ASSESSING THE EFFICIENCY OF SELECTED WATER FILTERS

By

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Contents

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PLATES

LIST OF FIGURES

LIST OF APPENDICES

APPENDIX

Introduction

1. INTRODUCTION

"Man depends for his existence on food and the source of food stuff is water".

The Bagavat Gita

Water is a basic essential element for all life forms. It is a chemical compound of hydrogen and oxygen, which is most abundantly and widely distributed and used on earth. It occurs in nature in all the three states namely solid, liquid and gas. It is a constituent of the cells of all animal and vegetable tissues. Water is essential for the health and hygiene of human beings and animals (Sivanappen, 1992). Hence it is the most important gift of nature to all living creatures.

According to Arumugam (1992) the standards of volume, weight and specific gravity of water are based on its properties. It is a colourless, odourless and tasteless liquid. Snow and rain are the purest natural source of water. Nearly three fourths of the surface of the earth is covered with water. Only about ten percent of the water of the earth is non-saline found in rivers and lakes. The present day world has the same amount of fresh water as there was in ages past. While approximately 40,000 cubic kilometer of fresh water was used by only one million people in 1820 A.D., it has to be shared by nearly six million people expected in 2000 A.D. (Schildgaarde, 1991).

Rajasekaran (1990) expounds that, on an average, a person consumes between two to five litres of water a day for drinking and for preparing food. A minimum of a further 20 to 50 litres per person is required for general hygiene purposes, such as personal and domestic washing. Water also finds extensive use in science and industry. The more we progress, the more the need for water for daily living as well as for industrial purposes.

To-day man is greatly concerned that water, the basic resource is threatened by his own haphazard development. Two problems plague the availability of water. First is the problem of quantity. The increasing demands are depleting the supplies and as a result critical shortages are a frequent occurrence. Quality of water which is being polluted is the second and more recent problem (Mahalingam, 1992).

Water is said to be polluted when it changes its quality directly or indirectly, by admixture of various toxic chemical pollutents and becomes less suitable for drinking (Pandey, 1992). Kale (1986) defines pollution as contamination of natural resources. Pollution can happen naturally as a result of decaying plant life and impurities washed from soil. But most pollution is man-made and comes from the community and industry around the river banks (Purohit and Saxena, 1990).

Too much or too little of water and its quality have always been responsible for the largest number of diseases and death. The water that flows out of the tap may not always be safe. There are many ways by which water could be contiminated. Water thus contaminated is the leading cause of diseases like typhoid, cholera, diarrhoea, gastroenteritis, dysentry, polio, viral hepatitis, typhus fever and malaria. Several other disease causing germs also could be traced in a contaminated water (Manivasakam, 1989). In India many of the water borne and water related diseases account for 50 to 60 per cent. Due to this, more than 15 million children upto four years of age as well as 30,000 adults die each year (Tribune, 1986).

The non-availability of safe drinking water has direct bearing on the level of health of the people and thus their capacity for fruitful production. The provision of safe drinking water in adequate quantity is thus a basic necessity for the healthy life of the community.

Satisfactory household water for human consumption besides being adequate in amount, must be odourless and free from disagreeable taste. It should be soft, that is, free from excess clacium and magnesium and also should be free from harmful bacteria and impurities. For this reason, water is subjected to various methods of treatment to render it fit for use either before or after distribution to domestic or trade users (Nanda, 1992).

The general state of health of the masses would remain poor so long as this can be ensured only through regular monitoring and survillence of the drinking water quality, from the point of view of physical and chemical standards, toxic materials, bacteroilogical and virological standards and radio-activitiy (The Hindu, 1992).

There are various purification techniques adopted for obtaining safe drinking water at household level. Three methods are generally available for purifying water on an individual or domestic scale. These methods are boiling, filtering and treating with disinfectants, such as alum, chlorine, bleaching powder, iodine, potassium permanganate and chlorine solution. (Mathew,1988 and Park and Park, 1991).

In this era of scientific advancement a number of gadgets have come into the market for purification of water. Popular belief is that filtering removes only dirt and suspended particles whereas filters like U-V radition filter and polyiodide resin filter removes bacteria also to a certain extent.

To-day it is being realized that nobody can take water for granted. More so with a runaway population, the pressure on the sources of potable water is mounting up. People must now work together to make this a reality and prove that "Happy are those who build their development on water" (World Health, 1986). As water concerns everyone man, woman and children, it is the duty

of all to see as to how to economise and efficiently use this great gift of nature without polluting or wasting it.

Hence the present investigation on "Assessing the Efficiency of Selected Water Filters" was taken up with the following objectives to :

1. Study the sources of water supply and the water management practices among selected families.
2. Find the homemakers attitudes towards efficiency of water filters.
3. Analyse the physical, chemical and microbiological quality of drinking water collected directly from different sources and filtered using selected filters.

The problem of polluted drinking water is faced by the whole world to-day. It is not just a matter of debate but a matter of life and death. Therefore it is hoped that the study to find out the potability of drinking water and the efficiency of water filters, will be useful to everyone concerned with water.

Review of Literature

II. REVIEW OF LITERATURE

The literature pertaining to this study on "**Assessing the Efficiency of Selected Water Filters**" is reviewed under the following heading :

A. Importance of Water

B. Sources of Water

C. Water Pollution

D. Health Hazards due to Polluted Water

E. Qualities Essential in Drinking Water

F. Purification of Water.

A. Importance of Water

Water is an absolute essential for human existence. It is the heritage to all, without which, there is no life. For human beings, it is a life sustainer in every sense (Shukla, 1992). Water is aptly described as the mother of life. It is the liquid-gold. It is the universal solvent and largest medium of life (Arumugam, 1992). Everywhere in the world, water is recognised as a symbol of life and every religions whorships rain as God or uses water as a means of purification from their sins.

Water is the chief constituent of a living cell. Sixty percent of a person's weight is nothing but water. In the words of White (1988) water is commonly a driving force to keep the community going as an identifiable group. It provides energy for maintaining social relationships as well as economic productivity. Water is a commodity which cannot be replaced in its multiple use-drinking, cooking, washing, transport of wastes, agriculture, generating electric energy, industrial purposes, protection of life and property against fire and many others (Cvjetanovic, 1986).

Actually, the name "Earth" for our planet is a misnomer because the land part of our planet is only 29 percent, the remaining 71 percent being water. Hence the correct name for our planet should be "Water" and not earth (Shukla, 1992).

Water did not create life but it brought the necessary elements together (Joshi, 1989). It is concerned in all metabolic processess and correction of dehydration and is therefore a most important aspect of treatment. All the vital functions of the body depend on the presence of proper amount of water (Singh 1986 and Nath 1989). Water plays an essential role in healthy economic, social and cultural development of the nation. Hence water resource development has now come to be regarded as a power tool for raising the standard of living and for stimulating the socio-economic changes.

B.Sources of Water

No life is possible on this planet or anywhere else without the life-giving water. It is a strange paradox that even with so much water floating on the earth's surface, fresh, clean and safe water for drinking, cooking and washing still remains a luxury. Most of the water available on the earth is, salt water in the ocean. And again 70 percent of 2.8 percent of fresh water is in the form of ice in the polar regions. Most of the remainder, is either in the form of ground water or derived from hydrological cycle whereby water is precipitated on the surface of the earth in the form of rain or snow, procolates as ground water, evaporates from soil and plants, or runs off in rivers and lakes, until it reaches the sea from where it evaporates again (Nair, 1984).

Srinivasan (1980) and Neill (1985) present the break-up of percentage of water on the earth as

Surface	Percentage
Oceans	97.2
Ice-caps	2.0
Ground water	0.62
Fresh water lakes	0.009
Inland seas and salt lake	0.008
Atmosphere	0.001
Rivers	0.0001
	99.8381

As viewed by Avinashilingam (1987) only 1.4 billion cubic kilometer of water is fresh and suitable for human use. Of this again 77.2 per cent is permanently frozen, 22.4 per cent occurs as ground water and soil moisture, 0.35 per cent are contained in lakes and wet lands and less than 0.01 per cent is rivers and streams.

As stated by Manivasakam (1991) and Arumugam (1992) the main sources of water are precipitation and run off. The basic source of water is precipitation. This is the water falling from the atmosphere to the surface of the earth as rain, snow etc. Part of the rain and melted snow seeps into the soil. The rest becomes what is called surface 'run off'.

According to Feachem et. al. (1977) and Park and park (1991), fresh water are :

1. Rain Water
2. Surface Water
   a. Impounding reservoirs
   b. Rivers and streams
   c. Tanks, ponds and lakes
3. Ground Water
   a. Shallow wells
   b. Deep wells, bore wells or tube wells
   c. Springs.

1. Rain Water :

The prime and basic source of water is rain water. A part of the rain water sinks into the ground to form ground water, part of it evaporates back into the atmosphere and some runs off to form streams and rivers, which flow ultimately into the sea. Rain water is the purest water in nature. In country, districts where the air is pure, rain water may be safely used and is much softer, cleaner and better fitted for general use than water obtained from other sources (Richardson, 1989).

2. Surface Water :

The net quantity of rain water which remains on the surface is termed as surface water (Frenke and Frenke, 1975; Mullick, 1981; and Park and Park, 1991). Surface water indicates the water that collects or flows over the surface to form brooks, creeks, canals, streams, lakes, ponds, rivers and reservoirs (Manivasakam, 1991). India has been best owed with substantial surface water resources. Overall water sources of the country have been assessed at 1880 Km^3 annually (Verma, 1990).

a. Impounding Reservoirs/Lakes :

These are artificial lakes constructed usually of earth work or cement masonary in which large quantities of rain or surface water is stored for future use. Dams built across rivers, mountain and streams also provide large reservoir of surface water. This

water is usually clear, soft, palatable and ranks next to rain water in purity. This water is used for all the purposes (Manivasakam,1991).

b. Rivers and Streams :

Many large cities obtain their entire water supply from rivers. Many rivers furnish a dependable supply of water. River water is turbid during rainy season. Clarity of water is no guarantee that the river water is safe for drinking. It contains dissolved and suspended impurities of all kind (Bhatacharya, 1986).

Many lakhs of rupees are spent yearly in the collection and purification of water obtained from this source. The water before use is purified by pouring it through filtering bed made of stone of different sizes and sand of coarse and fine quality. After being thus purified it is distributed throughout the city by means of smaller branch pipes and conveyed into the houses of those who can afford to pay it (Thomann and Mueller, 1987).

c. Tanks and Ponds :

Tanks are large excavation in which rain water is stored. They are an important water source in some Indian villages. The water of tanks are often used for drinking and other domestic purposes. Tanks are recepient of contamination of all sorts of

micro organisms, unless carefully watched. Water from tanks is certainly unsafe to all, owing to the dirty habits of the people who use them and by animals.

Ponds are depression in plains in which water is collected during rainy season. The quantity of water in ponds is very little and contains large amount of impurities, hence it cannot be used for human consumption (Schilfgaarde 1991).

3. Ground Water :

Ground water is the accumulation of water below the surface of ground. Ground water has long been considered a source of safe drinking water. It is the cheapest and most practial means of providing water to small communities. In general, it is better protected and of higher chemical quality than surface water, and also this water is superior to surface water, because the ground itself provides an effective filtering medium (Pillai, 1987).

During recent decades however, changing activities at the soil surface have influenced the quality of ground water.

Types of Ground Water :

In traditional villages, water was always more than a simple commodity. Water wells were places for gathering, for religious and other rituals and festivities. The soothing, sounds of water fountains were an expression of the harmony among human and within nature.

a. Shallow Wells :

Wells which are less than 50 feet in depth or they are sometimes mere hollows on the ground. They obtain their water supply from the surface soil and are therefore very easily polluted by dirty water and other filthy liquids, hence it should not be used (Cvjetanovic, 1986).

b. Deep Wells :

Wells over 50 feet in depth are described as deep wells. Only such wells are sunk through the surface soil and through an underlying impervious stratum into a deeper water bearing zcne (Pillai, 1987). Water from this source, is, as a rule, also gcod and safe to use.

c. Artesian Wells :

Artesian wells are made by boring and extend to a great depth at times through impermeable strata before water is reached. The water sometimes escapes from them like a water from a fountain, owing to the great pressure to which it is subjected (Park and Park, 1991).

d. Springs :

Water is sometimes obtained from great depth in the ground through springs. Hollow tubes are sometimes sunk in the ground to great depths in order to obtain a supply of water. The water in such cases being raised by pumping. These are know as tube wells.

Water obtained from this source is the best and safest for drinking purposes. Springs and tube wells should, however, be carefully protected against pollution (Forsland, 1987).

C. WATER POLLUTION

'Water is the corner stone in the very existence of life, together with air, food and energy. The use of water by man, plants, animals and birds is universal. It is the principal raw material for all development and activities. (Alamelu, 1986). The quality of water is of vital concern for mankind, since it is directly linked with human welfare (Bland, 1987). On the one hand rapid population growth, increasing living standards, wide spheres of human activities and industrialisation have resulted in greater demand of good quality water, while on the other hand pollution of water resources is increasing steadily. Some of the major diseases caused by polluted water are malaria, fluorosis, filariasis, diarrhoea, guinea worms etc., (WHO, 1984).

The term pollution may be defined as the deterioration in the chemical, physical and biological properties of water, brought about mainly by human activities. (Purohit and Saxena, 1992). As mentioned by Pailwal (1983) pollution means the addition of any foreign materials, ie., inorganic, biological or radiological or any physical change in natural water which may harmfully affect living life. Lamb (1985) defines pollution as the presence of materials in water that interfere unreasonably with one or more benefecial uses of it. About 71 per cent of the global population usually struggle

to get water and then worry about its safety in drinking (Garelick 1987). Numerous incidents of epidemic of infectious water borne diseases in many countries is attributed to wide spread contamination of water (Imperio, 1987).

Nearly 80 per cent of all diseases in the developing world is related to unsafe water supply and inadequate sanitation (Mahler, 1984). Polluted water is the culprit in all cases. The major sources of water pollution are domestic waste from urban and rural areas, and industrial wastes which are discharged with natural water bodies.

