

Potable Water and Uncontaminated Food at Every Household: Dream Orreality? A Study Among Tribal Population of Naxalbari Block, Darjeeling District, West Bengal, India

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Abstract:Introduction - Water quality, water behaviour along with food quality, food behaviour, domestic environment and food handler's hygiene play pivotal role in preventing food and water-borne diseases. Studies reveal rural areas lack access to potable water and have inappropriate waterhandling techniques. Food behaviour remains unsatisfactory and contamination prevalence is high. Working women seemingly face more hazards and perceived negligence is higher in hilly tribal population. Thus the pilot study was undertaken.

Objectives : To assess water quality at source and household level, To assess cooked food quality, immediate domestic environment, determine existing knowledge/ practices regarding water and food handling techniques. Reasons for identified gaps were ascertained.

Methods: Descriptive community based cross-sectional study was conducted in collaboration with Department of Microbiology for three months (May-July 2018) in Kiranchandra tea estate. Water quality was assessed among all 5 sources and selected 50 households using PA Coliform Kits. Water behaviour was assessed in 187 households. All 120 houses with women as permanent workers were studied for food behaviour, food handler hygiene and domestic environment. 50 selected houses were assessed for cooked food quality using PA H₂SHi-Dip Media kit. Results were interpreted after 48 hours incubation and confirmed by culture.

Results: Contamination was noted in both open wells and 33 houses with E.coli and Klebsella. Improper water carriage, storage and treatment was found in 67.2%, 76.3% and 88.2% cases respectively. Food quality and domestic environment were inappropriate in 56.3% and 68.4% cases respectively. 25% and 39.2% had appropriate storing and handwashing practices whereas only 32.6% displayed satisfactory food handler hygiene. Illiteracy and lack of administrative support were significantly associated.

Conclusion: Water and food was found unfit for consumption in vast majority. Water and food behaviour was inappropriate. Identified causes need sustainable and viable solutions. A larger study is recommended.

Key words: Water quality, water behaviour, food quality, food behaviour

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I. Introduction

Water and food, basic necessity, a fundamental right of each individual needs to be accessible, available, affordable as also potable and hygienic. 80% of all human morbidities are caused through contaminated food and water (WHO)¹. Gastroenteritis, cholera, typhoid, giardiasis, hepatitis, diarrhoea are few major public health problems in developing countries incurring huge financial burden². Thus water quality of drinking water and water behaviour of beneficiaries play decisive role in ensuring favourable health indicators. Moreover Goal 2 of SDG stating Zero Hunger, it is imperative to ensure right quantity and right quality of food reaches every platter. Cooked food quality, its immediate domestic environment comprising of the kitchen utensils and dining area, food handler's hygiene and appropriate food behaviour become mandatory prerequisites in avoiding food borne illnesses.

Public water systems like communal wells and tube wells are required by state to provide biologically safe water. Individuals in rural areas are often required to collect water from a faraway source, transport and store water for use as majority are deprived of continuous water supply³. In poor resource settings practice of open wells at source and open storage drinking-water allows for faecal contamination to occur inside the household. Contamination by hands and domestic animals are proven predominant causes of declining water

quality^{4,5}. Hence appropriate water handling technique is as pertinent as access to safe drinking water in preventing household water contamination by potentially harmful bacteria and other microorganisms.

Unfortunately cooked food quality, another relevant area of priority concern, is oftly neglected. Hygienically prepared clean food, proper storage, uncontaminated kitchen utensils, clean dining area ensure a healthy nation at large. Appropriate food behaviour like handwashing and food handler hygiene are a prerogative in avoiding the food borne illnesses caused by bacteriological contamination⁵.

Rapid detection field site user friendly kits are available to detect contamination of water and food beyond acceptable levels for physical, chemical and microbiological parameters. Water quality is analysed by PA coliform kit which detects microorganisms at first opportunity at even lowest bacterial concentration. PA H₂SHi-Dip Media Kit and swab sticks are used to detect bacteriological contamination for cooked food and kitchen utensils respectively. Microbiological culture after incubation reveals the exact causative organism⁶.

Different studies in various settings reveal contamination of water to vary between source and point of consumption as also do cooked food quality variation exists among different households. Varying sociodemographic characteristics inherent to local community also play a decisive role. Hence indicators like existing knowledge and prevailing practice regarding food and water handling techniques along with effective service utilization by beneficiaries determine the final quality improvement strategies designed.^{7,8}

Tribal disadvantaged population residing in rural hilly areas have their own discreet socio-cultural characteristics and belief systems. Perceived to be neglected and researchers seldom probing deep the pilot study was undertaken. Hot and humid months observe a rising trend of food and water borne diseases. Working women without alternate caregiver in family bear a dual burden and hygienic issues stand chances of utmost compromise there .

