ORIGINAL ARTICLE

TREATMENT OF RAW WATER USING *FORSSK FARINOSA* SHRUB, A TRADITIONAL WATER CLARIFIER BY "TSEMEY BENA" PEOPLE

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ABSTRACT

BACKGROUND: *Access to safe water supply should be as close to the home as possible, in order to faster the use of larger amount of water for hygienic practices and to avoid contamination during transportation. In areas where water sources are untreated or the water treatment plant is not reliable in all times, household treatment methods, which are familiar by the community, are very much important. One of such traditional water purification system used by "Tsemey Bena" people, in SNNPR, is the use of Forssk farinose shrub. But such traditional methods need to be studied about their efficiency of contaminant removal.The main aim of this study is to see the contaminant removal efficiency of Forssk farinosa shrub from raw water.*

METHODS: *Different Doses of Forssk farinosa was used to see the removal efficiency of turbidity, color and coliform organisms in the laboratory of school of environmental health. Its effect on pH was also studied. Sixty mg of the unbared root of farinosa was used after different doses are compared for the removal of contaminants. To identify the effective shrub part that is important in the removal of the study variables; the leaf, bared root, and unbared root was used. In addition, different stirring and settling times were also considered to know the best contaminant removal time.*

RESULTS: *The result showed that Forssk farinosa is 99% efficient in the removal of Turbidity. This shrub has no effect on the change of the pH of the water. Color and fecal coliform removed up to 99% after 150 minutes of settling time. In both study variables the recommended level by WHO was achieved at different settling times.*

Stirring time has an effect on the removal of contaminants when the time of stirring is increasing the removal efficiency is decreasing. Better turbidity removal is obtained at 2 minutes of stirring.

Further detail study needs to be done to find the functional group that is relevant in the elimination of turbidity, color and coliform organisms, and to see the potential effect on consumers.

KEY WORDS: Forssk farinosa, local clarifier, household water treatment, removal efficiency.

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INTRODUCTION

As water is basic human need for health indeed, without safe water and sanitation there will not be real development. Safe water is the doorway to health and health is the pre- requisite for progress, social equity and human dignity (1). Because of the essential role-played by water in supporting human life it also has, if contaminated, great potential for transmitting a wide variety of diseases and illnesses (2).

It has been estimated that as many as 80% of all diseases in the world are associated with unsafe water consumption (3). Providing people with adequate and safe water will reduce morbidity and mortality from water born and other water related diseases (4). Access to the water supply should be as close to the home as possible, in order to hasten the use of larger amount of water for hygienic practices (5). When a source of pure water is close at hand children are less to surfer from poor hygiene and rampant disease (6).

Due to increased number of people in developing countries lack of access to safe water supply has resulted untold sufferings from many communicable diseases (7).

Problems related to lack of safe water supply are most acute in Africa and west Asia, but insufficient water is already a major constraint to industrial world. If current consumption patterns continues, United Nations Environmental Program (UNEP) concluded that two out of every three people will live in water- stressed regions by 2025 (8).

In developing countries the high incidence of water born diseases and wide spread use of untreated and often highly polluted water sources is common and its improvement in one or more components of water supply and sanitation can substantially reduce the rates of morbidity and severity on Ascariasis, Hook worm infection, Schistosomiasis and trachoma. In over all child mortality, provision of safe water, also reduces 55% of diarrhea (9, 5).

To overcome challenges related to water and sanitation, many African countries have launched experimental program of low cost appropriate technology, which is easy to implement, and culturally acceptable by the local communities (10)

Low cost community based water supply and sanitation does not mean ' low level technology; it means the application of those technologies which are appropriate to the specific community is allowed to participate fully in this identification, planning, design, construction, operation and maintenance (11, 12).

Since conventional water treatment systems are expensive to implement and run in sustainable way, Traditional flocculants have been recommended for domestic water purification in rural areas of Africa and Asia (13, 14).