Sources of Pollution :

Pollution can be natural caused by hydrological processes also in which the decomposed animal and vegetable materials and weathering products of rocks, minerals and soil ingredients are brought into the main water resources. All these processes lead to degradation of the natural environment. (Salim, 1987).

Figure I indicates the factors causing water pollution.

Pollution of Surface Waters :

Since surface water is exposed directly to atmosphere as well as connected with several minor inlets as rivulets, seasonal streams and surface drains there is continous exchange of dissolved and atmospheric gases and addition of waste materials through

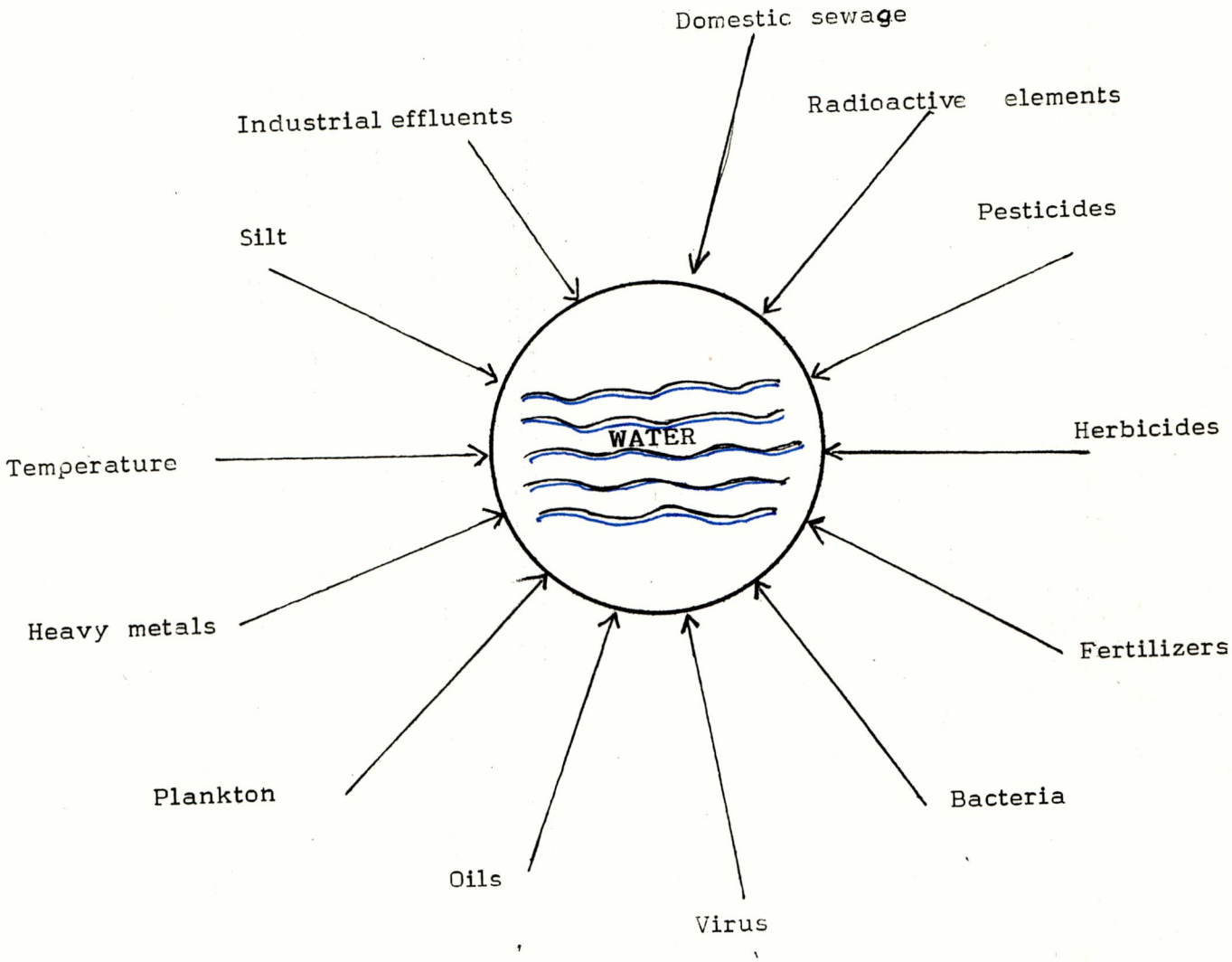


FIGURE - I

FACTORS CAUSING WATER POLLUTION

water conveyances. The main sources of surface water pollution are

1. Atmospheric gases
2. Surface water run-off
3. Decomposition products of animal and plant materials
4. Industrial and municipal wastes (Sapru, 1987).

Pollution of River Waters :

Near the cities, the surface water resources as rivers, ponds and lakes where effluents are discharged from municipal and industrial waste are highly polluted. A rapid increase of industries including those of textile, rayon, paper, antibiotics, synthetic drugs, oil refineries, photofilms, insecticides and several others discharges of large quantities of highly objectionable wastes into the main source of water - water pollution is an immediate result of industrial activity. (The Tribune, 1986 and The Hindu, 1992).

River water is also polluted through the connecting drains if they are passing through an industrial area carrying industrial wastes. In Delhi, Nejafgarh drain carrying a heavy load of industrial effluents discharged by various factories adds to the water pollution problem of Yamuna (Mohan, 1988)

Besides this, the river waters are also polluted by the pesticide, residues transported from the agricultural lands and a higher contamination is fatal to fish which are sensitive to insecticides (Webb, 1962; Weber, 1972; Mellenby, 1967).

Pollution of Groundwater :

The problem of pollution in ground water is much less than in surface water as the soil acts as an absorbent retaining a large part of colloidal and soluble ions with a maximum of its cation exchange capacity. Still, ground waters are not absolutely free from the menance of pollution, however, they are likely to be free from the suspended solids. Only slouble effluents pollute the ground water and the extent of pollution is likely to be more in sandy soils, with high water table conditions; and in humid regions. Seepage from polluted lake, pond or stream can also pollute the well waters. (Neill and Roucher, 1990 and Collin and Melloul, 1991).

Some ground waters of high rain fall areas are polluted naturally by excessive iron. This problem has often been observed in the ground water of Assam, West Bengal, Orissa and Kerala. Iron in toxic amounts as high as 20 ppm exists in deep tube wells as ferrous ion. Such waters are very harmful for drinking purposes as the permissible limit is only 0.3 ppm (Paliwal, 1983 and Vohra 1984).

The Government has undertaken many steps in controlling the pollution by putting forth many pollution control acts. The Water Pollution Control Act 1961, the Water Quality Act 1965 and the Prevention and Control of Pollution Act 1974 are the some of the efforts taken to put down the hazard of pollution.

The Tamil Nadu Water Supply and Drainage Board (TWAD) scheme being executed at a cost of about rupees 600 lakh, when completed will supply potable water to twenty Panchayats and also to the bustling industrial City of Coimbatore (TWAD, 1992).

D: Health Hazards Due to Polluted Water :

"We need water, not gold", says a Signboard in a dry zone village of Myanmar which reflects the significance of water as a basic necessity and key to life. This truth in seen in the fact that most organisms have 80-90 per cent of water in their body composition. The body water is used up in different metabolic activities of the body including excretion and evaporation - transpiration or sweating (Rajasekharan, 1990).

Health plays a crucial role in any effort for development and good health is closely related to the status of water supply. Poor sanitation contributes to a variety of water borne diseases like cholera, typhoid and infectious hepatites. Surveys conducted by World Health Organization in the seventies disclosed that 80 per cent of all diseases were associated with contaminated water (Kalra, 1990).

The relative of water and health had been recognised for many years and "cleanliness is next to godliness" is very much a nineteenth century maxim, though only relatively recently have a series of epideriological studies shown that the details of access to water determine the incidence of several infective diseases. Most of

the diseases such as typhoid fever, bacillary dysentry cholera, amoebic dysentry, jaundice and infective hepatitis are attributed to he drinking water only (Manivasakam, 1991). Water related diseases kill approximately 10 million people every year, and 5 million children die every year before their first birth day (Nair, 1984).

Nearly 40 to 50 lakhs children die every year due to diarrhoea. Diarrhoeal disease have the dubious disfinetion of being the major child killer (Nair, 1984) :

Guest (1981), Kar (1984), Laugeri (1986) remarks that an astonishing number of people suffer from water related diseases at any one time. He cited the following examples :

1. 400 million people with gastroenterities
2. 160 million people with malaria
3. 30 million people with severe blindness and
4. 200 million people with schistosomiesis.

Murthy (1990) report that through the contaminated water, 50 crores are affected with trachoma and blindness, 25 crores shiver with malaria, 10 crores have diarrhoea, 3 crores discharge blood with urine, 105 crores, under 5 years children die every year from water borne disease. Fifty per cent of world hospital beds occupied by these patients. India loses 730 lakhs Man day every year, as workers fall sick. Appromixately 450 crores are spent for their treatment every year.

Consuming water containing substances gives rise to ailments and in human beings. Water carries the toxins and sometimes. It also acts as an agent to render cumulative chemical reaction resulting in the formation of toxins. (Ratna 1986 and roy 1982).

Brundtland (1986) says in order to survive and maintain gcod health, man must remain on guard against one of the most important elements in his environment - WATER. Singh (1986) suggested that providing water and sanitation services is the single most important activity to improve people's health. However, more supply of safe water does not mean freedom from water borne disease. People's education and awareness is essential to use safe water and avoid pollution of water (Neri and Hewith, 1991).

E. Qualities Essential in Drinking Water

Next to air, water is the most essential commodity required for living. It is the prime need for human development and is essential for every human activity (Arumugham, 1992).

The quality of water out of necessity should be as per certain standards set on the basis of maximum concentration of injustices that can be tolerated in water, supplied for some use. These standards are exposure limits for physical, chemical, bacteriological and virological agents that have been adopted by Government.

World Health Organization (1984); Tamil Nadu Water supply and Drainage Boad, (1986); Manivasakam, (1991); Park and Park, (1991) and I.S. (1991) have laid down the following standards for drinking water.

S.No.	Characteristic	Acceptable	Cause for rejection
	i) Physical :		
1.	Turbidity (on Jackson turbidity unit scale)	2.5	10
2.	Temperature	10° to15.6°	--
3.	Taste	Unobjectionable	Unobjectionable
4.	Odour	Unobjectionable	Unobjectionable
5.	Colour (on platinum cobalt)	5.0	25.0
	ii) Chemical :		
1.	pH value	7.0 - 8.5	6.5 - 9.2
2.	Total dissolved solids	500	1,500
3.	Total hardness ($CaCo_3$)	200	600
4.	Chlorides	200	1,000
5.	Sulphates	200	400
6.	Fluorides	1.0	1.5
7.	Nitrates	45	45
8.	Calcium	75	200
9.	Magnesium	30	150
10.	Iron	0.1	1.0

S.No.	Characteristic	Acceptable	Cause for rejection
11.	Manganese	0.05	0.5
12.	Copper	0.05	1.5
13.	Zinc	5.0	15.0
14.	Anionic detergents	0.2	1.0
15.	Phenolic compounds	0.001	0.002
16.	Mineral and toxic substances	NIL	NIL
17.	Arsenic	0.05	0.05
18.	Cadmium	0.01	0.01
19.	Chromium	0.05	0.05
20.	Cyanide	0.05	0.05
21.	Lead	0.1	0.1
22.	Selenium	0.01	0.01
23.	Mercury	0.001	0.001
24.	Polynuclear aromatic hydrocarbons	0.2 hg/1	0.2 hg/1
	Radio alpha activity		
25.	Gross alpha activities	3 PCU	3 PCU
26.	Gross Beta activity	30 PCU	30 PCU

PCU - (Picocurie)

iii. Bacteriological standards :

1. Water entering the distribution system :

Coliform count in any sample in 100 ml should be zero (Rozov, 1983).

2. Water in the distribution :

Water in distribution system shall satisfy the following criteria indicated below :

- E-coli count in 100 ml sample should be zero
- coliform organisms not more than 10 per 100 ml shall be present in any sample
- coliform organism should not be detectable in 10ml of any two consequetive samples or more than 50 per cent of the samples collected for the year.

3. Individual or small community supplies :

E-coil count should be zero in sample of 100 ml and coliform organisms should not be more than 3 per 100 ml.

4. Virological standard :

0.5 mg/1 of free chlorine residual for one hour is considered sufficient to inactivate virus in water, insisted in all disinfected supplies. For other areas, 0.2 mg/1 of free chlorine residual for half an hour should be insisted (Varshney, 1983).

F. Purification of Water

Water is a basic necessity of life, thus the requirement of water for domestic use is needless to explain. Urban water system usually are characterised by several classes of use. They are

households, industry, commercial establishment and public facilities. It is essential that the water for human consumption should be free from unpleasent or harmful impurity (Sivanappan and Danfors, 1992).

Water is generally contaminated with disease causing bacteria either at the source or during supply due to the seepage from sewage system in water pipe line. Being invisible to naked eye it is impossible to tell whether bacteria are present or not. Hence purification of water is of great importance (Joshi, 1990).

The process of destroying all forms of pathgenic life is called purification. The control of microbial life in water is very important. The principle reasons for controlling micro-organisms are as follows :

- To prevent transmission of disease and infection.
- To eradicate micro-organism from the host that is infected.
- To prevent deterioration and spoilage of materials by micro-organism

(Purohit and Saxena, 1990).

Water is purified on a large scale at the reservoir and then purified at household level. Urban water supply is purified in a large scale under three main stages. They are storage, filteration and chlorination (Miloradav, 1992).

Storage :

The water is stored in basins and reservoirs to permit the agent of self purification to effect changes in the water. Water, stored for 12 to 24 hours removes 90 to 95 per cent of the suspended matter, the remainder body will be removed by filteration or coagulation. Most important factor in self purification is oxidation, whereby hydrogen sulphide, sulphates, ferrous iron and other salts are removed (Mathew, 1988).