Moreover food and water quality assessments indicate a current situational analysis aiding to develop viable and sustainable solutions. Need for institutional safeguards in food and water quality monitoring along with ensuring appropriate food and water behaviour may decrease untoward health hazards. Hence in the aforementioned context the study was conducted with the following objectives.

II. Objectives

1. To analyze water quality analysis at source and usage points in study area
2. To determine cooked food quality and its domestic environment among study subjects
3. Assessing food and water behavior and its determinants among study participants
4. To ascertain reasons for the identified gaps and find if any significant associations exist
5. Information dissemination on pertinent issues and recommending point of use operationally feasible interventions at local level

III. Materials and Methods

• Study design and setting -

A descriptive cross-sectional study was conducted in Kiranchandra tea estate, Naxalbari Block, the rural field practice area of North Bengal Medical College between May-July 2018. However a larger study with a more representative sample would have given a complete overview.

The study was conducted in two parts. One for water quality analysis and its related issues and another for food quality testing and studying its other determinants.

• Study subjects and Sampling Techniques -

Water quality assessment:

Water sources in study area and households were the sampling units. Samples were collected at source and point of consumption the usage level. All 5 water sources (3 deep tube wells and 2 open wells) were included and water sample was collected from each maintaining aseptic techniques. 50% houses catered by one source (a source catered 20 houses approximately) were studied. Hence at usage level 50 households were selected for water sample collection. In addition, head of families from each household were assessed for water behaviour and exploring its various determinants. It was intended to include all 200 families by complete enumeration. However only 187 eligible households could be studied.

Food quality assessment:

Households were the sampling units. Food behaviour was assessed among all 120 families with working women as permanent workers. Alternate caregiver was present in 42 families. Food handler hygiene and their domestic environment was also observed. Primary caregiver from each family was interviewed. It was intended to perform cooked food quality analysis among 50% of 120 families. However 10 families were unwilling, cooked food samples of 50 families were tested by kit using recommended guidelines.

- **Study criteria, Tools and techniques**

Inclusion criteria considered were permanent residents of study area and voluntary participation. Those who were severely ill or absent on day of visit despite prior sensitization were excluded from the study. Responses were collected from eligible study participants applying appropriate tools and techniques.

Water quality assessment -

Study subjects availing water from available local sources were included. Predesigned pretested semi structured questionnaire consisting of variables related to sociodemographic profile, water handling techniques, related knowledge and practice to assess water behaviour and episodes of water borne diseases was used. Checklists, PA COLIFORM Kit⁹ used for testing bacterial contamination, culture media to isolate causative agent, incubator, zip lock bags and sample collector boxes and IEC materials were other tools. Interview method, water collection and testing techniques and observation methods were study techniques.

Food quality assessment-

All families having working woman as permanent workers where she is the prime caregiver of the family were included. Predesigned pretested semi-structured questionnaire was administered consisting of variables on socio demographic characteristics and determinants of assessing food behaviour like cooked food storage, cooking process, reheating of food, intake of old and stale food, handwashing practices, use of domestic refrigerators, awareness on intake of clean and hygienically prepared fresh foods and episodes of food borne diseases. Food handler hygiene and domestic environment was also observed and tested respectively. Checklists, PA H2S Hi Dip Media kit¹⁰ were used for food quality analysis, culture media to isolate causative agent, incubator, zip lock bags and sample collector boxes and IEC materials were other tools. Interview method, observation method, food collection and testing techniques were used.

IEC activities and demonstrations were done along with sensitization meetings held with district officials and tea manager to ensure unanimous service coverage

- **Principle of the test-**

Water quality testing kit:

Aseptically collected water sample was transported in ziplock bags, 100 ml poured in the provided bottles and then mixed with the PA Coliform kit powder maintaining the recommended guidelines and incubated for 48 hours to check coliform growth. First mixing imparted purple colour to sample whereas positive kits had colour change to red confirming coliforms were present in more than acceptable level. (Fig.2) Test was incapable to differentiate between various types of bacteria. Contamination with Arsenic and other micronutrient would go unnoticed also.

Advantage over MPN test is saving of time and space and also being able to detect alternate bacteria. In addition microbiological analysis by culturing in chromogenic agar for 24-48 hrs was done to identify colonizing microorganisms in tested positive water samples. *Klebsiella* would appear as blue colonizing species and *E.coli* magenta coloured.

