A STUDY OF DRINKING WATER MANAGEMENT PRACTICES AND INCIDENCE OF WATER BORNE DISEASES IN SELECTED VILLAGES OF DISTRICT KANGRA

THESIS

By

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Submitted to

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IN

Partial fulfilment of the requirements for the degree

OF

MASTER OF SCIENCE IN HOME SCIENCE

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Dedicated

to

my

Reverend

Parents

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CERTIFICATE – I

This is to certify that the thesis entitled **"A study of drinking water management practices and incidence of water borne diseases in selected villages of district Kangra"** submitted in partial fulfilment of the requirements for the award of degree of **Master of Science (Home Science)** in the subject of **Family Resource Management** of Chaudhary Sarwan Kumar Krishi Vishvavidyalaya, Palampur is a bonafide research work carried out by **Ms. Sumita Sood** (Admission No. H-2000-30-08) daughter of **Shri. Romesh Sood** under my supervision and that no part of this thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been fully acknowledged.

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Place : Palampur
Dated: the 10th Oct., 2002

CERTIFICATE – II

This is to certify that the thesis entitled " **A study of drinking water management practices and incidence of water borne diseases in selected villages of district Kangra** " submitted by **Ms. Sumita Sood** (Admission No. H-2000-30-08) daughter of **Shri. Romesh Sood** to the Chaudhary Sarwan Kumar Krishi Vishvavidyalaya, Palampur in partial fulfilment of the requirements for the degree of **Master of Science (Home Science)** in the subject of **Family Resource Management**, has been approved by the Advisory Committee after an oral examination of the student in collaboration with an External Examiner.

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INTRODUCTION

Chapter I

INTRODUCTION

Potable water which was once thought to be an indefinite natural resource is infact the fast depleting scarce commodity and at present rate of consumption by mankind it would not last longer. Gaur and Sood (1989) reported that the need of a person is 150-200 litres of water per day but its availability is much less especially in rural areas where it is as low as 5 – 10 litres per head per day. It is reported that there are one billion people in this world without adequate water supply. Unprecedented demands on water resources have made human beings to use more than one half of all accessible surface water and this proportion is expected to increase to seventy per cent by 2025 thereby reducing the quantity and quality of water available (WHO, 1981).

Not only the quantity of drinking water available is alarming but the contamination of the drinking water is adding fuel to the fire. Practically, all the water, that appears in public or private supplies has been exposed to contamination. As far as possible, sources must be protected from contamination by human and animal waste which may contain a variety of bacterial, viral and protozoal pathogens. Failure to provide adequate protection and effective treatment will expose the community to the risk of outbreak of intestinal disorders and other infectious diseases. The population at the greatest risk of water borne diseases include infants and young children, people who are debilitated or living under unsanitary conditions, the sick and the elderly. Quasim (1992) reported that eighty per cent of the morbidity and mortality in the developing countries are due to water pollution and poor sanitation. He also reported that diarrhoeal diseases caused by unsafe drinking water are among the worlds greatest killers.

Generally the greatest microbial risks are associated with human and animal excreta. Microbial risks can never be entirely eliminated because the diseases that are water borne may also be transmitted by person to person contact, aerosol and food intake, thus a reservoir of cases and carriers is maintained. Ideally, drinking water should not contain any micro-organisms known to be pathogenic. It should also be free from bacteria indicative of pollution with excreta. The detection of faecal (thermotolerant) coliform organisms, in particular *Escherichia coli* provides evidence of faecal pollution. Water borne disease out breaks are particularly to be avoided because of their capacity to result in the simultaneous infection of a high proportion in the community.

Water contamination is a problem not only in metropolitan cities of India, but also in an unexploited state like Himachal Pradesh. Recent media reports show that there was outbreak of jaundice in Mandi district of Himachal Pradesh and the reason given for the outbreak of disease was sewage contamination in drinking water. It is reported that Government authorities were lifting contaminated and polluted water from Beas. District Kangra, is not exception to this scenario, as in Bandal village of district Kangra sixty nine gastroenteritis cases were reported due to intake of contaminated *bauri* water. The crystal clear water of Kangra rivers and *nallahas*/rivulets has turned into cesspools due to rise in contamination. Most water resources of this valley have become polluted by Biological waste. Municipal councils of different towns of the valley are dumping their waste in these rivulets (Anonymous, 2002).

In the rural areas, the condition becomes worse when untreated drinking water is transported and stored in unclean utensils in unhygienic ways. Water quality however good at source deteriorate during transport and storage in domestic containers before drinking (Dworkin and Dworkin, 1980) because of the reason that most of the people are illiterate, as a result there is ignorance of safe drinking water storage under hygienic conditions. Thus, a substantial amount of water that a women bring home is neither safe nor adequate. So it is the liability of government or non-government agencies to provide safe and pure drinking water starting from source upto the user's glass. The need of the hour is to educate the rural women so as to how to get best out of worst, i.e. what ever the quantity or quality of water is available in their household, how they can get pure and safe water for drinking purpose by using economical, quick and easily available effective purification techniques. Unfortunately, very little work has been carried out so far regarding the effective use of purification techniques in rural areas. Keeping in view the above facts, a study was planned to evaluate drinking water management practices and purification techniques used in villages of district Kangra with the specific objectives as follows.

1.1 Objectives of the study

1.1.1 To explore sources of drinking water and prevalent water storage practices.

1.1.2 To study awareness, adoption and efficiency of popular water purification techniques.

1.1.3 To examine incidence of water borne diseases in the sampled households in relation to water management practices.

1.2 Scope of the study

The present study is an attempt to explore the favourable conditions for promoting village water sanitation with use of water management practices including safe drinking water devices through action research.

The inferences drawn from the present study would provide some guidelines to know the constraints for the adoption of water management practices in rural households and would help the educators and extension workers to formulate realistic and constructive education programme to facilitate these villages with appropriate water facility. These efforts would ultimately help people to attain good health and sound living conditions.

Limitations of the study

1. The present study, being undertaken as a student researcher, has its own limitations of resources, particularly laboratory facilities, time and money.
2. The study was limited to one hundred ten respondents of two blocks i.e. Baijnath and Panchrukhi. Hence findings emanating from it cannot be generalized but are illustrative for villages with similar conditions.

REVIEW
OF
LITERATURE

Chapter-II

REVIEW OF LITERATURE

This chapter contains a retrospective survey of prior work related to the present study. Before exploring new phenomena and for precise formulation of problem, it is essential to look into brief review of research related directly or indirectly to the study. Keeping this in view, literature has been reviewed and presented in order of specific objectives.

2.1 Drinking water management practices

2.2 Physico-chemical and bacteriological analysis of water

2.3 Water decontamination techniques

2.1 Drinking water management practices

Sanyal (1977) reported that about 500 million people in developing countries suffer from water borne diseases every year and provision of safe water can cut down 80 per cent of sickness in the world but it is a grim fact that more than 1200 million people in developing countries have no access to safe water supply which gives rise to outbreak of number of diseases like cholera, typhoid, gastroenteritis, diarrhoea, dysentery and viral hepatitis.

Anonymous (1977) reported that contaminated water and poor sanitation endanger human health and threaten life itself. Millions of people suffer from disabling diseases associated with unsafe water like cholera, diarrhoea, dysentery, gastroenteritis, typhoid, jaundice and these diseases are passed on from man to man by faecal discharges from patient washed into water without knowing the consequences.

Kaur (1985) in her study reported that 80 per cent of respondents considered tap as the safest source of water due to their being covered and 86 per cent considered characteristics of safe water to be colourless, fresh and without suspended matter.

Verma (1986) assessed the drinking water quality in Lucknow and indicated that 42 per cent of the sample population was using fresh water for drinking purpose but rest were storing water to be used in different activities. The quantitative flow of water was found to be significantly associated with the bacteriological quality of water. The results revealed that stored water is deteriorated with increasing size of the family due to more hands reaching out to the stored water introducing some contamination every time.

Singal and Sangwan (1986) revealed that working housewives showed a tendency towards preponing of activities like bathing or cleaning the house whereas non working housewives postponed the performance of activities till the timing of regular water supply.

Sangwan *et al.* (1987) reported that in two villages of Bhiwani district, the state of water sanitation was generally poor as manifested by ignorance about the effect of contaminated drinking water, poor drainage and existing practices of disposal of waste water.

Bala (1990) studied the consumption pattern of water for different activities and revealed that maximum consumption of water for drinking purpose was upto 120-140 litres of water per day followed by washing of utensils where it was 60-80 litres per day but for cooking purpose, water consumed was comparatively less (40-60 liters per day) and maximum consumption of water was for bathing (200 – 400 litres per day) during summer.

Mehta *et al.* (1992) studied the residential area of Kanpur and found that respondents were health conscious as they were following the hygienic practices, 83 per cent of the respondents used detergent for cleaning the vessel and 46 per cent were washing them once a day and majority of the respondents used glass especially kept for taking out water from the vessel.

Miglani *et al.* (1992) studied the effect of chemically contaminated water on activities such as cooking of foods and washing of garments and results revealed that with the successive increase in hardness of water, cooking time and fuel consumption increased reducing the palatability of cooked items.

Mehta and Dass (1992) reported that there was no regular supply of water in the residential area of Kanpur, so residents had to store water for various purposes. Regarding the use of storage structures it was reported that 67 per cent of the respondents were using earthenware vessels followed by plastic bucket (37 per cent) stainless steel and brass vessels (17per cent each) during summers whereas in monsoons and winters plastic buckets were more common.

Bhardwaj *et al.* (1993) conducted a study in district Hamirpur of Himachal Pradesh and found that 94.4 per cent of villages of district were covered under piped drinking water supply. Besides this, the state came under the grip of dual epidemics viz. typhoid, fever and cholera. He also reported that during the investigation of these epidemics various traditional sources of water such as wells, *bauris*, springs, ponds and khatris were tested and it was revealed that khatri water was much better than tap water bacteriologically and if this source is tapped properly, it can go a long way in solving drinking water supply problems.

Bala *et al.* (1994) conducted a study on the availability of water, its quality and reasons for pollution in two villages of Haryana. The results revealed that water from public well and tap was available and used by majority of the respondents. She also reported that defecation by people or animals near water sources was main cause of water pollution. Clinical test indicated that water sample from all sources were not potable as per standards of Indian Council of Medical Research.

Kusum (1995) reported that there was lack of piped water supply in Muzaffarpur district of Bihar and bucket was commonly used as a storage device followed by earthenware for storing water but least preference was given to brass and copper thus reaching the conclusions that the respondents did not know about bacteriocidal effects of copper and regarding their knowledge about purification techniques, only minority of people were aware about using them.

Tyagi (1996) assessed the water stored in different containers and reported that in summer season earthen pot was used by 100 per cent of rural people and 76 per cent of urban people followed by water filter, (38 per cent) stainless steel bucket (34 per cent), plastic bucket (26 per cent), galvanized iron bucket (18 per cent), brass pitcher and cement tank (10 per cent) whereas in winter, earthen pots were not used and their was no effect of caste and income on use of storage containers except for water filters which was possessed by high income groups.

Chhabra (1999) reported that major cause of water pollution in Delhi was mixing of sewage water with drinking water which caused gastroenteritis among 300 people of Delhi.

Anonymous (2002) reported that 69 residents of Bandal village in the Daka Palera Panchayat of Kangra district of Himachal Pradesh, suffered illness due to gastroenteritis problem and reason for illness was that one of natural source of drinking water (*bauri*) was contaminated which resulted in the out break of disease in the village.

Physico-chemical and bacteriological analysis of water

World Health Organization (1981) in its report on the international drinking water and sanitation decade showed that three out of five persons in the developing countries did not have an access to safe drinking water. In rural areas only twenty nine per cent had adequate water supply.

Ray *et al.* (1982) observed the occurrence of all grades of dental fluorosis which had increased with the increase in fluoride concentration of water. At 0.2 to 0.3 ppm level of fluoride in water high prevalence (35.5 per cent) was observed. The cause of high prevalence at low concentration was not known definitely but was reported that it might be due to excess of fluoride from beverages like alcohol.

World Health Organization (1984) reported that health risk due to toxic chemicals in drinking water differs from that caused by microbiological contaminants. It is very unlikely that any one substance could result in acute health problem except under exceptional circumstances. The water usually become unfit for drinking after such incidents for obvious reasons such as its taste, odour and appearance.

Kaur (1985) studied the effect of ground water quality for use in household and reported that water samples contained hardness to the extent of 200-504 mg which affected the cotton fabrics.

Pallah (1990) studied the chemical analysis of water and developed the corrections among the chemical parameters of drinking water. The results revealed that SO_4 concentration in water was higher and also showed that with increase in pH of water, there was decrease in total hardness of water.

Chandra *et al.* (1991) analyzed drinking water quality in Allahabad during Mahakumbh Mela in the month of January-February. Eighty five drinking water sample from tube wells and handpumps were analyzed. No bacterial contamination was detected in any samples which had free residual chlorine of 0.2 mg/lt or above.

World Health Organization (1991) reported that problem associated with chemical constituents arise primarily from their ability to cause adverse effects after prolonged periods of exposure of particular concern are cumulative poisons and carcinogens. It must remain a basic tenet of public health protection that exposure to toxic substances should be as low as possible. Several of the inorganic elements for which guidelines have been recommended are recognized to be essential elements in human nutrition.

Gupta (1991) analysed ground water samples of Nagpur district and revealed that fluoride and nitrate concentrations increased with increase in salinity while high fluoride waters were rich in sodium content. High nitrate water had relatively high percentage of calcium and magnesium. High value of phosphorus was observed in association with high fluoride and potash showing its occurrence due to mineral weathering and local pollution.

World Health Organization (1993) reported that colour above 15 TCU (True colour units) can be detected in a glass of water by most people. Colour below 15 TCU are usually acceptable to consumers but acceptability may vary according to the local circumstances. No health based guidelines value is proposed for colour in drinking water. It further stated that cool water is generally more palatable. Low water temperature tends to decrease the efficiency of treatment process including disinfection and may thus have a deleterious effect on the drinking water quality. However high water temperature enhances the growth of microorganisms and may increase taste, odour, colour and corrosion problems.

Oberoi (1994) studied the bacterial quality of water by taking different samples of water and analyzing them at 37°C and 22°C and found that bacterial count at both the temperatures was similar and bacteria identified from household water were mostly non pathogenic in nature.

Bala *et al.* (1994) studied the quality of drinking water in two villages of Hissar district of Haryana and introduced the technology of safe drinking water. She highlighted that water from all sources was highly polluted with coliform organisms, which were more than 1800/100 ml. In Kherampur village, the faecal coliform were maximum (120/100 ml) in diggi water whereas in Ladwa these were maximum (65/100 ml) in well water.

Gill (1995) examined the ground drinking water of rural area of Ludhiana district of Punjab and reported higher concentration of magnesium and chloride than the acceptable limits in almost all the water samples resulting in hardness of water, whereas, only one third of ground drinking water sources was suitable for drinking purpose.

Colquhoun *et al.* (1995) developed the test method for assessing inactivation of viruses by materials used in domestic plumbing and found that 5 viruses when allowed to flow through pipes made from aged samples of five plumbing materials showed that most of the material had only modest virucidal effects though copper produced significant reduction in the level of five viruses.

Nayak *et al.* (1996) evaluated zinc, lead and copper concentration in drinking water throughout Mumbai city. Results indicated that the concentration of heavy metals in certain areas of the city were higher than their concentration at supply sources. It also indicated that there was contamination in the line due to corrosion of piped water supply or by seepage of contaminated water.

Rahman *et al.* (1996) examined contamination of the water supply in Karachi, Pakistan. Except municipal water from some areas, water from most other sources contained coliform bacteria and faecal coliforms in higher amounts. It was indicated that ground water was the main contributor of contaminants and contamination source of the ground water was sewage.

Sapeak (1996) reported that most causes of water pollution in Poland were associated with the storage and handling of animal waste.

Tyagi (1996) reported that water samples collected from different homes of Hissar district were highly polluted with faecal coliform and concluded that drinking water available was not fit for human consumption. Reports also revealed that hand pump water of urban areas of Hissar was also unfit for consumption because of content of faecal coli in it.

Vanita (1997) analyzed water sample from different localities of Ludhiana, viz. Haibowal, Jawahar Nagar and Shivpur and reported that the hand pump water quality was poor as compared to tap water in all the localities because of higher mean bacterial counts in hand pump water. She further revealed that hand pump water was not desirable for human consumption as it may lead to certain water borne diseases.

John *et al.* (1997) determined iron content of water in different rural water supply sources of north Lakhimpur district of Assam and Papumpare district of Arunachal Pradesh. Results revealed that water was highly ferruginous having iron content as high as 8 mg/lt. It was observed that almost all iron removal plants established were either nonfunctioning or abandoned.

Singh *et al.* (1997) studied physico-chemical parameters like pH, conductance, dissolved oxygen, chloride, sulphate, nitrate, nitrite total hardness, alkalinity, total dissolved solids, total soluble solids of river Beas. The results revealed that heavy metal manganese and iron were fairly exceeding permissible limits of drinking standards.

Sharma *et al.* (1998) reported that majority of families in Bochidharma village of Nainital district collected water twice a week and stored it in diggies. There was no knowledge about any purificant in water. Thus water in the diggies was found to be highly contaminated as compared to tube well water. During rainy season, bacterial count was 2400 cells/100 ml, pH value was found to be 250 mg/lt, temporary hardness was 172 mg/lt which was much more than standards of WHO.

Arora (1999) carried out the study in localities of Ludhiana and the results demonstrated that 93.3 per cent of respondents considered tap as safe source of drinking water and expressed mixing of sewage with drinking water as main cause of contamination. In boiled samples of water, total coliform count was negligible followed by filtered water through Aquaguard (96.4-98.4 per cent), Zero B (96.4 – 97.7 per cent) and candle filter (45.2-47.6) per cent.

Virk *et al.* (2000) studied the effect of water quality from different sources on cleanliness of utensils and revealed that over all mean bacterial count on utensils washed with hand pump water was much more higher than mean bacterial count found on utensils when washed with distilled water.

Garg *et al.* (2000) carried out the quality analysis in Eastern part of Hisar city through the estimation of pH, electrical conductivity, total dissolved salts, total hardness, total alkalanity, sodium, potassium, calcium, magnesium carbonate, bicarbonate, chloride and sulphide and the results indicated that on an average all the samples had one or the other chemical constituent beyond the permissible limit.

Anonymous (2002) reported that people in Kasauli town in Himachal Pradesh were forced to drink dark brick red coloured water which was found to be unfit for human consumption. It was also reported that water had high concentration of suspended solids measuring 67.4 mg per litre with total dissolved solids being as high as 290 mg per litre as compared to prescribed standards of potable water according to which the amount of suspended solids should be nil.

Water decontamination techniques

Bhatti (1989) revealed that most of the people were illiterate and ignorant of safe drinking water storage under hygienic conditions. She also observed the unfavourable attitude in adoption of water filters because of developed immunity therefore, not feeling need (88%) followed by economic constraints (48%), low capacity of filtration (36%) and least suitable method for purification was constant water jar (100%) because it needs cleaning regularly followed by chlorination (50%) as it alters colour, smell, taste of water and then boiling (25%) as it alters taste of water and is also time consuming.

Anonymous (1989) reported that it is important to disinfect drinking water in situation where the water supply cannot be adequately protected because this would guard against water borne diseases and various ways of disinfecting water are boiling, filtration, chlorination and traditional water purifying seeds.