Filteration :

A filter consists of a bed of sand from 24 to 30 inches thick. As the small particles move through the pores in the sand they come in contact with sand surface and adhere. In filteration 98-99 per cent of bacteria are removed.

Chlorination :

Chlorination is the last step for dis-infecting large bodies of water. Chlorine is applied either as chlorine gas or chloramine or as perchloron (Park and Park, 1991).

Water can be purified for domestic purposes by the following methods :

Boiling :

Among the conventional methods of water purification boiling is the most popular and stisfactory method of purifying water for household purpose. To be effective, the water after it reaches boiling point, has to continue boiling for atleast 20 minutes. The taste of water is altered but this is harmless. It kills all the bacteria, spores, cysts and ova and yields sterilised water (Purohit and Saxeena, 1990).

Chemical Disinfection :

Certain chemical disinfectants such as bleaching powder, chlorine tablets, iodine, potassium permanganate and alum are used.

i. Bleaching Powder :

Bleaching powder or chlorinated lime is a white amorphous powder with a pungent smell of chlorine. It should be stored in a dark, cool, dry place in a closed container that is resistant to corrosion (Park and Park 1991).

ii. Chlorine Tablets :

Chlorine tablets are available under various trade names in the market. A single tablet of 0.5 gms of it is sufficient to disinfect 20 litres of water. Chlorine tablets of chlorine compound take a long time to be effective and reported to produce curcinogen.

They are good in disinfecting small quantities of water but they are costly. (The Hindu, 1992).

iii. Iodine :

Iodine may be used for emergency disinfection of water. Two drops of 2 per cent ethanol solution of iodine will suffice for one litre of clear water.

iv. Potassium Permanganate :

Although a powerful oxidizing agent, it is not a satisfactory agent for disinfecting water. It may kill cholera vibrios, but is of little use against other disease organisms. Also it alters the colour, smell and taste of water (Purohit and Sexena, 1990).

v. Alum :

Alum is used to settle suspended impurities. Alum acts if the water contains carbonates. It forms a precipitate with the alkaline carbonate present in water which entangle impurities and bacteria. Ordinarily one to four grains of alum will suffice for one gallon of water depending upon the turbidity and colour, temperature and the pH value of the water (James, 1985).

Filteration :

Water can be purified in a small scale by filtering water through ceramic filters called Berkefed filters. The candle of the filters is made of deatomaceous earth which is a fine, usually white silicious powder composed chiefly or wholly of the remains of diatom. There are two cylinderical containers. They are placed one on the other. In the top cylinder, the earthen-ware candle is fitted by means of a screw and washers into a cylindrical glass mantle and the metal tube of the filter passes through a rubber stopper which is fitted into the neck of the flask. Figure-II explains the parts of the candle filter. (National Research Develop--ment corpoiration of India, 1986).

Water filters effectively removes all possible unwanted particles, any detectable taste and odour thus one gives crystal-clear water (ICMR - Indian council of Medical Research, 1992).

U-V radiation filter :

It is the recent water purifying appliance that has come into market. It has three main anodized aluminium chamber. The first consists of a special activated carbon catridge. The second chamber encloses the the ultra-violet lamp and its quartz shield, an electronic eye which constantly monitor the quality of water. The third chamber houses the electronic circuit which monitors the

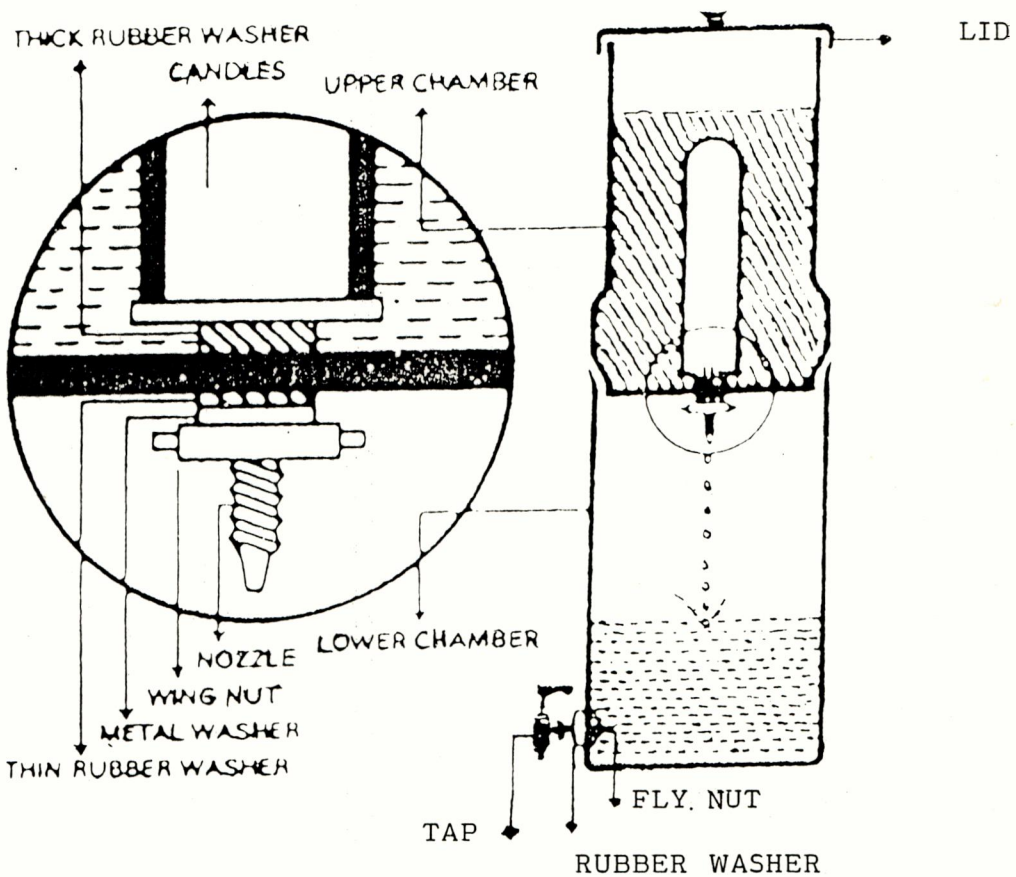


FIGURE - II

PARTS OF THE CANDLE FILTER

equipment to give safe drinking water. Water from the tap flows directly through the pre-filter which reduces the turbidity and removes mud and dust. It then flows into chamber for the water treatment process. This process treats the water for organic chemicals, free chlorine colour and odour. Due to this treatment, the water may taste slightly different. After treatment, the water flows into the next chamber around the quarts shield and is treated by ultra-violet light. This germicidal treatment effectively destroys harmful bacteria such as E.Coli, coliform as well as virus.

Before flowing to the drinking water outlet, the water passes the electronic eye which constantly scans and shuts off the flow, in case the quality falls below predetermined standards.

The U-V radiation filter functions on electricity and it is directly connected to the water taps either in the kitchen or dining hall. If there is a power failure, it fails to function. It can be fixed to the walls or placed on any flat surface. (U.V. Tech systems, 1992)

Polyiodide resin filter attached to tap :

It is a disinfecting device that can be used both inside and outside the home. It is idealy suited to purify water from any piped drinking water source such as a water cooler.

The filter attachment, first, filter the water by removing suspended and minute particles present in the water. The clear water then flows through a unique purification medium which uses a polyiodide resin to eliminate disease causing bacteria and virus on content. The iodine released by the medium ensure that the water remains pure and safe for several hours. Figure III indicates the parts of the polyiodide resin filter attached to the tap.

As regarded to the toxicological effect on the human body on ingestion of iodine, extensive studies shows that the iodine ingested by human beings (in quantities much higher than that released by this filter) have not caused any physiological abnormality in the body. Hence it is the safest and most economic method of purifying water. [Ion Exchange (India) Ltd., 1991].

Polyiodide resin filter is versatile and is marketed in convenient forms -

1. The tumbler - a portable device which can be used both inside and outside the home.
2. Tap attachment for candle filters for municipal taps. Filters and purifies water straight from the household taps.
3. On line attachment - Ideal for coolers in offices, factories and for residence.

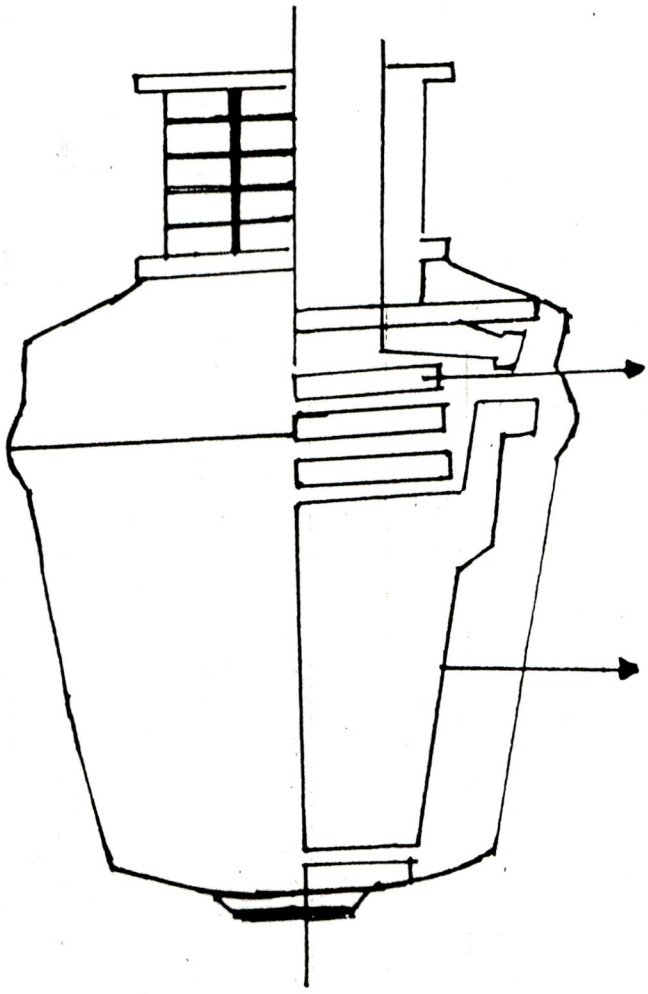


FIGURE - III

PARTS OF THE POLYIODIDE RESIN FILTER ATTACHED TO THE TAP

The multipurpose use of water for all types of human activities need both, to provide protection against the adverse impact of water and to protect water as an environment inhabited by different life forms. This clearly, shows that the planning, management and use of water resources are closely related tc the planning and development sense, of entire economy and society in the broadest sense.

Methodology

III. METHODOLOGY

The study on **"Assessing the Efficiency of Selected Water filter"**, consisted of the following aspects :

A. Household Survey

B. Assessing the Quality of Selected Water Samples

C. Evaluating the Efficiency of Selected Water filters and

D. Analysis and Presentation of Data.

A. Household Survey :

This aspect of the study consists of the following steps :

1. Selection of area
2. Selection of sample
3. Selection of tool
4. Preparation of interview schedule
5. Pretesting the schedule
6. Collection of data

1. Selection of area :

The household survey was conducted in selected areas on the basis of availability of water from different sources. Siruvani a reservoir is the major source of water supply for the population residing in this area. Therefore residential locations of R.S.Puram, Saibaba Colony and Shungam were selected for conducting the household survey.

Figure IV illustrates the locations identified for the conduct of the household survey.

2. Selection of Sample :

The success of any study depends on the careful selection of sample. The choice of the sample must be decided based on factors such as nature of the study, size of the universe, size of the sample, degree of precision desired and availability of resources (Elhance, 1984).

According to Gupta (1991) purposive sampling is a technique in which a desired number of sample unit is selected deliberately or purposely depending upon the objective of enquiry. Hence purposive sampling procedure was used for selecting the sample.

According to the Housing Board Urban Development Corporation (1987) the income level of the family was categorised as low income group (below Rs.1,500/- per month) middle income group (Rs.1,500/- - 5,000/- per month and high income group (above Rs.5,000/- per month). Based on this income range, 100 households were selected of which 50 belonged to the high income group and 50 belonged to the middle income group.

