ANALYSIS OF GROUND AND SURFACE WATER OF IGBOTAKO AND ODE-AYE COMMUNITIES IN OKITIPUPA LOCAL GOVERNMENT AREA OF ONDO STATE, NIGERIA

Uzonu Ikenna Ugonna
Department of Environmental Management and Toxicology, Michael Okpara University of Agriculture Umudike, Nigeria.

ABSTRACT

After air, water has been known to be the most precious natural resource available to man. It is however limited as only a part of it is good for use. The inhabitants of Igbotako and Ode – Aye communities in Okitipupa Local government Area of Ondo State rely solely on water harvested from the rain, few wells and the four streams that criss-cross the communities. This study therefore is aimed at analysing the quality of these water bodies and to form a baseline for future references. Water samples from the four streams and four wells were taken and analysed using standard protocols. The results were compared to the Federal Ministry of Environment Standards for drinking water as highlighted in the National Guidelines and Standards for Water Quality in Nigeria, 1999. Results show that the ground water in Igbotako is acidic (pH; 4.44 – 5.12) with high turbidity levels especially in Ode-Aye ranging from 0.79 – 6.9 NTU. The surface water contains coliform and heterotrophic bacteria. Ammonium and manganese ion levels are higher (0.71 – 2.1 mg/L and 0.29 – 0.77 mg/L, respectively) than the limits set by the Federal Ministry of Environment. The study recommends the necessary treatments for the different water bodies before use.

Keywords: *Water quality, microbial load, Physico-chemical analysis, groundwater, streams*

INTRODUCTION

Water is a life resource that is very essential to sustenance of life as we know it. As a result, adequate safe and accessible supply must be ensured all year round irrespective of area of habitation (WHO,2004). The public/environmental health significance of water quality cannot be over emphasized. Many infectious diseases are transmitted by water through the fecal-oral route. Diseases contracted through drinking water kill about 5 million children annually and make a 1/6th of the world population sick (WHO, 2004). Water is vital to our existence in life and its importance in our daily life makes it imperative that thorough biological and physiochemical examinations be conducted on water. Potable water is the water that is free from disease producing microorganisms and chemical substances that are dangerous to health (Lamikanra, 1999).

Naturally occurring water is never pure; it constantly contains some amount of dissolved substances, gases and dissolved solids. Some of these substances cause hardness of water especially with the presence of dissolved calcium and magnesium salts. Water Quality is the chemical, physical and biological characteristics of water, usually in respect to its suitability for a designated use. Water can be used for recreation, drinking, fisheries, agriculture or industry. Each of these designated uses has different defined chemical, physical and biological standards necessary to support that use (Roy, 2018).

Subsistence agriculture is the main stay of the Nigerian and African economy. Agricultural practices usually result in the application of both organic and chemical fertilizers, pesticides and many other farm inputs. The intensive use of farm slots for subsistence farming may lead to the pollution of water bodies both surface and underground with these agricultural inputs. These water sources also serve the communities bathing, washing and sundry sanitation needs. Agricultural activities also introduce chemicals and dirt into the water bodies hence exposing residents who depend on these waters to microbes and chemicals some of which might be toxic with deleterious consequences. The position of these surface streams are naturally such that during the wet season, the run-offs pick up a lot of materials and substances including both human and livestock faecal matter and drains them into these streams. This also applies to ground water especially hand – dug wells that not only are they usually open but are shallow thus allowing chemicals and organic substances to gain access to them. Deeper wells and boreholes are usually not open but are deep enough to filter the rain water and not allow faecal materials to gain access.

Usually in Africa and the rest of the global south, these waters are consumed both directly and indirectly domestically without any further forms of treatment. The aquatic life and the rest of the ecosystem are also endangered. These cascades of cause and effect end up having some negative economic implications for the population who depend on these water sources for their day to day needs as well as fishermen and other aqua culturists who depend on these water sources for survival.