Food quality testing kit:

The kit having agar surfaces was pressed firmly upon the surface of the cooked food sample for 10 seconds after removing the protective plastic cover maintaining asepsis. It was then incubated for 18-24 hours. Change in colour of media or growth noted was considered positive. Kit can detect a range of microorganisms though microbiological subculture revealed the exact causative organism. Kits are sensitive, specific and require less time and space. They are user friendly and can be easily applied at community level.

- **Data collection techniques:**

Data was collected after ensuring anonymity and confidentiality to participants and obtaining requisite permission from relevant higher authorities. Ethical clearance and voluntary verbal consent were sought and obtained after explaining the intent and benefit of the study in a brief pre-sensitization session. Data was collected on prefixed working days without disturbing their normal routine. Fears were allayed and queries addressed. It was ensured data will be used for academic purpose only.

Water quality analysis:

Water samples were collected maintaining the recommended guidelines from the designated sites both at point of source and usage level. Data was collected from selected respondent from each family using appropriate tools and techniques. Samples were collected in 5 working days and data collection by

interview was done in 10 working days by a two membered team. In one and a half month period, data for water analysis was collected.

Food quality analysis–

Food samples were collected maintaining recommended guidelines. Data was collected from selected respondent from each family using appropriate tools and techniques. Samples were collected in 10 working days by a two membered team, studying 12 families each day. In one and a half month period, data for food quality analysis was collected.

- **Data analysis plan :**

Data was collected, cleaned and compiled. Collected data was checked for consistency, completeness entered in Microsoft Excel data sheet and analysed using principles of descriptive and inferential statistics as and where applicable using IBM SPSS v.20 software. Diagrammatic representation was also done.

- **Ethical Issues:**

Permission was taken from Block Medical Officer of Health, Naxalbari block, Principal, North Bengal Medical College and Head of the Department, Department of Community Medicine, NBMCH. Ethical clearance from Institutional Ethics Committee was taken after intimating them about study purpose and benefit. Voluntary verbal consent was taken from head of the family ensuring no harm and good health as study outcome. Managers of the tea garden were taken into confidence and sensitized. Anonymity and confidentiality was ensured.

IV. Results

Study results have been subdivided into two subsections - section A for water quality analysis and section B for food quality assessment. Majority of study subjects were tribals, hindus, living in quarters, married, below poverty line, illiterate and addicted. Diarrhoea and food poisoning cases depicted rising trend common in these months. Study was performed in poor resource settings with few logistic constraints. Hawthorne effect encountered while assessing behaviour.

Section A -

Piped water supply was absent in study area and Swajaldhara project was abruptly scrapped. All 5 water sources, 3 deep tube wells and 2 open wells (not an ideal source) along with 50 sampled households were tested for water quality using PA Coliform Kit. At point of source, both open wells were found to be contaminated. At point of consumption, 66% households were found to be consuming contaminated water. 16 houses were catered by uncontaminated deep tube wells though (Fig.1). Prevalence of E.Coli, Klebsiella and Enterobacteriaceae were found in abundance among contaminated samples at both source and usage level.

187 eligible families were studied for water behaviour assessment. Water handling techniques were observed and knowledge, practice regarding water behaviour assessed. 93 families reported incidence of diarrhea (recall period 2 months). Only 36.4% had appropriate water behaviour. 66.3% had inappropriate knowledge regarding appropriate water handling techniques though 79.7% opined consuming clean water was essential for good health (Table 1). Inappropriate water storage, carriage and treatment were found in 85.1%, 59.4% and 84.5% cases respectively. Unclean containers, open buckets and small mugs were used to store and transport water. 10.2% used packaged mineral water and 104 respondents having under five children, 44.9% families used boiling water.

Illiteracy, BPL status, history of diarrheal episodes were found to be significantly associated with improper water handling techniques ($p < 0.05$) (Table 2). Interview revealed halting of Swajaldhara and lack of administrative support as other factors.

Section B -

120 eligible families were studied for domestic environment, food behaviour and food handler hygiene. 50 sampled households were assessed for cooked food quality. Majority of 56% detected food contamination (Fig.1). Microbiological subculture 19 Klebsiella positive cases. Domestic environment assessment using swab test revealed 68.4% families used contaminated kitchen utensils and dining table.

Food behaviour assessment in different components revealed inappropriate cooked food storage practices and lack of effective handwashing practices in 25% and 60.8% cases respectively. Stale, reheated and old food without refrigeration was consumed in 31.7% cases. Hygienic cooking practices though were followed in most cases. Food handler hygiene was adequate in only 32.6% cases (Table 3). Majority had boils and cuts in dominant hand and continued food handling in absence of any alternative. Alternative food handler was the alternate caregiver present in 42 families.

