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Analysis of the Determinants Influencing the Home Treatment of Drinking Water in the Peri-urban Environment of Bumba. (Mongala Province, Democratic Republic of Congo)

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Abstract

Introduction: This study aims to identify factors associated with household drinking water treatment in the peri-urban area of Bumba.

Materials and methods: An analytical cross-sectional study was conducted among 422 households between July and November 2023. Data were collected via an administered questionnaire and an observation guide, while frequencies, odds ratios (OR) with their 95% confidence interval were calculated. A downward logistic regression analyzed the associated factors.

Results: The results show that only 23.9% of households practice water treatment at home. This practice is more likely ($p<0.05$) when water comes from an unimproved source (aOR: 0.5; 95% CI: 0.29-0.78), when households have a favorable attitude towards water treatment (aOR: 4.7; 95% CI: 2.65-8.43) and when they have good knowledge about drinking water (aOR: 2.4; 95% CI: 1.25-4.68).

Conclusion: In conclusion, household water treatment is low in Bumba and depends on source quality, household knowledge and attitudes. Promoting this practice is essential to prevent diarrheal diseases in areas with limited access to drinking water.

Keywords: Analysis; bumba; determinant; drinking water; peri-urban environment; home treatment

Introduction

Water is a vital resource for human beings, playing a key role in health and economic development. However, in developing countries where infrastructure is often insufficient or limited, access to quality drinking water remains a major challenge. Globally, consumption of untreated water is responsible for approximately 1.8 million deaths annually, of which more than 99.8% occur in developing countries, mainly affecting children [1], while water must be drunk without risk to health, exempt from all pathogenic germs (bacteria, viruses) and parasitic organisms, and have a good smell and taste [2].

Furthermore, in peri-urban areas, populations are often faced with unimproved water sources, thus increasing the risk of water-borne diseases such as cholera, typhoid and severe diarrhea [3]. These diseases are responsible for significant morbidity and mortality, particularly in children under five years of age [4].

However, the World Health Organization (WHO) estimates that the Household water treatment can reduce episodes of diarrheal diseases by 39%, as Sustainable Development Goal (SDG) 6 calls for ensuring availability and sustainable management of water and sanitation for all by 2030 [1].

Furthermore, domestic water treatment, including boiling, sedimentation, filtration, chlorination and solar disinfection (SODIS), is the simplest and most cost-effective way to prevent waterborne diseases [5]. These methods are becoming an important public health intervention, especially in communities unable to develop large-scale water treatment systems [6].

Furthermore, data from the Ethiopian Demographic and Health Survey (DHS) revealed that only 18% of households in sub-Saharan Africa treat water thoroughly and effectively [7], by boiling, filtration and chlorination. Therefore, these methods constitute an efficient intervention in developing countries [8].

Thus, Tamene A. et al. in their studies conducted in Ethiopia, noted that the sexual orientation of the head of the household, the level of education, familiarity with water treatment methods and the type of water source have significant influences on water treatment at the point of use [1].

The DRC is one of the largest countries on the African continent, possessing more than 50% of African water resource reserves. According to the 2018 MICS-Palu survey, 98.3% of rural households and 98.9% in Mongala Province do not use any method of water treatment at home [9], and also the results of the study conducted by LINANGELO in 2018 in the territory of Bumba, concluded that 86% do not treat water before consumption [10].

Thus, within the framework of this scientific reflection, particular attention is focused on the population of households in the peri-urban area of Bumba, to evaluate their practices in terms of home treatment of drinking water, highlighting all the factors influencing this practice.

The objective of this study is to identify the factors influencing the treatment of drinking water at home in the peri-urban environment of Bumba, in the Mongala Province, in the DRC.

Materials and Methods

Study framework

The city of Bumba served as the setting for this study. Bumba is one of three territories and entities located within the administrative limits of the Mongala Province, in the part North of the Democratic Republic of Congo(DRC).

In sum, the selection of Bumba reflects a strategic interest in understanding and improving water treatment practices in a peri-urban setting where challenges are exacerbated by lack of infrastructure, socio-economic disparities and lack of regular access to drinking water.