In this case, scientists are seeking water treatments methods, which are inexpensive and not wild to the local community.

As evidences showing, use of different traditional materials like seeds of plants and other green plant products have been used for the last many years. More recently, children folklore texts from the 19th century refer to water clarification using the sap from the 'tuna' cactus (*Opuntia fiscus indica*). At certain rural areas in the Sudan, women collecting water from the River Nile use seeds of *Moringa oleifera* to clarify water (16). "Tsemey"and "Hamer" people of Ethiopia in the southern region specifically 'Brailie' are using 'Gelf' plant to clarify drinking water. They use to clarify turbid water of Woito River. By adopting this technology, workers in Braile Agricultural development plc and food and drink establishments in the area are using the plant to clarify water.

Considering these practices, this study was performed aiming to determine the effectiveness of 'Gelf' in the removal of contaminants of water with the intention of disseminating the information to the needy community.

MATERIALS AND METHODS

Study type and design

An experimental study was conducted in environmental health school laboratory, Jimma University, to evaluate the effectiveness of *Forssk farinosa* (Gelf) in purifying water at household level.

The root and leaf of this shrub has been collected from "Tsemey Bena" Woreda in southern Nations and Nationalities People Regional State (SNNPR). The root was prepared as bared and unbared.

The samples of water were collected from "Kochi" spring, in Jimma town, where known contamination have been recorded and initial analysis and determination were done for all the selected variables before the test. The collected water was deliberately contaminated with mud from the stream to have sufficient amount of contamination. The samples were divided into three: control, sample of water stirred with inert rod to control the effect of stirring, and sample of water treated with the leaf, bared and unbared root of the shrub *farinosa* in different containers. To see the effect of stirring time the control was left without stirring.

Different preparation was done to treat the water samples with the leaf, and bared and unbared root.

Determination of dose and stirring time

To know the effective stirring time, different samples were prepared and stirred for 1, 2, 3, 6, and 10 minutes and tests for different contaminates were done every 15 minutes of settling time.

To find effective dose of the farinosa, 60, 100, 300, 600, 1000 mg of unbared root was added to different samples. After essential comparison is made effective dose was selected and used for experiment.

Sample size and Sampling technique

Sufficient volumes of raw water were collected from Kochi spring, which is convenient to transport into the laboratory and make agitation. After collection, 5 liter of water was pored to different containers. From each container further sampling were done for testing of experimental variables using sterile equipment.

To find the part of *Forssk farinosa* effective for contaminant removal, the leaf, bared and unbared root of the shrub was added separately to different samples of raw water. Effectiveness of turbidity, color, and total coliform removal was observed and the effective shrub part was selected and used for the experiment.

During the use of the leaf of Forssk farinosa, in the control sample, 'Tid' leaf was used after its ineffectiveness in the turbidity removal is confirmed. In the case of the root, just a magnetic stirrer was used with out adding the bared or unbared root as control.

Laboratory analysis

Total coliform count was done using fermentation test tube method. Probability tables for estimating the most probable number (MPN) of fecal and total coliform in 100 ml of the sample were estimated from the number of tubes that have given a positive reaction to the test using a statistical table of probability with confidence interval of 95%. Turbidity, Color and pH were analyzed using standard methods.

To assure the experimental quality of each test triplicate tests were done to each test and the averages are taken for presentation and discussion.

RESULTS

Contaminant reduction has been found after the treatment of raw water with the

leaf, bared and unbared root of *Forssk farinosa*.

Treating raw water with Leaf of *Forssk farinosa*

A water sample having turbidity of 938 FTU were treated with 60 mg of leaf of Forssk farinosa. Measurements of turbidity at every 15 minutes were done up to 90 minutes of settling time. Maximum of 90 % of turbidity were reduced which is similar with the control (Table 1). The pH was recorded between 6.5 – 6.7 at a temperature of 22.5 – 24.8 °C.

Table 1. Turbidity reduction after raw water is treated with leaf of *Forssk farinosa* Jimma, Southwestern Ethiopia, 2005.