MAP OF COIMBATORE CORPORATION

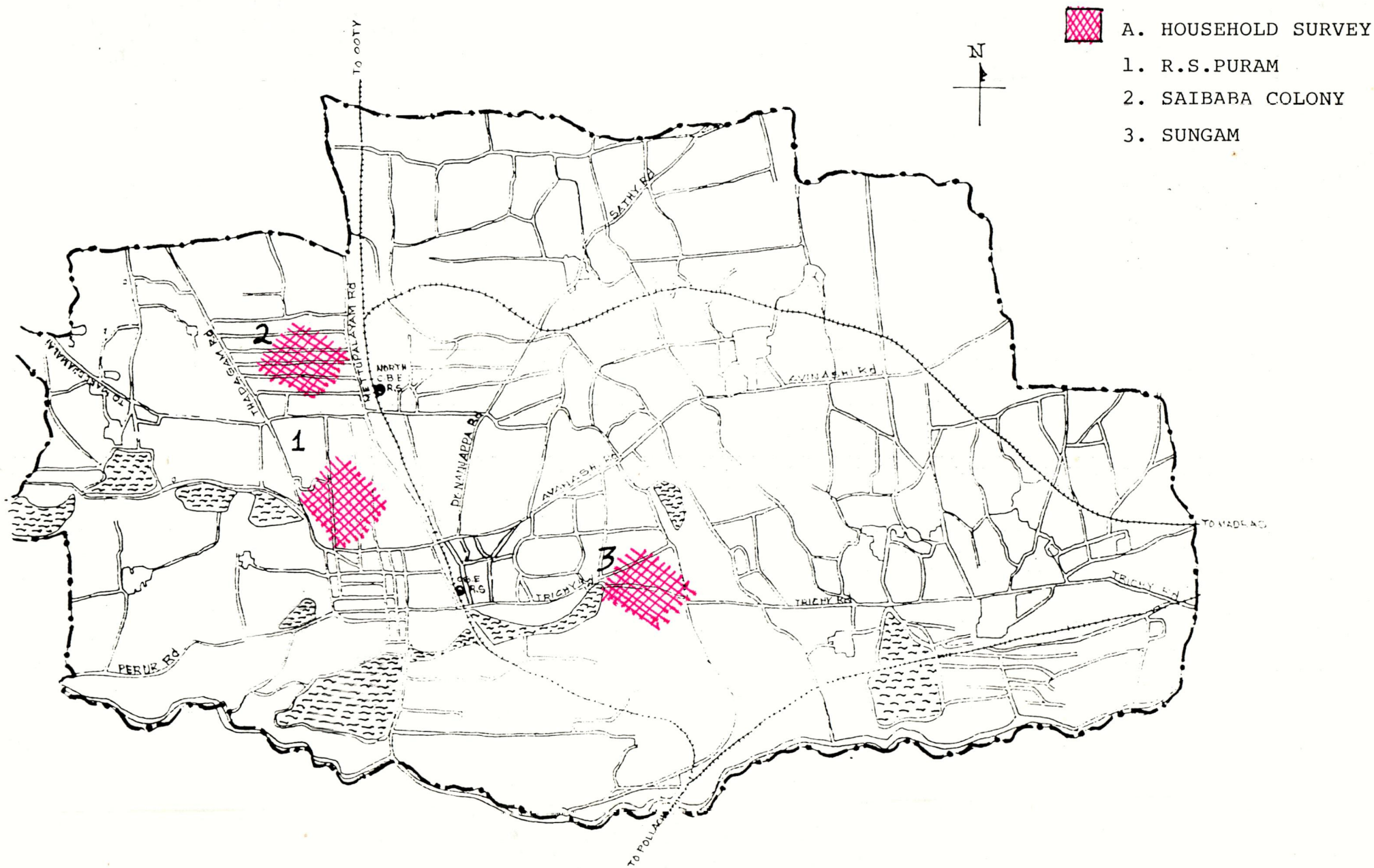


FIGURE - IV

LOCATIONS IDENTIFIED FOR HOUSEHOLD SURVEY

3. Selection of tool :

Interview is a two-way method which permits exchange of ideas and information. It is a unique method, in that it involves the collection of data through direct verbal interaction between the interviewee and the interviewer (Sidhu, 1985). Therefore the tool selected for this study was interview method.

4. Preparation of interview schedule :

To collect details related to this study, it was necessary to include in the schedule questions which could help to elicit information on socio-economic status of the sample, different sources of water supply, water distribution system, collection and storage of water, and purification techniques of drinking water. The schedule was carefully drawn to elicit the required information.

5. Pretesting the Schedule :

Kothari (1991) states that pretest helps the investigator to equip with the understanding of the overall objective of each question, as it is trying to measure it, previously. It helps the investigator to find out the drawbacks of the schedule.

The schedule was pretested in 10 households so as to help in checking the appropriateness of standard measures.

Thus the interview schedule was finalised and is presented in Appendix I.

6. Collection of data :

To understand the water management practices of the home makers and water purification methods adopted by them it was necessary to conduct a survey among selected households. With the help of the finalised interview schedule the survey was carried out in the selected areas. The required information was recorded simulataneously.

B. Assessing the Quality of Selected Water Samples :

Water which is of excellent quality when it enters the distribution system may still undergo some changes before it reaches the consumer.

Home makers were aware of the reasons for contamination of drinking water and adopted various purification methods for obtaining safe drinking water. They were satisfied with the methods they adopted but were not aware of the physical, chemical and microbiological quality of the drinking water. Hence this initiated the investigator to examine the physical, chemical and microbiological quality of drinking water collected from different sources and water filters.

In order to assess the quality of drinking water from different sources, the following steps were adopted.

1. Selecting the water samples
2. Collecting the water samples and
3. Conducting water analysis.

1. Selecting the water samples

The water samples selected were from,

a) different sources of water and

b) selected water filters.

a. Water samples from different sources of water.

Initial study revealed that Siruvani water was the main source of drinking water which was being supplied by the Coimbatore corporation. In addition to it eight percent of middle income families and 12 percent high income families had borewell water supply. During summer, scarcity in corporation water, necessiated the families to depend on borewell water. Therefore the water from these two sources were considered for analysis.

b) Water samples collected from selected water filters.

Data collected from the household survey, revealed that stainless steel local candle filter, polyvinyl standard candle filter, polyiodide resin filter attached to the tap and U-V radiation filter were used by the urban home makers for filtering purpose.

Water samples were collected directly from polyiodide resin filter attached to tap and U-V radiation filter. In the case of candle filters, water were collected without boiling and after boiling. Total nine samples (Plate I) of water passed through filters were taken from the households surveyed.

2. Collecting the water samples :

Water samples were collected for analysis as per the approved procedures. The procedure adopted for taking samples for analysis is as follows :

a) Physical and chemical analysis.

b) Microbiological analysis.

a) Physical and chemical analysis :

A clean new jerry can made up of plastic with two and half litres capacity was used to collect water samples. The tap was opened fully and water was allowed to run off to flush the interior of the nozzle and to discharge the stagnant water in the pipe in order to avoid the contamination of the sample. Before collecting the sample, the jerry can was carefully rinsed 3 or 4 times with the water to be analysed. Water was drawn into the jerry can leaving some air space, and closed tightly with the stopper with a piece of cloth tied over it and then sealed.

PLATE 1 - DRINKING WATER SAMPLES COLLECTED FOR ANALYSIS

b) Microbiological analysis :

To collect the drinking water samples for microbiological examination eight neutral glass bottles with stopper of 200ml capacity were obtained from the Chief Water Analyst, Public Health Laboratory. In the laboratory, the bottles were cleaned thcroughly and thensterilized in an autoclave for one hour. Care was taken not to open the bottle until the tap was first opened fully and water was allowed to flow for 2 minutes and then the water was collected by holding the bottle near the base with one hand and then the stopper was removed. When the bottle was filled, it was immediately closed. By following the above procedure the drinking water samples were collected for microbiological analysis.

3. Conducting the water analysis :

The selected drinking water samples were tested for physical, chemical and microbiological examination by following the procedures given below.

a) Physical examination of the water samples :

The physical characteristics such as colour, odour or smell, taste and turbidity were analysed in the laboratory. The colour of the water sample was measured by comparision with standards. The odour and taste are assessed by testing the sample by smelling and tasting the water sample. The turbidity was measured by Jackson Candel Turbidity Meter. The procedures followed for the determination of colour and turbidity are given in Appendix-II.

b) Chemical exmination of the water samples :

The chemical examination was aimed at finding out the presence of substances like fluorides, nitrates, nitrites which may in turn affect the health of the population.

The characteristics which affect the potability of water are total solids, total hardness, calcium, magnessium, sulphates, chlorides, pH, saline ammonia, albuminoid ammonia, oxygen absorbed, total alkalinity, electrical conductivity were also analysed. The procedure for chemical analysis of water is given in Appendix - III.

c) Microbiological examination of the water samples :

The following two tests were employed in microbiological examination of drinking water.

i) Presumptive coliform test.

ii) Colony count.

The procedure adopted for these tests is given in Appendix - IV.

C) Evaluating the Efficiency of Selected Water Filters :

The efficiency of the water filters was evaluated based on the analysis of water samples collected from different water filters.

D) Analysis and Presentation of Data

The data thus obtained was consolidated, tabulated and presented in Chapter IV.

Results and Discussion

IV RESULTS AND DISCUSSION

The results pertaining to the study on **"Assessing the Efficiency of Selected Water Filters"** are analysed and presented under the following headings :

A. Household survey.

B. Assessing the quality of selected water samples.

C. Evaluating the efficiency of selected water filters.

A. Household Survey

The findings of the household survey are discussed under the following headings :

1. Family background
2. General information on domestic water
   a. Water supply
   b. Collection of water
   c. Storage of water
3. Purification of drinking water
   a. Purification methods.
   b. Details regarding water filters used.

1. Family background :

Under this heading, the type of family, type of dwelling, size of family, family income, educational and occupational status of heads of the family and home makers are discussed.

a. Type of family :

The study revealed that 84 per cent and 90 per cent of the middle and high income families respectively were nuclear type, whereas the rest of them belonged to the joint type, which shows the fast disintegration of joint family system.

b. Type of dwelling :

It was observed from the study that 72 per cent of the middle income families and 94 per cent of the high inccme families had their own houses and the rest 28 per cent and 6 per cent of the middle and high income families respectively were residing in rented house.

c. Size of family :

Table I shows the size of the selected families.

TABLE - I

SIZE OF THE SELECTED FAMILIES

Family size	Middle		High	
	Middle	Percentage	Number	Percentage
Small size (1-3 numbers)	24	48	26	52
Medium size (4-6 numbers)	20	40	17	34
Large size (7-9 numbers)	6	12	7	14
TOTAL	50	100	50	100

According to Devadas (1983) small family is one which comprises of 1-3 members, medium family of 4-6 members and large family of 7-9 members. Among the selected families, 48 per cent and 52 per cent of middle and high income families respectively belonged to small family size, followed by medium family size (40 per cent middle income and 34 per cent high income) and large family size (12 per cent middle income and 14 per cent high income). Naturally a majority of those who were in the joint family system were large in size. It is heartening to note that a majority of the families, irrespective of the income group, belonged to small family size pointing out the awareness created in members regarding the advantages of small families.

d. Family income :

The income which a family receives and the way in which it is spent are factors which are vital in bringing about satisfaction among family members. One half of the selected families has earned a monthly income between Rs.1,500 - 5,000 and belonged to middle income group. The remaining families received monthly income of Rs.5,000 - 10,000 and belonged to high income group. Among the 50 high income families, 39 per cent earned between Rs.5,000 and Rs.6,000 per month whereas the rest earned above Rs.6,000. Apart from this, only 12 per cent and 20 per cent of the middle and high income families respectively, obtained additional income from other sources such as land, rent, interest from investment and shares which helped them to improve their quality of life.

e. Educational status of the heads of the family and homemakers :

Table II depicts the educational status of the selected heads of families and homemakers.

TABLE - II

EDUCATIONAL STATUS OF THE SELECTED HEADS OF FAMILIES AND HOMEMAKERS

Educational Status	Middle income				High income			
	Family heads		Homemakers		Family heads		Homemakers	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Primary	5	10	16	32	3	6	2	4
Secondary	8	16	16	32	4	8	17	34
Graduate	23	46	12	24	17	34	13	26
Post-graduate	14	28	6	12	26	52	18	36
TOTAL	50	100	50	100	50	100	50	100

Seventy four per cent of the heads of the middle income families were graduates which a majority of 64 per cent of homemakers had only education upto the secondary level. In the high income families, 86 per cent of heads of the families and 62 per cent of homemakers were graduates. This shows that income has a great influence on the educational status of the family. Twelve per cent of homemakers in the middle income and 36 per cent in the high income families had education upto post-graduation. It is encouraging to see that all the selected families were educated declaring the changing trend in the values associated with education.

f. Occupational status of the heads of families and homemakers :

Occupational status decides the standard of living of any family. Table III shows the occupational status of the heads of families and homemakers.

TABLE - III

OCCUPATIONAL STATUS OF THE SELECTED HEADS OF FAMILIES AND HOMEMAKERS

Occupation	High income				High income			
	Family heads		Homemakers		Family heads		Homemakers	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Full time homemaker	--	--	28	56	--	--	41	82
Clerk	8	16	8	16	3	6	1	2
Doctor	8	16	--	--	7	14	1	2
Teacher	9	18	12	24	6	12	3	6
Engineer	8	16	--	--	9	18	--	--
Business	17	34	2	4	25	50	4	8
TOTAL	50	100	50	100	50	100	50	100

Being an industrial city, Coimbatore, offers wide opportunity for business. This was revealed in the study. Thirty four per cent and 50 per cent of middle and high income heads of families respectively were involved in business. Between 14 and 18 per cnet of heads of families irrespective of their income were either doctors or engineers. The rest were either teachers or clerks.

Regarding the occupational status of the homemakers. 56 per cent and 82 per cent of middle and high income groups respectively were full time homemakers. Four and eight per cent of the middle and high income homemakers were involved in business and only 10 per cent of high income homemakers were engaged outside, as teachers (two per cent) and doctors (two per cent) whereas in the case of middle income families, 40 per cent of the employed homemakers worked, 24 per cent as teachers and (16 per cent) as clerks. With the help of their income, the homemakers were able to supplement their family income. Thus they could improve the economic status of the family.

2. General information on domestic water :

a. Water supply and distribution system

The information such as sources of water supply, water distribution, location of drinking water points, frequency of water supply and adequacy of water supply are discussed under this heading.

i. Sources of water supply :

Table IV indicates the sources of water supply for the selected families.

TABLE - IV

SOURCES OF WATER SUPPLY BY THE SELECTED FAMILIES

Sources of water *	Middle		High	
	Number	Percentage	Number	Percentage
Open well	2	4	--	--
Bore well	4	8	12	24
Siruvani	50	100	50	100

* Multiple responses

Since Siruvani water (plate 2) is supplied throughout the urban limit of Coimbatore City, all the selected families had Siruvani water supply.

Along with Siruvani water, eight per cent and 24 per cent of the middle and high income families respectively had borewell water also, whereas four per cent of the middle income families had open well. Having borewell in the house compound is a prestige issue for the high income families and this water is generally used for gardening and when Siruvani water becames scarce, is used for other household purposes also. (Plate 3) represents borewell water.

PLATE 2 - COMMUNITY TANK

PLATE 3 - BOREWELL

ii. Water distribution :

It was observed that all the selected families had individual water connection. The provision of individual tap help them to avoid wastage of water and water stagnation around the house.

iii. Location of drinking water points by the selected families :

Table V shows the location of drinking water points in the selected families.