It is subdivided into 16 Health Areas, a General Reference Hospital, 2 Reference Health Centers and health posts grouped in the Health Zone of Bumba, where it is located 1,337 km from the capital of the DRC by river and air. These Health Areas were chosen based on criteria of geographical distribution (peri-urban health areas and land territories) and source of drinking water supply where the urban part is covered by the water distribution authority "REGIDESO", while the peri-urban environment does not have a drinking water coverage program.

This study was carried out in households in the avenues of the peri-urban Health Areas of the Bumba ZS as illustrated in this figure. This figure shows the peri-urban health areas of the Bumba health zone, including Lokele Mongala, Mbinza, Bopoto, Mangondo and Gozen, which are identified as priority study areas. These areas are located in the Democratic Republic of Congo (DRC), in the Mongala province, more precisely in the Bumba territory.

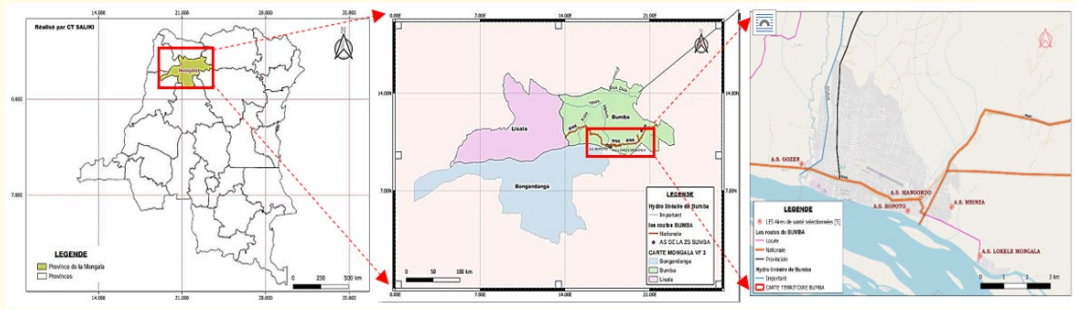

Figure 1: The setting for this study.

Study population

It consists of all heads of households or adults living in households.

Inclusion and non-inclusion criteria

Included in this study are: all heads of households or adults living in the avenues of the selected health areas, present on the day of data collection and available to answer our questionnaire. All heads of households or adults who did not meet these inclusion criteria were simply excluded from the study.

Type and period of study

A cross-sectional study with analytical aims was carried out between the 1st July and November 30, 2023 in the peri-urban health areas of the Bumba health zone (LOKELE MONGALA, MBINZA, BOPOTO, MANGONDO and GOZEN).

Sampling

The sample size was calculated using the LUNCH formula below:

$$n = \frac{Z^2 1-\alpha/2 \ P(1-P)}{d^2}$$

The proportion of the population treating drinking water at home was estimated at 50%, given that it remains unknown in our study area; with the coefficient Z=1.96, the degree of error 0.05 and an anticipated non-response rate of 10%. Our sample size was 422 households. These households were distributed proportionally across the 5 peri-urban Health Areas selected in a simple random fashion.

In each sampled health area, 5 avenues were selected at simple random from the exhaustive list of avenues in the health area. In all, 25 avenues were sampled.

Households were selected at avenue level using the systematic sampling technique, following a survey of the housing units in each avenue and calculation of the sampling step. The total number of households surveyed for the 25 avenues was 422. Eligible households were selected using the following procedure:

- Proportional distribution of 422 households in the 25 sampled avenues.
- Selection of households using the systematic sampling technique.
- After counting the number of households in an avenue (N), the sampling interval (k) was calculated by dividing the number of households in an avenue (N) by the size of the households to be surveyed in that avenue (n); then, a random number between 1 and k was drawn, corresponding to the number of the first household surveyed.
- The other households were identified by adding the sampling step.

Variables of interest

The dependent variable of our study was the treatment of drinking water at home with two modalities: yes, or no.

While, the independent variables retained were the level of knowledge on drinking water (good or low), the perception of the potability of the drawn drinking water (good or bad), the attitude towards the need for water treatment (favorable or unfavorable), the perception on the quality of the drinking water consumed (good or bad), the perception of the potable quality of the drawn and consumed water (good or bad), the main source of drinking water supply (improved or not improved), the treatment of drinking water at home (yes or no) and the techniques of home water treatment.