Bala (1990) observed that there were certain constraints for the adoption of different water sanitation technologies. Economic constraints were maximum followed by technological and time constraints. Maximum constraints were faced for adoption of boiling as purification technique followed by Janta water filter, bleaching powder, mug with handle and muslin cloth in order of their importance.

Vasisht *et al.* (1990) analysed the potable water of Chandigarh with different treatments and revealed that maximum number of organisms were present in untreated water, less in alum water, lesser in filtered and least in chlorinated water.

Singal *et al.* (1990) analysed the water sanitation practices in Baroda city of Gujarat and reported that majority of the respondents followed hygienic practices for storage of drinking water and regarding purification of water, majority of them used water filter but other methods like boiling or use of potassium permanganate were not being practised.

Mehta *et al.* (1992) concluded that 76 per cent of respondents were not using any type of filter while filling the drinking water in the vessel whereas rest 24 per cent were using nylon gauze cotton cloth, stone filter and candle filter.

Bhatti and Verma (1992) assessed the feasibility of water filter in context to the field situation in Hissar district of Haryana and found that highest percentage of respondents perceived the water filter as feasible and only 20 per cent of the respondents found the water filter not at all feasible for propagation after they had been exposed to the innovation through action programme.

Grabow *et al.* (1995) conducted a research on euroguard filter cum purifier for the domestic treatment of drinking water and revealed that this filter unit was capable of reducing various kinds of virus from water like *Rotavirus, Coliphage*, M82, *Somatic coliphage* and *Escherchia coli.*

Naranjo *et al.* (1996) studied water purification system for the removal of enteric pathogens and found that potable water treatment devices ensure the quality of drinking water and were especially useful to hikers and camphers often used in surface water supplies. He also evaluated potable iodinated water purification system and reported that it had the ability to inactivate virus.

Mizoguchi (1996) developed the technique for purifying drinking water by microbiological treatment. In this technique, soil bacteria and enzymes were injected into the moat and results of the experiment revealed that total environment including the sediment was purified along with improvement in the water quality.

Wagle (1996) reported that almost 70 per cent of water available in the country was not potable causing numerous types of illnesses. He also reported that the rural folk largely drew untreated water from both surface and ground sources whereas on the other hand urban population got treated surface water from the rivers and lakes. This treatment process covers three major operations namely sedimentation, flocculation, filtration and disinfection.

Olsen *et al.* (1997) examined the user acceptability and effectiveness of polyester cloth as a drinking water filter in a dracunculiasis endemic village in Northern Region of Ghana and revealed that the new cloth was superior to the nylon filter with regard to strength (83 per cent), filtering time (80 per cent) and ease with which the filter could be cleaned (87 per cent).

Thacker *et al.* (1997) conducted a comparative study about the treatment techniques for controlling THMs' (Trihalomethanes) in drinking water and the results indicated that diffused aeration 98 per cent, GAC (granular activated carbon adsorption) 96 per cent and alum coagulation 64 per cent of all THMs' from water thus purifying it.

Jeyaraj *et al.* (1998) reported that nuts of *Strychnos potatorum*, a plant distributed in the deciduous forest of West Bengal, Central and South India were found to be very effective in reducing turbidity, total solids and nitrate contents in water so that it can be recommended to be used with alum in order to improve the quality of water for domestic and industrial purpose.

Arora (1999) conducted a comparative study of water decontamination methods at household level and reported that total coliform count per 100 ml was negligible in boiled and filtered samples of water. The percentage removal of coliforms was found to be maximum in boiled water

(97.2-99.2 per cent) followed by Aquaguard (96.4-98.45 per cent), Zero B (96.4-97.7 per cent) and candle filter (45.2-47.6 per cent). Thus, she recommended Zero B for households belonging to middle and low income groups.

Huilgol (2000) studied the consumption pattern of water and carried out the qualitative analysis for chemical and microbial characteristics of water after applying different water purification techniques and found that most popular method of purification used in household was use of muslin cloth or an old saree cloth as a water filter. Use of plant material in obtaining pure water and the technical method of removing hardness and contamination using plant material like cloves, dry amla, drumstick seeds was observed.

Kusum *et al.* (2001) conducted a study in Muzaffarpur district of Bihar and revealed that 28.16 per cent of the respondents possessed knowledge about filtration of water. The method of straining water through muslin cloth was known and used by majority of them but knowledge regarding branded water filter and Janta water filter was lacking.

Sood (2002) reported that the waste generated from hospitals and medicinal institutions was a major source of environmental and water pollution problems in Kangra district of Himachal Pradesh. The Irrigation and Public Health Department has no water treatment plants for the water trapped from Bhiral and Bander khuds and the people were left with no alternative except to consume contaminated water.

MATERIAL AND METHODS

MATERIAL AND METHODS

The precision and fidelity of any scientific inquiry depends largely upon the sound methodological base on which the inferences are drawn and empirically tested. This chapter therefore, deals with the procedure and techniques used for conducting the present study. The study was conducted in two phases. Phase I included the household survey and Phase II included laboratory testing of collected samples.

Phase I

Household survey

It included features of the study area, selection of samples, designing of schedule for data collection, pre-testing of schedule and finally collection of primary and secondary data.

Phase II

Laboratory experiments

It included identification of popular water purification techniques, physico-chemical and bacteriological examination of treated water samples.

Phase I Household survey

3.1 Locale of the study

3.2 Sampling plan

3.3 Selection of variables

3.4 Designing and pre-testing of schedule.

3.5 Collection of data

3.6 Analysis of data

3.1 Locale of the study

For the present study out of twelve districts of Himachal Pradesh, Kangra district was purposely selected for the reason that the researcher belongs to this area and was well acquainted with the local situation, dialect, cultural norms and value system.

3.2 Sampling plan

3.2.1 Sampling design

A multistage random sampling technique was used to select blocks, villages and ultimate respondents.

3.2.2 Selection of the blocks

In the first stage of sampling, two blocks i.e. Panchrukhi and Baijnath were randomly chosen. From these selected blocks, a complete list of villages was prepared along with a list of Primary Health Centres (PHC) and Primary Health Sub-centres (PHSC) under which these villages lie. This list was prepared with the help of officials of the block development and Health department.

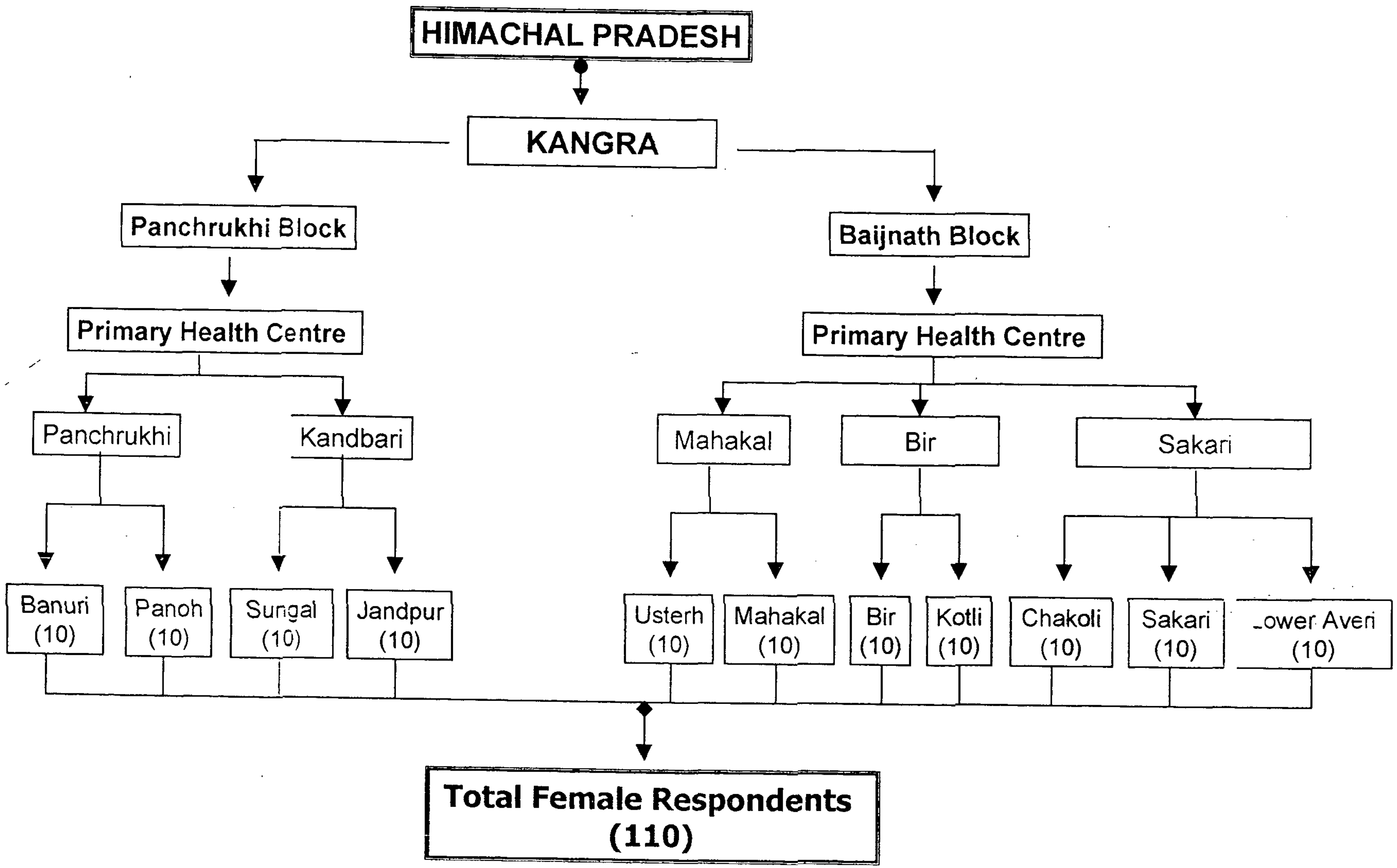

Fig. 3.1 Sampling Design

3.2.3 Selection of villages

In the second stage of sampling, a sample of eleven villages from both the blocks was selected at random from the list of villages prepared in previous stage. The selected villages were Banuri, Panoh, Sungal and Jandpur from Panchrukhi block and Chakoli, Mahakal, Usterh, Sakari, Kotli, Bir, Lower Averi from Baijnath block.

3.2.4 Selection of households and respondents

In each selected village, a complete list of families suffering from water borne diseases was prepared with the help of Medical Officials of the Primary Health Sub-centres of the concerned village. From that list, a sample of ten families from each village was chosen by simple random sampling technique and one home maker per family was interviewed. A total of one hundred and ten respondents were interviewed for the present study.

3.2.5 Period of study

Data for the present study were collected during the year 2001-2002 in the month of March.

3.3 Selection of variables

(a) Independent variables

Water management practices

1. Hygienic practices
2. Purification methods
3. Water storage practices

(b) Dependent variables

1. Frequency of incidence of water borne diseases

3.4 Designing of schedule

A well structured comprehensive interview schedule was developed for the purpose of data collection. It consisted of two main parts. The first part included the background information of the respondents related to their socio-demographic and economic aspects.

The second part of schedule included specific information such as source of water, availability and utilization of water, knowledge regarding safe drinking water and water purification techniques and diseases caused by unsafe water. The schedule is given in Appendix II.

3.4.1 Pre-testing of schedule

The schedule was tested on thirty families and accordingly relevant modifications were made in the schedule for data collection.

3.5 Data collection

Both primary and secondary data were collected for achieving the objectives of study.

Primary data

Primary data were collected by survey method on well structured pre-tested schedule through personal interview method from the respondents.

Secondary data

Secondary data were obtained from survey reports, research publications and publications of various departments. This information was obtained from journals, theses, books newspapers, magazines and various offices like District Rural Development Agency and Health department of Government of Himachal Pradesh.

3.6 Analysis of data

Commensurated with set objectives and information available for the study, analytical tools were employed for the analysis and interpretation of data.

In order to accomplish the objectives, tabular analysis was employed to work out averages, standard errors and percentages. This analysis included frequencies, percentages, means, and standard errors of various parameters.

Statistical analysis

In order to find out the relation of water management practices with water borne diseases, Karl Pearson's coefficient of correlation was worked out and the formula used was:

$$r_{xy} = \frac{\Sigma XY - \dfrac{\Sigma X \Sigma Y}{n}}{\sqrt{\left[\Sigma X^2 - \dfrac{(\Sigma X)^2}{n}\right]\left[\Sigma Y^2 - \dfrac{(\Sigma Y)^2}{n}\right]}}$$

where,

r = correlation coefficient

Y = the dependent variable (Water borne diseases)

X = independent variables (Hygienic practices/purification methods/frequency of cleaning water storage container and storage space)

The significance of "r" was tested by using "t" test as follows:

$$t^*_{cal} = \frac{r\sqrt{n-2}}{\sqrt{1-r^2}}$$

where, n is the number of observations.

the t^*_{cal} was compared with t_{tab} value to test the significance of parameters under the study.

Phase II Laboratory experiments

To study the purification level of various water purification techniques adopted by the respondents, laboratory tests for different treatments of water were conducted in IPH (Irrigation and Public Health) laboratory, Dharmshala.

3.7 Selection of water purification techniques

On the basis of results obtained from the household survey, four commonly used purification techniques were selected for the laboratory experiments. These were chlorination, candle filtration, boiling and boiling alongwith candle filtration.

3.8 Collection of water samples

Total five water samples were taken from the *bauris* which were commonly used by the people. Out of these, three samples were taken from *bauris* of Salyana, Sungal, Padiyarkhar of Panchrukhi block and Mahakal, Tharu from Baijnath block. These samples were collected in sterilized glass bottles and cans.

The laboratory tests were divided into two parts.

3.9 Physico-chemical analysis

Methods

3.9.1 Physical analysis

1. Conductivity Measurement (By water Analyzer Kit)

   Procedure:-

   - Rinsed the cell with one or more portions of test sample
   - Adjusted the temperature of a final portion to 25.0 + 1° C.
   - Measured the ample conductivity.
   - Noted the temperature.

2. Turbidity (Nephelometric Method)

   Procedure

   - Thoroughly shaked the test sample
   - Waited until air bubbles disappeared and poured the sample into turbidometer tube.
   - Read turbidity directly from the instrument scale.

3. Colour (Standard Method, 1985)

Procedure

- 50 ml of the sample was taken in the Nessler tube.
- Matched the sample with the colour standard.

4. Odour (Standard Method, 1985)

Procedure

- The sample was filled in the clean bottle.
- After putting the stopper it was vigorously shaken.
- Then quickly the odour was observed at room temperature.

5. Taste (Standard Method, 1985)

Procedure

- The sample was taken into the mouth of the observer for some time without swallowing.
- The observer compared the taste with the blank.

3.9.2 Chemical analysis

1. Measurement of pH (By analyzer kit)

Procedure : Electronic pH method

- Switched on the pH meter
- Make sure the electrode is connected
- Using prepared pH buffer solutions, placed the pH electrode in a pH 7.0 buffer.
- Rinsed the electrode in distilled water and transferred it to pH 4.0 buffer.

Rinsed the electrode in pH 9.0 buffer.

Checked the meter in all the three buffer solutions. When it read correctly all the buffers, tested the water samples and noted the reading.

2. Total dissolved solids (By analyzer kit)

Procedure

- Rinsed the cell with one or more portion of test sample
- Adjusted the temperature of a final portion to 25.0 + 1°C
- Measured the sample conductivity
- Noted the temperature

3. Hardness (Indian Standard, 1964)

Procedure:

- To 50 ml of sample added 2 ml of buffer solution
- Then added 6 g of Eriochrome Black-T
- Titrated with standard EDTA solution until the solution becomes blue

Calculations

$$\text{Hardness (as } CaCO_3\text{)mg/l} = \frac{1000\ V_1}{V_2}$$

where,

V_1 = Volume in ml of standard EDTA solution used in titration

V_2 = Volume in ml of the sample taken for titration

3.10 Bacteriological analysis

After receiving treated water samples in the laboratory, these were subjected to bacteriological analysis besides physical and chemical testing. Under bacteriological analysis, the water samples were tested for the presence of bacteria only.

3.10.1 Selection of method for bacteriological analysis

For counting of Most Probable Number (MPN) of bacteria in a given treated water sample, two commonly used methods were available.

1. Multiple tube method
2. Membrane filtration technique

Since the water samples were immediately transported to the laboratory within three hours, so multiple tube method was selected and was performed according to the method described by WHO guidelines for drinking water quality (WHO, 1985) and outline diagram of the procedure is plotted (Figure 3.2).

3.10.2 Multiple Tube Method (Presumptive Test) (WHO, 1985 and Senior, 1996)

Varying quantities of treated water to the tubes containing double and single strength Mac Conkey broth was added and incubated at 35 to 37^{o} C for 24 to 48 hours. An estimate of the number of coliform organisms forming acid and gas indicated the growth of coliform bacteria.

The following table shows the range used for each water sample.

Amount of sample	Mac Conkey's Broth	Number of tubes
0.1 ml	Single strength	5
1.0 ml	single strength	5
10.0 ml	double strength	5

Tubes were examined after over night incubation for positive reaction (gas and acid produced by the fermentation of lactose). In the media tubes, an inverted inner Durham tube was used to trap gas. As a result, the tubes showing gas formation were regarded as presumptive positive and remaining negative tubes were re-incubated for 24 hours. Any further positive results were added to the previous figures. The probable number of coliform/100 ml were then read out from the probability table of Mc Cardy.

