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Analysis of Defluoridation for Portable Water in Langtang North LGA of Plateau State, Nigeria

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Abstract: Analysis of defluoridation for portable water in Langtang north. One hundred and fifty questionnaires were distributed across three localities (Lajhan, Pilgani, and Kwalak) in Langtang North Local Government Area to analyse the effect and importance of defluoridation of portable water. Water sources, including dams, wells, boreholes, streams, and rivers, have similar taste profiles, and untreated consumption can lead to dental fluorosis. The study further highlighted key consideration for dental fluorosis how water contributes to it. The paper discovered that there is a significant relationship between portable water and government efforts on deflouridation of portable water in Langtang North LGA. The paper recommended that Homes can use common methods of deflouridation of portable drinking water to remove chloride ions from water to have safe drinking water such as the use of *Moringa olifeira* leaves.

Keywords: *Deflouridation, Dental Flourisis, Portable Water.*

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I. INTRODUCTION

Defluoridation of water involves the process of removing excess fluoride from drinking water to make it safe for drink consumption. Portable water refers to water that is safe, clean, and suitable for human consumption (Koleoso, 2024). Excess fluorine in conjunction with other elements such as excess iron, chlorine, and other metals can lead to a brown teeth coloration called dental fluorosis. This comes into being as a result of taking untreated water that has excess or less fluoride. It makes one or the affected individual lose confidence and self-esteem, especially when they travel out of the region to other places that do not have excess fluoride in their water.

This study deals with water that can be consumed without effects. It seeks to find suitable ways of obtaining clean, portable water that can be consumed without effects in Langtang North LGA of Plateau State.

➢ *Key Considerations for Defluoridation*

- Initial Fluoride Concentration: Defluoridation efficiency can depend on the initial fluoride level in the water.
- PH Levels: Defluoridation efficiency can vary under different pH conditions, with some techniques working better in acidic or alkaline environments.
- Adsorbent Dose and Contact Time: Optimal doses and contact times are crucial for effective defluoridation (Adagunodo, A..2023).

➢ *Dental Fluorosis*

Dental fluorosis is a condition caused by excessive fluoride consumption during tooth development, typically in children under eight years old (WHO, 2021).

➢ *How Water Contributes to Dental Fluorosis*

- High fluoride levels in water: Drinking water with fluoride concentrations above 1.5 mg/L can increase the risk of dental fluorosis. The World Health Organization recommends a maximum acceptable concentration of 1.5 mg/L.
- Prolonged exposure: Regular consumption of water with high fluoride levels over a long period can lead to dental fluorosis.
- Sources of fluoride in Water: Fluoride in water can come from natural sources, such as geological formations, or from municipal water treatment plants that add fluoride to the water supply (Gwala, P., Andey, S., Mhaisalkar, V., Labhasetwar, P., Pimpalkar, S., & Kshirsagar, C. 2021).

II. SCOPE AND LIMITATION

The study considered three villages or communities in Langtang North.

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(1). Lazhan (2) Pilgani (3) Kwallak

The sources of water in these communities are boreholes, streams, dams, and wells which contain high fluoride levels. The study aims to find the most suitable and affordable defluoridation techniques and materials to use locally in the home or at the community level.

➢ *Statement of the Problem*

Boreholes, wells, and rivers are the major sources of water in the research areas, but they have been found to have fluoride concentrations significantly above the World Health Organization limit of 1.5 mg/L.

➢ *Aim of the Study*

To analyse and propose a sustainable defluoridation method for portable water in Langtang North.

III. RESEARCH QUESTIONS

➢ *This Research Will Seek to Answer the Following Questions:*

- What are the prevalence and perception of mottled teeth?
- What are the water sources and quality in the research area?
- Are there government efforts in ensuring accessible portable water?

Hypothesis There is no significant relationship between defluoridation and portable drinking water.

IV. REVIEW OF RELATED LITERATURE

➢ *Zeolite-Based Materials:*

Studies by Dibal, H.., Lekmang, I.., and Lar, U.A. (2022).) have shown that zeolites, crystalline aluminosilicates with unique structural properties, can be effective in removing fluoride from water. Surface modification techniques, such as chemical or composite methods, can enhance their adsorption capacity.

