ANALYSIS OF PACKED WATER IN TEGINA, ZUNGERU, WUSHISHI, AND LEMU

BY

ACHOLAM C. MADU
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DEPARTMENT OF AGRIC ENGINEERING
FEDERAL UNIVERSITY OF TECHNOLOGY,
MINNA, NIGERIA.

IN

PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF POSTGRADUATE DIPLOMA IN SOIL & WATER.

DEDICATION

This research work is dedicated to my beloved wife , Mrs. Elizabeth Sunbo Madu.

DECLARATION

I hereby declare that this research work is my own work and has not been presented in any form for another qualification at any other Institution. The information derived from published or unpublished works of others has been dully acknowledged in this work.

Acholam C. Madu.

DEPARTMENT OF AGRIC ENGINEERING
FEDERAL UNIVERSITY OF TECHNOLOGY,
MINNA- NIGER STATE.

AUGUST 2000.

CERTIFICATION

This is to certify that ACHOLAM C. MADU of the Department of Agric Engineering , Federal University of Technology, Minna did conduct a research on the Analysis of Packed water in Tegina, Wushishi, Zungeru, and Lemu, Niger State and is approved for its contribution to knowledge and literary presentation.

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Engr. Femi Ayodeji **Date**
(Project Supervisor)

_____ _____

Dr. M.G. Yisa **Date**
(Head, Dept. of Agric. Engineering ,
Federal Univ. of Tech., Minna.)

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TABLE OF CONTENTS

TOWN	MAJOR SOURCES OF WATER.
Lemu	Bore-holes, Dug wells, Tap water.
Tegina	Bore- holes, Dug wells.
Wushishi	Bore-holes, Dug wells, Tap water.
Zungeru	Bore-holes, River Kaduna.

1.2 QUALITIES OF PURE WATER

Everyone, even those without any formal education, have an in–born feeling about how drinking water ought to be namely: "clear and without color, taste, or odor ". This, however, may not be enough.

A comprehensive definition of pure water should be as follows:

a. It must be free of pathogenic organisms, toxic substances, and an overdose of minerals and organic materials.
b. It should be pleasant i.e. free of color, turbidity, taste, and odor.
c. It should contain a high enough oxygen content.
d. It should have a suitable temperature.

1.3 OBJECTIVES OF THE RESEARCH

The following are the objectives of this research work:

i. To determine the suitability of the packed water for human consumption.

ii. To establish that most of the packed water do not pass through due processing

iii. T o establish the presence of bacterias in the packed water.

CHAPTER TWO

2.0 LITERATURE REVIEW

Bacteriological and chemical examination of water is carried out to determine its sanitary quality and its suitability for human consumption. According to Okafor (1985), the sanitary quality of water is the relative extent of the absence of suspended matter, colour, taste, unwanted dissolved chemicals and bacteria indicative of faecal pollution.

Drinking water supplies liable to contamination with sewage or other matter, as by stated Wright and Vernom (1976), are the vehicles of water- borne diseases such as typhoid fever, paratyphoid fever, cholera, amoebic and baccillery dystentry. In safe-guarding packed water supplies therefore, public health authorities should rely on the information obtained from the results of frequent bacteriological tests being carried out according to Cruickshank et al (1975).

As a result of the gross need of drinking water in these areas - Tegina, Zungeru, Wushishi, and Lemu - particularly during the dry season (November - April), most people from these areas rely on packed water to assuage their thirst. According to Kirkwood (1998), water for human consumption should have the following :

i. Be free from microbiological contamination

ii. Should not have chemical concentrations greater than prescribed units by World Health Organisation.

iv. Should meet local standards for taste, odour, and appearance.

According to him, microbiological contamination is the most common reason for water to be deemed unsafe and is usually detected by testing for indicator-bacteria such as faecal coliforms.

2.1 **THE SIGNIFICANCE OF PARAMETERS TO BE DETERMINED**

2.1.0 **COLOUR**

Drinking water derived from ground water can contain high quantities of fulvic and humic acids of natural vegetable origin, giving the water a yellowish or brownish colour. Drinking water can be coloured due to the presence of small algae that have passed through the filters of a plant. Water colour can also be caused by industrial compounds. The World Health Organisation standards for drinking water states that the desirable limit for colour is five (5) units with the highest level permissible at twenty (20) units.

2.1.1 **ODOUR AND TASTE**

A large variety of odourous compounds have been found in drinking water. These substances can be present in raw water sources; can be formed during treatment, particularly by chlorination; or can be introduced into the water during distribution. There are no quantitative tests for tastes and odours.