Data collection

The technique of interview structured interview led by investigators using an interview guide with household heads or representatives was deployed for data collection. It was coupled with direct observation to describe practices in the treatment and management of drinking water in households.

Data analysis

The collected data were encoded on Excel and analyzed on STATA 13 software. All these variables were taken in their dichotomous form. The qualitative variables were presented in the form of proportion and the quantitative ones in the form of mean ± Standard Deviation or median with the areas of variation according to the distribution is symmetrical or asymmetrical.

Bivariate analysis of factors associated with household water treatment was performed with the independent variables of interest. To show the association between these variables and household drinking water treatment, Pearson Chi-Square at the 5% threshold and raw ORs were calculated. All variables that showed a significant association in bivariate were aligned in a stepwise logistic regression model using a 10% downward approach. Adjusted ORs with CIs at the 95% threshold were deduced at the 5% significance point (WALD p value).

The assessment of the level of knowledge of household heads on drinking water focused on understanding of drinking water, treatment techniques, waterborne diseases and contamination factors. The level of knowledge was classified as “poor” when there were less than six response items given, and “good” when seven or more response items were cited.

Furthermore, the overall assessment of household heads on the drinking quality of water drawn and consumed in households focused on the assessment of the potability of the drawn drinking water and the attitude of household heads on the quality of the drinking water consumed. The overall assessment was classified as “poor” when the score was between 0 and 1, and “good” when the score was 2.

Ethical considerations

The objectives of the study and the data collection procedures have been clearly explained to the participants, in order to allow their voluntary and informed participation. All participants in the interview had given their informed consent to be interviewed and to express their opinions on questions concerning our research. Participation in the study was voluntary and did not confer any financial benefit.

Authorizations were obtained from the ethics committee of the University of Kisangani, the Dean of the Faculty of Medicine and Pharmacy, the political and administrative authorities of the MONGALA Province, the Bumba health zone and the health areas. Respondents' anonymity was guaranteed throughout the collection and dissemination of results. No names were recorded in the household database, or even in the data collection guides.

Results

Sociodemographic description of respondents

The results of this study indicated that, the dominant age group was 46 years and older, with a mean age of 41 ± 14 years. The majority of respondents were women, married, with secondary education and fishermen.

Household knowledge, attitude and practice on water consumption

Knowledge about water to consume

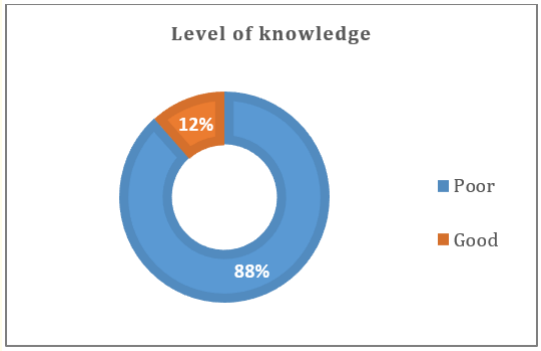

Figure 2: Distribution of the 422 respondents according to their knowledge of drinking water.

The results of this figure 2 indicate that, the majority of respondents had a low level of knowledge about drinking water.

Household attitudes towards water consumption

Variables	***Frequency***	***%***
Perception of the potability of the drawn drinking water	**n=422***	
Good	219	51,9
Bad	203	48,1
Attitude towards the need for home treatment of drinking water	**n=422**	
Unfavorable	189	44,8
Favorable	233	55,2
Perception of the quality of drinking water consumed	**n=420****	
Good	245	58,3
Bad	175	41,7
Perception of the drinking quality of water drawn and consumed in households	**n=420**	
Good	167	39,6
Bad	253	60,4

Table 1: Attitude of respondents regarding water consumed in households.

The results in Table 1 indicate that the perception of the potability of water drawn and consumed was generally good, as was the favorable attitude towards water treatment at home. Overall, the perception of respondents on the potable quality of drinking water drawn and consumed in households was mostly poor.