➢ *Hydroxyapatite-Modified Zeolite:*

One study developed a hydroxyapatite-modified zeolite material that demonstrated high fluoride removal efficiency, with a maximum adsorption capacity of 39.38 mg/g. The material showed good stability and reusability, maintaining over 85% efficiency for three cycles (Loganathan, P., Vigneswaran, S., Kandasamy, J., & Naidu, R. 2022).

➢ *Lanthanum-Modified Zeolite:*

Another study by Ajayi, D., and Arigbede, A. (2022) used lanthanum-modified zeolite to remove phosphate and fluoride from phosphogypsum leachate, achieving effective adsorption for both contaminants.

➢ *Iron and Zirconium-Doped Zeolite:*

Researchers such as Apshankar, K., and Goel, S. (2022) have also explored iron and zirconium-doped zeolite, which showed promising results in removing fluoride from wastewater. Ion Exchange Method.

➢ *Biochar-Based Materials:*

Additionally, biochar-based materials, such as Zr-MNSB, have been investigated for fluoride removal, exhibiting a maximum adsorption capacity of 11.97 mg/g. (Modi, 2023).

These developments highlight the potential of zeolite-based materials and other innovative adsorbents in effectively removing fluoride from drinking water.

➢ *Theoretical Framework*

The theoretical framework for water deflouridation involves several physicochemical principles, primarily focusing on adsorption, precipitation, ion exchange and membrane separation. The goal is to reduce naturally occurring or anthropogenic fluoride concentrations to a safe level typically below the WHO guideline of 1.5mg/L

V. METHODOLOGY

This study employed a survey research design to determine the effects of consumption of unfluoridated/undefluoridated portable water, with a case study of Langtang North Local Government Area of Plateau State. The survey design was used because it allows the researcher s to elicit information from a representative sample of the population and to use the data obtained to draw conclusions and generalize findings on the entire population of the study.

➢ *Population and Sample*

The population of this study consists of three selected communities in Langtang North Local Government Area of Plateau State. A sample size of 50 respondents will be used from each of the three selected communities, making a total of 150 respondents. The respondents comprise 100 males and 50 females.

➢ *Instrument for Data Collection*

The instrument for data collection is a structured questionnaire titled "Analysis of Defluoridation Method of Portable Water in Langtang North Local Government Area of Plateau State."

➢ *Procedure for Data Collection*

The researcher employed a direct delivery technique to administer the questionnaire, ensuring effective distribution and collection.

➢ *Method of Data Analysis*

The research questions were analyzed using mean scores, while the hypotheses were tested using Chi-Square (X^2). The 4-point Likert scale was used, with the following weights:

Strongly Agree (SA) 4; Agree (A) 3; Disagree (D) 2; Strongly Disagree (SD) 1; Decision Rule

VI. PRESENTATION OF RESULTS

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Table 1 Frequency Distribution of Respondents by Sex

Sex	Frequency	Percentage
Male	100	66.7%
Female	50	33.3%
Total	150	100%

The table shows the distribution of respondents by sex, with 100 (66.7%) males and 50 (33.3%) females.

Table 2 Age Distribution of Respondents

Age	Frequency	Percentage
15-30	39	26%
31-50	51	34%
51 and above	60	40%
Total	150	100%

➢ *This Table Shows the Age Distribution of Respondents:*

- *39 (26%) are between 15-30 years old
- *51 (34%) are between 31-50 years old
- *60 (40%) are 51 years old and above

The majority of respondents (40%) are 51 years old and above.

VII. ANALYSIS OF RESEARCH QUESTIONS

➢ *Research Question 1:*

- *Prevalence and Perception of Mottled Teeth*

Table 3 Prevalence and Perception of Mottled Teeth

S/N	Items	SA	A	D	SD	∑FX	Mean	Decision
1	Most people in the researcher area have mottled teeth	70	17	23	50	150	2.47	Accept
2	I am proud of my mottled teeth	20	60	40	30	250	2.73	Accept
3	Mottled teeth is inherited	30	20	40	60	150	2.13	Reject
4	Mottled teeth cannot be inherited	75	25	25	25	150	2.47	Accept
5	Mottled is a significant health concern in the research area	100	20	15	15	150	3.37	Accept
6	Mottled teeth affects self-confidence or self esteem	60	30	30	30	150	2.8	Accept

Overall Mean = 2.65 Therefore, Mean is Accepted

- *What are the Water Sources and Quality in the Research Area?*

Table 4 What are the Water Sources and Quality in the Research Area?