TABLE - V

LOCATION OF DRINKING WATER POINTS BY THE SELECTED FAMILIES

Location of drinking water points	Middle income		High income	
	Number	Percentage	Number	Percentage
Dining room	7	14	5	10
Outside	10	20	4	8
Kitchen	11	22	10	20
Entire house	22	44	31	62
TOTAL	50	100	50	100

Table V explains that 22 per cent of middle income and 20 per cent of high income families had provision of water facilities in the kitchen, whereas only 20 per cent and eight per cent of middle and high income families had provision outside the house and rest 14 per cent of middle income and 10 per cent of high income families had provision only in the dining room. Water facilities in the kitchen helps the homemakers to reduce time and energy spending in collecting water from outside. Between 40 per cent and 65 per cent of households had drinking water points in the entire house.

iv. Frequency of water supply :

Siruvani water supply is received daily in Saibaba colony and R.S.Puram and on alternate days in Shungam. Generally for two hours in the morning and very few areas received water supply in the evening. Therefore water had to be stored for use.

Table VI shows the frequency of water supply by the selected families.

TABLE - VI

FREQUENCY OF WATER SUPPLY BY THE SELECTED FAMILIES

Frequency of water supply	Middle income		High income	
	Number	Percentage	Number	Percentage
Daily	43	86	48	96
Alternate days	7	14	2	4
Total	50	100	50	100

It was observed from the Table that 86 per cent of the middle income families and 96 per cent of the high income families obtained water supply daily during a particular time. The remaining 14 per cent and four per cent middle and high income families respectively get water supply on alternate days.

V. Adequacy of water supply :

Regarding the sufficiency of water, only 20 per cent and eight per cent of middle and high income families respectively were complaining about the inadequacy of water for household purposes during summer. They could manage the scarcity by using water from bore wells or from neighbours, if required.

b. Collection of drinking water :

The information collected and considered for discussion under this aspect are collection of water for drinking purpose, containers used for collection, storage of water, and problems faced in collection of water.

i. Collection of water for drinking :

The information gathered during the household survey revealed that all the selected families collected water daily or on alternate days for drinking purpose.

PLATE 4 - OVERHEAD TANK

PLATE 5 - UNDERGROUND TANK

TABLE - VIII

CONTAINERS USED FOR COLLECTION OF WATER BY THE SELECTED FAMILIES

Type of containers	Middle		High	
	* Number	Percentage	* Number	Percentage
"Kudam"				
Aluminium	2	4	--	--
Brass	3	6	4	8
Plastic	29	58	17	34
Stainless steel	50	100	50	100

* Multipurpose responses

"Kudam" a traditional container made of different materials, such as stainless steel, plastic, brass and aluminium are used to collect water by all the selected families. An average sized "Kudam" holds 12-15 litres of water is used to collect water by all the selected families. Stainless steel "kudam" was popular among all the selected families followed by plastic. Kudam made of brass and aluminium was not popular and therefore was found only in less than ten per cent of the families.

iv. Problem faced in collecting water :

As the supply of water was only for certain specific hours, it was important to open the tank and the pipe and also to switch on the motor to lift water to the overhead tank and close the tank and pipe and switch off the motor to avoid over-flowing of water. For

PLATE 6 - DRINKING WATER STORAGE CONTAINERS

ii. Frequency of cleaning the drinking water containers :

Table X depicts the frequency of cleaning drinking water storage containers by the selected families.

TABLE - X

FREQUENCY OF CLEANING THE DRINKING WATER CONTAINERS BY THE SELECTED FAMILIES

Frequency of cleaning	Middle		High	
	Number	Percentage	Number	Percentage
Once in a week	2	4	1	2
Twice in a week	10	20	3	6
Alternate days	12	24	9	18
Daily	26	52	37	74
TOTAL	50	100	50	100

It was observed from the above Table that all the full time homemakers have time to clean the containers daily. Employed homemakers seem to clean the containers according to their convenience. A majority of 52 per cent of middle and 74 per cent of high income families cleaned daily, the containers used for storing drinking water. Only four per cent and two per cnet of the middle and high income families were cleaning, once a week whereas 20 per cent and six per cent of middle and high income families respectively clean the storage containers twice a week.

Rest of the selected families were very particular to clean the storage containers atleast on alternative days.

iii. Changed views of homemakers on the quality of stored water :

Tabel XI gives the views of homemakers on the quality of stored water.

TABLE XI

VIEW OF HOMEMAKERS ON THE QUALITY OF STORED WATER BY THE SELECTED FAMILIES

Quality observed	Middle		High	
	Number	Percentage	Number	Percentage
a. No change	4	8	9	18
b. Odour	10	20	9	18
c. Change in taste	14	28	4	8
d. Sediments	22	44	28	56
TOTAL	50	100	50	100

Forty four and 56 per cnet of middle and high income families respectively reported of sediments in the stored water within few hours. Twenty and 18 per cent of middle and high income families respectively point out some odour in water stored in mostly plastic containers. Change in taste was found by 28 per cnet and eight per cent of the middle and high income families in the stored water after three or four days. Hence they were cleaning the storage containers either on alternative days or atleast once in a week.

3. Purification of drinking water :

a. Methods of Purification :

Methods for water purification, Reason for purifiction, opinion about the method of purifying drinking water for various age groups and various situations are discussed under this heading.

i. Methods for water purification :

Table XII shows the different methods adopted for purification of drinking water.

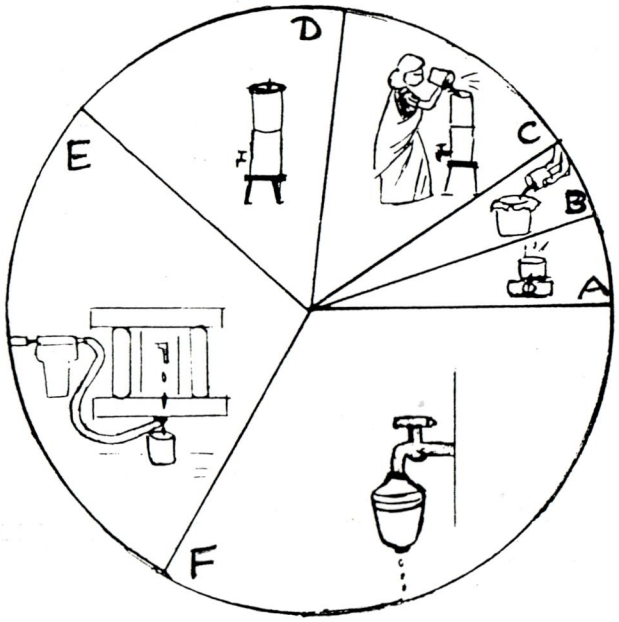
TABLE - XII

METHODS FOR WATER PURIFICATION BY THE SELECTED FAMILIES

Purification methods	Middle		High	
	* Number	Percentage	* Number	Percentage
Boiling	2	4	0	0
Boiling and filtering with cloth	2	4	--	--
Boiling and using candle filters	7	14	6	12
Using candle fitlers alone	21	42	20	40
U-V radiation filter	8	16	12	24
Polyiodide resin filter attached to tap	14	28	12	24

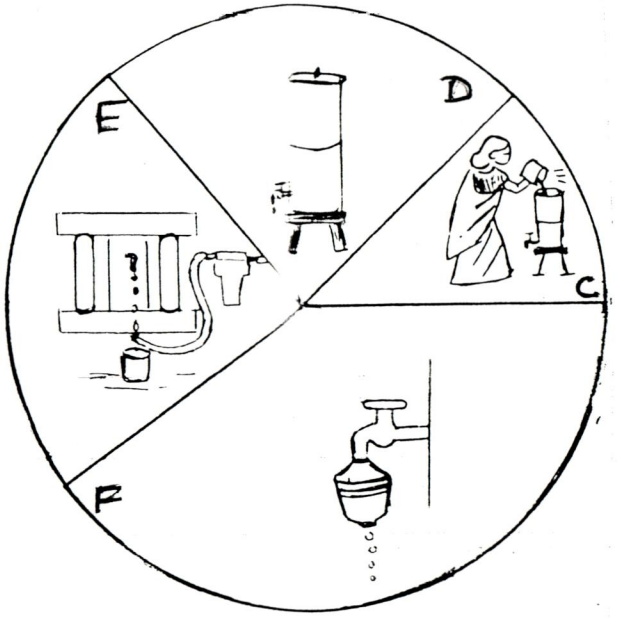
* Multiple responses.

It was interesting to note that cent per cent of the surveyed families followed atleast one of the purification methods such as boiling (Plate 7) boiling and filtering with cloth, boiling and using water filters (Plate 8 and 9) using ultraviolet radiation (Plate 10) and polyiodide resin portable filter to the tap (Plate 11) for purifying the drinking water. Figure V represents water purification methods adopted by the selected families.



MIDDLE INCOME

A. BOILING
B. BOILING AND FILTERING WITH CLOTH
C. BOILING AND USING CANDLE FILTER



HIGH INCOME

D. USING CANDLE FILTER
E. U-V RADIATION FILTER
F. POLYIODIDE RESIN FILTER.

FIGURE - V

PURIFICATION METHODS ADOPTED BY THE SELECTED FAMILIES

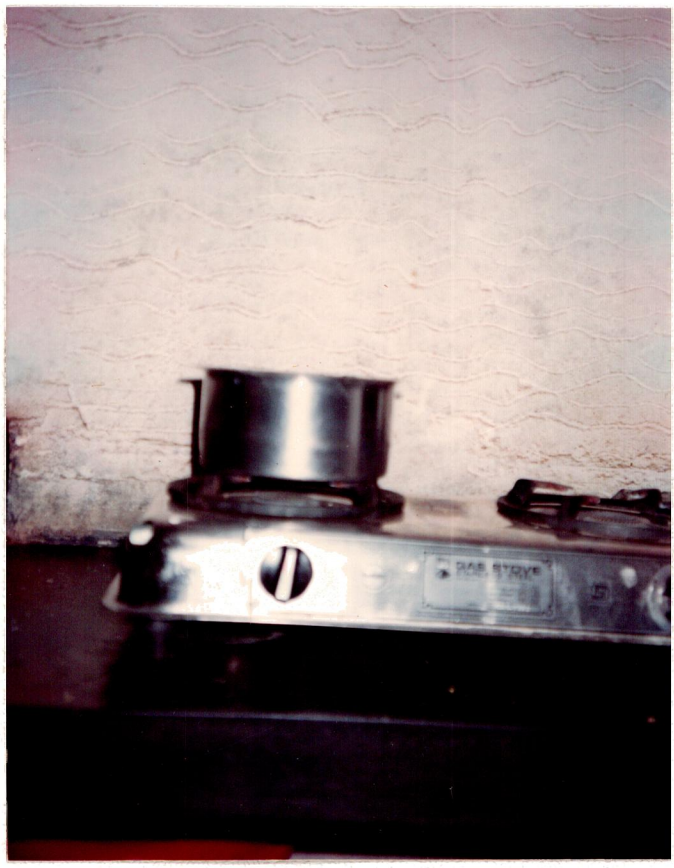


PLATE 7 - BOILING

WATER PURIFICATION METHODS ADOPTED BY THE SELECTED FAMILIES

PLATE 8 - POLYVINYL CANDLE FILTER

PLATE 9 - STAINLESS STEEL

CANDLE FILTER

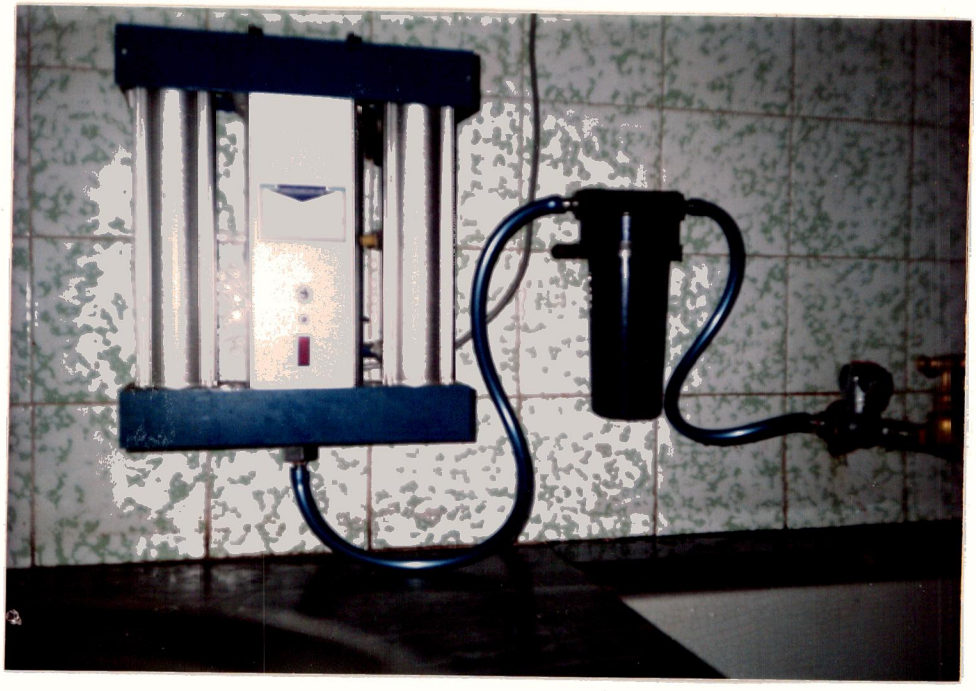


PLATE 10 - U-V RADIATION FILTER

PLATE 11 - POLYIODIDE RESIN PORTABLE FILTER ATTACHED TO THE TAP

Thirty eight per cent of middle and 40 per cent of high income families filtered water in water filters made of stainless steel, & polyvinyl. Around 14 and 12 per cent of middle and high income families respectively adopted boiling and filtering. Between 15 and 30 per cent of middle income and high income families possessed U-V radiation filter and polyiodide resin filter attached to the tap inside the kitchen hence they directly collected the water from the tap and used for drinking and cooking. Polyiodide resin filter was popular for domestic use because the cost was very less (below Rs.250/-) when compared with U-V radiation filter costing (above Rs.3,500/-).

Only four per cent of the middle income families adopted simple indigenous methods of boiling and filtering the boiled cooled water with cloth for filtering. The data clearly indicated that the urban families surveyed had the concept of purifying drinking water and practiced any one method to obtain clear water for domestic consumption.

ii. Reasons for purifying drinking water :

Clean drinking water is the key to human survival. The connection between unsafe water and disease is a well established fact. Hence it is essential to purify water used for drinking.