3.10.3 Differential coliform test (Eijkman test) (WHO 1985) and (Senior, 1996).

Some spore bearing bacteria give false positive reactions in the presumptive coliform test. Their presence is most likely to be misleading in the examination of chlorinated drinking water. It is necessary therefore to confirm the presence of true (faecal) coliform bacteria in each tube showing presumptive positive reaction and it may be necessary to determine whether these coliform bacteria are *E. coli.*

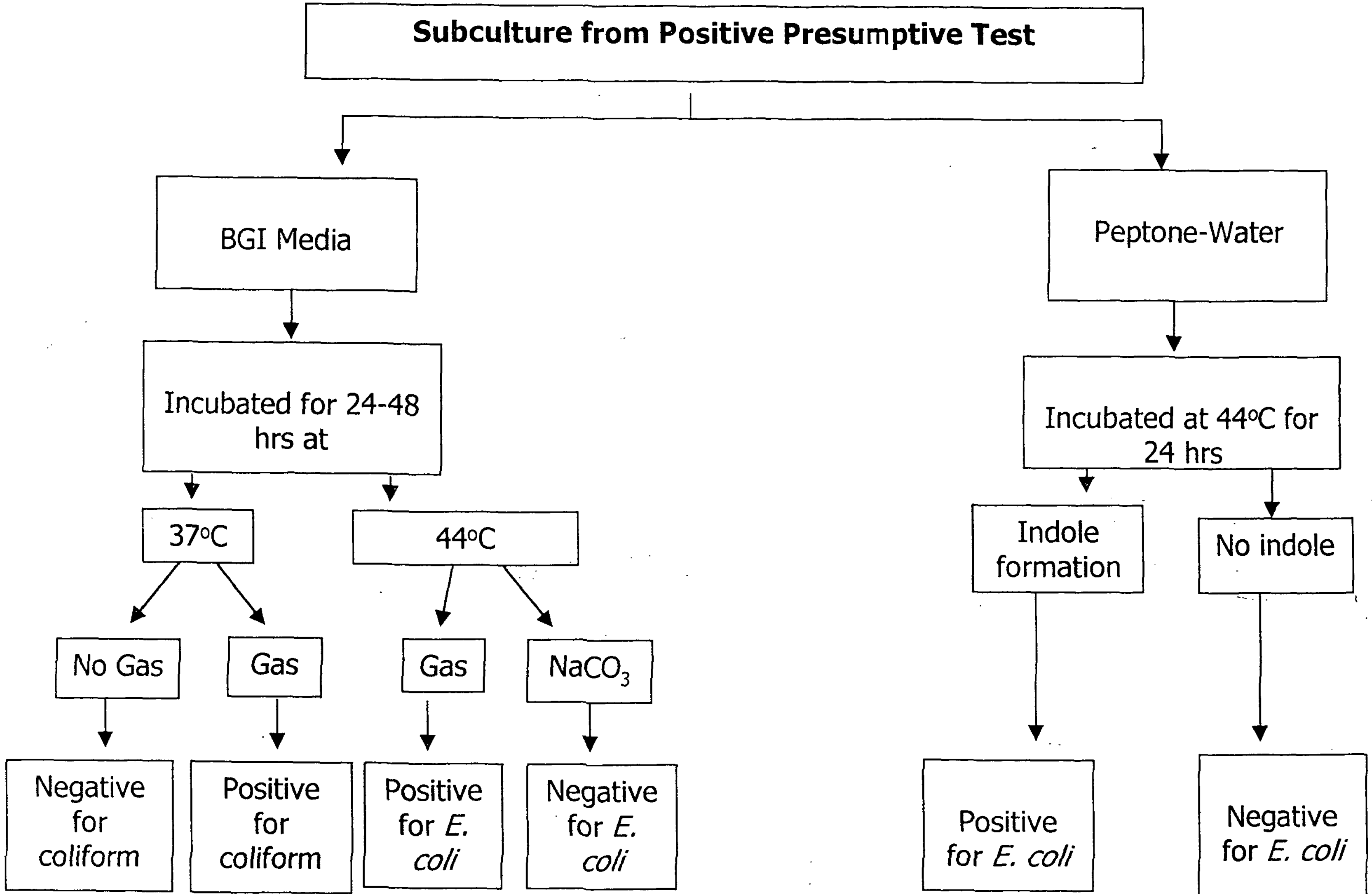

Fig. 3.2 FLOW CHART FOR THE METHODOLOGY OF THE TEST

The test was carried out by incubating subcultures from the positive presumptive test at 44° C and 37° C in Brillient Green Lactose Bile Broth and other subculture was made at 44° C in peptone water. The presence of coliform bacilli was confirmed by the production of gas from lactose at 37° C and the presence of *E. coli* was confirmed by production of gas from lactose and indole from tryptophan (Figure 3.2).

RESULTS

Chapter IV

RESULTS

The present chapter deals with the research findings. The results have been presented in two sections:

Section I

4.1 Background information of respondents.

4.2 Availability and utilization pattern of drinking water

4.3 Existing drinking water storage practices.

4.4 Awareness and usage of water purification techniques.

Section II

4.5 Physico-chemical examination of water.

4.6 Bacteriological examination of water.

4.1 Background information of respondents

The background information included age, education, occupation pattern of the respondents, type of family, size of family, family income, family occupation, educational status of family. The background information has been presented in Table 4.1.

4.1.1 Age

The Table 4.1 shows that majority of the respondents (72.72 per cent) were in middle age group (25-50 years) followed by 23.64 per cent in old age group (above 50 years) and only 3.64 per cent were in young-age category (below 25 years).

Table 4.1 Socio-economic and demographic features of the respondents.

Serial No.	Particulars	Number	Percent
1.	**Age (Years)**		
	Young (below 25)	4	3.64
	Middle (25-50)	80	72.72
	Old (above 50)	26	23.64
	Mean age	**40.54**	
	Standard error	**11.54**	
2.	**Education**		
	Illiterate	45	40.90
	Primary	27	24.56
	Middle	9	8.19
	High School	18	16.36
	Senior School	10	9.09
	Graduate	1	0.90
3.	**Occupation of the respondents**		
	Housewife	86	78.18
	Business	4	3.64
	Government Service	2	1.82
	Daily Wage Labourers	18	16.36
4.	**Family size**		
	Small (upto 3 members)	9	8.18
	Medium (3-5 members)	24	21.82
	Large (above 5 members)	77	70.00
	Average family size	**6.47**	
	Standard error (SE)	**2.07**	

5.	**Type of family**		
	Nuclear	78	70.91
	Joint	32	29.09
6.	**Family educational status**		
	Low (0-2)	58	52.72
	Medium (3-4)	37	33.64
	High (5-6)	15	13.64
7.	**Main occupation of family**		
	Farming	16	14.55
	Government Service	60	54.55
	Business	15	13.63
	Daily Wage Labourers	19	17.27
8.	**Family income (Rupees)/month**		
	Upto 1000	20	18.18
	1000-5000	67	60.91
	5001-10000	18	16.36
	10001-15000	5	4.55
	Mean income	**3415.55**	
	Standard Error (SE)	**2401.84**	
9.	**Type of house**		
	Kuccha	80	72.73
	Semi Pucca (Mixed)	5	4.55
	Pucca	25	22.72

4.1.2 Education

The Table 4.1 showed that nearly 41 per cent of the respondents were illiterate and proportion of those who were educated upto primary were 24.56 per cent, 16.36 per cent had their education level upto matric and 9.09 per cent had studied upto senior secondary school, 8.19 per cent upto middle school and 0.90 per cent of the respondents were graduates.

4.1.3 Occupation

Data enfolded in Table 4.1 showed that majority of the respondents were housewives (78.18 per cent) followed by 16.36 per cent daily wage labourers and very little percentage of women were in business and government services i.e. 3.64 per cent and 1.82 per cent respectively.

4.1.4 Family size

Regarding the family size, majority of the respondents (70 per cent) had large families (above 5 members) followed by 21.82 per cent having medium sized families (3-5 members) and 8.18 per cent having small families (upto 3 members).

4.1.5 Family type

Out of total respondents, majority of them (70.91 per cent) were belonging to nuclear type of family followed by joint families (29.09 per cent).

4.1.6 Educational status of family members

Table 4.1 shows that 52.72 per cent respondents had low level of education (0-2 members) followed by 33.64 per cent who had medium level of education (3-4 members) and 13.64 per cent of respondents had high level of education (5-6 members).

4.1.7 Family occupation

More than half of the respondents (54.55 per cent) were engaged in Government service followed by labour (17.27 per cent), farming (14.55 per cent) and business (13.63 per cent).

4.1.8 Family income

Data presented in Table 4.1 show that majority of respondents i.e. 60.91 per cent had an average income of Rs. 1000-5000 per month followed by 18.18 per cent who had lesser family income (upto Rs. 1000) whereas 16.36 per cent respondents had their family income between Rs 5001-10,000 but minimum percentage of respondents i.e. 4.55 per cent had high family income i.e. Rs 10,000-15,000.

4.1.9 Type of house

The study indicated that majority (72.73 per cent) of the respondents had *kuccha* house followed by 22.72 per cent respondents having *pucca* house and only 4.55 per cent having semi pucca (mixed) house.

4.2 Availability and utilization of drinking water

4.2.1 Available water sources

Table 4.2 shows the distribution of families according to sources of available water for their daily requirements. It is evident from the table that major sources of water were tap, *bauri*, hand pump, open water channel and motor driven pumps and majority of the respondents (96.36 per cent) used tap water followed by open water channel (52.73 per cent), *bauri* (29.09 per cent), hand pump (10.90 per cent) and a few families were using motor driven pumps (1.81 per cent).

Table 4.2 Distribution of households according to available sources of drinking water.

Serial No.	Source of water	Number	Percent
1.	Tap	106	96.36
2.	Open water channel	58	52.73
3.	*Bauri*	32	29.09
4.	Hand pump	12	10.90
5.	Motor driven pump	2	1.81

Multiple response

So it may be concluded that the major sources of water were tap, open water channel and *bauri* as these water sources were near to their houses and water was easily accessible to them. However, *bauri* water was mostly used during summer season for drinking purpose when there is scarcity of water in other sources.

4.2.2 Source-wise use of water for different activities

The data presented in Table 4.3 reveal that majority of the respondents used tap water for personal, household and kitchen activities. Nearly 91 per cent respondents used tap water for drinking in summer and 95.46 per cent were using tap water for drinking in winter followed by *bauri* water, 17.27 per cent in summer and 9.09 per cent in winter whereas, only 6.36 per cent of respondents in summer and 4.55 per cent in winter used hand pump water. For other kitchen activities like cooking and washing utensils, majority of the respondents used tap water that is 93.64 per cent in summer and 94.45 per cent in winter and only a few (3.64 per cent in summer and winter) used hand pump water. For other personal activity like bathing, 93.64 per cent respondents in summer and 94.55 per cent respondents in winter used tap water whereas nearly half of families (49.09 per cent) in summer and winter used open water channel for activities like washing clothes.

As regard to other activities like providing drinking water for animals and cleaning of animals, both tap and open water channels were utilized by the respondents whereas for kitchen garden irrigation, water from open water channel was used by majority of respondents (64.55 per cent) followed by tap water (35.45 per cent). It was found that majority of respondents were using tap water for different activities.

Table 4.3 Source-wise use of water for different activities

Sr. No.	Source of water	Drinking		Bathing		Cooking		Washing utensils		Washing clothes		Animal drinking		Animal Cleaning		Kitchen garden irrigation	
		S	W	S	W	S	W	S	W	S	W	S	W	S	W	S	W
1.	Tap	100 (90.90)	105 (95.46)	103 (93.64)	104 (94.55)	103 (93.64)	104 (94.45)	103 (93.64)	104 (94.45)	50 (45.45)	40 (36.36)	32 (29.09)	32 (29.09)	3`1 (28.18)	32 (29.09)	39 (35.45)	39 (35.45)
2.	Hand pump	7 (6.36)	5 (4.55)	4 (3.64)	4 (3.64)	4 (3.64)	4 (3.64)	4 (3.64)	4 (3.64)	3 (2.73)	3 (2.73)	2 (1.81)	2 (1.81)	2 (1.81)	2 (1.81)	2 (1.81)	2 (1.81)
3.	Open water channel	-	-	2 (1.81)	-	-	-	2 (1.81)	2 (1.81)	54 (49.09)	54 (49.09)	39 (35.45)	36 (32.72)	38 (34.72)	36 (32.72)	71 (64.55)	71 (64.55)
4.	Bauri	19 (17.27)	10 (9.09)	1 (0.90)	1 (0.90)	4 (3.64)	3 (2.73)	1 (0.90)	-	3 (0.90)	3 (2.73)	2 (1.82)	2 (1.82)	2 (1.82)	2 (1.82)	2 (1.82)	2 (1.82)

Multiple response
S – Summer
W – Winter
Note: Figures in parentheses indicate percentage to total.

4.2.3 Preference for the source of drinking water

The data in Table 4.4 reveal that 70.91 per cent of the respondents considered tap water safe for drinking as they considered tap water to be good for digestion and its taste was also liked by majority of the respondents, whereas 19.09 per cent of the respondents revealed their preference for *bauri* water. Water from open channel was not considered good for drinking as it was exposed to open environment and was contaminated.

Table 4.4 Distribution of households according to preference for source of drinking water.

Serial No.	Source	Number	Percent
1.	Tap	78	70.91
2.	*Bauri*	21	19.09
3.	Handpump	11	10.00
4.	Open water channel	-	-
5.	Motor driven pump	-	-

4.2.4 Consumption pattern of water for different activities

An attempt has been made to examine the consumption of water for different activities like kitchen activities including drinking, cooking and washing utensils, bathroom and other household activities including bathing, washing clothes and cleaning the house followed by other activities like animal drinking, animal cleaning and irrigation of kitchen garden keeping in view the seasons.

4.2.4.1 Quantity of water consumed during kitchen activities

(a) Drinking

The data in Table 4.5 reveal that during summer season, majority of the families (60 per cent) consumed water for drinking ranging from 20-40 litres per day followed by 36.36 per cent which consumed 10-20 litres of water and only 3.64 per cent consumed 40-60 litres of water while in winters maximum quantity of water consumed for drinking was 40-60 litres (3.64 per cent) whereas 35.45 per cent consumed 20-40 litres of water and 60.91 per cent consumed 10-20 litres of water so there was seasonal variation in consumption of water. In summer, consumption of water was more than winter for drinking purpose.

(b) Cooking

For the cooking activity, in summer 63.64 per cent families utilized 10-20 litres of water per day followed by 36.36 per cent which utilized 20-40 litres of water whereas in winter, majority of the respondents (82.73 per cent) consumed water ranging from 10-20 litres and only 17.27 per cent families were utilizing 20-40 litres of water per day.

(c) Washing utensils

For washing utensils, maximum quantity of water used was 60-80 litres/day (6.36 per cent) in summer and 4.55 per cent respondents in winter while maximum respondents i.e. 40 per cent and 49.09 per cent consumed water ranging 10-20 litres per day in summer and winter seasons respectively.

Table 4.5 Distribution of families according to quantity of water used for kitchen activities

Serial No.	Kitchen activities	Quantity of water used (litres/day)							
		Summer				Winter			
		10-20	20-40	40-60	60-80	10-20	20-40	40-60	60-80
1.	Drinking	40 (36.36)	66 (60.00)	4 (3.64)	-	67 (60.91)	39 (35.45)	4 (3.64)	-
2.	Cooking	70 (63.64)	40 (36.36)	-	-	91 (82.73)	19 (17.27)	-	-
3.	Washing utensils	44 (40.00)	36 (32.73)	23 (20.91)	7 (6.36)	54 (49.09)	36 (32.73)	15 (13.36)	5 (4.55)

Note: Figures in parentheses indicate percentage to total.

Bathroom and other household activities

(d) Bathing

The Table 4.6 shows the distribution of families according to quantity of water consumed for bathroom and household activities. The table reveals that majority of respondents (45.45 per cent) utilized 40-60 litres of water in summer for bathing followed by 18.18 per cent families consuming 60-80 and 100-120 litres/day. It was observed that 11.82 per cent families consumed 80-100 litres of water per day during summer season while in winters, 56.36 per cent families consumed 40-60 litres of water and 13.64 per cent consumed 20-40 litres of water. It was further seen that 11.82 per cent families consumed 60-80 litres and 80-100 litres in winter and summer respectively. Maximum consumption of water for bathing activity was 100-120 litres per day by 6.36 per cent families.

(e) Washing clothes

During summer, maximum consumption of water for washing clothes was 100-120 litres per day by 4.55 per cent families whereas majority of the families (58.18 per cent) consumed 40-60 litres followed by 24.54 per cent which consumed 60-80 litres of water for washing clothes, 5.45 per cent consumed 80-100 litres of water and only 2.73 per cent families used 10-20 litres of water. During winter, 63.64 per cent families consumed 60 - 80 litres of water followed by 10.90 per cent families

Table 4.6 Distribution of families according to quantity of water consumed for bathroom and other household activities.

Bathroom and other household activities	Quantity of water consumed (litres per day)												
	Summer						Winter						
	10-20	20-40	40-60	60-80	80-100	100-120	10-20	20-40	40-60	60-80	80-100	100-120	120-140
Bathing	-	7 (6.37)	50 (45.45)	20 (18.18)	13 (11.82)	20 (18.18)	-	15 (13.64)	62 (56.36)	13 (11.82)	13 (11.82)	7 (6.36)	-
Washing clothes	3 (2.73)	5 (4.55)	64 (58.18)	27 (24.54)	6 (5.45)	5 (4.55)	-	3 (2.73)	11 (10)	70 (63.64)	12 (10.90)	10 (9.09)	4 (3.64)
Cleaning the house	78 (70.91)	32 (29.09)	-	-	-	-	97 (88.18)	13 (11.82)	-	-	-	-	-

Figures in parentheses indicate the percentage to the total consuming 80-100 litres of water. It was further reported that 10 per cent families consumed 40-60 litres of water and 9.09 per cent consumed 100-120 litres of water. Only 2.73 per cent were consuming 20-40 litres of water.

(f) Cleaning of the house

Data in Table 4.6 reveals that in summer season, maximum consumption of water for cleaning the house was 20-40 litres by 29.09 per cent families and 10-20 litres by the rest of the families (70.91 per cent) whereas in winter, maximum percentage of families (88.18 per cent) consumed 10-20 litres followed by 11.82 per cent families consuming water 20-40 per litres per day.

Thus, it can be concluded that maximum consumption of water was for washing clothes followed by bathing

Quantity of water used for miscellaneous activities

Out of total families, 68.18 per cent of families possessed animals and it was observed that more than half of the families used the water from open water channel for animal drinking and cleaning purposes.

(g) Cleaning of animals

Table 4.7 shows that during summer season, maximum consumption of water was 80-100 litres per day by only four per cent families whereas 40 per cent families used 40-60 litres/day followed by 38.67 per cent using 20-40 litres, 13.33 per cent using 60-80 litres of water and only 4 per cent were found using minimum water i.e. 10-20 litres per day for cleaning the animals whereas in winter season, majority of families (42.67 per cent) consumed 20-40 litres of water per day for the activity followed by 24 per cent consuming 10-20 litres per day, 21.33 per cent consuming 40-60 litres per day and 8 per cent consumed 60-80 litres of water. Maximum consumption of water for cleaning the animals was 80-100 litres per day by 4 per cent families and minimum 10-20 litres/day was required by 24 per cent families in winter.

(h) Animal drinking

For animal drinking, majority of the families (57.33 per cent) in summer used 20-40 litres of water per day followed by 26.67 per cent families consuming 10-20 litres of water, 14.67 per cent families using 40-60 litres of water and only 1.33 per cent families were using maximum water i.e. 60-80 litres per day while in winter, maximum number of families (52 per cent) consumed minimum water i.e. 10-20 litres per day followed by 20 per cent consuming 20-40 litres, 26.67 per cent consuming 40-60 litres of water whereas minimum 1.33 per cent of families were consuming 60-80 litres of water per day for the purpose of animal drinking.

(i) Kitchen garden irrigation

Majority of the respondents (64.55 per cent) used open water channel for kitchen garden irrigation in summer and winter seasons. Cent per cent respondents irrigated their kitchen gardens during summer but variation in quantity of water consumed was due to the variation in temperature.

Table 4.7 Distribution of households according to quantity of water used for miscellaneous activities

Sr. No.	Activities	Quantity of water used for miscellaneous activities (litres/day)									
		Summer					Winter				
		10-20	20-40	40-60	60-80	80-100	10-20	20-40	40-60	60-80	80-100
1.	Cleaning the animals	3 (4)	29 (38.67)	30 (40)	10 (13.33)	3 (4)	18 (24)	32 (42.67)	16 (21.33)	6 (8)	3 (4)
2.	Animal drinking	20 (26.67)	43 (57.33)	11 (14.67)	1 (1.33)	-	29 (52.00)	15 (20.00)	10 (26.67)	1 (1.33)	-
3.	Kitchen garden irrigation	25 (22.73)	60 (54.55)	23 (20.91)	-	2 (1.81)	10 (9.09)	10 (9.09)	-	-	-

Figuresin parentheses indicate percentage to the total

The Table 4.7 shows that maximum quantity of water (80-100) litres was used by only 1.81 per cent of respondents in summer while majority of the families (54.55 per cent) consumed 20-40 litres of water followed by 22.73 per cent using 10-20 litres per day, 20.91 per cent consuming 40-60 litres of water. While in winters, only 18.18 per cent respondents were watering the kitchen garden and out of that 9.09 per cent were using 10-20 litres of water and rest were using 20-40 litres of water per day for kitchen garden.