Stirring time (min)	Control (stirred with "Tid" leaf)		Treated with 60 mg leaf of farinosa	
	Turbidity (FTU)	% Reduction	Turbidity (FTU)	% Reduction
0	938	0	938	0
15	396	58	359	61
30	214	77	154	84
45	213	77	147	84
60	189	80	105	89
75	174	81	131	86
90	105	89	96	90

Bared and unbared roots of Forssk farinosa

A raw water sample having turbidity of 520 FTU was treated with bared and unbared root by stirring for 3 and 6 minutes. Better turbidity reduction has been showed at 3 minutes of stirring with both bared and unbared root of farinosa (Table 2). The pH of the samples was neutral at both settling times (6.8 – 7 at 24 – 25 °C). As shown in figure 2, turbidity below 5 FTU was observed for unbared root at 150 minutes of settling time.

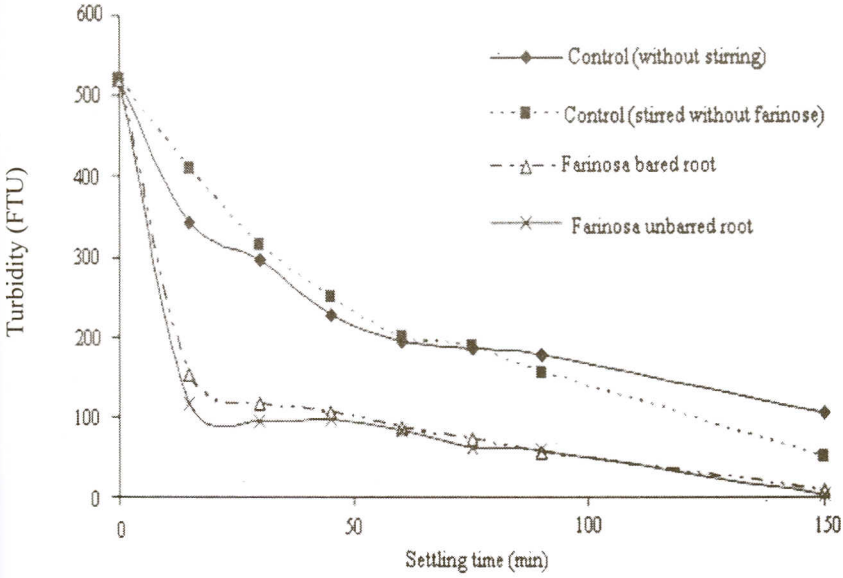

Figure 1. Turbidity reduction comparison between bared and unbared roots of *Forssk farinosa* by stirring for 3 minutes, Jimma, Southwestern Ethiopia, 2005.

Table 2. Efficiency of farinosa in removing turbidity using its bared and unbared root at different dosage, Jimma, Southwestern Ethiopia, 2005.

Settling time (min)	Control (left without stirring)		Control (stirred with inert rod)				Bared				Unbared			
			Dose of farinosa used for treatment				Dose of farinosa used for treatment and turbidity reduction				Dose of farinosa used for treatment and turbidity reduction			
	Turbidity (FTU)	% Reduction	Turbidity (FTU) treated with 3 gm	% Reduction	Turbidity (FTU) treated with 6gm	% Reduction	Turbidity (FTU) treated with 3 mg	% Reduction	Turbidity (FTU) treated with 6 gm	% Reduction	Turbidity (FTU) treated with 3 gm	% Reduction	Turbidity (FTU) treated with 6 gm	% Reduction
0	520	0	520	0	520	0	520	0	520	0	520	0	520	0
15	344	34	410	21	440	15	152	71	205	61	117	78	201	61
30	297	43	314	40	354	32	117	78	143	73	94	82	141	73
45	227	56	249	52	255	51	104	80	107	79	98	81	101	81
60	194	63	198	62	215	59	85	84	88	83	83	84	77	85
75	185	64	188	64	188	64	71	86	79	85	60	88	76	85
90	178	66	155	70	182	65	54	90	40	92	58	89	69	87
150	105	80	49	91	54	90	8	99	6	99	4	99	6	99