Table XIII depicts the various reasons given by the selected families for purifying the drinking water.

TABLE - XIII

REASONS FOR PURIFICATION OF DRINKING WATER BY THE SELECTED FAMILIES

Reasons	Middle		High	
	Number*	Percentage	Number*	Percentage.
Satisfaction	6	12	10	20
To eliminate dust and dirt particles	8	16	14	24
Doctor's advice	11	22	27	54
To avoid micro organisms	12	24	18	36
To avoid common cold	28	56	30	60
To be healthy	50	100	50	100

* - Multiple responses.

All the selected families purified drinking water to maintain good health. In order to avoid common cold 56 to 60 per cent of middle and high income families purified water respectively. Microorganisms are the root cause for spreading many infectious diseases. So in order to avoid these micro-organisms 24 per cent middle and 36 per cent high income families adopted some measures to obtain clear water. As per the doctor's instruction 22 per cent of middle and 54 per cnet of high income families followed water purification methods.

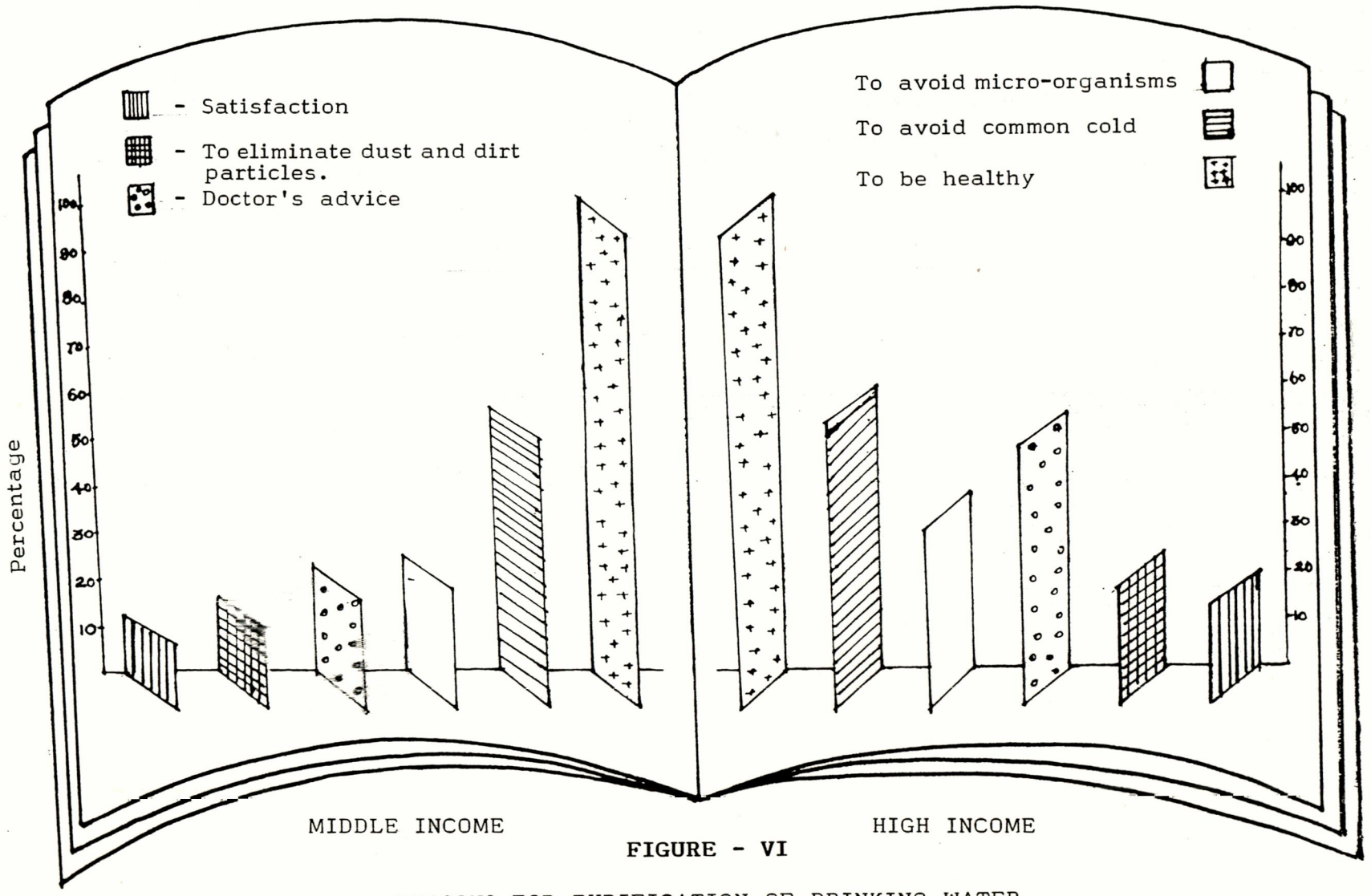


FIGURE - VI

REASONS FOR PURIFICATION OF DRINKING WATER

BY THE SELECTED FAMILIES

iii. Opinion about the method of purifying drinking water for various age groups :

The nature of treatment facilities realised to process water for various ages depends partly on the quality of the water available for use, partly as the specific requirement of the users and partly on the quantity of water that are to be processed (Versman and Welty, 1985).

Table XIV shows the different methods by which drinking water is purified for various age groups.

TABLE - XIV

METHOD OF PURIFYING DRINKING WATER FOR VARIOUS AGE GROUPS BY THE SELECTED FAMILIES

		Infant		Childhood		Adolescent		Adult		Old age	
		Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Middle	Boiling	10	20	9	18	6	12	2	4	9	18
	Filtering with cloth	-	-	1	2	1	2	-	-	-	-
	No specific methods	40	80	40	80	44	88	48	96	41	82
	Total	50	100	50	100	50	100	50	100	50	100
High	Boiling	9	18	6	12	2	4	-	-	9	18
	No specific methods	41	82	44	88	48	96	50	100	41	82
	Total	50	100	50	100	50	100	50	100	50	100

Boiling was the only method adopted by all to provide safe drinking water for infants. Aged people were given as much importance as it is given to infants, because they are more prone to infections. Here 18 per cent of each income group suggested boiling method. For adults most of the families do not take any special effort to provide pure water, as the adults will have the necessary immunity to withstand common infections. Rest of the families at both income groups are not following any specific method. Other than using filtered water passed through filters.

iv. Purification methods adopted during various situations :

The different methods by which drinking water is purified for various situations is shown in Table XV.

TABLE - XV

METHOD OF PURIFYING DRINKING WATER FOR VARIOUS SITUATION BY THE SELECTED FAMILIES

Methods of purifying water	Sickness		Rainy Season		Travel	
	Number	Percentage	Number	Percentage	Number	Percentage
Middle :						
Boiling	18	36	4	8	2	4
Filtering with cloth	2	4	-	-	-	-
No specific method	30	60	46	92	48	96
Total	50	100	50	100	50	100
High						
Boiling	18	36	2	4	2	4
No specific method	32	64	48	96	48	96
Total	50	100	50	100	50	100

Sickness is usually due to unhealthy living habits, like consuming impure water. Therefore, most of the household 36 per cent of each income group was boiling method and only 4 per cent of middle income households used the method of filtering with cloth. Rest of the households used the normal procedure of purifying water through filters.

During rainy season, the water will be usually muddy, therefore most of the households prefer to store the water and allow the mud particles to sediment. Eight and four per cent of middle and high income families respectively adopted the method of boiling to kill the micro-organisms.

However, some homemakers also expressed that during travelling polyiodide resin filter, can be used as it can be fixed to the tap to obtain clean drinking water. Rest 4 per cent families of high income group take water which is boiled and cooled with them while travelling.

b. Details of the water filters used :

This aspect includes, motivating factors for purchasing water filters, type of material with which water filters are made. Details on maintenance of water filter, problems faced in using water filter and quality of purified water are expressed by the homemakers.

i. Motivating factors for purchasing water filters :

Table XVI exhibits the motivating factors for purchasing water filters by the selected families it is represented diagramically in Fig.VIII.

TABLE - XVI

MOTIVATING FACTORS FOR PURCHASING WATER FILTERS BY THE SELECTED FAMILIES

Motivating factors	Middle		High	
	Number *	Percentage	Number *	Percentage
Neighbours	2	4	6	12
Employment status	4	8	4	8
Reasonable price	6	12	4	8
Advertisement	8	16	12	24
Health consciousness	12	14	10	20
Prestige value	14	28	14	28
Knowledge	28	56	32	64

* - Multiple responses

Fifty six per cent of middle income and 64 per cent of high income families had gained previous knowledge regarding filters and its use, through various magazines, friends and relatives. Inspite of that, the motivating factors that helped them to buy the filters were advertisement (between 15 and 25 per cent), neightours between 3-15 per cent) and cost of filters (12 per cent and eight per cent) among middle and high income families. The rest of the families bought the filters, for employment status and prestige value.

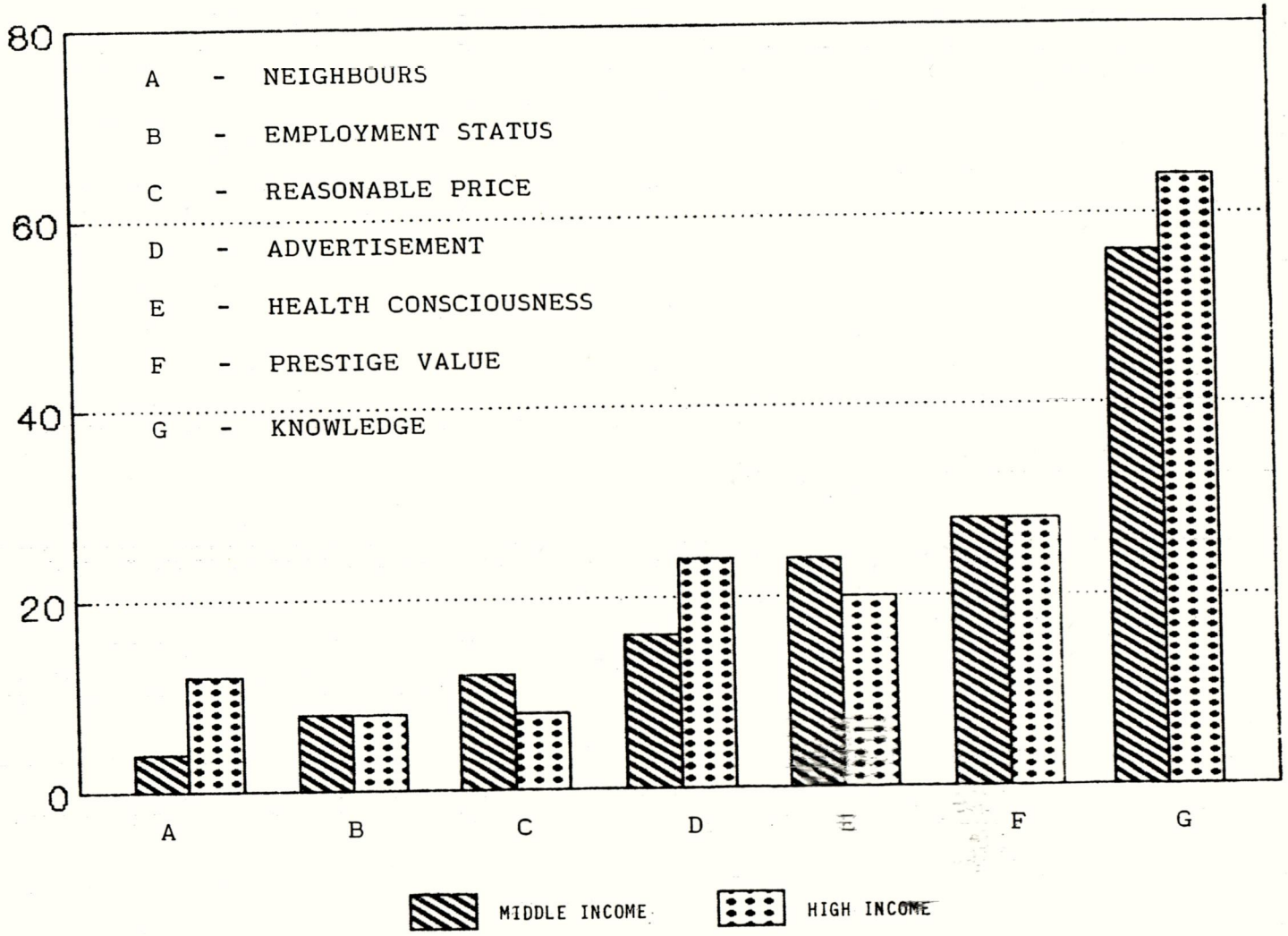


FIGURE - VII

MOTIVATING FACTORS FOR PURCHASING WATER FILTERS

ii. Type of material with which water filters are made :

There are many varieties of water filters available in the market with different brand names and materials with which the water filters are made up of.

TABLE - XVII

TYPES OF MATERIAL WITH WHICH WATER FILTERS ARE MADE

Brand name and material	middle		High	
	Number	Percentage	Number	Percentage
Polyiodide resin filter (attached to tap)	14	28	12	24
U-V radiation filter	8	16	12	24
Candle filters : (Standard type)	10	20	14	28
Stainless steel (Locally made)	18	36	12	24
TOTAL	50	100	50	100

The standard type of water filters made of polyvinyl are used by 20 per cent and 28 per cent of middle and high income families respectively. Thirty six per cent in middle and 24 per cent and high income families possessed stainless steel filters, which are made by local companies within Coimbatore City. Stainless steel local candle filters were for the range of Rs.250/- - 500/-, compared to standard polyvinyl candle litre which is above Rs.700/-.

iii. Details on maintenance of water filters :

Table XVIII shows the details on maintenance of water filters, i.e. frequency of cleaning of filter vessel candle and the frequency of changing of water.