2.1.2 **PH – HYDROGEN ION**

The PH value is a measure of the acidty or alkalinity of a water. Pure water does not consist of water only but also consist of a relatively small amount of negative hydroxyl ions , OH^- . The concentration of the hydrogen ions in pure water is found t o be approximately 1/10, 000, 000 of a gram per litre. Neutral water has a PH of 7.0 or more exactly 7.1 according to Twort et al (1974).

2.1.3 **ELECTRIC CONDUCTIVITY**

The electric conductivity of a water body refers to its ability to conduct an electric current stated Stirling (1985), which in turn is related to the total concentration of ions that is charged solutes. Different ions vary in their ability to conduct electricity but in general, the greater the concentration of ion in the natural water, the higher the conductivity. Adebiyi (1982) also stated that the determination of electrical conductivity provides a rapid and convenient means of estimating the concentration of electrolytes. The electrical conductivity of most portable water is in the range of 5 - 50msm^{-1}.

2.1.4 **HARDNESS**

Total hardness, states Twort (1974), consists of temporary or carbonate hardness and permanent or non- carbonate hardness. The former being removed by boiling while the latter is not. Hardness is defined as a characteristics of water which represents the total concentration of calcium carbonate equivalent. The

term "total hardness" refers to the total concentration of divulent metal ions (Ca & Mg) in water. It is commonly expressed as the equivalent concentration in milligrams per litre of $CaCo_3$.

2.1.5 **TOTAL SOLIDS/ TURBIDITY**

The concentration of dissolved and undissolved solids has to be considered for drinking purpose. Total dissolved solids can be measured by evaporating a filtered sample of water and weighing the residue, or they may be more quickly estimated from the conductivity of water.

Turbidity is caused by suspended solids in water. It is measured by comparing the sample with standard solution by optical means. Other simple methods are available e.g. water which is clear and bright in a 300mm tube may be registered as "clear and bright". The turbidity limit for drinking water is based on health consideration as it relates to chlorination treatment.

2.1.6 **WATER MICROBIOLOGY**

The microbiological quality of drinking water is typically expressed in terms of the concentration and frequency of occurrence of particular species of bacteria. Polluted water may contain pathogenioc bacteria, viruses, protozoa,or helminth's eggs.

It is a normal practice to detect and enumerate only what is called "bacteria indicator". The presence of indicator bacteria in water is therefore, indicative of faecal contamination of that water.

Indicator bacteria indicates the presence faecal contamination which suggests the potential presence of pathogens and thus, a health hazard.

The most commonly used indicator bacteria are the coliforms. Water is tested either for the presence of the total coliforms group or for the presence of faecal coliforms only. Faecal coliforms, mainly comprising of Eschericia Coli (E. Coli), are a sub-group of the total coliform group. Eschericia Coli is always present in faeces according to Carncross et al (1983).

CHAPTER THREE

METHODOLOGY

3.0 SAMPLING

One water sample was collected from each of the locations: Victory from Wushishi and Tegina respectively; Hilltop from Zungeru , and Melody from Lemu. They were collected for the purpose of determining their suitability for human consumption.

3.1.0 LABORATORY ANALYSIS

Odour, taste and colour: these were determined by observation.

3.1.1 HYDROGEN IONS (PH)

The PH of water sample was determined using PH meter (battery operated) Jenny 3010.

3.1.2 ELECTRIC CONDUCTIVITY

Conductivity were determined by measuring set model mc-1, Mark v 5013 model.

3.1.3 TOTAL SOLIDS

These were determined by measuring $25cm^3$ of the water sample into evaporating dish and consequently was made to evaporate using steam bath and the remains were dried in an oven and cooled in a dessicator and the weight determined, using analytical balances.

3.1.4 **BACTERIOLOGICAL EXAMINATION**

Presumptive tests were carried out on each of the samples and the number of coliforms determined using MPN table (see Appendix Three).

Confirmation tests were equally carried out to substantiate or deny the presence of E. Coli.

CHAPTER FOUR

RESULT AND DISCUSSION

4.0 RESULT

Many substances may be permitted to exist in a public water supply only to a limited extent. Certain properties of the water must also be controlled within specified limits to preserve a wholesome and palatable supply.