Home Drinking Water Treatment Practices

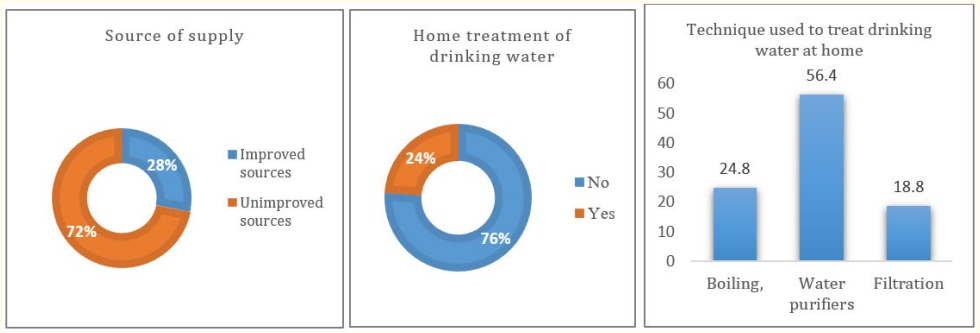

Figure 3: Distribution of respondents according to their practices regarding home treatment of drinking water.

The results of this figure 3 reveal that the majority of households obtained their water from unimproved sources and did not treat water at home. Of those who did treat water, most used water purifiers.

Factors influencing home treatment of drinking water

Associated factors	*Home treatment of drinking water*				
	Total	*No*	*Yes*	*P. Value*	*ORb(IC95)*
Attitude towards the need for home treatment of drinking water	**422**	**321**	**101**		
Unfavorable (%)	189 (44,8)	172 (53,6)	17 (16,8)	0,000	5,7 (3,17 - 10,69)
Favorable (%)	233 (55,2)	149 (46,4)	84 (83,2)		
Perception of the drinking quality of water drawn and consumed in households	**420**	**320**	**100**		
Good (%)	167 (39,8)	109 (34,1)	58 (58)	0,000	0,37 (0,23 - 0,61)
Bad (%)	253 (60,2)	211 (65,1)	42 (42)		
Level of knowledge about drinking water	**422**	**321**	**101**		
Weak (%)	373 (88,4)	293 (91,3)	80 (79,2)	0,001	2,7 (1,4 - 5,3)
Good (%)	49 (11,6)	28 (8,7)	21 (20,8)		
Main source of drinking water supply	**422**	**321**	**101**		
Improved sources(%)	119 (28,2)	74 (23,1)	45 (44,6)	0,000	0,37 (0,23 - 0,62)
Unimproved sources(%)	303 (71,8)	247 (77,9)	56 (55,4)		

Table 2: Analysis of factors associated with home treatment of drinking water in households.

The results in Table 2 had demonstrated that there was an association statistically significant between favorable attitude towards treatment at home drinking water (p<0,000), perception of the drinking quality of water drawn and consumed (p<0.000), level of knowledge about drinking water (p<0,001), main source of drinking water supply (p<0,000) and home treatment of drinking water in peri-urban households of Bumba.

Variables	*aOR (95% CI)*	*P. value*
Main source of drinking water supply		
Unimproved sources	0,5 (0,29 - 0,78)	0,004
Improved sources	1	
Attitude towards the need for home treatment of drinking water		
Favorable	4,7 (2,65 - 8,43)	0,000
Unfavorable	1	
Level of knowledge about drinking water		
Good	2,4 (1,25 - 4,68)	0,009
Weak	1	

Table 3: Multivariate analysis of factors influencing home treatment of drinking water.

The results in Table 3 reveal that, households that used unimproved sources (aOR: 0.5; 95% CI 0.29 - 0.78), who had a favorable attitude towards treating drinking water at home (aOR: 4.7; 95% CI 2.65 - 8.43), and who had a good level of knowledge about drinking water were more likely to treat water at home (p<0.05).

Discussion of Results

Sociodemographic description of respondents.

According to the results of this study, the majority of respondents were women (68.3%), aged 46 and over (35.8%), married (58.5%), with a secondary education level (54.7%), and mainly working as a fisherman (28. 2%). The median number of people per household was 10, with a median of 2 children under 5 years of age. These results suggest a population that is predominantly adult, female, married, and relatively educated, living in large households.

Comparing these results with other previous studies including those of Sridhar et al. [11], Kazadi [12], Mokili [13], Stanislas B. Linangelo et al. [10], Misenga TH et al. [14], and Amadou ibra diallo et al. [15], it is often observed that older people, especially women, play a central role in water management within households [16]. Furthermore, the high proportion of people who are married and have a secondary education could suggest a better awareness of water treatment practices, although the fishing occupation may limit regular access to drinking water due to working conditions [17].