The major reason for the elucidation of important parameters in water quality assessment may be attributed to the fact that in the overall utility of water, such parameters should not be ignored (Osuinde and Enuezie, 1999). Though according to Wegelin – Schuringa, (1999), provisions of quality drinking water is vested in Federal, State and Local Government Authorities. In spite of their efforts, a large number of people still lack access to adequate quality potable water for personal and agricultural uses. And it is particularly critical in rural communities all over Nigeria, since both past and present governments adduce paucity of funds as reason militating against the provision this fundamental human right.

The main aim of this studythereforeis to analyse the water quality for the different uses they are put to especially in the rural communities ofIgbotako and Ode-Aye and comparing the results with the Nigerian water standard which is a domestication of (WHO, 2004) and other similar international regulatory bodies' standards. Prior studies in other parts of Nigeria found out that pipe borne water and other natural water supplies in Nigeria have been reported to be unsatisfactory, with coliform counts far exceeding the level recommendation by W.H.O or the local standard for drinking water. (Dada *et al*.1990a, 1990b, Edema *et al*. 2001).

METHODOLOGY

Study Area

This study was carried out at Igbotako – 6°34'0" N and 4°39'0" Eand Ode-Aye – 6°35'0" N and 4°45'0" E communities in Okitipupa local government area of Ondo State, South-west Nigeria (Figure 1).It considered only the physical and chemical properties of their water. The climatic condition of the study area is of the Low Land Tropical Rain Forest type with distinct wet and dry seasons. Temperatures are generally high throughout the year with the maximum and minimum temperatures of 32°C and 31°C respectively. The mean annual rainfall within this area exceeds 2000mm with rains coming scantily in February till October. The heaviest downpour is usually recorded in August and September. The prevailing wing is the South – Westerlies accounting for about 60% of total wind in the area.(NIMET, 2010)