Effective dose and stirring time determination

To see the effect of stirring on contaminant removal of farinosa, different duration of stirring time was used. Raw water samples having unbared root of farinosa were stirred for 1, 2, 3, 6 and 10 minutes. The result showed that at 2 minutes of stirring, turbidity of 2 FTU is observed after raw water sample having initial turbidity of 948 FTU is treated and settled for 90 minutes (Figure 2).

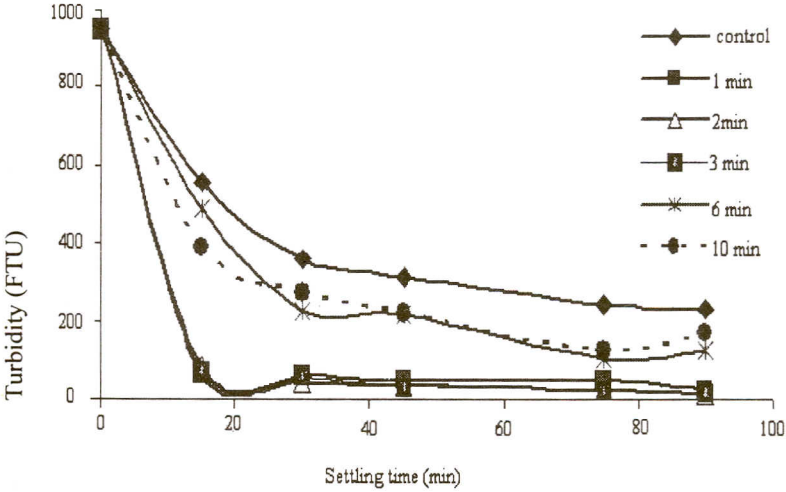

Figure 2. The efficiency of unbared root of farinosa in reducing turbidity stirred for 1, 2, 3, 6 and 10 minutes, Jimma, Southwestern Ethiopia, 2005.

To know the effective dose, 60, 100, 300, 500, and 1000 mg unbared root of *Forssk farinosa* was used to treat raw water samples. Through out each settling time 60 mg dose of unbared root of farinosa showed better removal of turbidity (Figure 3).

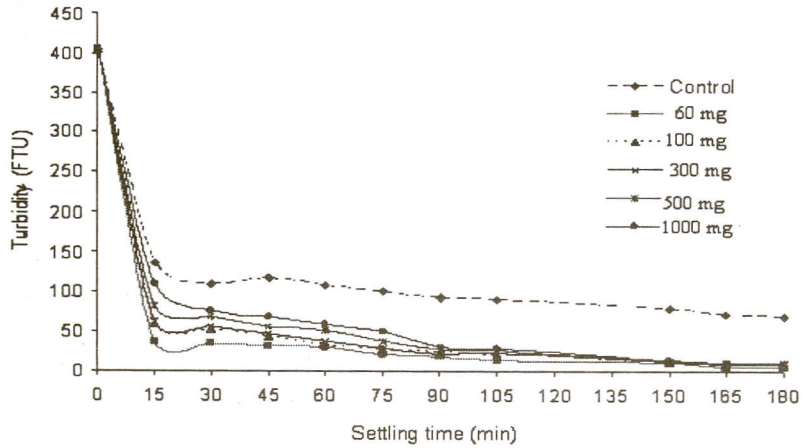

Figure 3. Effect of unbared root of *Forssk farinosa* in turbidity reduction at different dose, Jimma, Southwestern Ethiopia, 2005.