Household knowledge, attitude and practice on water consumption

Knowledge about water to consume

The results of our study show that the level of knowledge about drinking water was low for 88.4% of respondents. However, the Low levels of understanding about water consumption affect domestic water treatment practices, subjecting communities to diarrhea and waterborne diseases [18].

These results are consistent with those of Sridhar et al. who observed that the study population lacked knowledge about the consumption of quality drinking water, as many responded that quality water visually means clear water [11], and also with those conducted by Ouédraogo, S., and Diallo, A. in similar contexts, where they had shown that, although communities are aware of the dangers linked to unsafe water, knowledge of treatment methods and awareness remain insufficient [19]. This highlights the need to intensify education campaigns on water hygiene and effective treatment techniques [20].

Household attitudes towards water consumption

Regarding household attitudes towards drinking water, the results of our study indicate that 51.9% of respondents perceived that the drinking water drawn is good. In addition, 55.2% were in favor of treating water at home, and 58.3% considered that the quality of the water consumed was good. However, the overall perception of the quality of the water drawn and consumed remained mostly poor for 60.4% of participants.

These results suggest a contradiction between individual perception of water quality and overall attitude towards treating water at home. This could indicate a dissonance between perception and reality, often influenced by cultural beliefs or a lack of in-depth knowledge. The results of our study deviate from those of a survey conducted by *USAID-UNICEF-DRC* in 2002, showing that about 36% of the population in the DRC used poor quality drinking water. This is notable in Equateur, Bandundu, Kasai Occidental and Maniema, where the population was more disadvantaged in this area, with only 24%, 28%, 32% and 33% respectively drinking quality water [21].

Furthermore, previous studies by Smith, JA, & Clark, P. R have also shown that in similar contexts, positive perceptions of tap water do not necessarily correspond to water of good microbiological quality, highlighting a need for better awareness strategies [22].

Furthermore, the majority of respondents having a favorable attitude towards household water treatment is consistent with research carried out by Ali, S., & Ahmed, R who had indicated a growing willingness of the population to adopt improved practices, when the means are available [23].

Home Drinking Water Treatment Practices

The results of our study indicate that 71.8% of households obtained their water mainly from unimproved sources. This reflects common challenges faced in rural or peri-urban areas where access to safe drinking water sources is limited, and also shows a high reliance of households on potentially unsafe water sources, as Safe drinking water supply is an integral part of health and survival [24], and is crucial to ensuring the health and dignity of individuals [1].

Our results corroborated those of Basandja et al. [25], Berihun G. et al. [6], Misenga et al. [14], Mokili [13], and Kazadi [12] who estimated that almost the entire surveyed population used unimproved water sources. Furthermore, Pradhan et al. [26], Hothur et al. [27] and Amadou ibra diallo et al. [15] had otherwise highlighted the situation where the majority of the surveyed population consumed water from improved sources.

Compared to the results of the study conducted by Diawara, M., & Coulibaly, K., showing in similar contexts that the use of unimproved sources remains frequent, exacerbated by inadequate infrastructure and geographical constraints [28]. Thus, the results of a study conducted in 2017 by Gonzalez L., and Martinez F. in Latin America, had highlighted that the use of unimproved sources exposes households to an increased risk of waterborne diseases [29].

On the other hand, the results of our study highlight that 76.1% of households did not treat water at home. Among those who treated, 56.4% would use water purifiers. These results highlight low adoption of safe drinking water treatment practices at home. Thus, the results of this study corroborated those of Misenga et al. [14], Kazadi [12], Amadou ibra diallo et al. [15], Mokili [13], Likilo [30], Stanislas B. Linangelo et al. [10], Ngoyi KC et al. [31] and Kouadio [32] who had raised that the majority of households surveyed did not treat drinking water before consumption. Furthermore, according to the results of the study conducted by Patel M. and Shah S. in India, the use of water purifiers by those who treat water at home is consistent with trends observed in other contexts where these products are available and affordable [33].

Factors influencing home treatment of drinking water

Bivariate analysis of factors associated with home treatment of drinking water

The results of our study highlighted several factors associated with home treatment of drinking water in the households studied. Indeed, households perceiving water as good to drink were less likely to treat it (ORb = 0.41, 95% CI: 0.24-0.67), while those perceiving it as poor quality were more likely to treat it. This trend is statistically significant ($p < 0.001$).