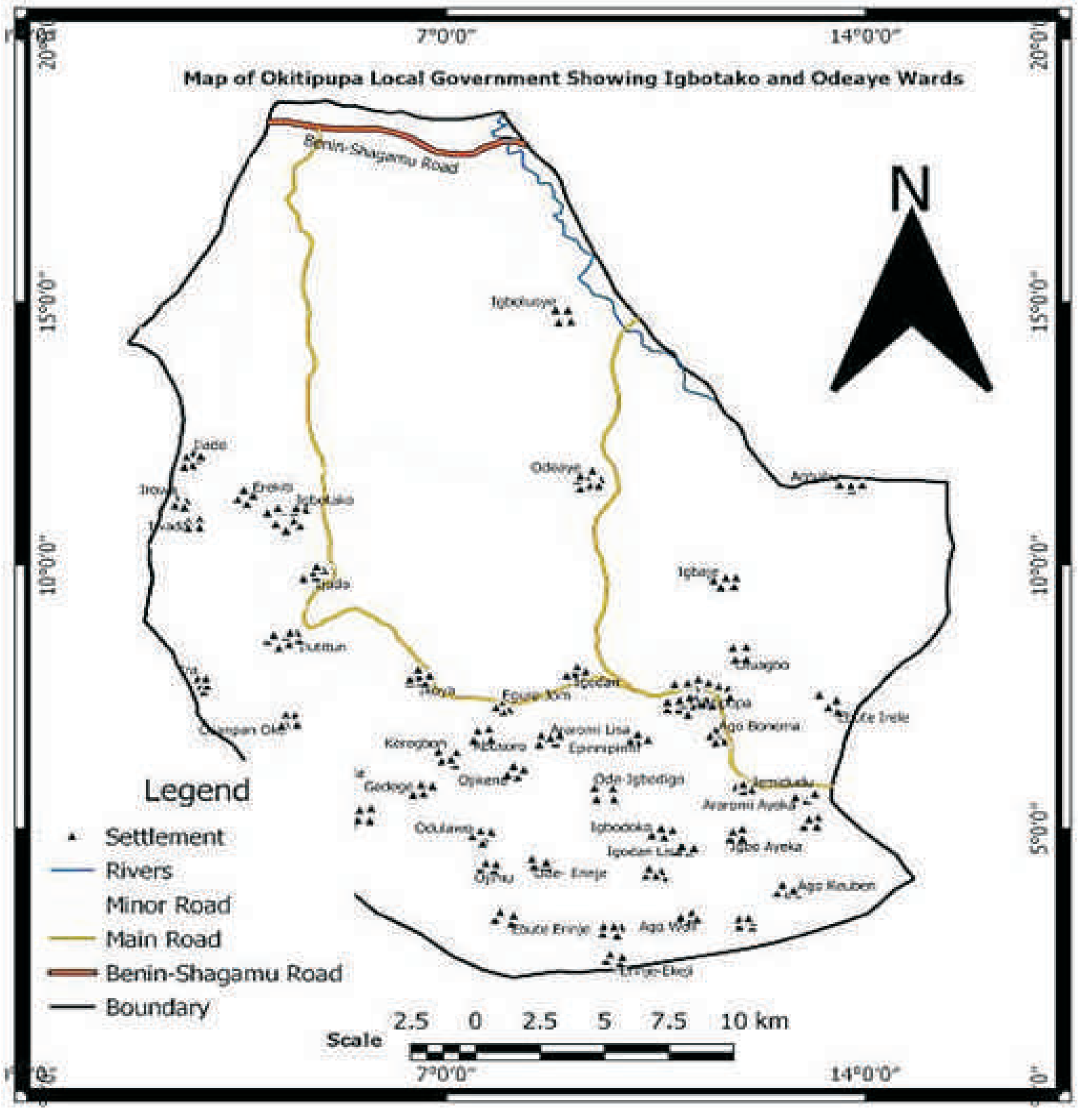

Figure 1: Okitipupa Local Government Area showing Ode-Aye and Igbotako Towns
Source: Field Survey,(2019)

The natives are predominantly farmers. The major cash crops being cultivated in the area are oil palm, rubber, cassava and yam. They also farm okro, beans, pepper, vegetables and melon. Their staple food are but not limited to "Pupuru" (baked cassava), yam, cassava, beans, yam flour and garri.

The indigenes rely solely on water harvested during rainfall; this is only possible during the wet season. During the dry season, the residents rely solely and extensively on the few surface water bodies that are found in the communities. The streams that usually serve the study area are the *Gbeguren*, *Oketiti*, *Gbagba* and *Akinu – Aye* streams. A few well to do indigenes of these communities,who do not reside permanently within the communities and are financially stable come home only during festive periods and key occasions. Some of these few have hand-dug wells that serve their homes whenever they are back in the community.

Sample Collection and Analyses

Collection of water samples

Water samples from boreholes were randomly collected from both communities with the location of delineated boreholes marked with the aid of satellite-based GPS (Timbrell 3000 series). Same went for the sampling of surface water sample. Water samples were collected directly from the sources utilizing new amber1.5L sample containers, thoroughly washed with deionized water, then nitric acid, and finally rinse twice with the water source before taking the sample with care to avoid contamination (Pacheco *et al,* 2006). The surface water samples were taken at downstream so as account for all manner of pollutions at the up and mid-stream levels. All water samples so collected were transported to our laboratory on ice. Samples were stored in the freezer at -20°C till analyses.

Determination of physico-chemical parameters of water samples

Some of the physico-chemicalparameters of the water samples were determined *in situ* with the aid of standard multi-parameter measuring equipment. Temprature, pH, Electric conductivity, Total dissolved solids (TDS), and Total suspended solids (TSS) were all measured with Labforce PC200, a standard multi-parameter equipment. Turbidity and viscosity were determined in the laboratory with the aid of a tephelometer and viscometer (Visco 39, India) respectively.

To further assess the quality of the water samples from both communities, sulphate (SO_4) concentration of the samples was determined using a simple turbidometric method as described by (Mengdi, 2003); nitrate and nitrite (NO_3 and NO_2) concentrations were determined cholorimetrically using the method annotated by the United States Environmental Protection Agency (USEPA), 1993. Ammonia (NH4) content was determined by the method of Le and Boyd, 2012, whereas salinity was determinedvia a method developed by FEW and APHA, (2005),Bartram andBallance, (1996).