4.2.5 Time consumed and distance covered in fetching water

Distance of water source from home

Data in Table 4.8 reveal that majority of the respondents (70.91 per cent) had the access to water within 10-115 meters and maximum distance covered was 325-500 meters by 9.09 per cent respondents followed by 220-325 meters (3.64 per cent), 115-220 meters (7.27 per cent) and 9.09 per cent respondents had provision of water source at door step.

4.2.5.1 Time consumed for collecting water

Data furnished in Table 4.8 confirm that maximum time consumed during summer for collecting water was 1.5-2 hours per day by 30.91 per cent respondents whereas 46.36 per cent respondents spent 1-1.5 hours followed by 12.73 per cent who spent 0.5-1.0 hour and only 10 per cent spent upto half an hour, while in winters, 5 hours were spent for the purpose by majority of the respondents (45.45 per cent) followed by 1 to 1.5 hour (20 per cent), upto half an hour (17.28 per cent) and 1.5-2 hours by 16.37 per cent respondents.

Table 4.8 Time consumed and distance covered in fetching water

Serial No.	Particulars	Summer	Winter
1. Distance from house (mt)			
1.	< 10 or at door step	10 (9.09)	10 (9.09)
2.	10-115	78 (70.91)	78 (70.91)
3.	115-220	8 (7.27)	8 (7.27)
4.	220-325	4 (3.64)	4 (3.64)
5.	325-500	10 (9.09)	10 (9.09)
2. Time consumed (hours/day)			
1.	Upto 0.5	11 (10.0)	19 (17.28)
2.	0.5-1	14 (12.73)	50 (45.45)
3.	1-1.5	51 (46.36)	22 (20)
4.	1.5-2	34 (30.91)	18 (16.37)
3. Frequency of collecting water (Times/day)			
1.	03-10	68 (61.82)	76 (69.09)
2.	11-18	29 (26.36)	30 (27.27)
3.	19-26	13 (11.82)	4 (3.64)
4. Total distance traveled (km)			
1.	Upto 0.5	23 (20.90)	55 (50.0)
2.	0.5-1.5	69 (62.73)	46 (41.82)
3.	1.5-3.0	13 (11.82)	7 (6.36)
4.	3.0-4.5	5 (4.55)	2 (1.82)

Figures in parentheses indicate percentage

4.2.5.2 Frequency of collecting water

It is evident from the data in Table 4.8 that during summer, majority of the respondents (61.82 per cent) went 3-10 times for fetching water, 26.36 per cent went 11-18 times and 11.82 per cent made 19-25 trips per day for collecting water. The data presented in Table 4.8 related to respondents fetching water in winter indicated that majority of the respondents (69.09 per cent) walked 3-10 times, 27.27 per cent walked 11-18 times and only 3.64 per cent walked 19-25 times per day for collecting water.

Thus, data show that in summer respondents travelled more number of times than in winter because in summer, consumption of water was more than in winter.

4.2.5.3 Distance travelled (km/day)

Table 4.8 shows the distribution of respondents according to distance travelled by the respondents. It was found that during summer, majority of the respondents (62.73 per cent) travelled 0.5 to 1.5 km, 20.90 per cent travelled upto 0.5 km followed by 11.82 per cent (1.5-3.0 km). The data further reveal that in winter majority of the respondents (50 per cent) travelled 0.5 to 1.5 km per day and 41.82 per cent travelled upto 0.5 km/day. Nearly 6 per cent families travelled 1.5-3.0 km/day and only 1.82 per cent travelled 3.0-4.5 km/day for collecting water.

Plate: 4.1 Women utilizing community tap water facility

Plate: 4.2 Water scarcity forces women washing clothes in open water channel

4.2.6 Perceived satisfaction regarding availability and quality of drinking water.

Under this sub-head, the degree of satisfaction regarding availability and quality of drinking water was assessed. The data in the Table 4.9 confirms that 69.09 per cent of respondents were dissatisfied from the water they were getting for drinking purpose as 38.16 per cent of the respondents reported dissatisfaction regarding quality of drinking water. Timings of water supply were not suitable (26.31 per cent) followed by in adequacy of water (19.74 per cent) and source of water being far away (6.58 per cent). Regarding the satisfaction level, only 3.64 per cent respondents were highly satisfied and 27.27 per cent of them were only satisfied for the reason that source of water was nearby (55.88 per cent) followed by the adequate quantity of water supply (29.41 per cent) and 14.71 per cent were satisfied for the reason that failure in water supply was rare (Table 4.10).

Thus, it can be concluded that the quality of water was the problem mainly in rainy season but quantity of water was the problem throughout the year but was predominant in the summer season when water supply is less. Also non uniformity in water supply throughout the year was reported in the study area.

Table 4.9 Extent of satisfaction with regard to availability of drinking water.

Degree of satisfaction	Number	Percent
Highly satisfied	4	3.64
Just Satisfied	30	27.27
Dissatisfied	76	69.09

Table 4.10 Reasons for satisfaction and dissatisfaction of the respondents.

Sr. No.		Number	Percent
Reasons for satisfaction (n=34)			
1.	Source of water is nearby	19	55.88
2.	Quantity of water supply is adequate	10	29.41
3.	Failure of water supply is rare	5	14.71
Reason for dissatisfaction (n=76)			
1.	Source of water is far away	5	6.58
2.	Timings of water release are not suitable	20	26.32
3.	Quality of water is not satisfactory	29	38.16
4.	Quantity of water supplied is not sufficient	15	19.74
5.	Failure in water supply is frequent	7	9.20

4.3 Existing water storage practices

4.3.1 Storage devices used for potable water

Cent per cent respondents were storing water for drinking purpose. The results in Table 4.11 indicate that earthen pot was commonly used by majority (81.82 per cent) of the respondents in summer followed by plastic bucket (23.64 per cent) and aluminium vessel (19.09 per cent) whereas in winter, only 23.64 per cent respondents used earthen pot but majority of respondents used plastic bucket (40.90 per cent) followed by aluminium vessel (36.36 per cent).

Regarding the refrigerator storage, 14.55 per cent of respondents stored water in it during summer season but during winter season, none of the respondents used it for storing drinking water. During summer season, 11.82 per cent of the respondents used water filter followed by plastic bottles (6.36 per cent), copper pitcher, brass pitcher (4.55 per cent each) and stainless steel bucket (2.73 per cent). Only 0.90 per cent respondents used galvanised iron bucket and plastic tank for drinking water storage whereas in winter also 0.90 per cent respondent used galvanised iron bucket followed by plastic bottles and brass pitcher (7.27 per cent each), copper pitcher (6.36 per cent), steel vessel (4.55 per cent).

Thus, the data shows that earthen pot, plastic bucket and aluminum vessel were the most common storage devices used for drinking water.

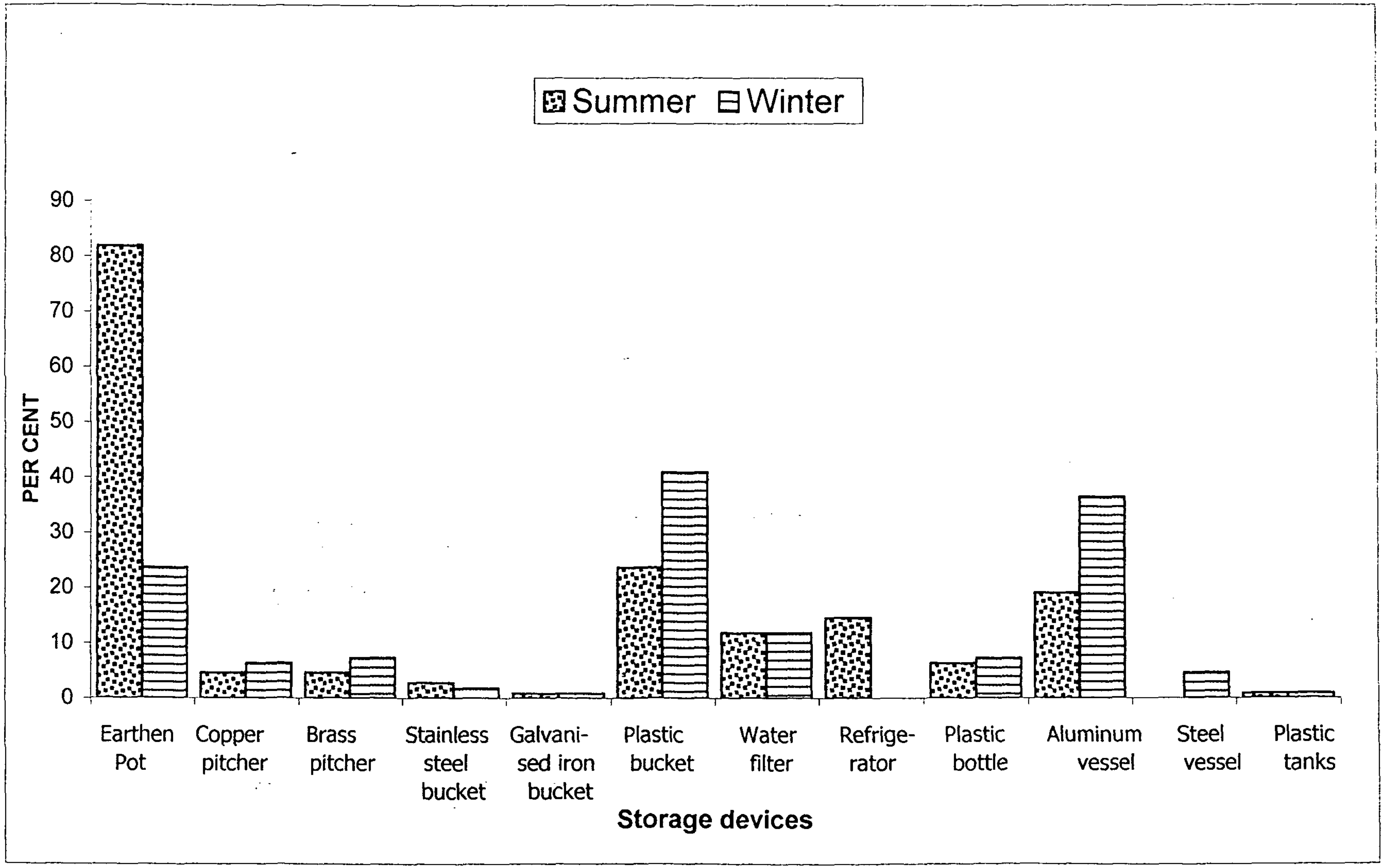

Fig. 4.1 Water storage devices used for storing water in summer and winter season

Table 4.11 Devices used for storing drinking water

Sr. No.	Storage device	Summer	Winter
1.	Earthen pot	90 (81.82)	26 (23.64)
2.	Copper pitcher	5 (4.55)	7 (6.36)
3.	Brass pitcher	5 (4.55)	8 (7.27)
4.	Stainless steel bucket	3 (2.73)	2 (1.82)
5.	Galvanised iron bucket	1 (0.90)	1 (0.90)
6.	Plastic bucket	26 (23.64)	45 (40.90)
7.	Water filter	13 (11.82)	13 (11.82)
8.	Refrigerator	16 (14.55)	-
9.	Plastic bottle	7 (6.36)	8 (7.27)
10.	Aluminium vessel	21 (19.09)	40 (36.36)
11.	Steel vessel	-	5 (4.55)
12.	Plastic tanks	1 (0.90)	1 (0.90)

Multiple response
Figures in parentheses indicates percentage

4.3.2 Opinions regarding suitable material for storing potable water and reasons for their liking.

Data presented in Table 4.12 express the opinion of respondents regarding the suitability of material for storing drinking water and Table 4.13 shows the reasons for liking particular material.

Plate: 4.3 Commonly used materials for water storage

Plate: 4.4 Earthenware water containers placed on shelf

Table 4.12 Per cent response on suitability and quality of storage devices.

Material	Number	Percent
Earthen	57	51.82
Brass	6	5.45
Copper	8	7.27
Steel	13	11.82
Plastic	12	10.90
Aluminum	20	18.18

Multiple response

Results presented in the Table 4.12 shows that more than half of the respondents considered earthenware to be most suitable material for keeping drinking water because it kept water cool (75.44 per cent) followed by traditional use (21.05 per cent), health safety (17.54 per cent) and economy (8.77 per cent).

Brass was considered suitable by only 5.43 per cent respondents because of the reasons that it is easy to handle and clean (33.33 per cent) and also because of tradition (33.33 per cent) and 16.67 per cent liked this material because it was unbreakable. Copper (7.27 per cent) was liked by the respondents as it purified the water (100 per cent) followed by safety for health (62.5 per cent), keeping water cool (50 per cent) and traditional use (37.50 per cent).

Table 4.13 Reasons for preference of material for water storage

Sr. No.	Reason	Earthen (n=57)	Brass (n=6)	Copper (n=8)	Steel (n=13)	Plastic (n=12)	Aluminum (n=20)
1.	Easy to handle	-	2 (16.67)	-	-	6 (50.00)	-
2.	Easy to clean	-	2 (33.33)	-	10 (76.92)	-	-
3.	Unbreakable	-	1 (16.67)	-	-	4 (33.33)	-
4.	Easy to replace	-	-	-	-	-	-
5.	Easy to maintain	-	-	-	7 (53.85)	-	-
6.	Because of tradition	12 (21.05)	2 (33.33)	3 (37.5)	-	-	15 (75)
7.	No other substitute	10 (17.54)	-	-	-	-	-
8.	Material purifies water	-	-	8 (100)	-	-	10 (50)
9.	Safe for health	10 (17.54)	-	5 (62.5)	-	-	6 (30)
10.	Keeps water cool	43 (75.44)	-	4 (50)	1 (7.69)	-	-
11.	Reasonable cost	5 (8.77)	-	-	-	4 (33.33)	-

Multiple response
Figuresin parentheses indicate percentage to the total

Steel was considered good by 11.82 per cent respondents because of the reason that it is easy to clean (76.92 per cent) followed by easy maintenance (53.85 per cent) and only 7.69 per cent respondents considered it safe for health. Plastic was liked by 10.90 per cent respondents because it is easy to handle (50 per cent), unbreakable and of reasonable cost (33.33 per cent each) whereas aluminium was liked by 18.18 per cent of respondents because of the reason that it is traditionally used (75 per cent), it purifies water (50 per cent) and is safe for health (30 per cent).

4.3.3 Method of covering the drinking water storage container

Table 4.14 presents that majority of the respondents (78.18 per cent) used plate or *thali* followed by earthenware lid (20 per cent), wooden piece (19.09 per cent), muslin cloth piece (14.55 per cent) tightly fitted lid (6.36 per cent) and loose fitted lid (4.55 per cent) for covering drinking water storage container.

Table 4.14 Method of covering drinking water storage container

Sr. No.	Method used	Number	Percent
1.	Loose fitted lid	5	4.55
2.	Tightly fitted lid	7	6.36
3.	By plate or *thali*	86	78.18
4.	Earthenware lid	22	20.00
5.	Wooden piece	21	19.09
6.	Muslin cloth or other cloth piece	16	14.55

Multiple response

4.3.4 Place of keeping storage container

Data revealed that majority of respondents (96.36 per cent) used kitchen as a place for storing drinking water and from that 57.55 respondents stored the container on shelf followed by 41.51 per cent on floor and only 0.94 per cent on stand. Nearly 3 per cent respondents stored water in dinning room on floor followed by only 0.90 per cent respondents in the verandah that too on the floor (Table 4.15).

Table 4.15 Place of keeping water storage container.

Sr. No.	Place	On stand	On floor	On shelf
1.	Kitchen (n=106)	1 (0.94)	44 (41.51)	61 (57.55)
2.	Dinning Room (n=3)	-	3 (100.0)	-
3.	Verandah (n=1)	-	1 (100.0)	-

* Figures in parentheses indicate percentage to total

4.3.5 Frequency of cleaning storage container

The data presented in Table 4.16 reveal that nearly half of the total respondents (56.36 per cent) washed their storage containers daily followed by 29.09 per cent of the respondents washing the containers weekly and 14.55 per cent washing them on alternate days.

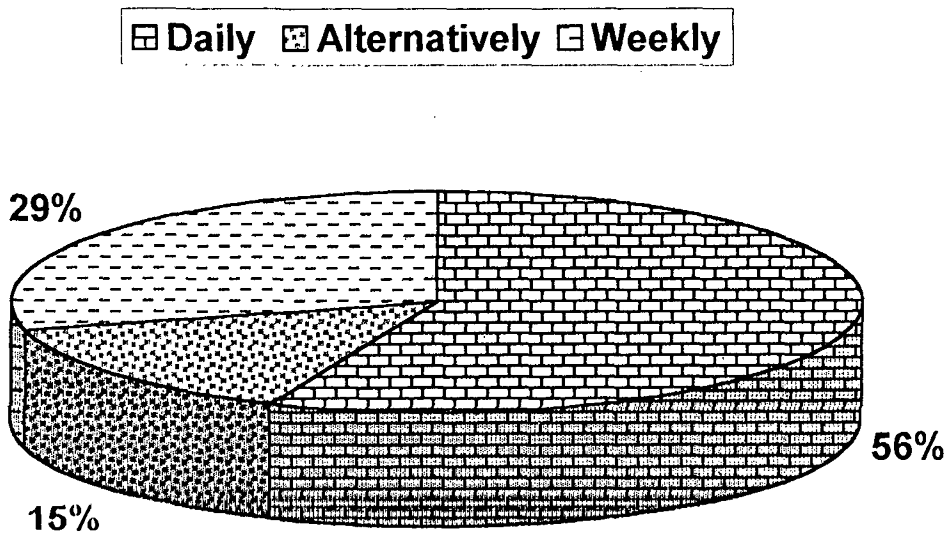

Fig. 4.2 Frequency of cleaning drinking water storage devices

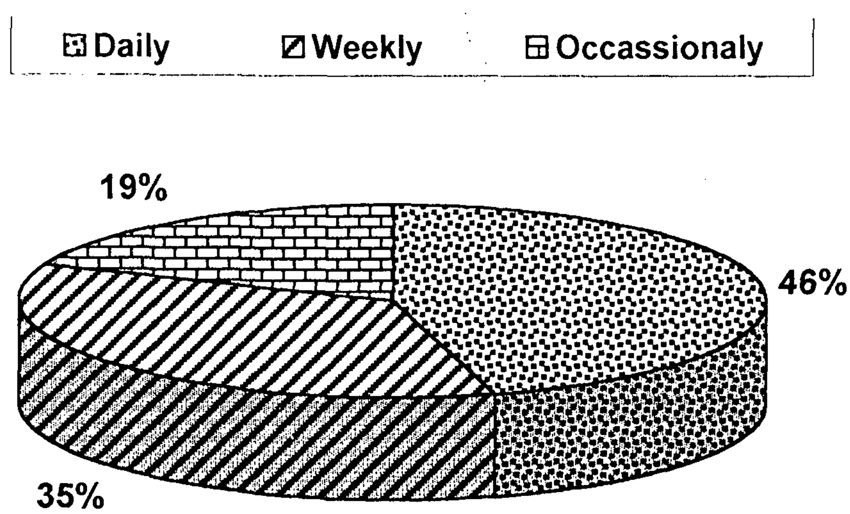

Fig. 4.3. Frequency of cleaning drinking water storage space

Table 4.16 Distribution of respondents according to frequency of cleaning water storage container and space.