Color removal

The unbared root of farinosa was also used to reduce color of the raw water sample at different settling time. Complete removal of color has been observed after 105 minutes of settling time (Figure 4)

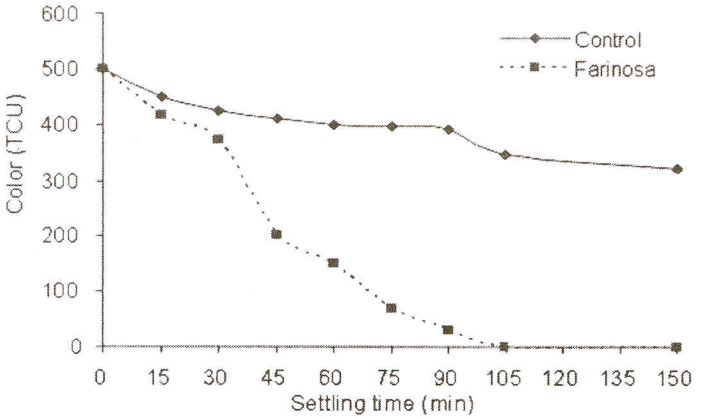

Figure 4. Color reduction efficiency of unbared *Forssk farinosa* over time, Jimma, Southwestern Ethiopia, 2005.

Comparison with Moringa olifera

Turbidity removal efficiency of farinosa was compared with that of *Moringa olifera*. Water sample having turbidity of 420 FTU was treated with equal weight of moringa and farinosa by stirring for 6 minutes. After 180 minutes of settling time the control showed 77.14% reduction, the sample treated with unbared farinosa achieved mean average reduction of 99 and average reduction of 98 % was achieved from the sample treated with Morninga olifera (Figure 5).

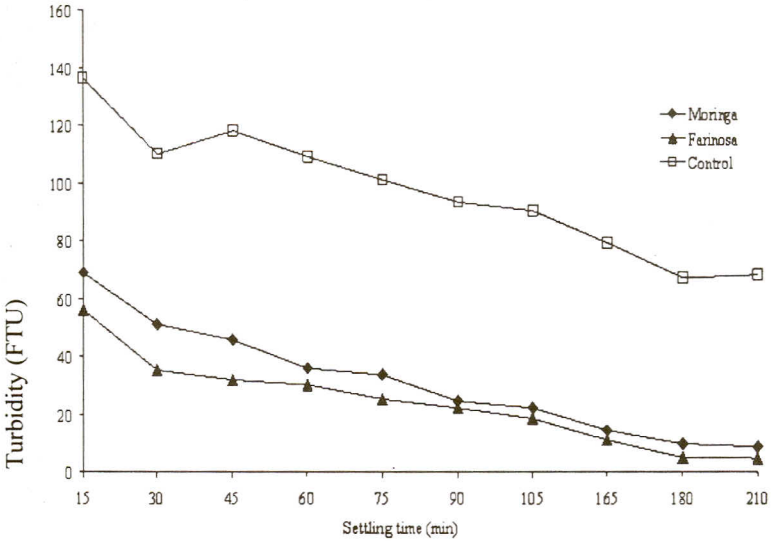

Figure 5. Comparison of turbidity removal between farinosa and moringa, Jimma Southwestern Ethiopia, 2005.

Effect on pH

To see the effect of farinosa on the pH of the water samples after treated with different doses of unbared root, measurements have been taken at different settling time. The result has showed that addition of different dose has not impact on the change of the pH of the water; rather the settling time has shown a slight increase of pH between the settling time of 60 – 105 minutes (Figure 6). This increase of pH was also observed in the control.