Determination of heavy metals in water samples

Water sample metal load was determined using the method of American Public Health Association, APHA (1998) as adapted by Okonkwo *et al*., (2018) described briefly below. Five milliliters of 1:1 HNO_3 was added to a test-tube containing 1 ml of water sample and the mixture covered in a wash glass. The sample was heated at 95°C on a hot plate and refluxed for 15 minutes in a fume cupboard without the mixture boiling over. The sample was allowed to cool down after which 2.5 mL concentrated HNO_3 was added. The wash glass was replaced and the mixture refluxed for 30 minutes repeatedly until complete oxidation. The mixture was cooled and 2 ml of distilled water and 3 ml of 35 – 40% H_2O_2 were added. The beaker was covered once more with a wash glass and was boiled again on a hot plate without the mixture boiling over. To the mixture was added 35 – 40% H_2O_2 in 1 ml aliquots but not exceeding 10 ml. This was continued until effervescence became minimal and the sample appeared unchanged. The beaker was removed from the hotplate and 5 ml of concentrated HCl and 10 ml of de-ionized water were added. The mixture was refluxed for another 15 minutes with boiling until sample became clear. The sample was made up to 100 ml with de-ionized water and transferred to acid-cleaned bottle. The sample was read off on Atomic Absorption Spectrophotometer (AAS) at 241 and 283 nm respectively.

All due laboratory protocols were observed and every chemical used was of analytical grade and purchased from reputable stockists. All the results gathered were compared with the Federal Ministry of Environment (FMEnv) prescribed limits for drinking water as highlighted in the National Guidelines and Standards for Water Quality in Nigeria, (FMEnv.,1999).

RESULTS

Table 1 shows the sampling point delineation for the surface and ground water samples that was carried out in the two communities of Igbotako and Ode-Aye under study. The delineated water sources took into consideration the accessibility of the sources to large number of users in the community.

Table 1: Geo- reference points delineated for water sample collection.

SURFACE WATER			
Points	**Description**	**Northings**	**Eastings**
SW1	Gbeguren Stream	6°35'38.4"	004°39'17.9"
SW2	Oketiti River	6°36'03.7"	004°40'08.2"
SW3	Gbagba Aye River	6°35'14.3"	004°42'51.6"
SW4	Akinu Aye	6°35'12.4"	004°43'01.6"
GROUND WATER			
GW1	Ode Aye	6°35'26.1"	004°44'35.5"
GW2	Ode Aye	6°35'58.3"	004°44'44.1"
GW3	Igbotako	6°35'05.4"	004°38'20.7"
GW4	Igbotako	6°34'24.5"	004°38'06.1"

Source: Field survey, 2019

Table 2: Physico-Chemical Parameters of Groundwater in the study area

Parameters and units	**Sample code (GW 1-4)→ Methodology ↓**	**Ode-Aye GW1**	**Ode-Aye GW2**	**Igbotako GW1**	**Igbotako GW2**	**FMEnv standard for drinking water**
Colour		Colorless	Colorless	Colorless	Colorless	Clear
Taste		Tasteless	Tasteless	Tasteless	Tasteless	Unobjectionable
Odour		Odourless	Odourless	Odourless	Odourless	Unobjectionable
Temperature	Thermoelectric	27.9	27.9	28.0	28.0	<40
pH@25°C	Electrometric	4.4	6.4	4.44	5.12	6.5 – 8.5
Turbidity NTU	Nephelometric	1.5	6.9	0.79	2.3	1
E.C µS/cm	Electrometric	24.1	69	28.9	11.1	1000
TDS mg/l	Electrometric	13.2	35	15.2	6.6	100
TSS mg/l	Gravimetric	2.5	5.9	2.2	4.9	100
V mg/l	Colorimetric	ND	ND	ND	ND	NS
T. Hardness	Titrimetric	51.7	61.1	52.2	43.0	100
SO_4^{-2} mg/l	Colorimetric	21.9	14.8	40.3	34.3	250
NO_3- mg/l	Colorimetric	1.76	0.71	2.23	1.01	10
NO_2- mg/l	Colorimetric	0.16	0.10	0.13	0.20	1.0
NH_4- mg/l	Colorimetric	0.86	1.11	2.00	1.01	< 1.0
Salinity	Electrometric	0.00	0.00	0.00	0.00	0.00
HCO_3- mg/l	Titrimetric	40.7	50.1	40.5	35.5	NS
Ni mg/l	Colorimetric	0.007	ND	0.001	ND	0.05
Fe^{2+} mg/l	Colorimetric	1.2	2.2	0.41	0.31	1.00