TABLE - XVIII

DETAILS ON MAINTENANCE OF WATER FILTERS BY THE SELECTED FAMILIES

	MIDDLE						HIGH					
	Cleaning of Vessel		Cleaning of candle		Cleaning of water		Cleaning of vessel		Cleaning of candle		Cleaning of water	
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Daily	30	60	7	14	30	60	36	72	5	10	36	72
Alternate days	8	16	8	16	15	30	5	10	10	20	8	16
Twice in a week	3	6	20	40	5	10	6	12	20	40	6	12
Weekly once	8	16	14	28	-	-	2	4	13	26	-	-
Fortnightly	1	2	1	2	-	-	1	2	2	4	-	-
TOTAL	50	100	50	100	50	100	50	100	50	100	50	100

Between 60 to 75 per cent of households clean the vessel daily, 15 to 10 per cent do it on alternate days and in the range of five to 15 per cent do it only twice a week by each income group.

Employed homemaker get time only during week ends and therefore about 16 per cent of middle and four per cent of high income group do it once in a week, rest two per cent of each group do it once in a fortnight.

Cleaning of candles are done by taking out the candles, putting it in warm water, then brushing its surface. As this is a time consuming job, it is done mostly during weekends, or twice a week by majority of the homemakers only 14 per cent of middle and 10 per cent of high income group do it daily and 16 and 20 per cent of middle and high income families respectively wash it on alternate days.

Changing of water is done daily or on alternate days, according to the use of water only 10 per cent of middle and 12 per cent of high income groups do it twice in a week.

iv. Problems faced in using water filters :

Table XIX shows the problems faced by using water filters by the selected families.

TABLE - XIX

PROBLEMS FACED IN USING WATER FILTERS BY THE SELECTED FAMILIES

	Middle		High	
	Number	Percentage	Number	Percentage
Leaking	-	-	2	4
No proper filteration	4	8	3	6
Pealing of paint	-	-	2	4
Replacing of candles	12	24	6	12
No problem	34	68	37	74
TOTAL	50	100	50	100

Replacing of candles is the main problem faced as it loses its efficiency like a bulb which becomes fused. Problem of leaking and pealing of paint has been faced only by few households (four per cent) of high income family. Between 65 per cent and 75 per cent of middle and high income families did not find any problem by using water filters.

v. Quality of Purified Water :

A purified water is one that cannot harm the consumer. It should be free from pathogenic agents, from harmful chemical substances. pleasant to taste, usuable for domestic purposes, colourless and odourless.

Table XX explains the qualities of purified water according to the homemakers view point.

TABLE XX

QUALITY OF PURIFIED WATER EXPRESSED BY THE SELECTED FAMILIES

	Middle		High	
	Number	Percentage	Number	Percentage
Taste	4	8	4	8
odour	2	4	3	6
No change	44	88	43	86
TOTAL	50	100	50	100

The surveyed family members were satisfied with their method and techniques for purifying drinking water. About 88 per cent of middle income families and 86 per cent of high income families expressed they did not find any quality difference in odour and taste and found it satisfactory. But a meagre percentage of eight per cent of each income group stated that they found difference in taste and in odour by four and six per cent of middle and high income families.

C. Assessing the Quality of Selected Water Samples :

The physical, chemical and microbiological examination of drinking water from different sources and water filters, was analysed in the laboratory and the findings are discussed below :

1. Physical examination of water
2. Chemical examination of water
3. Microbiological examination of water

1. Physical examination of water :

The physical characteristics such as colour, odour turbidity and taste of drinking water collected from the two sources are given in Table XXI.

TABLE - XXI

PHYSICAL CHARACTERISTICS OF DRINKING WATER BY THE SELECTED FAMILIES

S.No.	Characteristics	Sample		Acceptable limit
		Siruvani	Borewell	
1.	Taste	Acceptable	Slightly saltish	Acceptable
2.	Colour	Slightly whitish	Whitish	Colourless
3.	Turbidity	9 units	20 units	10 units
4.	Odour	None	None	No diagreeable odour

The findings on Siruvani water showed a satisfactory remark on physical characteristics when it was compared with the acceptable standards suggested by IS-10500-1991 (First revision). The siruvani water had acceptable taste, no disagreeable odour, slightly whitish in colour, and had only 9 units of turbidity.

Borewell water sample also had no disagreeable odour, and had whitish colour, whereas it had a slight saltish taste and its turbidity was very high in 20 units.

The degree of turbidity of a water source may be taken as a measure of the intensity of the pollution. Therefore, borewell water can be considered slightly polluted, whereas siruvani is apt far drinking purpose.

2. Chemical examination of water :

Table XXII exhibits the chemical characteristics of two samples from two sources with the standard given by IS-10500-1991 (First revision).

TABLE XXII

CHEMICAL CHARACTERISTICS OF DRINKING WATER

S.No.	Characteristics	Sample		Requirement (Desirable limit)	Undersirable effect outside the desirable limit	Permissible limit in the absence of alternate source
		Siruvani	Borewell			
1.	pH values	7.5	8.2	6.5 to 8.5	Beyond this range the water will affect the mucous membrane and or water supply system	No relaxation
2.	Total solids	29	1250	500	Beyond this palatability decreases and may cause gastro-intestinal irritation	2000
3.	Total hardness mg/l (as $CaCo_3$)	12	490	300	Encrustation in water supply structure and adverse effects on domestic use	600

S.No.	Characteristics	Sample		Requirement (Desirable limit)	Undesirable effect outside the desirable limit	Permissible limit in the absence of alternate source
		Siruvani	Borewell			
4.	Chloride (as cl) mg/l	6	160	250	Beyond this limit taste, corrosin and palatability are affected.	1000
5.	Nitrate as (No_2) mg/l	0	25	45	Beyond this methae -moglobinemia takes place	100
6.	Alkalinity mg/l	12	564	200	Beyond this limit taste becomes unpleasant.	600
7.	Fluoride(as F) mg/l	0.1	1.0	1.0	Fluoride may be kept as low as possible. High flurodie may cause fluorosis	1.5
8.	Iron (as Fe) mg/l	0	0	0.3	Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures and promotes iron bacteria.	1.0

S.No.	Characteristics	Sample		Requirement (Desirable limit)	Undesirable effect outside the desirable limit	Permissible limit in the absence of alternate source
		Siruvani	Borewell			
9.	Manganese (as Mn) mg/l	0	0	0.1	Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures	0.3
10.	Qualitative :					
	Sulphate (as So_4) mg/l	Trace	Trace	200	Beyond this causes gastrointestinal irritation when magnesium or sodium are present	400

From the results of the analysis, it was clear that, except total solids, total hardness and alkalinity (Methyl orange) in the borewell water, all the other chemical characteristics like chloride, alkalinity, fluoride, pH, manganese, iron, nitrate and sulphate were under the acceptable limit. The Siruvani water sample had the chemical characteristics below the acceptable values, whereas the borewell water had the chemical characteristic little above the acceptable values but below the permissible limit in the absence of alternate sources. Even though the total alkalinity was slightly higher it does not have any ill effects to the health of the population. So borewell water is used only during scarcity period.

From the chemical analysis it can be concluded that Siruvani water is the best for drinking purpose.

3. Microbiological examination of water :

The presumptive coliform test and colony count test was done to assess the quality of water from different sources and water filters regarding morbiological examination. Table XXIII exhibits the microbiological examination of water.

TABLE XXIII

MICROBIOLOGICAL EXAMINATION OF WATER

S.No.	Purification technique	Total Colonies per ml. on agar at 37°C	* M.P.N. Coliform bacteria per 100ml	Nature of coliform bacteria isolated
1.	Siruvani water directly from tap	60	>1800	Irregular-VI
2.	Private borewell	50	>1800	Irregular-VI K.aerogenes-I
3.	Siruvani water passed through locally made stainless steel candle filter	120	>1800	Irregular-VI
4.	Siruvani boiled water passed through locally made stainless steel candle filter cleaned occassionally	90	900	Irregular-VI
5.	Siruvani boiled water passed through locally made stainless steel candle filter cleaned regularly	10	20	Irregular-VI
6.	Siruvani water passed through standard polyvinyl candle filter	100	>1800	Irregular-VI
7.	Siruvani boiled water passed through standard polyvinyl candle filter	40	11	Irregular-VI

S.No.	Purification technique	Total colonies per ml. on agar at 37°C	*M.P.N. coliform bacteria per 100ml	Nature of coliform bactgeria isolated
8.	Siruvani water passed thorugh U-V radiation filter	15	0	-
9.	Siruvani water passed through polyiodide resin filter	50	35	Irregular-II & VI

* M.P.N. - Most Probable Number.

From the microbial analysis, it was found that water passed through U-V radiation filter had the least microbes, may be due to the effect of ultra-violet radiation. It had only 15 total colonies per ml on agar at 37°C, next best was siruvani boiled water passed through standard polyvinyl candle filter (40), siruvani water through polyiodide resin filter attached to tap (50) and siruvani boiled water through locally made stainless steel candle filter cleaned occasionally (90) and same filter cleaned regularly (10).

In U-V radiation filter, the number of coliform bacteria was nil, through standard polyvinyl candle filter (11) and boiled water passed through locally made stainless steel candle filter (900) cleaned occasionally and the same filter cleaned regularly (20) and rest of the samples had more than (1800).

The Escherichia coli (E-coli) bacteria was not noticed in all analysed water sample as they were free from faecal contamination.

The nature of coliform bacteria isolated were in the form of irregular-VI and K-aerogenes-I in the private borewell water sample, Irregular-II and VI, water was passed through polyiodide resin filter attached to the tap and in the rest of the samples had Irregular-VI except that was passed through U-V radiation filter which had nil coliform bacteria. Irregular-II, VI and K-aerogenes-I were non-faecal bacterias.

C. Evaluating the Efficiency of Selected Water Filters :

From these findings it can be concluded that because of U-V radiation, filters gives purified water, whereas polyicdide resin filter attached to the tap and candle filters give purified water only, if maintained properly.

Usually homemakers are of the opinion that water collected after passing through water filters is purified totally. Whereas these results show that this notion is wrong as water gets contaminated.

1. When kept for cooling after boiling the water.
2. When the filter vessels and filter taps are not cleaned properly.
3. When candles are not washed frequently and
4. When improper method of washing is followed.

Therefore only by proper maintenance of the filters, purified water is acquired.

Summary and Conclusion

SUMMARY AND CONCLUSION

The study on **"Assessing the Efficiency of Selected Water Filters"** was undertaken with the objective of assessing the quality of water used by the urban homemakers.

Household survey was carried for 50 middle income and 50 high income families residing within the corporation limits of Coimbatore city to study the Socio-economic background, mode of water supply and distribution system, collection and storage of water for drinking, adequacy of water and methods adopted for purification of water.

Physical, chemical and micro-biological analysis enabled to the assess the efficiency of water filters used by the urban homemakers and examine the physical, chemical and microbial quality (total colonies, MPN) of drinking water samples in the surveyed families for analysis.

The major findings of the study are summarised below :

A. Findings of the Household Survey

1. Examining the socio-economic characteristics of the families revealed that 84 percent of the middle income and 90 percent of high income families of nuclear type, while the rest were joint families.

2. Considering the housing patterns 72 percent of middle income and 94 percent of high income families resided in their own-houses while the rest 28 percent and six percent of middle and high income families resided in rented houses respectively.

3. Details on family size revealed that 48 percent of middle income and 52 percent of high income families were small families (1-3) members. Rest 40 percent and 34 percent were medium size families with (3-6) members and 12 percent and 14 percent were large families (7 or more) respectively.

4. Income has great influence on the educational status of the family. In the middle income families 74 percent of the heads of the families were graduates while a majority of 64 percent of homemakers had completed only their secondary level. In the high income families, 86 percent of heads of the families and 62 percent of homemakers were graduates. Twelve percent of middle income and 36 percent of high income homemakers were post graduates.

5. Occupational status of the family decides their standard of living, Coimbatore being an industrial city influenced 34 and 50 percent of heads of the families of middle and high income groups to opt for business. Fourteen percent and 18 percent of the heads of the families in middle and high income groups were professionals and the rest of them were either teachers or clerks.

Considering the homemakerse 56 and 82 percent of the middle and high income families were full time homemakers, while in the middle income group homemakers were teachers (24 percent), clerks (16 percent) and some of them also managed their business (four percent). In the high income families occupation opted by homemakers included that of business (eight percent) teachers (six percent) clerks and doctors (two per cent) each.

6. All the surveyed families had Siruvani water connection, considered as protected and safe for drinking purpose. On the other hand 24 percent and eight percent of high income and middle income families used borewell water in addition to their regular Siruvani' water supply.

7. All the households selected, had individual water tap connection. Sixty six percent of middle and 82 percent of high income families had water points in the kitchen, while 20 percent of middle income families and eight percent of high income families had water points located outside within the house.

8. Eighty six percent of middle income families and 96 percent of high income families had daily water supply. Whereas 14 percent of middle income families and four percent of high income families were provided water only on alternate days.

9. For storage of water, overhead tank and under ground tank was used by 60 percent of middle income families and 64 percent of high income families.

10. Collection of water posed no problem for 86 percent and 92 percent of middle and high income families respectively. While eight percent and 14 percent of middle and high income families felt that it was a time consuming job.

11. For storge of water for drinking, stainless steel containers and filters were used by (cent percent of both income groups), plastic kudam by (36 percent and 20 percent), brass kudam (three - 15 percent), mud kudam by (14 percent of both income group). Only four percent of middle income group used aluminium 'Kudam' for storing water.

12. Opinion of homemakers on changes observed in stored water for a period of 3 days revealed, change in colour (28 percent and 18 percent), change in taste (28 percent and eight percent) and collection of sediments (44 percent and 56 percnet). On the other hand eight percent and 18 percent of middle andhigh income families expressed no changes in stored water.

B. **Methods of Purification**

13. All the families of both income groups adopted at least one of the purification methods. Method of boiling was adopted by four percent and two percent, boiling and filtering using cloth four percent of middle income group alone. Families boiling and using candle filter included 14 percent and 12 percent, using candle filter alone 42 percent and 40 percent, U-V radiation filter 16 percent and 24 percent and polyiodide resin filter 28 per cent and 24 percent among the middle and high income families respectively.