Sr. No.	Characteristics	Number	Percent
1.	**Cleaning the storage container**		
	Daily	62	56.36
	Alternatively	16	14.55
	Weekly	32	29.09
2.	**Cleaning the storage space**		
	Daily	50	45.46
	Weekly	39	35.45
	Occasionally	19	19.09

4.3.6 Frequency of cleaning storage space

Results reveal that cent per cent respondents cleaned the storage space where the drinking water containers are kept and out of that 46.30 per cent respondents cleaned the storage space daily followed by 36.11 per cent cleaning it weekly and 17.59 per cent occasionally (Table 4.16).

4.3.7 Cleaning agent used for cleaning drinking water storage container

Results presented in Table 4.17 show that maximum number of respondents (51.82 per cent) were using only water for cleaning. Only 36.36 per cent were using detergent followed by ash which is known to be sterilized material for cleaning (24.55 per cent) and lemon/tamarind + salt was being used by 9.09 per cent of respondents, though this cleaning agent was used occasionally for special water storage containers of brass and copper.

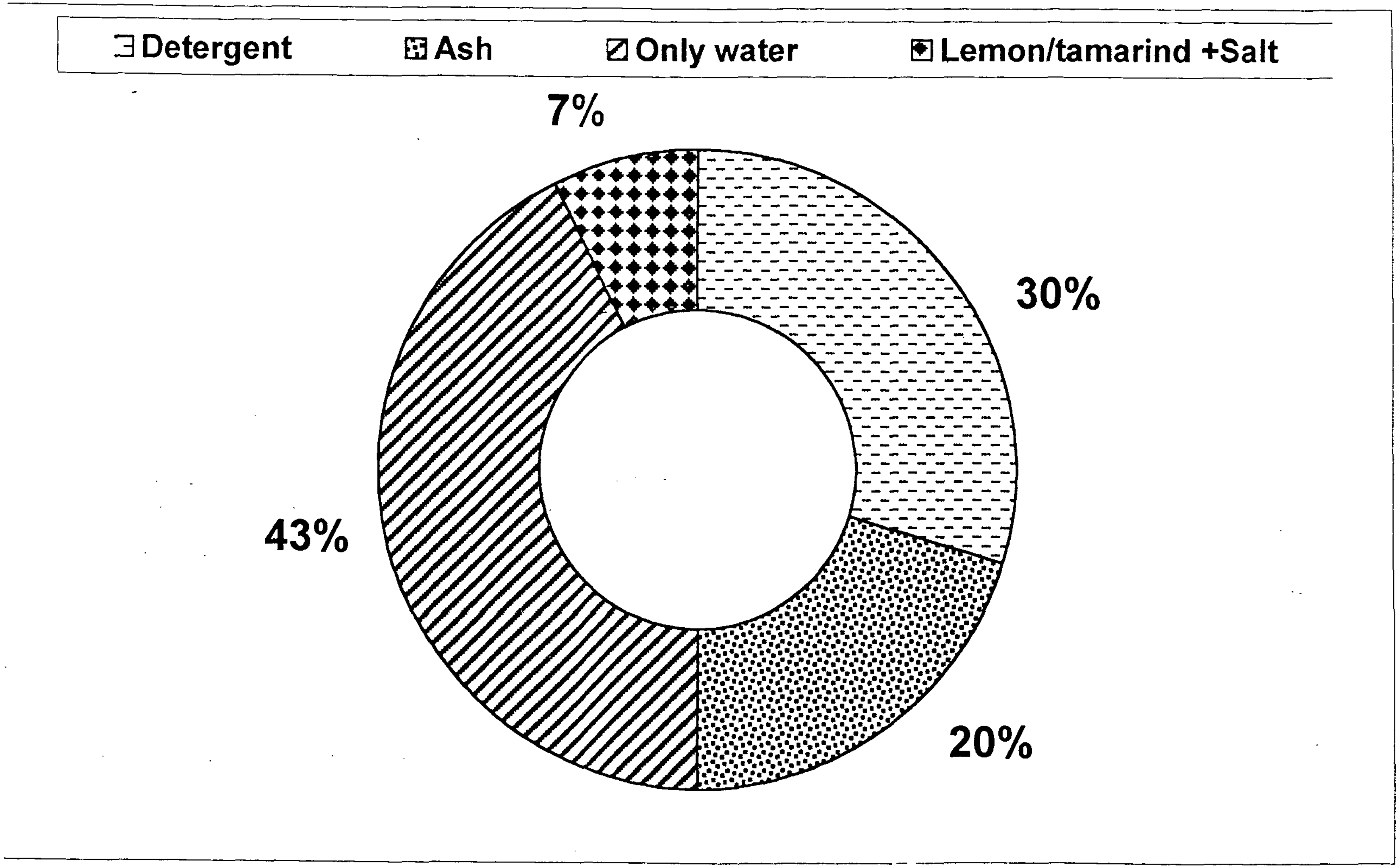

Fig. 4.4 Material used for cleaning water storage devices

Table 4.17 Materials used for cleaning the water storage container.

Sr. No.	Cleaning agents	Number	Percent
1.	Detergents	40	36.36
2.	Ash	27	24.55
3.	Only water	57	51.82
4.	Lemon/ tamarind + salt*	10	9.09

Multiple response
* Using occasionally

4.3.8 Hygienic practices followed before taking out water from the container

The data presented in Table 4.18 show that more than half of the respondents (58.18 per cent) used no vessel for taking out water but were getting the water by tilting the pot followed by use of glass and container with handle (*dohri*) (20.90 per cent each).

Also the data revealed that more than half of respondents were using hygienic practices for taking out water such as not touching hands with water (25.45 per cent) followed by washing of hands before taking out water from the pots (18.18 per cent) and use of spotlessly clean vessel for taking out water (14.54 per cent).

Table 4.18 Vessels used and hygienic practices followed for taking out drinking water.

Sr. No.	Practices	Number	Percentage
Vessel used for taking out water			
1.	Container with handle (*dohri*)	23	20.91
2.	Glass	23	20.91
3.	Tilting the pot	64	58.18
Hygienic practices followed			
1.	Washing hands before taking out water	20	18.18
2.	Use of clean vessel for taking out water	16	14.54
3.	Not touching hands with water	28	25.45

4.4 Awareness regarding the practices followed for water purification

4.4.1 Knowledge regarding characteristics of safe water

It was found that majority of the respondents i.e. 77.27 per cent considered safe water to be colourless and free from suspended matter whereas about 58.18 per cent considered water to be safe when it is odourless, 40 per cent when water is sweet in taste and only 9.09 per cent considered it safe when it is free from bacteria (Table 4.19).

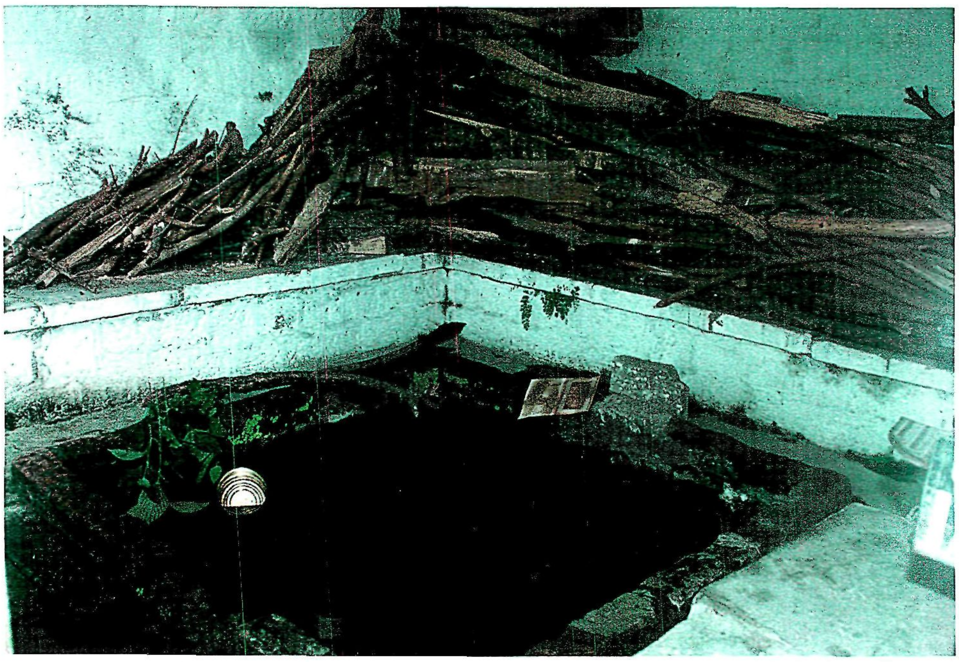
Plate: 4.5 A local water source in use (*Bauri)*

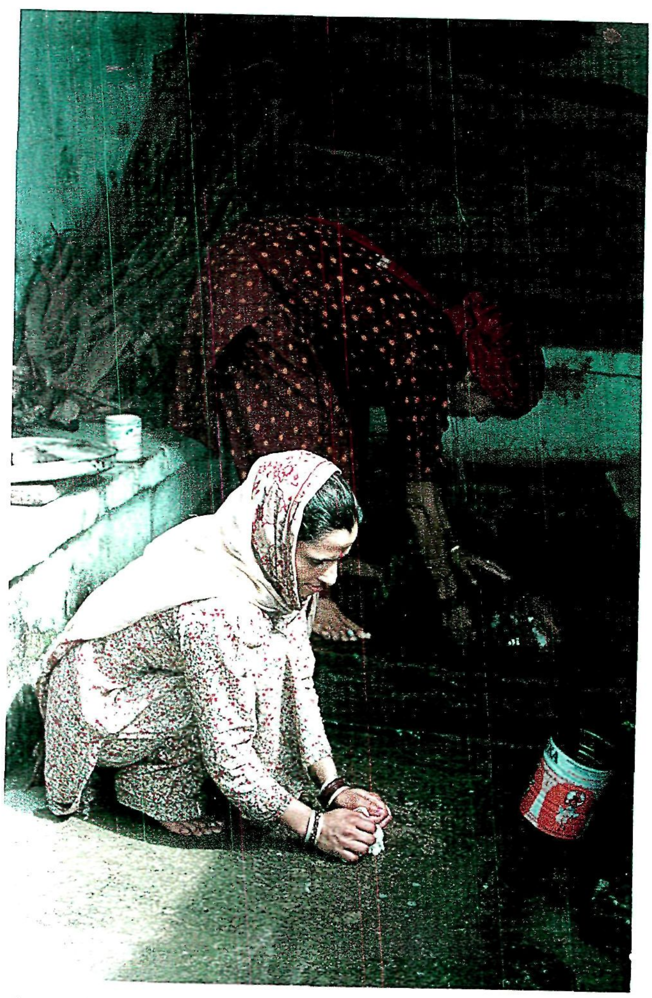
Plate: 4.6 Unhygienic condition around drinking water source

Table 4.19 Knowledge of the respondents regarding characteristics of safe water

Sr. No.	Characteristics	Number	Percent
1.	Colourless	85	77.27
2.	Odourless	64	58.18
3.	Sweet in taste	44	40.00
4.	Free from foreign particles or suspended matter	85	77.27
5.	Free from bacteria	10	9.09

Multiple responses

4.4.2 Awareness regarding water purification

Majority of respondents (81.82 per cent) strongly agreed to the statement that boiling is the water purification technique followed by just agree (12.73 per cent) and do not agree (5.45 per cent). Majority of the respondents (50.91 per cent) agreed that filtration is the purification technique followed by strongly agree (36.36 per cent) and 12.73 per cent did not agree. Chlorination was considered important purification technique by majority of the respondents strongly (54.55 per cent). Nearly 44 per cent of respondents did not agree with the statement that use of Potassium permanganate or *laldawai* is a purification technique, 36.36 per cent agreed and 20 per cent strongly agreed. Nearly 61 per cent strongly agreed followed by 21.27 per cent just agreed and 11.82 per cent do not agree to the statement that boiling kills germs. About 64 per cent respondents

Table 4.20 Awareness of respondents regarding water purification

Sr. No.	Statements	Strongly agree	Agree	Don't agree
1.	Boiling	90 (81.82)	14 (12.73)	6 (5.45)
	Filtration	40 (36.36)	56 (50.91)	14 (12.73)
	Chlorination	60 (54.55)	36 (32.72)	14 (12.73)
2.	Use of Potassium permanganate as purifying material	22 (20)	40 (36.36)	48 (43.64)
3.	Boiling kills germs	67 (60.91)	30 (21.27)	13 (11.82)
4.	Use of muslin cloth removes suspended impurities but not germs	70 (63.64)	30 (27.27)	10 (9.09)
5.	Chlorine tablets are white in colour	75 (68.18)	23 (20.91)	12 (10.91)
6.	One tablet of chlorine is meant for 20 lit of water	20 (18.18)	20 (18.18)	70 (63.64)
7.	Tapfilter, candle filter and electronic filter are filtration techniques	24 (21.82)	72 (65.45)	14 (12.73)
8.	Candle filter should be sterilized once in a month	30 (27.27)	45 (40.91)	35 (31.82)
9.	Jaundice, polio, cholera, dysentery, diarrhoea are diseases due to water contamination	100 (90.91)	6 (5.45)	4 (3.64)
10.	Safe drinking water storage devices are good for health so one should go for a change	96 (87.27)	10 (9.09)	4 (3.64)

strongly agreed, 27.27 per cent just agreed and 9.09 per cent not agreed that use of muslin cloth removes suspended impurities but not germs. Most of the respondents (68.18 per cent) strongly agreed followed by just agreed (20.91 per cent) and do not agree (10.91 per cent) that chlorine tablets are white in colour . Regarding the dose of chlorine tablet for water purification majority of the respondents did not agree (63.64 per cent) followed by strongly agreed (18.18 per cent) and just agreed (18.18 per cent).

About 65 per cent respondents agreed and only 21.82 per cent strongly agreed that tap filter, candle filter and electronic filters are filtration techniques. Most of the respondents agreed (40.91 per cent) that candle filter should be sterilized once a month followed by do not agree (31.82 per cent) and just agreed (27.27 per cent). Jaundice, polio, cholera, dysentery, diarrhoea are diseases due to intake of contaminated water were strongly agreed (90.91 per cent) respondents followed by agreed (5.45 per cent) and do not agree (3.64 per cent). Majority of the respondents strongly agreed (87.27 per cent), agreed (9.09 per cent) and do not agree (3.64 per cent) that safe drinking water storage are good for health so one should go for change (Table 4.20).

4.4.3 Method of procurement of drinking water

The results of Table 4.21 depicts that out of 110 respondents, a large majority of the respondents (88.18 per cent) procure water directly from the source whereas only 11.82 per cent respondents used muslin cloth piece either around the tap or on the storage container before filling water in it.

Plate: 4.7 Women are drinking water managers

4.21 Distribution of respondents according to the process of procurement of drinking water.

Sr. No.	Process of procurement	Number of farmers	Percent
1.	Directly from the tap or source of water	97	88.18
2.	After filtration (muslin cloth)*	13	11.82

* More prevalent in rainy season

4.4.3 Reasons of contamination of drinking water

The data presented in Table 4.22 indicates that 61.82 per cent respondents reported that rain water contaminated water followed by improper drainage system (50 per cent), mixing of sewage with drinking water (25.45 per cent) and only 9.09 per cent of the respondents reported that water gets contaminated due to improper storage and due to the reason that people or animal defecate near the source of water. The research findings clearly depict respondents having different levels of awareness regarding causes of water contamination.

Table 4.22 Knowledge of respondents regarding different sources of drinking water contamination

Sr. No.	Reasons for pollution	Number	Percent
1.	Mixing of rain water	68	61.82
2.	Improper drainage	55	50.00
3.	Animals drink from same source	12	10.91
4.	People or animal defecates near source	10	9.09
5.	Improper storage	10	9.09
6.	Mixing of drinking water with sewage	28	25.45

Multiple responses


Plate: 4.8 Boiling of drinking water

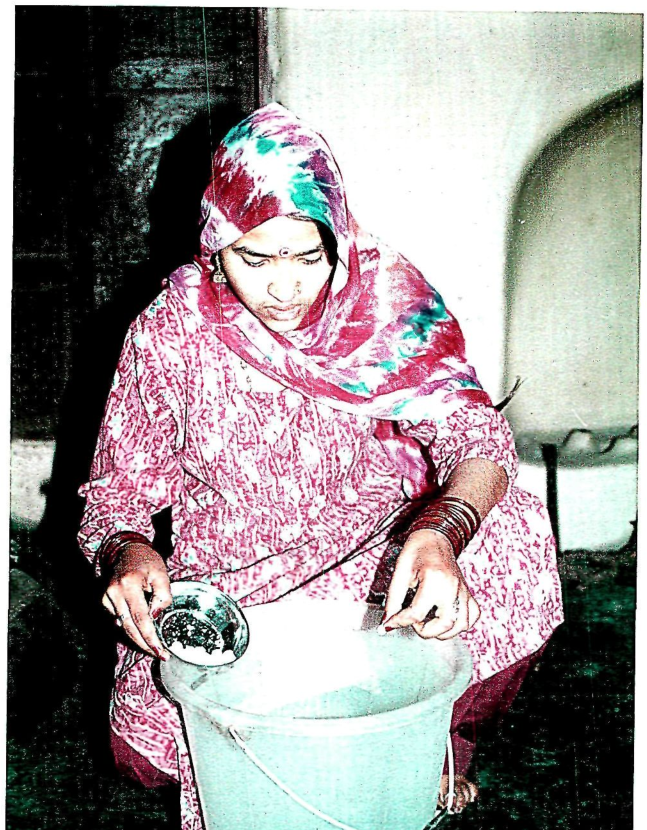
Plate: 4.9 Chlorination of drinking water

4.4.4 Purification of water

Although majority of the respondents were getting water from tap which is considered to be treated water, yet 59.09 per cent respondents were giving treatment to water at home which is presented in Table 4.23. The findings revealed that out of total respondents, 53.85 per cent respondents used boiling as purification method, 30.77 per cent respondent kept water still for some time to remove the suspended impurities, 23.08 per cent used candle filters, 20 per cent practiced filtration with the cloth. Use of chlorine tablets (18.46 per cent) and use of bleaching powder (3.08 per cent) was also found. Boiling and chlorination were the techniques of water treatment adopted by the majority of the respondents in rainy season.

Table 4.23 Distribution of respondents according to treatments for water purification used at household level.

(n=65*)

Sr. No.	Treatment	Number	Percentage
1.	Filtration with cloth	13	20.00
2.	Keeping water still	20	30.77
3.	Boiling	35	53.85**
4.	Chlorination	12	18.46**
5.	Bleaching powder	2	3.08
6.	Filtration with filter	15	23.08

Multiple responses
* Sixty five respondents were giving treatments to drinking water
** Boiling and chlorination were the two treatment techniques which were prevalent in rainy season only.