Parameters and units	Sample code (GW 1-4)→ Methodology ↓	Ode-Aye GW1	Ode-Aye GW2	Igbotako GW1	Igbotako GW2	FMEnv standard for drinking water
Pb^{2+} mg/l	Colorimetric	ND	ND	ND	0.001	0.05
Zn^{2+} mg/l	Colorimetric	0.1	1.2	1.01	1.02	5.0
Cu^{2+} mg/l	Colorimetric	0.001	0.012	0.004	0.014	0.5
Cl^{-} mg/l	Colorimetric	16.7	20.1	17.9	19.0	200
Mg^{2+} mg/l	Colorimetric	5.07	4.91	5.02	4.10	20
Mn^{2+} mg/l	Colorimetric	0.97	0.10	0.39	0.42	0.001

Source: Field survey, 2019

Table 3: Physico – chemical and microbial analysis of surface water in the study area

Parameters and units	Sample code (SW 1-4)→ Methodology ↓	Gbeguren Stream SW1	Oketiti River SW2	Gbagba Aye River SW3	Akinu Aye River SW4	FMEnv standard for IRRIGATION
RESULTS OF PHYSICAL AND CHEMICAL ANALYSIS OF SURFACE WATER SAMPLES						
Colour		Clear	Clear	Clear	Amber	NS
Taste		Tasteless	Tasteless	Tasteless	Tasteless	NS
Odour		Odourless	Odourless	Odourless	Odourless	NS
Temperature	Thermoelectric	27.9	27.7	28.0	27.9	NS
pH@25^{o}C	Electrometric	4.49	5.70	5.4	6.05	NS
Turbidity NTU	Nephelometric	2.0	2.1	4.5	2.5	NS
E.C µS/cm	Electrometric	21.5	14.7	17.5	35.8	NS
TDS mg/l	Electrometric	11.5	7.3	12.0	18.9	NS
TSS mg/l	Gravimetric	4.0	8.7	3.5	5.0	NS
V mg/l	Colorimetric	ND	ND	ND	ND	NS
T. Hardness	Titrimetric	75.2	50.7	51.0	50.1	NS
SO_4^{-2} mg/l	Colorimetric	41.3	45.5	35.0	38.2	NS
NO_3- mg/l	Colorimetric	1.77	0.71	0.69	0.99	NS
NO_2- mg/l	Colorimetric	0.12	0.09	0.09	0.04	NS
NH_4- mg/l	Colorimetric	2.10	1.22	0.97	0.71	1.0
Salinity	Electrometric	0.00	0.00	0.00	0.00	0.00
HCO_3- mg/l	Titrimetric	65.1	41.7	41.1	41.5	NS
Ni mg/l	Colorimetric	0.01	0.007	ND	0.01	0.2
Fe^{2+} mg/l	Colorimetric	1.20	0.51	0.71	0.40	5.0
Pb^{2+} mg/l	Colorimetric	ND	ND	ND	ND	0.2
Zn^{2+} mg/l	Colorimetric	1.0	0.76	1.21	1.33	5.0
Cu^{2+} mg/l	Colorimetric	0.001	0.003	0.001	0.002	1.0