S/N	Items	SA	A	D	SD	∑FX	Mean	Decision
1	Water used in the community are from wells, streams, dams, rivers and boreholes.	80	30	20	20	150	3.13	Accept
2	Water from well, rivers, streams, dams and boreholes taste the same.	60	30	30	30	150	2.8	Accept
3	Water from natural sources require treatment before consumption	30	40	40	40	150	2.4	Reject
4	All communities in Langtang Northern LGA have access to safe and clean drinking water	25	50	50	25	150	2.5	Accept
5	Deflouridation of portable water is crucial for public health in Langtang North LGA	40	50	30	30	250	2.67	Accept
6	Water quality is a significant concern for residence in Langtang North LGA	85	25	20	20	150	3.17	Accept
7	The government is responsible for ensuring access to clean and safe drinking water in Langtang North LGA	45	35	35	35	150	2.6	Accept

Overall Mean = 2.75 Therefore, Mean is Accepted

- *Are There Government Efforts in Ensuring Accessible Portable Water?*

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Table 4 Are Their Government Efforts in Ensuring Accessible Portable Water?

S/N	Items	SA	A	D	SD	∑FX	Mean	Decision
1	Government has made effort to provide portable water	35	40	35	40	150	2.47	Reject
2	Portable water is readily available in the community	25	50	50	25	150	2.5	Accept
3	The government has allocated sufficient funds for providing portable water in Langtang North LGA	30	40	40	40	150	2.5	Reject
4	Local communities are involved in decision making process for providing portable water	20	60	40	30	150	2.47	Reject
5	Government regularly monitors and taste the quality of drinking water in Langtang North LGA	40	30	40	40	150	2.47	Reject
6	Residence have access to information about the quality of drinking water in their communities	35	40	35	40	150	2.47	Reject
7	Government effort to provide portable drinking water have improved the health and wellbeing of residence in Langtang North LGA	30	40	40	40	150	2.4	Reject

Overall Mean = 2.46 Therefore, Mean is Rejected

- *Hypothesis Testing*

There is no significance relationship between portable water and government efforts on deflouridation

Table 5 There is no Significance Relationship Between Portable Water and Government Efforts on Deflouridation

Cell	fo	fe	Df	X^2-calc	X^2-crit	∝=	Decision
i.	35	30.0					
ii.	40	45.0	3	8.886	7.815	0.05	Reject
iii.	35	42.5					
iv.	40	32.5					

The Hypothesis table above shows that the chi-square calculated value X^2-Calc. = 8.886 is greater than (>) the chi-square critical value X^2-Crit. = 7.815 for df = 3 at ∝ = 0.05 level of significance. Conclusively, the null hypothesis was rejected and the alternative hypothesis was accepted. Therefore, there is a significant relationship between portable drinking water and government efforts on deflouridation of portable water in Langtang North LGA.

VIII. SUMMARY

Deflouridation of portable water involves the process of removing excess fluoride from portable water, to make it safe for consumption. Consumption of water that contains excess fluoride causes issues like dental fluorosis (teeth discoloration or mottled teeth) and skeletal fluorosis.

Safe drinking water can be obtained in the research area through deliberate efforts of the government and individual's efforts on deflouridizing water, to enjoy safe drinking water.

IX. CONCLUSION

There is a significant positive relationship between deflouridation and portable water in Langtang North Local Government Area of Plateau State. Water from dams, wells, boreholes, streams and rivers all taste the same, if not treated can lead to dental fluorosis.

RECOMMENDATIONS

- Government should put more effort in ensuring the availability of portable water by ensuring prompt payment for water intervention water cases
- Individuals and community leaders should organize water projects for the benefit of their communities.
- Heath care professionals should create awareness on the need for deflouridation of portable drinking water.
- Homes can use common methods of deflouridation of portable drinking water to remove chloride ions from water to have safe drinking water such as the use of *Moringa olifeira* leaves

SUGGESTIONS FOR FURTHER STUDY

Implementation and Regulation: The Centers for Disease Control and Prevention (CDC) should provide guidelines for water fluoridation, its effectiveness and potential risks including requirements for personnel, monitoring, and reporting.

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