4.4.5 Constraints in adoption of purification technique

The major constraints faced by the respondents were economical constraints (51.82 per cent), attitudinal constraints (41.82 per cent) which included attitudes like not ready to accept new things or not feeling the need of purification, technological constraints (14.55 per cent) and only 7.2 per cent faced time constraints (Table 4.24).

Table 4.24 Constraints in adoption of purification technique

Sr. No.	Constraints	Number	Percent
1.	Technological constraints	16	14.55
2.	Time constraints	8	7.21
3.	Attitudinal constraints	46	41.82
4.	Economical constraints	57	51.82

Multiple responses

4.4.6 Incidence of water borne diseases in different age groups

An attempt has been made to find out the percentage of water borne diseases in different age groups. Table 4.25 shows incidences of water borne diseases which they suffered for last 2 years and frequency of its occurrence in accordance to their age.

Incidence of cholera was least seen in any age group except for adult males where 3.85 per cent respondents were found to be suffering from this disease once in a year followed by adolescent females where only 1.09 per cent female respondents had this disease.

Table 4.25. Incidence of water borne diseases according to age groups

	Water borne diseases										
	Cholera	Typhoid	Dysentery	Dental caries	Dyspepsia	Constipation	Diarrhoea	Hepatitis	Gastroenteritis	Jaundice	Worm infestation
Infant (upto 2 years) n=30											
Not at all	30 (100)	29 (96.67)	30 (100)	30 (100)	30 (100)	30 (100)	17 (56.67)	30 (100)	30 (100)	20 (66.67)	30 (100)
MF	-	-	-	-	-	-	-	-	-	-	-
F	-	1 (33.33)	-	-	-	-	13 (43.33)	-	-	10 (33.33)	-
Early childhood (2-6 years) n=22											
Not at all	22 (100)	20 (90.91)	20 (90.91)	22 (100)	22 (100)	19 (86.36)	11 (50)	22 (100)	22 (100)	22 (100)	18 (81.82)
MF	-	-	-	-	-	-	-	-	-	-	-
F	-	2 (9.09)	2 (9.09)	-	-	3 (13.64)	11 (50)	-	-	-	4 (18.18)
Late childhood (6-12 years) n=34											
Not at all	34 (100)	33 (97.06)	28 (82.35)	28 (82.35)	34 (100)	34 (100)	34 (100)	32 (94.12)	34 (100)	34 (100)	32 (94.22)
MF	-	-	-	-	-	-	-	-	-	-	-
F	-	1 (2.94)	6 (17.65)	6 (17.65)	-	-	-	-	-	-	2 (5.88)
Adolescence Male (12-21 years) n=85											
Not at all	85 (100)	80 (94.12)	77 (90.50)	85 (100)	85 (100)	85 (100)	68 (80)	85 (100)	81 (95.29)	85 (100)	75 (88.24)
MF	-	-	-	-	-	-	-	-	-	-	-
F	-	5 (5.88)	8 (8.41)	-	-	-	17 (20)	-	4 (4.71)	-	10 (11.76)
Adolescence Female (12-21 years) n=97											
Not at all	96 (98.97)	95 (97.94)	56 (57.73)	97 (100)	96 (98.97)	97 (100)	73 (95.26)	97 (100)	94 (96.91)	97 (100)	97 (100)
MF	-	-	11 (11.34)	-	1 (1.03)	-	6 (6.18)	-	-	-	-
F	1 (1.03)	2 (2.06)	30 (30.93)	-	-	-	18 (18.56)	-	3 (3.09)	-	-
Adulthood Male (21-58 years) n=208											
Not all	200 (96.15)	196 (94.23)	203 (97.60)	208 (100)	208 (100)	193 (92.79)	194 (93.27)	208 (100)	206 (99.04)	205 (98.56)	208 (100)
MF	-	-	-	-	-	6 (2.88)	-	-	-	-	-
F	8 (3.85)	12 (5.77)	5 (2.40)	-	-	9 (4.33)	14 (6.73)	-	2 (0.96)	3 (1.44)	-
Adulthood Female (21-58 years) n=183											
Not at all	183 (100)	181 (98.91)	157 (85.79)	182 (99.45)	180 (98.36)	181 (98.90)	163 (89.07)	181 (98.91)	176 (96.17)	181 (98.91)	181 (98.91)
MF	-	-	8 (4.37)	-	2 (1.09)	1 (0.55)	2 (1.09)	-	-	-	-
F	-	2 (1.09)	18 (9.84)	1 (0.55)	1 (0.55)	1 (0.55)	18 (9.84)	2 (1.09)	2 (1.09)	7 (3.83)	2 (1.09)
Old age Male (58 onwards) n=40											
Not at all	40 (100)	40 (100)	37 (92.50)	40 (100)	40 (100)	30 (75)	36 (90)	40 (100)	34 (85)	40 (100)	40 (100)
MF	-	-	-	-	-	10 (25)	-	-	-	-	-
F	-	-	3 (7.50)	-	-	-	4 (10)	-	6 (15.0)	-	-
Old age Female (58 onwards) n=55											
Not at all	55 (100)	54 (98.18)	46 (83.64)	55 (100)	55 (100)	53 (96.36)	36 (65.46)	54 (98.18)	55 (100)	55 (100)	55 (100)
MF	-	-	5 (9.09)	-	-	-	5 (9.09)	-	-	-	-
F	-	1 (1.82)	4 (7.27)	-	-	2 (3.64)	14 (25.45)	1 (1.82)	-	-	-

Figures in parentheses indicate percentage to total.
MF: Most frequent (once in 6 months)
F: Frequent (with in a year)

Highest percentage (9.09%) of respondents in early childhood were suffering from typhoid followed by 5.88 per cent adolescent males, 5.77 per cent adult males, 3.33 per cent infants, 2.94 per cent in late child hood and 1.82 per cent in old age female, they all were found to have suffered from this disease frequently.

Dysentery was the disease found maximum in adolescents i.e. 9.41 per cent males, 30.93 per cent females frequently while 11.34 per cent females suffered most frequently, 17.65 per cent in late child hood, 8.41 per cent adolescent males, 9.84 per cent adult females, 7.5 per cent old age males and 7.27 per cent old age females were suffering from the disease frequently and other family members who suffered from the disease most frequently were present in all age groups except for infants, early childhood and late childhood where the number was less than five per cent.

Dental caries was the disease which was not present in any age group except in late child hood where 17.65 per cent respondents suffered from the disease frequently and only 0.55 per cent adult female respondents were suffering from the disease frequently.

The prevalence of dyspepsia was least seen in any age group. Its occurrence was reported in adolescent and adult females but number was less than 2 per cent.

Regarding constipation, majority of old age male (25 per cent) respondents were suffering from the disease most frequently, adult males (2.88 per cent) and 13.64 per cent respondents from early childhood were also suffering from this disease very frequently.

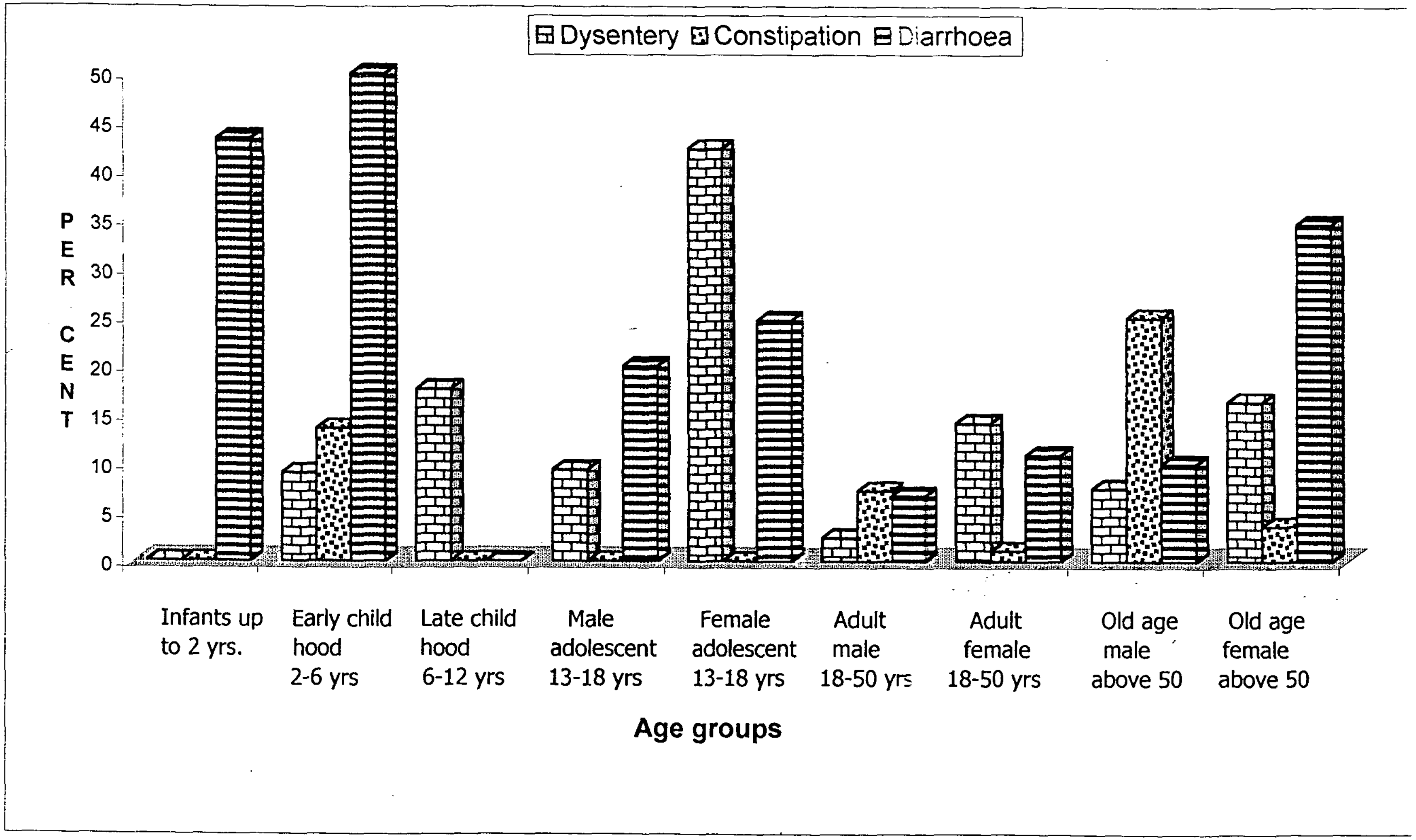

Fig. 4.5 Prevalence of water borne diseases in different age groups (%).

Diarrhoea was the disease which was most common in all the age groups and its percentage was highest in infancy (43.33 per cent) and early childhood (50 per cent) whereas in old age females (25.45 per cent), adolescent males (20 per cent), adolescent females (18.56 per cent) suffered from the disease frequently whereas in other age groups, its percentage was less than 10 per cent.

Data regarding the hepatitis disease reveals that majority of the respondents were not suffering from this disease in any of the age groups except 1.09 per cent respondents belonging to adult female and old age female (1.81 per cent) age group who had suffered from the disease.

Gastroenteritis was not present in childhood but was present in old age males, adult females and males and incidences were 15 per cent, 1.09 per cent and 0.96 per cent respectively but in adolescent males and females, its occurrence was 4.71 per cent and 3.09 per cent respectively.

Out of total family members in different age groups, very few respondents were found to have suffered from jaundice problem. The sufferers were adult males (1.44 per cent) and females (3.83 per cent) who were found suffering from this problem frequently, while in infancy its percentage was higher i.e. 33.33 per cent.

Regarding worm infestation, it was found to be common in early childhood, adolescence and late childhood i.e. 18.18 per cent, 11.76 per cent and 5.88 per cent respectively. It was also found that this disease was not present in adulthood and old age.

Thus, the results show that diarrhoea was present in all the age groups but was more prevalent in different stages of childhood which was observed due to lack of resistance in children against contaminated water which result in diarrhoeal diseases frequently, whereas, other diseases like constipation and dyspepsia were more common in old age which may be due to the reason that less intake of diet specially roughage content and lack of digestive enzymes due to old age may cause constipation and dyspepsia.

Relationship between water borne diseases and water management practices

The correlation coefficients worked out between frequency of water borne diseases and water management practices used by the sampled households are presented in Table 4.26.

Table 4.26 Relationship between water borne diseases and water management practices

Water management practices	Water borne diseases (Correlation coefficient)
Hygienic practices	-0.22184**
Purification method	-0.28482**
Frequency of cleaning the storage container	-0.19860*
Frequency of cleaning the storage space	-0.10053^{NS}

**Significant at 1 per cent level
* Significant at 5 per cent level
^{NS} Non significant

It was found that frequency of cleaning water storage container, other hygienic practices and purification method were significantly negatively correlated with incidence of water borne diseases. Out of these highest correlation value was shown by purification methods which implies that purification of water can add to a great deal in reducing the incidences of different water borne diseases. Frequency of cleaning water storage space can also reduce the frequency of water borne diseases in the family. However, the coefficient of correlation was statistically non significant. Therefore, it can be concluded that frequency of cleaning the container, use of other hygienic practices and purification techniques emerged as the important factors which can reduce vulnerability of people to water borne diseases.

Laboratory experiments

Drinking water samples were collected from natural water sources i.e. *bauris* in five different localities of the study area. These were subjected to different treatments and analyzed for physical, chemical and bacteriological characteristics.

Physio-chemical examination

4.5.1 Physical examination

Physical examination of all the water samples both treated and untreated showed water to be odourless with acceptable taste and colour. The turbidity level varied between 0.5 to 3.9 NTU for raw water samples and

Table 4.27 Physical analysis of water samples at different stages of purification treatment

SAMPLE PARTICULARS Stages of Purification & Treatment.	Place	Sample No	Color Hz. Units 5*	Odour	Taste	Turbidity NTU 5*	Conductivity mhos/ cm 50-1500*
Untreated	Mahakal	BO-1	3.5			3.9	334
	Tharu	BO-2	4.0			3.3	457.6
	Salyana	BO-3	2.0	Unobjectionable	Agreeable	1.4	164.7
	Sungal	BO-4	2.5			1.4	221.7
	Padiyarkhar	BO-5	1.0			0.5	172.2
Chlorinated	Mahakal	BO-1	1.0			4.2	389.2
	Tharu	BO-2	3.5			3.5	487.8
	Salyana	BO-3	1.5	Unobjectionable	Agreeable	1.9	197.8
	Sungal	BO-4	2.5			1.9	177.3
	Padiyarkhar	BO-5	0.5			0.7	177.3
Candle Filter	Mahakal	BO-1	2.5			1.9	287.2
	Tharu	BO-2	3.0			1.7	312.6
	Salyana	BO-3	1.0	Unobjectionable	Agreeable	1.2	132.2
	Sungal	BO-4	0.5			0.9	131.8
	Padiyarkhar	BO-5	0.5			0.2	121.4
Boiled	Mahakal	BO-1	2.0			1.7	187.7
	Tharu	BO-2	1.0			1.3	279.9
	Salyana	BO-3	1.0	Unobjectionable	Agreeable	0.7	97.2
	Sungal	BO-4	1.0			Nil	117.4
	Padiyarkhar	BO-5	0.5			Nil	97.2
Boiled & C.F.**	Mahakal	BO-1	1.0			0.9	144.2
	Tharu	BO-2	0.5			0.2	213.8
	Salyana	BO-3	0.5	Unobjectionable	Agreeable	0.1	87.7
	Sungal	BO-4	Nil			Nil	59.2
	Padiyarkhar	BO-5	Nil			Nil	64.2

* Acceptable limits.
** Boiled and Candle Filter.

was minimum i.e. 0.5 NTU for *bauri* in Padiyarkhar. After chlorination, the turbidity level increased but remained in the acceptable range (< 5 NTU). The maximum reduction of turbidity was recorded after samples were boiled and candle filtered. The conductivity of untreated water samples ranged within 164.7-457.6 mhos/cm as shown in Table 4.27 and was maximum at Mahakal. After chlorination, an increasing trend in conductivity was noticed except for one sample. There was maximum reduction in conductivity after the water was boiled and candle filtered but was within the acceptable limits i.e. 50-1500 mhos/cm.

4.5.2 Chemical examination

Results of chemical analysis of water samples are presented in Table 4.28.

pH level

In untreated water sample, pH was found to vary between 7.21-7.87 (acceptable range 6.5 to 8.5) and maximum reduction in pH was found after boiling and then passing it through candle filter followed by only boiling while after candle filtration there was negligible reduction in pH (Table 4.28). After water treatment, pH was also with in the acceptable limits.

Total dissolved solids

Total dissolved solids (TDS) level in untreated samples was found between 132-242 mg/lt (acceptable limit < 600 mg/lt). Table 4.28 indicates the variation in total dissolved solids level after giving treatments

Table 4.28 Chemical analysis of water samples at different stages of purification treatment

Stages of Purification & Treatment	Place	Sample	pH 6.5-8.5*	TDS mg/l 600*	% reduction in TDS	Hardness as $CaCO_3$ mg/l 50*	%reduction in hardness
Untreated	Mahakal	BO-1	7.87	176	_	160	_
	Tharu	BO-2	7.41	242	_	180	_
	Salyana	BO-3	7.42	157	_	100	_
	Sungal	BO-4	7.21	146	_	140	_
	Padiyarkhar	BO-5	7.28	132	_	80	_
Chlorinated	Mahakal	BO-1	7.12	162	7.5	153	4.38
	Tharu	BO-2	7.42	221	8.68	172	4.44
	Salyana	BO-3	7..37	152	3.18	92	8.00
	Sungal	BO-4	7.12	144	1.37	136	2.86
	Padiyarkhar	BO-5	720	130	1.52	80	0.00
					(4.45)		(3.94)
Candle Filter	Mahakal	BO-1	7.67	171	2.84	160	0.00
	Tharu	BO-2	7.37	235	2.90	180	0.00
	Salyana	BO-3	7.32	150	4.46	98	2.00
	Sungal	BO-4	7.17	139	4.79	136	2.86
	Padiyarkhar	BO-5	7.22	130	1.52	80	0.00
					(3.30)		(0.97)
Boiled	Mahakal	BO-1	7.42	154	12.5	135	15.63
	Tharu	BO-2	7.01	182	24.79	152	15.55
	Salyana	BO-3	7.28	137	12.73	80	20
	Sungal	BO-4	7.02	121	17.13	120	14.29
	Padiyarkhar	BO-5	7.10	120	9.09	60	25
					(15.25)		(18.09)
Boiled & C.F.**	Mahakal	BO-1	7.31	142	12.5	135	15.63
	Tharu	BO-2	7.00	179	15.55	148	17.78
	Salyana	BO-3	7.26	132	20	80	20
	Sungal	BO-4	6.98	120	14.29	120	14.29
	Padiyarkhar	BO-5	7.08	119	25	60	25
					(17.47)		(18.54)

*Acceptable limits.
**Boiled and Candle Filter.
Figures in bracket indicate mean reduction

to different water samples. It was found that maximum reduction in total dissolved solids (TDS) level was noticed after it was boiled and candle filtered (17.47%) followed by boiling only (15.25%), chlorination (4.45%) and candle filtration (3.30%).

The results thus indicate that boiling and candle filtration are the best treatments for removal of total dissolved solids in water followed by boiling, chlorination and candle filtration.