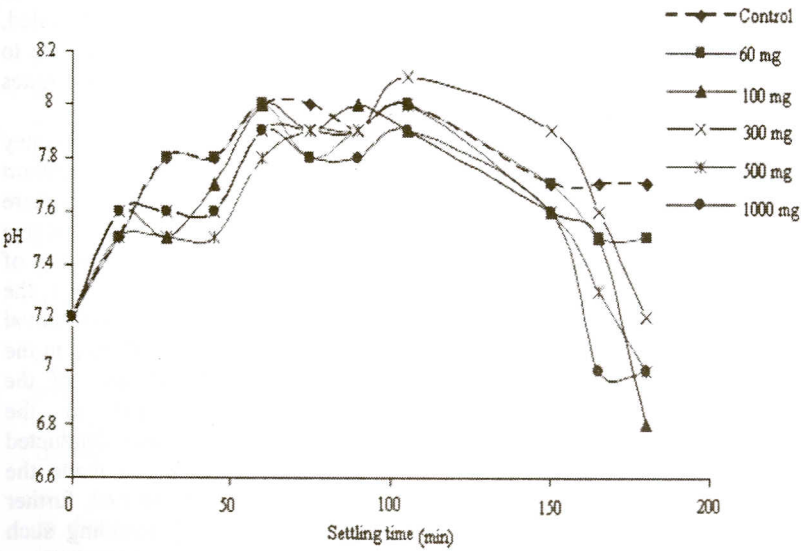

Figure 6. The trends of pH after water samples are treated with different doses of unbared root of farinosa, Jimma, Southwestern Ethiopia, 2005.

Coliform removal

As that of turbidity, fecal coliform count using MPN technique was conducted for the raw water treated with 60 mg of *Moringa olifera* and *Forssk farinosa* separately. The result has indicated that initial fecal coliform counts of 410 MPN/100ml have been reduced to 41MPN/100ml for both farinosa and moringa treated with 60mg. Zero fecal coliform count has been observed after exposure of the raw water sample for 3 hours with both of moringa and farinosa.

When water samples having initial total coliform count of 1100 MPN/100mL was treated with 100 and 300 mg of unbared root of farinosa, 7 MPN/100ml was counted (Table 8).

Table 8. Total coliform count of water samples having 1100 MPN/100 ml are treated with different dose of *farinosa*, Jimma, 2005.

Dose (mg)	Coliform count (MPN/100ml)	Percent reduction
0	460	58.2
60	15	98.6
100	7	99.4
300	7	99.4

DISCUSSION

One of the viable approaches in the provision of safe water supply for rural communities could be the use of natural coagulants (4). Because installation of conventional water treatment plants especially in developing countries including Ethiopia is, at present, impractical due to economic reasons and settlement characteristics of the population (8). One of such natural coagulants could be *Forssk farinosa*. In this study the efficiency of *Forssk farinosa* to eliminate turbidity, color, coliform organisms and trial to see its effects on pH were assessed.

When comparison is made between the bared and unbared root, the latter has showed better efficiency in contaminant removal. In this case unbared root was used for different contaminant removal from water samples through out the study.

Presence of turbidity can have a significant effect on the microbiological quality of dinking water. This can be both by complicating the detection of bacteria and viruses in dinking water and by protecting pathogenic organisms from the action of disinfectants. As this study revealed, unbared root of *Forssk farinosa* is able to eliminate turbidity by 99% after 90 minutes of settling time.

Though, traditionally, the "Tsemey Bena" people are using the root of *farinosa* for the treatment of drinking water, there was an assumption that the leaf of this tree can also help in the removal of contaminants. But as shown in Table 1, the leaf has no considerable turbidity removal efficiency. This may be probably due to the distance from the collection area of the farinosa ("Tsemey" Woreda) to the laboratory where the study was conducted (Jimma University), which has made the leaf to dry unlike the root. In fact, further study need to be done by avoiding such physical interferences.

More over the time of agitation or stirring has showed impact on reduction of turbidity (Table 1), better turbidity removal

has been showed when the water sample is stirred for 2 and 3 minutes which have almost similar turbidity removal efficiency but when the time of stirring is increased to 6 and 10 minutes, the removal efficiency decrease. This might be probably due to "charge reversal" reaction, which destabilized the flock formed and consequently increasing the turbidity, as this is common in natural plant coagulants (16). However, further study need to be undertaken to justify the reason why increasing stirring time has a negative effect.