In addition, an unfavorable attitude towards water treatment was associated with a low rate of home treatment (ORb = 5.7, 95% CI: 3.17-10.69), with high statistical significance ($p < 0.001$). Households with a favorable attitude treated their water more. Furthermore, households that considered water quality to be good were less likely to treat it (ORb = 0.38, 95% CI: 0.22-0.64), while those that found it poor were more likely to do so, which was also statistically significant ($p < 0.001$).

On the other hand, a low level of knowledge was strongly associated with non-practice of water treatment (ORb = 2.7, 95% CI: 1.4-5.3). Conversely, a good level of knowledge would promote treatment ($p < 0.001$). However, households using unimproved sources for their water had an ORb of 0.37 (95% CI: 0.23-0.62), indicating a greater likelihood of treating water compared to those using improved sources ($p < 0.001$).

Therefore, these results suggest that perceptions and attitudes positive households, as well as their level of knowledge, play a crucial role in the decision whether or not to treat drinking water at home. This confirms the importance of awareness campaigns to improve understanding of the dangers of untreated water and encourage good practices. Therefore, these results were in agreement with those of Fernandez, A., & Lopez, G. who had shown that the positive perception of water encourages treatment behaviors to ensure its potability [34]. These factors highlight the need for better indicators to assess the consistent use of home drinking water treatment.

Multivariate analysis of factors influencing home treatment of drinking water

After adjustment, some factors retained a significant association with household water treatment. It appears that households using unimproved sources were significantly more likely to treat their water at home, with an aOR of 0.5 (95% CI: 0.29-0.78, p = 0.004).

This shows that households using an unimproved water source had a 50% chance of treating drinking water at home. Therefore, this result highlights the importance of targeting households using unimproved sources for water treatment interventions. Thus, these results confirm those of Kouassi, Y., and Traoré, S. who had highlighted the importance of water supply sources as a major determinant of household treatment practices [35].

Furthermore, households with favorable attitude towards water treatment were significantly more likely to practice this method (aOR = 4.7, 95% CI: 2.65-8.43, p < 0.001). This demonstrates the importance of perceptions and beliefs in the implementation of public health practices.

Furthermore, households with a good level of drinking water knowledge were also more likely to treat their water at home, with an aOR of 2.4 (95% CI: 1.25-4.68, p = 0.009). These results confirm the importance of knowledge and perceptions in household behavior towards drinking water treatment. Efforts to improve water quality in these communities should therefore focus on education and awareness raising, particularly regarding the importance of treating water, even if it appears clean or comes from sources perceived as safe.

Conclusion

The results of this study revealed that, the practice of household water treatment is low. The use of unimproved water sources, a positive attitude towards water treatment, and a good level of community knowledge about drinking water are key factors influencing household water treatment. Indeed, concerted efforts to improve these factors could have a significant impact on public health in peri-urban settings of Bumba and beyond.

The adoption by households of new behaviors and techniques in terms of harmonious treatment of drinking water at home would make it possible to considerably reduce the rate of water-borne diseases, and also cases of high mortality.

Finally, we note a strong need for communication and education on household water treatment practices to improve public health and achieve the Sustainable Development Goals by 2030.

In view of the above, a series of recommendations are included in this article:

- Households must treat their drinking water at home before consumption.
- Boiling, then filtering, before consumption as physical water treatment methods, would eliminate germs, then suspended solids.
- Set up interventions to support the population in peri-urban areas with drinking water supply systems, while recommending regular maintenance.
- Erect and maintain water purification plants to prevent pollution of water sources.
- Awareness-raising campaigns on the benefits of home treatment of drinking water.
- Accompany all necessary water infrastructure projects with a communication component to ensure greater community involvement.

Conflicts of Interest

The authors declare that there is no conflict of interest.

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The study was funded by the researcher himself.

Roles of the Authors

- All authors contributed to the conduct of this research and to the writing of the manuscript. They all read and approved the final version.
- Saliki Lifita: data collection, analysis, and manuscript writing.
- Zoe Arthur Kazadi and Panda Lukongo Kitronza: protocol validation and final reading.

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