Hardness of $CaCO_3$

Two water samples collected from Mahakal and Tharu were considered hard (150-300 mg/lt) and rest three samples were moderately hard (50-150 mg/l). Table 4.27 indicates the percentage removal of hardness after giving treatment to different water samples. It is revealed from the table that maximum amount of hardness in water was removed after boiling and then passing through candle filter i.e. 18.54 per cent followed by only boiling (18.09 per cent), chlorination (3.94 per cent) and candle filtration (0.97 per cent).

Bacteriological examination of water

Bacteriological examination of water from different *bauris* of the study area along with different water treatment techniques used for purification was conducted and the results are presented in Table 4.29.

Table 4.29. Bacteriological analysis of water samples at different stages of purification treatment

Sample particulars			Total No MPN*/ 100 ml	Origin		Inference
Stages of Purification & Treatment	Place	Sample No		Faecal	Non Feacal	
Untreated	Mahakal	BO-1	245	Faecal	-	Non Potable
	Tharu	BO-2	550	-	Non Faecal	Non Potable
	Salyana	BO-3	110	Faecal	-	Non Potable
	Sungal	BO-4	700	Faecal	-	Non Potable
	Padiyarkhar	BO-5	50	Faecal	Non Faecal	Non Potable
Chlorinated	Mahakal	BO-1	Nil	-	-	Potable
	Tharu	BO-2	Nil	-	-	Potable
	Salyana	BO-3	Nil	-	-	Potable
	Sungal	BO-4	Nil	-	-	Potable
	Padiyarkhar	BO-5	Nil	-	-	Potable
Candle filter	Mahakal	BO-1	120(51.02)	Faecal	-	Non Potable
	Tharu	BO-2	130(76.36)	-	Non Faecal	Non Potable
	Salyana	BO-3	50(45.45)	Faecal	-	Non Potable
	Sungal	BO-4	550(21.43)	Faecal	-	Non Potable
	Padiyarkhar	BO-5	28(54.55)	-	Non Faecal	Non Potable
Boiled	Mahakal	BO-1	Nil	-	-	Potable
	Tharu	BO-2	Nil	-	-	Potable
	Salyana	BO-3	Nil	-	-	Potable
	Sungal	BO-4	Nil	-	-	Potable
	Padiyarkhar	BO-5	Nil	-	-	Potable
Boiled & C.F.**	Mahakal	BO-1	Nil	-	-	Potable
	Tharu	BO2	Nil	-	-	Potable
	Salyana	BO3	Nil			Potable
	Sungal	BO4	Nil	-	-	Potable
	Padiyarkhar	BO5	Nil	-	-	Potable

*Most probable number
**Boiled and candle filtered
Figures in parentheses indicate percentage removal.

All the untreated five samples were found non potable after performing presumptive, confirmative and completed test for the presence of *Faecal coliform*. *Bauri* in Sungal area of Panchrukhi block had maximum number of coliforms (700) followed by Tharu (550), Mahakal (245) and Salyana (110).

Gas production and change in colour due to metabolic activity of coliforms was recorded after 16 hrs while in some cases, it was recorded after 24 hours. The growth indicator bacteria *E. coli* on EMB Agar was recorded after 24 hours. These non potable samples were then tested for type of contamination i.e. faecal and non faecal by incubating subcultures from positive presumptive test at 44°C and 37°C in Brillent Green Lactose Bile Broth and other subculture prepared at 44°C in peptone water. The presence of *E. coli* (faecal contamination) was confirmed in four samples of Mahakal, Salyana, Sungal and Padiyarkhar by the production of gas from lactose at 37°C and indole from tryptophan.

Non potable samples were further subjected to various treatments to make water potable. These treatments included chlorination, candle filtration, boiling and boiling with candle filtration. Thus, the results presented in Table 4.29 reveal that water was rendered completely free of indicator bacteria i.e. *E. coli* after chlorination, boiling and boiling along with candle filtration but the percentage removal of total coliform count/100 ml was less in candle filter i.e. Tharu (76.36 per cent), Padiyarkhar (54.55 per cent), Mahakal (51.02 per cent), Salyana (45.45 per cent), Sungal (21.43 per cent).

Conclusively, it was found that candle filtration was not a good purification technique for removing bacteria like coliforms whereas chlorination and boiling were found to be comparatively better techniques.

DISCUSSION

Chapter V

DISCUSSION

This chapter contemplates the findings emerged out from the results of study displayed in preceding chapter along with critical and logical analysis in the light of earlier work.

5.1 Field survey

5.1.1 General profile of the respondents

The description of sample reveals the socio-economic and demographic features of families surveyed. Majority of the respondents belonged to the middle age group (25-50 years) which is the most productive and energetic period of one's life. Most of the respondents were illiterate followed by the respondents having education level upto primary. Majority of the respondents were only a housewives, another section consisting of daily wage labourers in addition to being housewives and only small portion of the respondents were engaged in government service.

The family characteristics of the respondents revealed that majority of families were having the size of more than five members with average family size of 6.47 which is a large family size. Most of them belonged to nuclear families. This clearly shows that gradually, the joint family system is becoming unpopular. This may be due to preference of couples to lead independent life. The increasing cost of living has also discouraged joint family system. Maximum number of respondents had monthly family income between Rs 1000 to Rs 5000 per month with an average of Rs 3415.55. More than half of the respondent families had low level of educational status which meant only 0-2 members of the family were literate and government service was the main occupation of respondent families followed by daily wage labourers. Maximum number of respondents had *kuccha* house depicting scarcity of resources in the study area.

5.1.2 Availability and utilization pattern affects the drinking water management practices of a family

Regarding the availability of water, majority of the families used tap water followed by open water channel and *bauri*. Similar results were reported by Bala *et al.* (1994). She observed that in Hisar town, tap was the most common water source used by 88 per cent families as the source was near to their residence and easily available.

Preference of the respondents regarding the source of safe drinking water showed that maximum number of respondents considered tap water safest followed by *bauri* and hand pump. Arora (1999) reported in her study at Ludhiana that maximum percentage of respondents i.e. 93.3 per cent believed tap as source of safe water. As majority of respondents utilized tap as source of water through pipe line connections. So it becomes the responsibility of government to ensure safe drinking water through protection of water sources and water supply free from contamination.

Most of the families used tap water for activities viz. drinking, bathing, cooking and washing utensils while open water channel was used by majority of respondents for activities like washing clothes, animal drinking, animal cleaning and kitchen garden irrigation. *Bauri* and hand pump was used mainly for drinking purposes. Bala (1990) reported that majority of families used tap water for activities viz. drinking (83.3 per cent), cooking (73.3 per cent), washing utensils (78.6 per cent) and bathing (84.6 per cent).

Furthermore regarding amount of water consumption for different activities, kitchen activities like drinking, cooking and washing utensils; bathroom activities like bathing, washing clothes and cleaning of house; other activities like drinking water for animals, cleaning the animals and kitchen garden irrigation, a seasonal variation in quantity of water utilized was observed. The utilization of water was found to be more in summer than in winter thus leading to water scarcity problem in summer. Maximum utilization of water was reported to be for bathroom and household activities. For drinking, majority of the families consumed 20-40 litres of water per day in summer and 10-20 litres per day in winter.

While assessing the satisfaction of respondents for availability of drinking water, majority of the respondents were dissatisfied because of the reason that quality of water available was not satisfactory followed by improper timings of water release. Among satisfied respondents, only a few respondents were highly satisfied and rest were just satisfied. The respondents who were highly satisfied expressed the reason for their satisfaction as source of water being very near to their residence. This explicits the importance of distance of water source from the place of residence in the minds of rural people. In addition to distance, quantity of water was the major problem faced throughout the year but was predominant in summer season when supply of water is very scarce. It was also observed during the study period that there was no uniformity in distribution of water supply in the area. Similar finding were revealed by Singal and Sangwan (1986) in which majority of housewives both working and non working felt the shortage of regular water supply.

Women are the main agency for water procurement in villages with scarce water supply. Besides, they are also involved in other household chores as cooking, washing, cleaning of kitchen, caring for other family members and looking after livestock which makes their lives miserable. The study indicated that majority of women travelled a distance of 0.5 to 1.5 km for collecting water which consumed 1-1.5 hours/day in summer while in winter, the distance travelled was less (0.5 km) thus reducing the time consumption (0.5-1.0 hour/day). Hence, modern or alternate water sources and storage methods need to be planned and promoted in the village to solve the problem of women and water.

5.1.3 Existing drinking water storage practices

With regard to storage devices, cent per cent respondents were storing water for drinking purpose. Majority of them were using earthenware in summer followed by plastic bucket and aluminium vessel whereas in winter, maximum number of respondents used plastic bucket followed by aluminium vessel and earthenware. Mehta *et al.* (1992) reported that in Kanpur. majority of respondents used earthen pots for storing drinking water in summer. Earthenware was considered to be most suitable material for storing drinking water because of its ability to keep water cool, its being traditionally used and considered safe for health. They expressed least preference for galvanised iron bucket and plastic tank. Economy as underlying value could be the reason at the back of this preference. Steel was considered good only by few respondents because it was easy to clean and maintain and was believed to be safe for the health. It was not being used by the respondents again due to economy reasons. Since steel does not get any replacement in the market.

Cent percent respondents were found to cover the stored drinking water. Most of the respondents used plate or *thali* followed by earthen ware lid for covering the storage container. Most of them kept the storage container on shelf in kitchen and cleaned the shelf daily while a few of them cleaned it weekly. Majority of them washed the storage container daily but few respondents cleaned the vessel once in a week. The practice highlights that although respondent families had lower educational status, hygienic practices were still being followed by them in contrary to the general belief.

Regarding the use of cleaning agents, most of them used only water for cleaning the storage container which affects the quality of cleanliness. Use of detergents and ash was also practised and few respondents applied lemon with salt occasionally for special storage containers of brass and copper. Similar findings were revealed by Tyagi (1996) in which majority of rural respondents (76 per cent) used simple water as a cleaning agent for storage container. Contrary to this study, Mehta *et al.* (1992) revealed that in Kanpur, majority of the respondents utilized detergents as a cleaning agent. This may be ascribed to rural urban variation in the practice. Rural people believe in staying nearer to the nature by observing such practices.

For assessing the hygienic practices followed for taking out drinking water from the pot, it was observed that majority of the respondents did not use any vessel for taking out water but they got water by tilting the pot which can be considered quite a hygienic practice except for making the surrounding place meshy. Few respondents used hygienic practices like not touching hands with water followed by washing hands before taking out water and use of clean vessel for taking out water. The researcher observed some of the respondents lifting the drinking water glass with fingers inside the water. This practice needs to be improved by creating awareness among rural masses. Markand (1985) stated that village water sanitation practices depend upon provision of health and education to people and economic upliftment.

5.1.4 Awareness regarding water contamination

Maximum number of respondents considered safe water to be colourless followed by its being free from suspended matter, odourless, sweet in taste and a few respondents considered it safe when it was free from bacteria similar results were revealed by Kaur (1985).

The findings of the study clearly depict that respondents were aware about the different causes of water contamination. Majority of them suggested that water gets contaminated due to mixing rain water to drinking water sources followed by improper drainage, mixing of sewage in drinking water. Few respondents reported that water gets contaminated because of improper storage and due to defecation of people and animals near the source of water. These findings are in congruence with those of Kusum (1995). She observed that majority of the respondents (77 per cent) reported mixing of rain water with the drinking water as the main cause of water contamination followed by improper drainage (60 per cent).

Majority of the respondents were aware about the existence of purification techniques for drinking water and some of them were treating the water in rainy season when muddy water came through their taps and water contamination was severely felt and seen with naked eye. Boiling and chlorination were the techniques of water purification adopted by the respondents only during the rainy season. Among the constraints faced in adoption of water purification techniques, economic constraint was reported to be the major one as most of them were from low income group families. Second set of constraints was attitudinal constraints which included willingness to accept the purification techniques which can serve as a guide for the scientist to work for bringing out attitudinal change towards practices and purification techniques in order to improve health of rural masses. A few respondents also faced time constraint in adoption of purification technique.

Similar findings were revealed by Kusum (1995) according to which majority of respondents faced economical constraints (19 per cent) followed by time constraints (17 per cent) and technological constraints (15 per cent).

5.1.5 Impact of water on health

For assessing the impact of water on health, correlation was worked out between different water management practices and water borne diseases. The study revealed significant negative correlation of different water management practices viz., purification methods, frequency of cleaning water storage containers and hygienic practices with water borne diseases. All the three practices reduced the incidences of water borne diseases to a considerable extent. However, purification methods contributed the maximum.

According to Bureau of Indian Standards (BIS) report 1996, in India nearly 3000 people die of water borne diseases everyday. In the present study diarrhoea was found to be more prevalent among all the age groups while comparatively less incidences of other diseases as typhoid, gastroenteritis, constipation, dysentery and worm infestation was observed in the study area.

5.2 Laboratory experiment

5.2.1 Physico-chemical characteristics of water samples

On physical examination of water samples, it was found that all the raw water samples as well as treated water samples were odourless with acceptable taste and colour. Geographical variation was depicted through variation in turbidity for raw water samples which was maximum in Mahakal and minimum in Padiyarkhar. Similarly, water conductivity was observed to be maximum in Tharu and minimum in Salyana. After giving four different treatments, maximum increase in turbidity and conductivity was observed in water after chlorination and reduction in turbidity and conductivity was observed maximum after boiling first and then passing the water through candle filter.

pH

Results revealed that pH in raw water samples was maximum in Mahakal and minimum in Sungal but was within the acceptable limits for all water samples. Maximum reduction in pH was observed after samples were boiled and then passed through candle filter and this reduction in pH was minimum when it was only candle filtered.

Total dissolved solids

Total dissolved solids in untreated water sample were maximum in Tharu and minimum in Padiyarkhar. It was revealed that maximum amount of total solids were removed when samples were boiled and then passed through candle filter followed by boiling and then by chlorination. Thus, it can be concluded that boiling along with candle filtration was the best treatment technique for removal of total solids in water. Arora (1999) reported that maximum amount of total solids in water are removed after boiling (22.5-37.7 per cent) followed by filtration by various filters viz. Aquaguard (14.7-13.1 per cent), Zero-B (4.0-16.6 per cent) and candle filter (2.0-10.0 per cent).

Hardness as $CaCO_3$

Water samples collected from Mahakal and Tharu were considered hard and samples from Salyana, Sungal and Padiyakhar were considered moderately hard. Results reveal that percentage removal of hardness after giving treatment to water samples was maximum when samples were boiled and then passed through filter. However, after candle filtration only, there was negligible removal of hardness. Mittal *et al.* (1994) and Gill *et al.* (1995) support the findings of the present study by reporting that water having hardness of 200 mg/lt or more was not fit for household purpose. They concluded that water of Ludhiana city was very hard, as no filter was effective in purifying the water to the acceptable limit regarding hardness.

5.2.2 Bacteriological analysis of water

Results revealed that all untreated water samples were non-potable after performing presumptive and confirmatory tests. Water samples from Sungal had maximum number of coliforms followed by Tharu and Mahakal. But after treatment, it was revealed that water was completely free of indicator bacteria i.e. *E. coli* when it was chlorinated, only boiled and boiled first then candle filtered. Percentage removal of coliforms was negligible in candle filtration.

It can be concluded that only candle filtration was not good purification technique for removal of bacteria like coliforms. Wagle (1997) supported the above findings and revealed that candle filters were ineffective water purifiers as they could not make water germ free, as small bacteria and virus could pass through pores. He also reported that five minutes of actual boiling was sure method of killing pathogens in water. A longer period, about 10-15 minutes would be necessary if a resistant virus like Hepatitis B was present.

Thus at household level, boiling was found to be best and economical method for decontamination of water as there was removal of various chemical parameters like hardness, total solids after boiling and highly satisfactory results were found from microbiological analysis after boiling of water. Therefore, boiling of water for 10-15 minutes was the best and economical method for decontamination of water.

SUMMARY

Chapter VI

SUMMARY

Introduction

Water is considered as life supporting gift for human beings. The supply of good clean drinking water is one of the basic requirements for good health. Insufficient supply and increasing contamination lead to the occurrence of additional number and types of water borne diseases. Therefore, it becomes important that water meant for human consumption must be free from chemical substances and microorganisms which might be dangerous to the health of living beings. Provision for safe drinking water forms an indispensable aspect of disease prevention hence, public access to information on contamination of drinking water and hygienic storage practices for the drinking water are of great importance. Keeping this in view the present study was envisaged with the following objectives.

Objectives

1. To explore sources of drinking water and prevalent water storage practices.
2. To study awareness, adoption and efficiency of popular water purification techniques.
3. To examine incidence of water borne diseases in the sampled households in relation to water management practices.

Methodology

The present study was conducted in two blocks of Kangra district of Himachal Pradesh which was a purposive selection. One hundred and ten respondents were randomly selected from eleven villages of two blocks namely Baijnath and Panchrukhi on the basis of list prepared with the help of medical officials of Primary Health Centres and Sub-centres regarding the families suffering from water borne diseases. Ten respondents from each village were selected from the list through random sampling technique. Well structured and pretested interview schedule was used for collection of primary data through survey method. Secondary data were collected for research work from the survey reports, publications, research papers from journals, theses, books, newspapers and magazines.

Major findings of the study

1. Majority of the respondents were housewives belonging to age group of 25-50 years (72.72 per cent) and a large fraction (40.90 per cent) among them were illiterate.
2. Nearly seventy five per cent of the respondents belonged to large family size group and nuclear family system was more prevalent in the study area (70.91 per cent).
3. More than half of the respondent families (50.73 per cent) had low educational status while 33.64 per cent families had medium level of educational status.

4. Government service was the main occupation of families (54.55 per cent) followed by daily wage labourers (17.27 per cent). Maximum number of respondents had monthly family income between Rs. 1000-5000.
5. Majority of the respondents had *kuccha* house (72.73 per cent) and 22.72 per cent had *pucca* house.
6. Tap was the main source of water available to majority of respondents (96.36 per cent) followed by open water channel (52.73 per cent), *bauri* (29.09 per cent) and hand pump (10.90 per cent).
7. Majority of the respondents used tap water for drinking purpose in summer (90.90 per cent), winter (95.45 per cent) and they considered tap to be the safest source of water for the purpose.
8. Tap was the most common source of water for all activities except for washing clothes and kitchen garden irrigation for which majority of respondents (49.09 per cent, 64.55 per cent respectively) used open water channels.
9. For kitchen activities, maximum consumption of water was for washing utensils i.e. 60-80 lt/day in summer (6.3 per cent) and winter (4.55 per cent) followed by drinking where it was 40-60 litres/day (3.64 per cent) in both summer and winter but for cooking purposes, water consumed was comparatively less i.e. upto 40-60 litres/day by 36.36 per cent respondents in summer and 17.27 per cent respondents in winter.

10. For bathroom and other household activities, maximum consumption of water was for washing clothes and bathing i.e. 100-120 litres of water per day by 4.55 per cent and 18.18 per cent respondents respectively in summer and 6.36 per cent and 9.09 per cent respondents in winter whereas for cleaning the house, maximum consumption of water was 20-40 lt/day by 29.09 per cent respondents in summer and 11.82 per cent in winter.

11. Regarding other activities, maximum consumption of water was for cleaning the animals and kitchen garden irrigation i.e. as 80-100 litres/day in summer by 4 per cent and 2.73 per cent respondents respectively whereas for animal drinking, maximum consumption of water was 60-80 lt/day by 1.33 respondents in both summer and winter.