In comparison with *Moringa olifera* seed, Farinosa has showed better turbidity removal.

In the determination of the effective dose, 60 mg was sufficient and better than the greater doses added to a liter of water in turbidity removal. When the dose is increasing the removal efficiency decreases. This might be explained in a similar reason with a stirring time.

This shrub can be used to treat water at a household level with an average of 1.5 hours of settling time. Water sources that can be treated using farinosa are turbid stream waters or waters that are treated conventionally but disturbed by heavy rain or cross-contaminated as mostly witnessed in Jimma town water supply system. The water sample from Jimma town water supply system has showed turbidity of 10 FTU due to conditional flood cross-connection as a result of heavy rain. In such situations this treatment technology can be applied at an individual household.

Treating water with farinosa has showed better turbidity reduction than other traditional treatment methods like; moringa, raw water storage and filtration through "Beha" rock (17, 18).

Color as another important parameter in dinking water quality the measurement in assessing color elimination efficiency of farinosa revealed a very interesting result. As it is indicated in figure 3, it takes only 105 minutes to reduce the color from 500 TCU to zero, which is by far better than other traditional water treatment studies (17, 18).

CONCLUSION AND RECOMMENDATION

In general, the result of full-course experimental trials of this study indicated that *Forssk farinosa* is very effective in reducing turbidity, coliform organisms and color to the level where they are accepted by WHO recommendation for drinking water. In addition the pH of the water is not significantly changed by the addition of this shrub.

More generally, the cumulated results suggested that, if further studies on the chemical nature of the shrub are done, it could be a valuable replacement of conventional coagulants like alum. But the mechanism of bacterial removal is not studied, further study need to be done whether to use other disinfectants together with farinosa or not.

In general the following recommendations are forwarded.

- Further studies have to be made to know the chemical constituents and functional groups working on water clarification.
- The Toxicological or effect on human health should be studied before popularizing this treatment method.
- There should be cultivation trial by the concerned bodies especially to the areas where training and research centers are near to conduct further extensive studies.

ACKNOWLEDGEMENT

The investigators are grateful to Jimma University for the financial support made to undertake this study.

REFERENCES

1. Napalkov, N. P. water for all human rights, in world health magazine, 1991.
2. Tebbot, THY, K. principles of water quality control, 1992 4th edition, Pergamon Press, Oxford.
3. NETA USA. Water and Sanitation news, 1995, 2(8).
4. Helmer R. News from the water front, In World Health, 1999.
5. Moe, C.L. and Sobsay, M.D. Bacterial indicators of risk factors of diarrheal diseases from drinking water in the Philipins, bulletin of WHO, 69(3).
6. Time Magazine, 149(24), June 1997: 6-7
7. American Chemical Society. Water and poverty. Environmental Science and Technology, 34(15): 2000.
8. Mindu M. Clean water at low cost, World Health Magazine, 1992.
9. Shotanus, D. CRDA membership water and sanitation survey, Arbaminch water technology institute, 1996.
10. Mindu Ngoma. Aug. 1992, clean water at low east. In world health magazine
11. Juli, S.S., Training in low cost water supply and sanitation, Water line: 9(4); 9 – 13.
12. NETWAS. Low cost sanitation. Water and sanitation newsletter, 1991;1(4);
13. Samai A.J., Proper use of African coagulants for rural water supply, Germany; 1988.
14. Akerele, O., Natures medical botany, do not throw it away; World Health forum, 14: 390 – 395.
15. Chinajive, S. Water and health for all, water lines; 1990; 10(1).
16. Worku, L. Environmental quality control, Biological aspect; Teaching Manual; 2004.
17. Argaw, A. and Kebede, F., Raw water storage and simple fluoride filters as a method of appropriate treatment for removal of biological, physical, and chemical impurities. Eth. J. H. Sc. 1999; 9(2).
18. Wondwosen B., Assessment of the efficiency of 'Beha' rock for household level water treatment (Unpublished),2000.