Illiteracy and BPL status were found to be significantly associated factors. Interestingly working women status with no alternate caregiver was also found to be a significantly associated factor for inappropriate food behaviour ($p < 0.05$). Lack of awareness generation and administrative support and dearth of cooked food storage facilities were other reasons identified.

Section C - Imparting Health education

Hazards of unsafe water use and consumption of contaminated food was explained in health education and awareness generation sessions held twice during study period. Information dissemination on important public health issues like food handler hygiene, hand washing techniques, keeping domestic environment clean, using freshly prepared food in absence of refrigeration, ORS preparation demonstration, household method of well disinfection and proper water handling techniques were taught. Residents were urged to use uncontaminated wells till further directed.

V. Discussion

Present study iterated the importance of food and water analysis, role of institutional safeguards in its monitoring and harped upon importance of operationally feasible sustainable solutions to deal with the roadblocks encountered. It emphasized importance of food and water behaviour among beneficiaries and gave a deeper insight into understanding determinants playing decisive role so that quality improvement strategies can be targeted for utmost benefit in accordance.

All studies revealed hot and humid weather to cause rising trend of food and water borne diseases. Though MDG 7, Target 10 states to reduce proportion of people without safe water access to half contamination both at source and usage level is rampant as found by various studies.⁷ A study conducted in regions of North East India found contaminated water usage both at source and usage point similar to present study. However a global study on water quality assessment noted no contamination at source and mild contamination at household level¹¹. Increased contamination was noted during floods in riverine belt of Nigeria. E.coli was found in abundance as with present study.¹² In contrast to present study, majority of community water supply came from surface and ground waters but seldom from open wells.¹³

Water behaviour varied in urban India where correct knowledge persisted on prevention and treatment of water borne diseases, benefits of potable water, well disinfection techniques, ORS preparations. Unfortunately similar to present study tribal population remained largely neglected especially on pertinent issues of water handling techniques.^{12,14}

In contrast to present study other studies revealed urban areas to have better food handling techniques, handwashing practices and food handler hygiene than rural settings. However all studies unanimously noted consuming freshly prepared hygienic food rather than reheated foods or unrefrigerated stored foods led to decreased food contamination risks with Shigella, Salmonella, E.Coli and other microorganisms. Various studies found not only food but an unclean, unhygienic domestic environment causing acute gastro enteritis^{15,16}. Similar to present study, other institution and community based study emphasized importance of food handler hygiene in preventing disease transmission. Need for food safety and regular monitoring was reinforced.¹⁷

However scarcity of literature existed about studies assessing food quality among working women in anticipation it would get compromised given the difficult working hours in absence of an alternate caregiver at home. Illiteracy, false perceptions were common culprits identified by many studies which cited pre-sensitisation, periodic focussed awareness generation on relevant issues and implementing context specific interventions improves food and water handling technique in community.¹⁸

VI. Conclusion

Study concludes that potable water and uncontaminated food at every doorstep of community is a dream yet to be completely realized. Prevalent contaminations were found during water quality analysis at point of source and point of consumption. Food quality analysis also revealed contaminations in a majority. Domestic environment and food handler hygiene was found to be contaminated and unhygienic respectively in majority of cases. Food and water behaviour among majority of study subjects was also found inappropriate and unsatisfactory. Lack of awareness generation activities, administrative support, illiteracy, ignorance and poverty were the common reasons identified with later being significantly associated with food and water handling techniques. Health education sessions were conducted which witnessed a good audience and a warm response.

Study revealed despite community having easy access to water sources majority still remain deprived of safe water. Compounded with improper water handling techniques the problem became grave. It was seen that food quality and food behaviour got compromised more in families of working women possibly due to their job routine and lack of appropriate food storage facilities.

However a larger study with a more representative sample is recommended. Operationally feasible modifications viz. reinstallation of Swajaldhara, prompt disinfection of contaminated wells, using low cost solar refrigerators for community use and rescheduling of job timing of working mothers who were primary caregivers in families was requested. Imparting training to peripheral health field functionaries. ICDS workers and local school teachers on relevant issues may be conducted at regular intervals.

