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Project title:

Wells Hard Water Improvement in the Municipality of Abomey-Calavi

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Abstract

In the municipality of Abomey-Calavi, the Benin Water Corporation (SONEB) does not cover all communities in the distribution of drinking water. This situation forces households with no means to drill into using well water for all domestic uses including drinking.

The methodological approach applied includes the collection of data, their processing, and the analysis of data collected. A total of three reasonably-selected households have been surveyed based on determined cumulative criteria. Field and laboratory data have first been codified, and manually and digitally scanned. Word and Excel software have been used to analyze the results.

The results obtained from the three samples for the analyses show that the household waters are hard. The results obtained from the three samples regarding hardness reveal that the waters are hard. As a result, households face financial expenses. This is of crucial importance for our project.

Keywords: wells water, hard water, hardness, household.

Contents

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Introduction

Water, the primary food and source of life, comes in several forms, namely liquid, solid, and gas. During its journey, it comes into contact with natural or artificial chemical elements where it gets certain properties and nutrients that are the source of **hardness**.

In some localities in the Republic of Benin, the water from the water table collected channeled into wells is hard. These include the municipalities of Abomey-Calavi, Dassa-Zounmè, and other municipalities in the region of Zou. The population who does not have access to drinking water from the Benin Water Corporation (SONEB) uses well water and, is confronted with the consequences of water hardness.

To improve life in households and allow access to fresh water, we, therefore, propose the softening of household hard water with vinegar (acetic acid).

Taking into account these remarks, a simple technique that can help households soften well water, apart from the chlorination disinfection of these waters after softening, is considered. The softening will be done with the white vinegar but for disinfection, it will be done with the assistance of an office of expertise that is already in the territory for this purpose. This work is organized into four parts. The first part is about the theoretical framework. The second part presents the research environment and the quality of the well water. The third part contains problems related to the consumption of hard water. The fourth part presents the softening of hard water, discussions, suggestions, and the way forward to other research.

Chapter I: Theoretical Framework

The theoretical framework highlights the problem, hypotheses, and research objectives.

1.2. Statement of the Problem

Over the past 50 years, water demand has increased worldwide (WWAP). Water is essential to all aspects of life and is, therefore, the key to sustainable development. This is why, aware of the seriousness of the situation of a continuous increase in needs considering stagnation, even a reduction and a depreciation of available water resources, the international community is increasingly organizing itself to bring humanity to review its vision, to reconsider its position and to adopt a more responsible attitude towards these resources (National Water Policy, 2009, p. 11).

For this reason, the company Burex-3eA, based in Burkina Faso and Benin, has developed a water chlorination station called PocEau Ménage for the benefit of households. This makes it possible both to treat the contaminated water of the castles through chlorination using a disinfectant made from sodium hypochlorite called Chl 'Eau and to control their Physico-chemical and bacteriological quality. Here, the softening technique will make it possible to soften the water. It is in this perspective that this research entitled: "Improvement of the hard water quality of wells in the Commune of Abomey-Calavi" is carried out. From this problem evolves the following central question: How to soften the hard water of the wells at home? Thus, the research questions are as follows:

→ How hard is the water in household wells?

→ What are the influences of the use of these well waters on the population?

→ What improvements has the use of white vinegar brought to the water quality of home wells?

1.2. Research Hypotheses

- The water consumed by households would be rich in magnesium ions ($Mg2^{+}$) and calcium ions ($Ca2^{+}$).
- The use of these waters would lead to the drying of the skin and financial expenses.

1.3. Overall Objective

The overall objective of this research is to soften the water in household wells. Specifically, it:

- Analyzes well water;
- Proposes a technique for softening household hard water;
- Analyzes the treated water following the treatment and suggests techniques to households.

Chapter II: Research Environment and Water Quality

This chapter is about the presentation of the study framework (geographical location, biophysical and human data) and the situational analysis.

2.1. Research Environment

The Municipality of Abomey-Calavi is located in the southern part of the Republic of Benin in the Atlantic region and bounded to the north by the municipality of Zè, to the south by the Atlantic Ocean, to the east by the municipalities of Sô-Ava and Cotonou, and to the west by the municipalities of Tori-Bossito and Ouidah. It is the largest municipality in the Atlantic region, representing more than 20% of the region. It covers an area of 539 km², representing 0.48% of Benin's national surface area, and has nine districts, including Abomey-Calavi, Akassato, Godomey, Golo-Djigbé, Hêvié, Kpanroun, Ouèdo, Togba and Zinvié. Abomey-Calavi is historically a dismemberment of the kingdom of Abomey. It was created by the latter to be closer to the Cotonou counter for commercial transactions. It has a population of 656,358 (2013 General Population and Housing Census). The municipality of Abomey-Calavi has a slightly rugged terrain. The main features include a sandy strip with shorelines, a plateau of bare dirt, and depressions and swamps. The climate is subequatorial with two rainy and two dry seasons. The vegetation of the municipality varies according to the facies crossed. For example, mangrove and coconut groves are found in the coastal zone, a degraded savannah on the plateau with a dominance of oil palm fallow, and a grassy cluster in the swamps and along the shores of Lake Nokoué.