The following tests carried out revealed the following:

4.1 HYDROGEN ION (PH)

Hilltop	7.10
Victory	7.10
Victory	7.15
Melody	7.10

4.2 ELECTRIC CONDUCTIVITY

Hiiltop	44 (μohms/cm)
Victory	49.7 "
Victory	48 "
Melody	50.3 "

4.3 TOTAL SOLIDS

Hilltop	112 mg/l
Victory	77mg/l
Victory	79mg/l
Melody	91mg/l

4.4 MICROBIOLOGICAL QUALITY

The presence of bacterium especially E. Coli in water supply indicates pollution by faecal contamination. Other coliforms bacteria will usually be present as well but if E. Coli are absent, then the inference is that pollution primarily arise from soil or vegetation. The following are the results obtained from the microbiological tests carried out from the four locations under consideration:

4.5 ZUNGERU (HILLTOP)

The lactose broth tubes were observed for evidence of gas production at the end of the incubation period which was forty eight hours. The result obtained is shown below:

Result Of Presumptive Test

Concentration (ml)	No. of Tubes Giving Positive Reaction (Out of 5 tubes each)
10	5
1	1
0.1	0

From the MPN index table, thirty three (33) coliforms per 100 ml of the water sample .

Confirmed Test

1. MacConkey Agar plate was streaked from one of the tubes of lactose broth that showed gas formation. This was done for all the positive tubes that showed gas formation and acid formation.

ii. These plates were incubated at 37°C for 24 hours.

iii. These plates were observed after incubation for colonies of coliform organisms.

Result

There were pinkish colonies. This confirmed the presence of E. Coli.

The same process was used for the other samples in the remaining locations. These results are as follows:

4.6 **LEMU (MELODY)**

Result Of Presumptive Test

Concentration (ml)	**No. of Tubes Giving Positive Reaction (Out of 5 tubes each)**
10	5
1	5
0.1	5

This gives ≥ 2400 coliforms per 100ml of the water sample.

Confirmed Test

i. Six (6) sterile petri-dishes containing 15ml MacConkey agar was streaked with innoculation from the positive tube.

ii. These plates were incubated at 37°C for 24 hours

iii. All the plates were observed at the end of the period of incubation.

Result.

Pinkish colonies were observed and this confirmed the presence of E. Coli.

4.7 TEGINA (VICTORY)

Result Of Presumptive Test

Concentration (ml)	No. of Tubes Giving Positive Reaction (Out of 5 tubes each)
10	5
1	1
0.1	0

This gives a total of thirty three (33) coliforms per 100ml of the water sample.

Result

The result from the confirmation test shows a pinkish colony. This confirms the presence of Eschericha Coli (E. Coli).

4.8 WUSHISHI (VICTORY)

Result Of Presumptive Test

Concentration (ml)	No. of Tubes Giving Positive Reaction (Out of 5 tubes each)
10	5
1	1
0.1	0

This gives a total of Thirty three (33) coliforms per 100ml of the water sample.

Result From The Confirmation Test

The result showed pinkish colonies. This thus confirms the presence of Eschericia Coli.

Tables 1-3 show the summary of the results obtained:

TABLE ONE: TEGINA

TESTS	RESULT	WHO(STANDARD).
Odour	Unobjectionable	Unobjectionable
Taste	"	"
PH	7.15	7.0 - 8.5
Conductivity	48 μohms/cm	
Total Solids	79mg/l	500mg/l
Bacteriological Test:		
Presumptive Test	33 coliforms	1. Throughout any year, 95% of samples should not contain any coliform organisms in 100ml.
Confirmed Test	There was pinkish colonies which confirmed the presence of Eschericha Coli.	2. No sample contain more than 10 coliform organisms per100 ml. 3. No sample should contain E.Coli in 100ml. 4. Coliform organisms should not be detectable in 100ml of any two consecutive samples.

TABLE TWO: ZUNGERU

TESTS	RESULT	WHO (STANDARD).
Odour	Unobjectionable	Unobjectionable
Taste	"	"
PH	7.10	As in Table One
Conductivity	44μohms /cm	
Total Solids	112mg/ l	
Bacteriological Tests:		
Presumptive	33 coliforms	
Confirmed	There was pinkish colonies which confirmed the presence of E. Coli .	As in Table One

TABLE THREE: WUSHISHI

TESTS	RESULT	WHO (Standards).
Odour	Unobjectionable	Unobjectionable
Taste	"	"
PH	7.10	7.0 - 8.5
Conductivity	49.7 μohms/ cm	
Total Solids	77mg/ l	500mg/l
Bacteriological Tests:		
Presumptive	33 coliforms	
Confirmed	There was pinkish colonies which confirmed the presence of E. Coli.	The same as in Table 1.

TABLE FOUR: LEMU

TESTS	RESULTS	WHO (Standards)
Odour	Unobjectionable	Unobjectionable
Taste	"	"
PH	7.10	7.0 - 8.5
Conductivity	50.3 μohms/ cm	
Total Solids	91mg/l	500mg/l.
Bacteriological Tests:		
Presumptive	2400 coliforms	
Confirmed	There was pinkish colonies which confirmed the presence of E. Coli.	The same as in Table 1.