Conflict of Interest: None

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Figures and Tables

Figure 1 : Diagrammatic representation of contamination detected by kits (n=50)

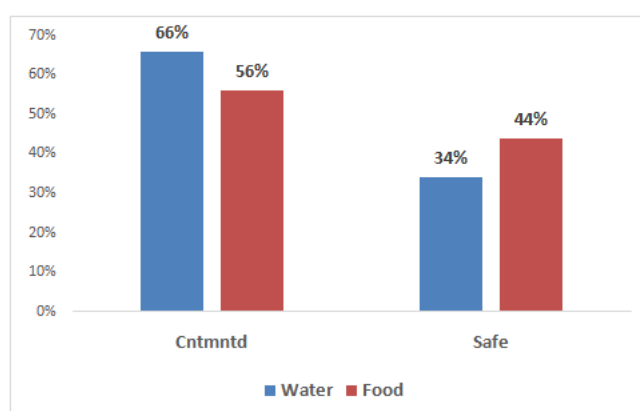


Fig 2 - Water quality testing using the PA Coliform Kit

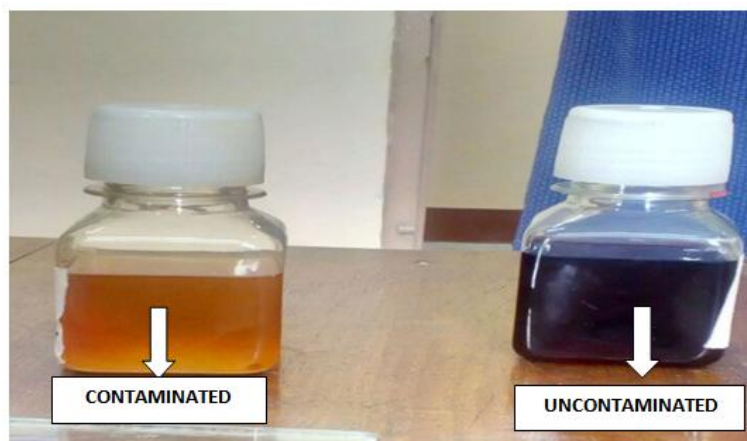


Fig.3 – PA H2S Hi Dip Media Kit

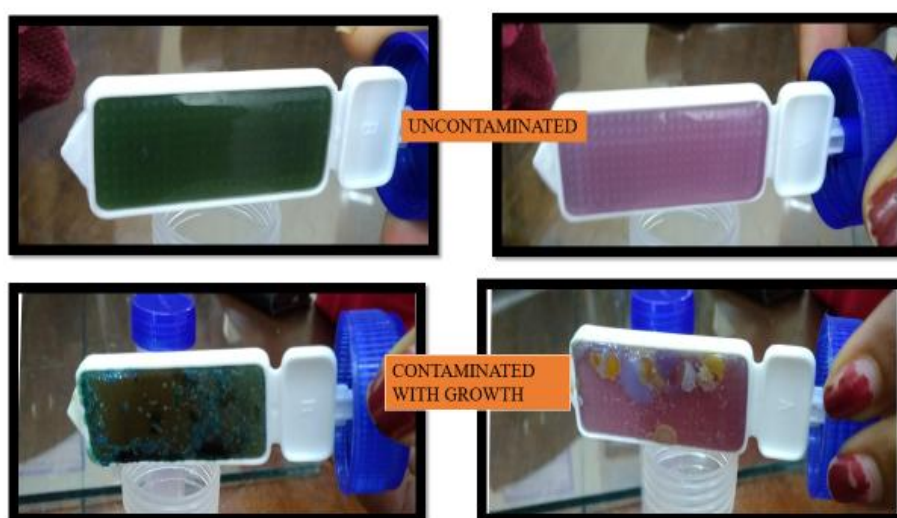


Table 1 : Table showing various determinants of water behaviour (n =187)

Factors	Appropriate	Inappropriate
Water storage	28(14.9%)	159(85.1%)
Water carriage	76(40.6%)	111(59.3%)
Water treatment	29(15.5%)	158(84.5%)

Table 2 : Association of socio demographic factors with water behavior (n =187)

Factors	Water behavior appropriate	Water behavior in-appropriate	Tests of association (p value, Chi sq. test)
Illiteracy	46 (24.6%)	122 (65.3%)	(29.46, 0.00,significant)
Below poverty line	15 (8.1%)	80 (42.8%)	(27.70, 0.00,significant)
Diarrheal illness episode	26 (13.9%)	97 (51.8%)	(25.34, 0.00,significant)

Table 3 : Table showing various determinants of food behavior (n =120)

Factors	Food behavior appropriate	Food behavior in-appropriate
Food Storage	30 (25%)	90 (75%)
Handwashing practices	47(39.2%)	73(60.8%)
Consuming fresh food	82(68.3%)	38(31.7%)
Domestic environment	38 (31.6%)	82 (68.4%)
Food handler hygiene	39(32.6%)	81(67.5%)

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