14. Reasons stated for purifying water as opinioned by the homemakers were maintanance of health (100 percent of both), for psychological satisfaction (12 percent and 20 percent), eliminate dust and dirt particles (16 percent and 24 percent), as per doctor's advice (22 percent and 54 percent), to destroy micro-organisms (24 percent and 36 percent) and to avoid on set of infection as cold (56 percent and 60 percent) in the middle and high income families respectively.

15. Factors that motivated the purchase of filters as expressed by the homemakers included that of advertisement (16 per cent and 24 per cent), neighbours (four per cent and 12 per cent) and cost (12 per cent and eight per cent) among middle and high income families. On the other hand employment status (eight per cent each) and prestige value (28 per cent each)

were also stated as factors which influenced their purchase among middle and high income families.

16. Survey also revealed that the selected homemakers using the polyiodide resin filters attached to the tap, were used by (28 per cent and 24 per cent), U-V radiation filters (16 per cent and 24 per cent), standard polyvinyl candle filter (20 per cent and 28 per cent) and local stainless steel candle filter by (30 per cent and 14 per cent) of middle and high income families respectively.

17. The filters used in the families were maintained by daily cleaning done by 60 per cent and 70 per cent of middle and high income families respectively. While 16 and 10 per cent preferred to do it on alternate days, six and 12 per cent of families cleaned their filter twice a week and 16 per cent and four per cent did the cleaning only once a week. Irrespective of the income groups, they stated that the candle was being cleaned atleast once in a week.

18. Common problems experienced in using the filters included that of leaking and pealing of paint (four per cent) among high income group. Replacement of candles 16 and 12 per cent of middle and high income families respectively. It was rather encouraging to observe that 68 and 74 percent of middle and high income families expressed satisfaction in the perfect functioning of their filters.

19. It was rather astonishing to know that even on using filters for water purifications, physical changes in water in terms of change in odour (eight per cent of each income group) change in taste (eight per cent of both income groups), while (88 and 86 per cent) of families in each income groups expressed no change in the physical quality of water.

C. **Water Sample Analysis**

20. Analysis of Siruvani water revealed that it was acceptable in odour, taste and turbidity, while borewell water was slightly saltish and had higher turbidity value, indicating the onset of pollution.

21. Chemical analysis of the water sample in relation to standard value for upper limit of acceptability revealed acceptable value for Siruvani water, while the borewell water sample had higher acceptabel value but below the permissible limit, which meant that borewell water could be used in the absence of an alternative source of water supply.

22. Microbiological analysis of the water samples indicated that water was thoroughly purified on using U-V radiation method, than by the other methods. Another method by which purification can be guaranteed is by using the thoroughly cleaned candle filters and by using boiled water passed through candle filters, adopting the correct procedure in using the same.

Today mankind as a whole has the knowledge and the means to ensure the supply of clean drinking water by various new methods to improve its quality. As water is a prime need for human survival and industrial development, effective management of water resources and control of pollution are becoming increasing the important for sustainable development and human welfare. Hence it is the concern of all the human beings to see that this great nature's gift is conserved and used in the best optimal manner.

Recommendations

1. Create an awareness among the homemakers that water passed through water filters may not always be safe, and may be affected by improper maintenance. Therefore complete instruction mannual should be accompanied on purchase of the water filters to enable efficient use of the same by the homemakers.

2. Develop low cost purification technology for effective and efficient use of water by the rural and urban families, thus enabling a vast majority of the population to become aware of the need for purifying water to maintain better health standards.

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Appendices

APPENDIX - I

AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCTION FOR WOMEN (DEEMED UNIVERSITY), COIMBATORE - 43.

An Interview schedule to Elicit Information on the water Management Practices Adopted by the selected families in Coimbatore City.

I. General Details :

1. Name of the interviewer -
2. Name of the interviewee :-
3. Address :-
4. Type of family - Nuclear/Joint
5. Size of the family - Small/Medium/Large
6. Type of dwelling- Owned/Rented.

Family Background.

A.	Serial Number	Name of the Family members	Sex	Age (Yrs)	Educational status	Occupation	Income/ month in Rs.

Income from other sources :-

B. Serial Number	Sources	Income (Rs.)
1.	Land	
2.	Rent	
3.	Interest from investment	
4.	Poultry	
5.	Kitchen garden	
6.	Shares	
7.	Dairy	
8.	Subsidary Account	
	TOTAL	

II. General information on domestic water

A. Sources of water supply.

Sirivani	Borewell	Openwell

B. Water Distribution

Serial Number	Method	Yes	No
1.	Kitchen		
2.	Outside		
3.	Dining room		
4.	Entire house		

D. Water Supply.

ADEQUECY OF WATER		FREQUENCY OF WATER SUPPLY	
YES	NO	DAILY	ALTERNATE DAYS

III. Collection of water

Storage of water		Type of containers used for collecting				Problems faced in collecting water	
Under -ground tank	Overhead tank	Alumi- nium	Brass	Stain- less	Plastic	Time Consum- -ing	Energy consum- -ing

IV. Storage of water

Type of containers used						Frequency of cleaning water containers.			
Alumi- nium	Brass	Mud pot	Plastic	Stain- less steel	Filter	Daily	Alternate days	Twice in a week	Once in a week

Quality observed in stored water

Serial Number	Quality	Yes	No
1.	Change in odour		
2.	Change in taste		
3.	Sedineents		
4.	No change		

V. Purification of Drinking Water.

A. Methods of purification

1. Do you purify drinking water before use?

Yes/No

a) If Yes indicate the methods adopted.

Serial Number	Method	
i.	Boiling	
ii.	Boiling and filtering with cloth	
iii.	Boiling and using candle filters	
iv.	Using candle filters alone	
v.	U-V radiation filter	
vi.	Polyiodide resin filter attached to tap	

b) Any special purification methods adopted for various age group

Serial Number	Stages of life	Methods
1.	Infant	
2.	Childhood	
3.	Adolescent	
4.	Adult	
5.	Oldage	

) Purification methods adopted during various situations.

Serial Number	Situation	Methods
1.	Sickness	
2.	Rainy season	
3.	During travel	

VI. Details on water filters.

Type	Brand name	Material made off	Place of purchase	Year of purchase	No.of candles	Cost

Reasons for purchase

Motivating factors in purchasing the filter.

Serial number	Factors	
a.	Advertisement	
b.	Neighbour	
c.	Employment status	
d.	Prestige of value	
e.	Health consiousness	
f.	Knowledge	
g.	Reasonable price	

iii) Care and maintenance

Cleaning of the filter and its parts

	Filter vessel	Candles	Changing of water
Daily			
Thrice a week			
Twice a week			
Weekly			
Fornightly			

iv) Problems faced in using water filters

Serial Number	Problems faced	
1.	Leaking	
2.	No proper filteration	
3.	Pealing of paint	
4.	Replacing of candles	
5.	No problem	

C. Quality of purified water and its use.

1. Is the method of purification satisfactory?

Yes/No

2. Give your views on the quality of purified water.

Serial Number	Quality	
a.	Taste	
b.	Odour	
c.	Colour	
d.	No change	

V. What is your general opinion about your filter?

APPENDIX - II

PROCEDURE FOR ESTIMATING THE PHYSICAL CHARACTERISTICS OF WATER WATER.

A. Colour

The term 'Colour' means the 'true colour' that is the cclour due to substances in solution and due to the substances as present as fine colloids. For true colour determination, the sample has tc be centrifuged to remove turbidity.

Apparent colour is the colour due to both suspended and dessolved matters. Hence apparent colour determination needs no centrifugation.

The standards method for colour comparison involves the use of potassium chloroplatinat and cobaltous chloride colour was compared visually with standards. The determination of the colour was done on the day of collection itself.

B. Turbidity

The turbidity measured by the Jackson Candle Turbidimerter and considered to be the standard. It measure the turbicity based upon the absorption of light from a standard candle. Turbidity measured by this turbidity meter was expressed in terms of Jackson Turbidity Unit (JTU). Since Silica has bnen choser as the arbitary standard.

Jackson Tubidity Unit = 1mg S1 02/I

APPENDIX - III

PROCEDURE FOR ESTIMATING THE CHEMICAL CHARACTERISTICS OF DRINKING WATER.

A. Total Hardness :

EDTA Titrimetric Method

1. Place a suitable volume (filtered if necessary) in conical flask and dilute to 50ml.
2. Add, 1ml of buffer solution per 50ml volume. The pH of the titre should be 10.0 $\pm$ 0.1. Add 1 ml sodium sulfide inhibitor if necessary. Add 1 drop of indicator solution or an appropriate amount of dry powder.
3. Titrate with standard EDTA solution slowly, until a reddish tinge appears and add the last few drops within 3-5 seconds. At the end point the solution will be blue. The whole titration procedures should be completed within 5 minutes after the addition of buffer.

Hardness as $CaCo_3$ in mg/l	Classification
0-75	Soft
75-150	Moderately hard
150-300	Hard
Above 300	Very hard

Hard water are reported to cause no harmful effects upon the health of consumers.

Procedure :

Place 50ml of the sample in a Nassler tube. If the sample contains any residual chlorine add 1 drop of sodium arsenite solution for each 0.1 mg Cl_2 and mix well. Add exactly 10ml of the acid - zirconyl - SPADNS reagent and mix well. After setting the speetophotometer to zero-absorbance with the reference solution, measure the absorbance of the sample. Find out the mg floride of the sample equivalent to the observed optical density from the calibration graph.

Express the result as mg floride (as F) per litre of the sample.

Fluoride in amounts of 1 to 1.5 mg/l it is an effective preventive of dental caries. Above this amount, fluoride may cause dental fluorosis and skeltel fluorosis. Such water chould be defluoridated to reduce the fluoride concentration to the acceptable water.

B. Chloride

Silver Nitrate Method

Place 100ml of the sample or an aliqut containing not more than 10mg chloride in a porcelain basin of about 300ml capacity. (If the 10H of the sample is in the range of 7 to 9.5 it can directly be fibrated). Add 1 ml of potassium chromete indicator soln. Tibrate against standard silver nitrate solution with

constant stiring until a slightest perceptible redish coloration persists. Condust a blank by placing 100ml chloride-free distilled water instead of sample. A blank of 0.2 to 0.3 ml is usual for this method.

Chlorides in drinking water are generally not harmful to human beings. Higher concentrations however may affect some persons who already suffer from diseases of heart of dreys. Generally, it is the cation (Cal, mg, Na or K) associated with the chloride that produces a harmful effect.

C. Nitrite

Diazotisation Method

1. Pipet 0.1, 0.2, 0.4, 0.6, 0.8, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0ml standard nitrite solution into 50ml nessler tubes and make up to the mark with distilled water. Include a nessler tube as blank. Place 50ml distilled water limit.

2. Transfer 50ml of the clear sample (Neutralised to pH7) or an aliquot diluted to 50ml in a nessler tube, Add 1.0 ml EDTA solution and stir well.

3. Add 1.0 ml sulfanilic acid to blank, standards and sample. Mix After 10min, add 1.0ml naphthylamine hydrochloride solution and 1.0 ml sodium acetate buffer solution and mix thoroughly.

4. After 10min compare the colour visually or by spectro meter. Prepare a calibration curve and find out g nitrite nitrogen, equivalent to the optical density.

APPENDIX - IV

PROCEDURE USED FOR MICROBIOLOGICAL EXAMINATION

Preparation of Mc conkeys media :

This is a useful medium for the cultivation of enteric bacteria. It contains a bile salt to inhibit non-intestinal bacteria and lactose with Aeutral red to distinguish the lactose fermenting coliform organisms from the non-lactose formenting salmonella and dysentery groups.

Ingredients

Peptone	-	20 gms.
Sodium taurocholate	-	5
Commercial water	-	1 litre
Nutral red	-	above 3.5 ml
Solution 2% in ethanol.		
Agar	-	20 grams
Lactose	-	10% aqueous solution (100 ml)

Method :

Peptone and taure cholate (bile salt) were dissolved in water by heating. Agar was added and dissolved it in the steamer or autoclave. If necessary, filleration was done.

A. Procedure for presumptive coliform test :

The following quantity of water and medium were added with sterile graduated pipettes.

50ml quantity of water to 50ml - double strength.

Neconkey's fluid medium -

10ml quantity of water to 10ml double strength Mc conkey's fluid medium.

1 ml quantity of water to - 5ml single strength Mc conkey's fluid medium.

1 ml quantity of water to 5ml single strength.

The above mentioned proportion were followed to analyse coliform organisms present in water sample. The media was sterilized before adding it into water sample in order to prevent contamination. After adding the medium, the test tube were closed tightly with sterilized cotton plug. Then incubeted at 37°C for 48 hours.

Indole Test :

This test demonstrates the ability of certain bacteria to decompose the amino acid tryptophane to indole which accumulate in the medium. Indole is then tested by a colourimetric seaction with P - dimethyl amino benzeldehyde.

Medium for growth

Peptone (brand containing suffcient teyptophone)	:	20 gm.
Sodium chloride	:	5 gm
Distilled water	:	1 litre

Adjust the pH to 7.4 sterilize by auto claving at 21°C for 15 minutes.

Method :

Inoculate medium and incubated for 48 hours at 37°C, might be required for optimum accumulation of indole.

B. Procedure for colony count :

The required number of nutrient agar tubes was placed in boiling water until the medium was completely melted and then cooled to 45° - 50°C. The medium would remain in the liquid state at this temperature.

Using sterile pipetee, 100ml of nutrient agar was taken from the bottle and introduced into the sterile petri dish. The melted agar (45°C) was poured into the Petridish containing the sample. The cover of the dish was raised as little as possible to do this and was immedeately replaced. The samples were shaken well in order to ensure uniform mixing of the sample. They were mixed throughly with rapid, to and fro circular motion and allowed to solidify. Then plates were incubated at 37°C for 48 hours.

Nitrites are generally formed in water due to bacterial action on ammonia and organic nitrogen. It is generalisation that the ammonia and nitrite content of drinking water should not exceed 0.1 mg/l.