2.2. Water Quality

The water samples have been taken from wells in the municipality of Abomey-Calavi.

Photo 1: Water sampling stage

The experiments are carried out at the water treatment laboratory of Cotonou F. M. Coulibaly Technical School. On a hard water sample, the following results have been obtained:

Table 1: Before the addition of acetic acid (start)

Parameters / Beaker	Concentration in mg	$Mg2^+$	$Ca2^+$	total	pH	Conductivity χ in µS/cm (25°C)
1	0	44	6	50	8.3	348
2	**0**	**44**	**6**	**50**	**8.3**	**348**
3	0	44	6	50	8.3	348
4	0	44	6	50	8.3	348
5	0	44	6	50	8.3	348
6	0	44	6	50	8.3	348

Chapter III: Problems Related to the Consumption of Hard Water

Microbiological, as well as physicochemical quality, remains the primary concern of public health. The consumption of water unfit for consumption can lead to health risks such as cholera, typhoid, polio, hepatitis A and E (through ingestion of water or contaminated food), diarrhea, etc. Hard water can thus cause certain problems for human health, such as:

- Drying of the skin leading to the appearance of skin disorders such as itching, plaque, or redness;
- Brittle, dry, dull hair.

These problems can lead to long-term or short-term incidents in human health.

Hard water will hurt your wallet: purchase of more washing powder, purchase of more soaps, purchase of descaling product, replacement of damaged appliances. There are more and more expenses, but your energy bill will also be higher. All the same, all of this is due to the hard water that:

- Tarnishes your dishes as they are washed;
- Makes you over-consume cleaning products;
- Causes your piping to lose the flow, which can even go so far as to become clogged;
- Makes household devices scale and degrade faster.

Some devices will also see their energy efficiency decrease due to the excessive hardness of the water. In addition, consumers will tend to use more washing powder as limestone prevents the product from foaming sufficiently. In addition, gas consumption is increasing considerably. ~~And~~ All this has, of course, an influence on the environment.

Residues of the cleaning agent are present in greater quantities in wastewater and the number of defective devices deposited in waste disposal facilities continues to grow.

Chapter IV: Household Hard Water Softening

For the experiments, the acetic acid used has been diluted 10 times to obtain the concentration of acetic acid in the vinegar.

Table 2: 24h after the addition of acetic acid (End)

Parameters / Beaker	Concentration in mg	$Mg2^+$	$Ca2^+$	TH-total	pH	Conductivity χ in µS/cm (25°C)
1	20	-13	24	11	3.98	503
2	**40**	**- 26.7**	**37.5**	**10.8**	**3.78**	**623**
3	60	$15.5	30	14.5	3.79	702
4	80	-0.4	13	12.6	3.57	845
5	100	-5.8	16	10.2	3.55	846
6	120	-9.6	21	11.4	3.51	878

For better use of hard water, it must be softened. This consists in removing the magnesium and calcium ions partially or totally from this water and thus fresh water is obtained. To achieve this change, there are several methods and devices are available, but these softening methods are not available in all households and this is because these methods are very expensive for households.

After the experiment has been carried out in the laboratory, the results recorded in Table 2 have been found. In this experiment, firstly, a quantity of 1 liter of hard water sample is introduced in 6 different beakers. Then, the parameters of these waters have been measured ($Mg2^+$, $Ca2^+$, TH-total, pH, and conductivity). Finally, it is introduced into each beaker a certain concentration of acetic acid (diluted 10 times to obtain a concentration of acetic acid equal to that in vinegar) ranging from 20 to 120 mg. This added item only comes into action after 24 hours. After 24 hours, the results recorded in the table above have been obtained, which indicates that acetic acid has played its full role by eliminating magnesium and partially calcium, and this is visible at the level of each beaker. It is also noted that at the level of beaker 2, the results are all the more optimal because according to the results in this environment, magnesium has been eliminated more than it has been in the other beakers. The same applies to calcium, but it is partially eliminated.

Softening hard water with acetic acid is a natural method without negative effects on nature, the ecosystem, and man. This proves to be beneficial to the latter.

From the results of our experiment, it can be deduced that for the softening of hard water, it is necessary to use acetic acid (vinegar) at a concentration of 20 mg/L of water to be able to have a more objective result.

We are considering other experiments using vinegar. These results can be very useful to the population because it is a cheap product (which is cheaper). We are also considering the use of a tablet made from the active ingredient of a Beninese plant (moringa for example).

Photos 2 and 3: Experiments in the laboratory

Photo 4: Microbiologic analysis of well water

Conclusion

Based on the results of this experiment, we can conclude that the softening of hard water is feasible and objective with vinegar. It is a natural method without risk of pollution and degradation of nature and the ecosystem and poses no risk to humans while being beneficial to them. Then, the use of this method or a cheap tablet will be fairer and more beneficial to the population, the environment, and for better sustainable development.