12. Majority of respondents made 3-10 trips for collecting water in summer (61.82 per cent) and winter (69.09 per cent). 70.91 per cent respondents had provision of water source at distance of 10-115 meter s.

13. Maximum number of respondents i.e. 62.73 per cent in summer travelled upto 1.5 km per day and fifty per cent respondents in winter travelled upto 0.5 km per day for fetching water and majority of them spent 1-1.5hrs in summer and 0.5-1.0 hrs in winter for collecting water.

14. In view of over all satisfaction, majority of the respondents (69.09 per cent) were not satisfied with the water available for drinking purpose because of the reason that quality of water was not satisfactory (38.16 per cent) followed by improper timings of water release (26.31 per cent).

15. Majority of the respondents (81.82 per cent) in summer used earthenware followed by plastic bucket (23.64 per cent) and aluminium vessel (19.09 per cent) for storing drinking water whereas in winter, majority of them (40.90 per cent) used plastic bucket followed by aluminum vessel (36.36 per cent) and earthenware (23.64 per cent) for the purpose.

16. With regard to the preference of the material for storage, maximum number of respondents (51.82 per cent) considered earthenware to be the most suitable material for storing drinking water as it kept water cool (75.44 per cent), it was traditionally used (21.05 per cent) and 18.18 per cent respondents considered aluminum to be the most suitable material because of the reason that it was traditionally used (75 per cent) and it was believed to purify water (50 per cent).

17. Most of the respondents (57.55 per cent) were placing the water storage container on shelf in the kitchen. Plate or *thali* was commonly used for covering the container (78.18 per cent) followed by earthenware lid (20 per cent) and wooden piece (19.09 per cent).

18. Maximum number of respondents (88.18 per cent) procured water directly from the tap and only 11.82 per cent procured it after filtration which was more common in rainy season.
19. Majority of the respondents took out water from the pot by tilting it (58.18 per cent), with handle container (20.91 per cent) and glass (20.91 per cent).
20. Regarding the hygienic practices followed minimum number of the respondents (14.54 per cent) used clean vessel for taking out water, washed their hands before taking out water (18.18 per cent) and do not touch hands with water (25.45 per cent).
21. Most of the respondents (56.36 per cent) cleaned their storage container daily whereas some cleaned it weekly (29.09 per cent). The storage space was cleaned daily by 46.30 per cent respondents and 17.59 per cent cleaned it occasionally. Simple water was used as a cleaning agent by majority of the respondents (51.82 per cent) followed by detergent (36.36 per cent) and ash (24.55 per cent) whereas lemon with salt was used occasionally by 9.09 per cent respondents.
22. Out of total number, 59.09 per cent respondents gave some treatment to water at home. Majority of them boiled (53.85 per cent) their drinking water followed by keeping water still for some time (30.77 per cent) to remove suspended impurities, filtration with filter (23.08 per cent), filtration with cloth (20 per cent) and use of chlorine tablets (18.46 per cent). Boiling and chlorination were more prevalent during rainy season.

23. Major constraints in adoption of purification technique were economical constraints (51.82 per cent) followed by attitudinal constraints (41.82 per cent) which included attitudes like not ready to accept new things and do not feel need of purification techniques and technological constraints (14.55 per cent) included the lack of knowledge regarding purification practices.

24. Regarding the health problems of rural families, it was found that in infants, the disease which occurred most frequently was diarrhoea (43.33 per cent). In early childhood years also, maximum occurrence of diarrohoea (50 per cent) was reported while in late childhood years, occurrence of dental caries and dysentery were common.

25. Majority of the male adolescents suffered from diarrhoea (20 per cent) while female adolescents (30.93 per cent) suffered from dysentery and diarrhoea (18.56 per cent).

26. Among adult males, occurrence of diarrhoea was maximum (6.73 per cent) while in females, occurrence of diarrhoea and dysentery was maximum (9.84 per cent). In old age males there was most frequent occurrence of constipation (25 per cent) followed by diarrhoea (15 per cent) and dysentery (10 per cent) while in females, frequent occurrence of diarrhoea was reported.

27. Different water management practices viz. purification methods, frequency of cleaning storage container and hygienic practices were significantly negatively correlated with frequency of water borne diseases.

Laboratory experiments

Laboratory tests were conducted in IPH (Irrigation and Public Health Department) Laboratory, Dharmshala for studying the water purification level of four important water purification techniques identified during survey. The laboratory tests were divided into two sections:

a. **Physico-chemical analysis**

b. **Bacteriological analysis**

Laboratory findings

31. All the water samples collected from *bauris* of different areas were found to be colourless, odourless and without any objectionable taste and after treatment similar results were found.

32. Cent per cent water samples were found to have turbidity < 5 NTU and conductivity within 50 – 150 mhos/cm which was well with in the acceptable limits.

33. The pH of drinking water samples was found to vary between 7.21 – 7.87 which is well within the acceptable limits (6.5 – 8.5) and there was maximum reduction in pH after boiling alongwith candle filtration and minimum when it was only candle filtered.

34. Total dissolved solids were found to vary between 132 – 242 mg/lt (acceptable limit 500 mg/lt) for raw water samples but after treatment, maximum reduction in TDS was found after sample was boiled and then passed through candle filter (17.47 per cent) and minimum when it was only candle filtered (3.30 per cent).

35. The hardness of the untreated water samples varied between 80-180 mg/lt. Water samples from Mahakal and Tharu were considered very hard (150-300 mg/lt) and that from Salyana, Sungal, Padiyarkhar were moderately hard (50-150 mg/lt). When treatment was given, there was maximum reduction of hardness after boiling alongwith candle filtration (18.54 per cent) which is more than just boiling (18.09 per cent).

36. Water samples collected from different *bauris* were found to have total coliform count ranging from 50 – 700, whereas, samples from Mahakal, Salyana, Sungal and Padiyarkhar were found contaminated with *E. coli.*

37 The results obtained from the bacteriological examination of treated water samples i.e. chlorinated, boiled and boiled & then candle filtered showed "zero" coliform count (cfu) indicating excellent quality of drinking water but after candle filtration there was less reduction in coliform count (21.43 – 76.3 per cent).

CONCLUSION

On the basis of the results, the following conclusions have been drawn.

1. Most of the respondents were from middle age category, illiterate had nuclear family type but large family size and low educational status. Majority of them had family income ranging from Rs 1000-5000 per month. Most of the respondents were house wives and large number among them lived in *kuccha* houses.
2. Tap was the most commonly used source of water for majority of activities including drinking.
3. Majority of the respondents were dissatisfied regarding the quantity as well as quality of drinking water available to them.
4. The most commonly used storage device in summer was earthenware and in winter it was plastic bucket.
5. With regard to material used for storage devices, majority of the respondents considered earthenware good for storing drinking water. Aluminium was believed to purify the water. Only a few respondents considered copper and brass as good material for storing drinking water
6. The main causes of water contamination expressed by majority of respondents were improper drainage, mixing of rain water and sewage with potable water sources.

7. Purification methods, cleaning of water storage container and other hygienic practices were found significantly negatively correlated with incidence of water borne diseases.
8. Diarrhoea and dysentery were the most frequent diseases in all the age groups.
9. Majority of respondents were aware about water purification techniques but did not apply them due to economical, attitudinal, technological constraints. Time constraint was last consideration.
10. The estimation of different chemical characters governing the water quality showed that the samples of all the five areas picked from *bauris* were not fit for drinking purpose due to higher amount of coliform count. After boiling and chlorination, all the samples were fit for drinking purpose as revealed by physico-chemical and bacteriological analysis.
11. The bacteriological analysis of water emphasized that candle filter through which the water samples were passed did not improve the quality of water as the filter was unable to remove *E. coli* which is a major cause of water borne diseases.
12. A dose of 0.2 – 0.5 mg of chlorine per litre of water was sufficient for effective treatment of bacteriologically contaminated water samples.
13. Boiling of water for 10 – 15 minutes was the best and economical method of decontamination of water.

Suggestion and recommendations

Based on the findings of the study, the following recommendations and implications are suggested for improved drinking water management for rural households.

1. Government rural water supply programmes should focus on adequate supply of drinking water especially in rural areas to improve the health of rural masses.

2. Private sector efforts for construction and maintenance of drinking water projects can be encouraged. Every effort should be made to adopt a low cost approach employing technical and scientific knowledge and experience already gained by several Non Governmental Organizations in this regard.

3. Awareness campaign should be organized by the home scientists for information pertaining to importance of water management practices including water handling, disposal and its storage.

4. As majority of respondents in study were getting water through pipe line connections so the best method of ensuring safe drinking water is protection of water sources and water supplies from contamination hence it is strongly recommended.

5. Each panchayat should make a special effort for regular chlorination of *bauris* in the villages and should maintain a proper and effective coordination with district authorities for regular checking of safe drinking water supply.

6. It is also suggested that specific programmes on drinking water management and related aspects for television and radio should be planned and disseminated to the masses.

7. It is important to adopt integrated coordinated approaches by various agencies and departments like Health and Education to promote water sanitation technologies at local level.

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* Original not seen

APPENDICES

Appendix-I

Quality standards for drinking water

The acceptable level and the maximum permissible levels for various parameters in drinking water as per Bureau of Indian Standard (BIS) specifications are listed below:

Sr. No.	Characteristics	Acceptable limit	Maximum permissible limit (mg/l)
1.	**Physical**		
	Turbidity (units on silica scale)	5 units	25 units
	Colour (units on silica scale)	5 units	25 units.
	Conductivity	50 mhos/cm	1500 mhos/cm
	Odour	Unobjectionable	Unobjectionable
	Taste	Agreeable	Agreeable
2.	**Chemical**		
	pH	7.0-8.5	6.5-9.2
	Total hardness (as $CaCO_3$)	300 mg/l	600 mg/l
	Total solids	500 mg/l	1500 mg/l
3.	**Bacteriological**		
	Total coliform count	0	> 10/100 ml

Appendix-II

A study of drinking water management practices and incidences of water borne diseases in selected villages of district Kangra

General Information

Q1. Name of the Respondent:

Q2(a). Age:
- i) Young (below 25)
- ii) Middle (25-50 years)
- iii) Old (above 50 years)

Q2(b) Education:
- i. Primary
- ii. Middle
- iii. High school
- iv. Senior School
- v. Graduate
- vi. Post Graduate

Q3. Type of Family:
- a. Nuclear
- b. Joint

Q4. Family Composition:

Sr. No.	Relation to respondent	Age	Sex	Education	Income	Occupation

Q5. Monthly income from all sources
- a. upto Rs. 1000
- b. 1000-5000
- c. 5001-10,000
- d. 10001-15000
- e. 15001 and above

Q6. Type of house
a. Kaccha
b. Mixed
c. Pucca

Specific information

Q1. What are the sources of water available to meet daily requirement?

a. Tap water
b. *Bauri*
c. Hand pumps
d. Motor driven pumps
e. Tubewells
f. Private wells covered/uncovered
g. Public wells covered/uncovered
h. Ponds
i. Open water channel or kuhl
j. Any other

Q2. What is schedule of drinking water supply
a. Whole day
b. Morning
c. Noon
d. Evening

Q2(b) Does this schedule suit you? Yes/No
If No, why?
a. Fixed timings of water supply
b. Quantity of water supply is not sufficient.
c. Any other

Q2(c) What are the timings of the water supply
a. Morning
b. Noon
c. Evening

Q3. Do you feel satisfied regarding the availability of water for drinking purpose?

Highly satisfied	Satisfied	Dissatisfied

Reasons for satisfaction	Reasons for dissatisfaction
1. Source of water is nearly 2. Timings of water release are suitable 3. Quantity of water supplied is sufficient 4. Stored water is sufficient 5. Quality of water is satisfactory 6. Failure of water supply is very less 7. Any other	1. Source of water is faraway 2. Timings of water release are not suitable 3. Quantity of water supplied is not sufficient 4. Stored water is not sufficient 5. Quality of water is not satisfactory 6. Failure of water supply is frequent 7. Any other

Q4. What are the probable reasons for failure of water supply according to you?

Utilization Pattern

Q5 (a). For which purpose water from different sources you utilize and how much in a day?

Source		Water taken	Drinking	Bathing	Cooking	Washing Utensils	Washing Clothing	For animal Drinking	Cleaning of Animal	Kitchen Garden irrigation
1. Taps	Summer									
	Winter									
2. Hand pump	Summer Winter									
3. Tube well	Summer									
	Winter									
4. Well	Summer									
	Winter									
5. Open water channel	Summer									
	Winter									
6. Bauri	Summer									
	Winter									
8. Any other	Summer									
	Winter									

Q5(b) Quantity of water used in a day for different activities.

	Activities	Quantity (lt.) Summer	Winter
(A)	Kitchen Activities		
	a. Drinking		
	b. Cooking		
	c. Washing utensils		
(B)	Personal and house hold activities		
	a. Bathing		
	b. Washing clothes		
	c. Cleaning the house		

(C) Animal Care
- a. Cleaning the animals
- b. Animal drinking
- c. Kitchen garden irrigation

Q6. Which water do you like the most for drinking purpose?
- a. Tap
- b. Bauri
- c. Hand pump
- d. Tube well
- e. Well
- f. Pond
- g. Open water channel

Q. Reasons
- a. Sweet in taste
- b. Cold in summer
- c. Warm in winter
- d. Good for digestion
- e. Free from chemicals

Q7. Frequency distance from home, time consumed, quantity of water people use in a day.

Source		Once	Twice	Three times	Very frequently	Rounds			Time consumed			Distance from home	Quantity of water in each round
						M	N	E	M	N	E		
1. Taps	Summer												
	Winter												
2. Hand pump	Summer												
	Winter												
	Winter												
3. Tube well	Summer												
	Winter												
4. Well	Summer												
	Winter												
5. Baoli	Summer												
	Winter												

M=Morning, N= Noon, E=Evening or what?

Q8 . Do you store water for different activities? Never/sometimes/always

Q9. Indicate the storage devices used for storing water for drinking purpose?

Sr. No.	Storage device	Summer	Winter
1.	Earthen pot		
2.	Copper pitcher		
3.	Brass pitcher		
4.	Stainless steel bucket		
5.	Galvanized iron bucket		
6.	Plastic bucket		
7.	Water filter		
8.	Refrigerator storage		
9.	Glass bottles		
10.	Plastic bottles		
11.	Aluminum vessel		
12.	Stainless steal vessel		
13.	Cemented tank		
14.	Sintex tanks		
15.	Metal tank or drum		
16.	Any other		

Q10. By your opinion which material is suitable for keeping drinking water?

a. Earthen
b. Glass
c. Brass
d. Copper
e. Steel
f. Plastic

Q11. Why do you use particular material for the storage of drinking water?

a. Easy to handle
b. Easy to clean
c. Unbreakable
d. Easy to replace
e. Easy to maintain
f. Because of tradition
g. No other substitute
h. Material purifies water
i. Safe for health
j. Keep water cool
k. Reasonable cost
l. Any other

Q12. How do you clean the containers in which drinking water is stored?

Cleaning agent	Once in a day (a)	Twice in a day (b)	Weekly (c)	Every time water stored (d)	When ever needed (e)
1. Detergent					
2. Mud					
3. Ash					
4. Tamarind					
5. Without detergent					
6. Any other					

Q 13. Where do you keep the vessel in which the drinking water is stored.

		On stand (a)	On floor (b)	On shelf (c)
1.	Kitchen			
2.	Dinning room			
3.	Varandah			
4.	Any other			

Q14. Do you clean the space where the drinking water is stored? Yes/No if yes, how often?

a. Every day
b. Once in week
c. Whenever needed

Q15. Process of filling the storage container.

a. Directly from tap/source
b. After filtration

Q16. Do you keep stored water covered? Yes/No if yes, then How?

a. Loose filtered lid
b. Tightly filled lid
c. By plate/thali
d. Earthenware lid
e. Wooden piece
f. Muslin cloth
g. Leaf plant material
h. Any other

Q17. Do you take out the drinking water from the vessel?

a. With a handle container
b. By tilting the pot
c. With glass
d. Any other

Q18. Do you follow the following practices while taking out the drinking water from the vessel.

a. Wash your hands and nails thoroughly
b. The hands do not touch the water
c. Vessel for taking out water is cleaned
d. Any other

Q19. Level of awareness regarding water purification.

Technique	Strongly agree	Agree	Don't agree
1. Boiling,			
Filtration			
Chlorination			
Are three important purification techniques			
2. Use of $KMnO_4$ or laldawai is purification *technique*.			
3. Boiling kills germs			
4. Use of muslin cloth removes suspended impurities but not germs.			
5. Chlorine tablets are white in color and are used for purification.			
6.One tablet of chlorine is meant for 20lt of water			
7. Tap filter, candle filter and electronic filter are the filtration techniques available in market			
8. Candle of filter should be sterilized once in a month			
9. Jaundice, Polio, Cholera , Dysentery, Diarrhoea are diseases due to intake of contaminated water			
10. Safe drinking water storage devices are good for health so one should go for change			

Q20. Which of the following characteristics of safe water, you take into account for drinking?

a. Colourless
b. Odourless
c. With or without suspended water
d. Sweet in taste
e. Free from bacteria

Q21. Source of water which you thing is safest for drinking.

Source	1	2	3	4	5	6	7	8	9	10
1. Tap water										
2. Hand pump										
3. Tube well										
4. Wells										
5. Pond										
6. *Bauri*										

Q22. Do you purify water before use? Yes/No

Q23. If yes, How do you purify?
a. Filtration with cloth
b. Keeping water still for some time and then taking out the upper portion
c. Boiling
d. Adding phatkari (alum)
e. Adding lal dawai ($KMnO_4$)
f. Filteration with three matkas
g. Any filter used
h. Using chlorine tablets
i. Bleaching powder
j. Herbs used name, Quantity
k. Any other

Q24. Do you have filter? If yes, what type of filter do you possess?
a. Electronic
b. Candle type
c. Pen type
d. Tap filter

Q25. Name the brand of filter at your home?
a. Aquaguard
b. Zero-B
c. Aquopen
d. Bajaj
e. Any other

Q25 (b). What is the filteration capacity of this filter?
_____________ lt/hour

Q25 (c). Do you clean your filter? Yes/No if yes
a. Daily
b. Weekly
c. Fortnightly
d. Monthly
e. Once in a while

Q. Are you satisfied with quality of your filtered water? Yes/No

Q26. What are the constraints in adoption of purification techniques
a. Economical constraints
b. Time constraints
c. Attitudinal constraints
d. Technological constraints
e. Special constraints

Q27. What do you think are the reasons for pollution of drinking water?

a. Rainy season
b. Improper drainage
c. Animals drink from same source
d. People or animal defecate near the source of water
e. Improper storage
f. Contact of drinking water supply mix sewerage line
g. Any other.

Q29. Name the diseases from which you have suffered from last two yrs and how frequency

Name of disease	Infant (2yrs) (a)	ECH (2-6 yrs) (b)	LCH (6-12 yrs) (c)	Addensence (13-18 yrs) Male (d)	Female	Adulthood Male (e)	Female	Old age Male (f)	Female
1. Cholera									
2. Typhoid									
3. Dysentry									
4. Dental caries									
5. Dyspepsia									
6. Constipation									
7. Diarrhoea									
8. Hepatits									
9. Gastroenteristis									
10. Jaundice									
11. Filaria									
12. Dengu fever									
13. Liver problems									
14. Thread worms									
15. Round worms									

a. Frequently (once in year)
b. Most frequently (once in six months)