4.9 **DISCUSSIONS**

The results obtained clearly showed that the physical tests carried out such as odour, taste, PH, and total solids fall within the World Health Organization's (WHO) standards. This is clearly indicated in Appendix one (1).

The results from the bacteriological tests showed that the samples from each of the stations that is, Lemu, Tegina, Wushishi, and Zungeru respectively are contaminated or polluted. In accordance to the World Health Organisation (WHO) standard therefore, they are unsafe for drinking.

According to the bacteriological examination of water supplies, London (1969), high counts of E. Coli was recorded in the sample from Lemu is an indication of heavy pollution and this could either be an excretal pollution of human or animal.

The other three (3) locations showed a low count of thirty three (33) E. Coli per 100ml of the water sampled. This is an indication of slight or relatively remote pollution.

Since drinking water standard generally specify that water is safe provided that testing in a specified manner does not reveal more than an average of one coliform organism per 100ml, it is therefore, concluded that all the water samples tested are not safe for human consumption.

CHAPTER FIVE

5.0 RECOMMENDATION

Having established the fact that some of the packed water being sold around are unsafe, it is therefore necessary to put up some recommendations to prevent the continuous sales of polluted water to the general public. This will equally reduce the spread of water-borne diseases such as typhoid fever, cholera, para-typhoid fever etc. which are rampant in these days.

The following are therefore recommended:

i. NAFDAC should live up to expectation of the purpose of her being established - National Foods And Drugs Agency Control (NAFDAC).

ii. NAFDAC should carry out regular examination of packed water

iii. Issuance of partial registration licence should be discouraged.

iv. Thorough examination of venues of production of packed water be done to ensure total compliance to the rules and regulations guiding the establishment of packed water business.

v. Illegal sales of unregistered packed water in market places should be looked into.

vi. Those involved in the shady business of producing illegal packed water nylon should be thoroughly dealt with to serve as a deterrent to others.

vii. An awareness program on the danger these types of packed water poses to the general public should be carried out from time to time.

viii. There should be heavy penalty on the illegal, unregistered packed water producers.

ix. The sources of water to be packed should be ascertained before any approval either full or partial, is given to the interested packed water business producers.

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APPENDIX ONE.

DETERMINATION OF PH

Materials.

i. PH meter (battery operated)

ii. Combination glass- calomel electrode, gallen kemp.

iii. 100ml beaker.

PROCEDURE

The electrode was standardised in buffer solution of PH 4.0 and 10.0 respectively.

The buffer solution bracketted the expected range of the PH sample . The specified sampling procedure was then carried out, washing the electrode after each immersion into the solution under test meanwhile preventing contamination of the test sample and the buffer solution. The electrode was then stored in a buffer solution of PH 7.0. The PH meter used in this work was not adapted to temperature regulation.

DETERMINATION OF CONDUCTIVITY

MATERIALS

i. Electrolytic conductivity measuring set model Mc-1, mask v 5013 model

PROCEDURE

The cell was thoroughly cleansed with deionised distilled water followed by the sample to be measured. The cell was then filled with the sample and the connecting cable plugged into the "measuring cell" socket.

The actuator button was pressed down and the measuring dial slowly rotated until the balance indicator move to the centre scale. The dial setting at which this occurred was read and multiplied by the range factor. The result was the specific conductivity of the sample in μohms/cm

DETERMINATION OF TOTAL SOLIDS MATERIAL

i. Porcelain evaporating dishes 100cm and 9cm diameter

ii. Steam bath

iii. Drying oven equipped with a thermostatic control capable of maintaining the temperature with a 2°C range

iv. Dessicators

v. Analytical balance

PROCEDURE

Clean porcelain evaporating dishes were kept in an oven set at 103°-105°C overnight. These were then cooled in dessicators and weighed. 25cm portion of the sample was pipetted into a dish and evaporated to dry on a steam bath. The evaporated sample was then dried in the oven of 103°-105°C for one (1) hour. This was cooled in a dessicator and weighed. The process of drying ,

cooling in a dessicator and weighing were repeated until a constant weight was obtained. Triplicate determinations were carried out simultaneously for each sample and average results were used in the calculation.

BACTERIOLOGICAL EXAMINATION

PREPARATION OF MEDIA

1. Lactose broth (single strength) 1g of lactose dissolved in 100ml distilled water 5ml of phenol red indicator was added.

2. Lactose broth (double strength) 2g of lactose dissolved in 100ml distilled water 5ml of phenol red indicator was added.

