the prejudices concerning the unsanitary nature of SODECI water distributed in Daloa. Since the most important effect related to turbidity is probably its ability to protect microorganisms against disinfection, physico-chemical and bacteriological

tests should be carried out on the different types of water available in Daloa.

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