3. Phenol red indicator

10g of phenol red dissolved in 100ml of distilled water that, is 1g of phenol red indicator to 10ml of distilled water

4. MacConkey Agar.

52g of MacConkey agar dissolved in 1 litre of distilled water

STERILIZATION

The media was prepared through the procedure described above. All other glass wares used for the experiment were sterilised, using an autoclave at 121°C for fifteen (15) minutes

MATERIALS

i. Five (5) text tubes of lactose broth double strength with Durham tubes

ii. Ninety (90) ml of MacConkey Agar in six (6) petri dishes

iii. Two (2) sterile ten (10)ml pippette

iv. One (1) sterile one (1)ml pippette

PROCEDURE FOR PRESUMPTIVE TEST

Test tubes containing single strength of lactose broth of 10ml each was innoculated with 1.0ml and 0.1ml respectively (five (5) tubes for each volume). Tubes containing 10ml of double strength (DS) of MacConkey broth which equally were five (5) in number were innoculated with 10ml of the sample.

All the tubes contain Durham tubes for the purpose of detecting gas production. All the fifteen (15) test tubes above were incubated at 37°C for forty-eight (48) hours.

APPENDIX TWO

Table 1. Water Quality Criteria. (summarised from WHO international standards for Drinking Water).

Parameters	Undesirable affect that may be produced	Highest desirable level	Maximum permissible level
A. physical			
Color (units)	Discoloration	5	50
Odour	Odours	Unobjectionable	Unobjectionable
Taste	Tastes	Unobjectionable	Unobjectionable
Total solid (m/l)	Taste	500	1500
	Gastrointestinal		
Suspended matter	Irritation	5	25
	Turbidity		
	Gastrointestinal Irritation		

B. Bacteriological

Standards for the bacteriological quality of drinking water are:

1. Throughout any year, 95% of sample should not contain any coliform organisms in 100ml
2. No sample should contain E.coli in 100ml
3. On sample should contain more than 10 coliform organisms per 100 ml.
4. Coliform organisms should not be detectable in 100ml of any of two consecutive samples

APPENDIX THREE

MPN TABLE

MPN Index and 95 percent confidence Limits for counts by the Multiple-Tube Fermentation Technique for Various combinations of Positive and Negative Results When Five 10-ml, Five 1-ml, and Five 0.1-ml portions Are Used .

No. of Tubes Giving Positive Reaction out of			MPN Index per 100 ml	95% Confidence Limits	
5 of 10 ml Each	5 of 1 ml Each	5 of 0.1 ml Each		Lower	Upper
0	0	0	<2		
0	0	1	2	<0.5	7
0	1	0	2	<0.5	7
0	2	0	4	<0.5	11
1	0	0	2	<0.5	7
1	0	1	4	<0.5	11
1	1	0	4	<0.5	11
1	1	1	6	<0.5	15
1	2	0	6	<0.5	15
2	0	0	5	<0.5	13
2	0	1	7	1	17
2	1	0	7	1	17
2	1	1	9	2	21
2	2	0	9	2	21
2	3	0	12	3	28
3	0	0	8	1	19
3	0	1	11	2	25
3	1	0	11	2	25
3	1	1	14	4	34
3	2	0	14	4	34
3	2	1	17	5	46
3	3	0	17	5	46
4	0	0	13	3	31
4	0	1	17	5	46
4	1	0	17	5	46
4	1	1	21	7	63
4	1	2	26	9	78
4	2	0	22	7	67

No. of Tubes Giving Positive Reaction out of			MPN Index per 100 ml	95% Confidence Limits	
5 of 10 ml Each	5 of 1 ml Each	5 of 0.1 ml Each		Lower	Upper
4	2	1	26	9	78
4	3	0	27	9	80
4	3	1	33	11	93
4	4	0	34	12	93
5	0	0	23	7	70
5	0	1	31	11	89
5	0	2	43	15	110
5	1	0	33	11	93
5	1	1	46	16	120
5	1	2	63	21	150
5	2	0	49	17	130
5	2	1	70	23	170
5	2	2	94	28	220
5	3	0	79	25	190
5	3	1	110	31	250
5	3	2	140	37	340
5	3	3	180	44	500
5	4	0	130	35	300
5	4	1	170	43	490
5	4	2	220	57	700
5	4	3	280	90	850
5	4	4	350	120	1000
5	5	0	240	68	750
5	5	1	350	120	1000
5	5	2	540	180	1400
5	5	3	920	300	3200
5	5	4	1600	640	5800
5	5	5	≥2400		

Source. *Standard Methods for the Examination of* and Waste water