Parameters and units	Sample code (SW 1-4)→ Methodology ↓	Gbeguren Stream SW1	Oketiti River SW2	Gbagba Aye River SW3	Akinu Aye River SW4	FMEnv standard for IRRIGATION
Cl^- mg/l	Colorimetric	27.1	21.1	21.1	21.1	100
Mg^{2+} mg/l	Colorimetric	7.5	3.71	6.0	5.01	NS
Mn^{2+} mg/l	Colorimetric	0.77	0.32	0.66	0.29	0.2
Ca^{2+} mg/l	Colorimetric	30.01	21.1	20.6	20.1	NS
As mg/l	Colorimetric	0.002	0.003	ND	0.001	0.1
K^{2+} mg/l	Flametric	35.3	1.9	4.6	5.7	NS
Na^{2+} mg/l	Flametric	11.1	2.4	3.0	2.6	NS
Cadmium mg/l	Colorimetric	ND	0.003	ND	0.002	0.01
Ba mg/l	Colorimetric	0.010	0.007	0.01	0.01	NS
BOD^5 mg/l	Reflux	5.5	4.0	6.0	7.0	7.0
DO mg/l	Electrometric	6.0	5.0	6.0	5.6	7.5
COD mg/l	Reflux	13.8	12.2	14.9	16.0	NS
PO_4 mg/l	Colorimetric	1.2	0.76	0.61	0.09	NS
Cr mg/l	Colorimetric	ND	ND	ND	ND	NS
Cobalt mg/l	Colorimetric	ND	ND	ND	ND	NS
Hg mg/l	Spectrometric	ND	ND	ND	ND	NS

Source: Field survey, 2019 NS – No Standard, ND – Not detected

Table 2 shows the results of the physico-chemical analysis of groundwater from the delineated points from Table 1. Being small communities without plenty hand dug wells, we randomly picked and sampled from four (4) wells spread around the two communities with two (2) wells sampled from each community. The wells are the ones that service more members of the community owing to their location and accessibility. Table 3 shows the results of the physico-chemical analysis of the four (4) major streams serving the water needs of the two communities were also sampled. The streams are utilized by the indigenes for drinking, to wash, clean, irrigation, fishing, and sundry other uses, serving the communities well into the dry months when the wells may have dried up.

DISCUSSION

The recorded conductivity which is an index of the Total Dissolved Solids in water ranged from 11.1 – 69µS/cm. The TDS concentrations ranged between 6.6 – 35mg/l. The concentrations of chloride, nitrate and sulphate ranged from 16.7 – 20.1 mg/l, 0.001 – 0.007 mg/l and 14.8 – 40.3 mg/l respectively. The concentrations of magnesium, copper, zinc and lead levels ranged from 4.10 – 5.07 mg/l, 0.001 – 0.014 mg/l, 0.1 – 1.2 mg/l and 0.0 – 0.001 mg/l respectively. All these values were within permissible/ recommended limits prescribedby the Federal Ministry of Environment and World Health Organisation. Chromium, Vanadium, Cobalt and Mercury were however, not detected in the groundwater.

However, the water is acidic for GW1 Ode-Aye and GW1 and 2 Igbotako; turbidity is higher than the standard in GW1 and 2 Ode-Aye and GW2 Igbotako; NH_4- is high in GW2 Ode-Aye and GW1 and 2 Igbotako; $Fe^{2+}$is high in the two water bodies of Ode-Aye while $Mn^{2+}$is high in all the water bodies.

Physico-chemical properties of surface water

The results of the analysis of the surface water show that most of the parameters measured in samples taken from the rivers were within the FMEnv regulatory permissible limits for irrigation except for manganese as well as ammonium in Gbeguren and Oketiti Rivers.

The pH water samples from the study area ranged from 4.49 – 6.05 indicating the water is acidic. This level of acidity may be due to the geology of the area. The water samples across all samples are colourless, tasteless and odourless with turbidity of the water ranging from 2.0 – 4.5.

The recorded conductivity which is an index of the total dissolved solids in water ranged 14.7 – 21.5 µS/cm. The TDS concentrations ranged from 7.3 and 18.9mg/l indicating that the water is polluted. The Gbeguren Stream which has high conductivity of 21.5µS/cm with corresponding high TDS of 11.5 mg/l indicating the water is polluted. The concentration of chloride, nitrate and sulphate ranged from 21.1 – 27.1mg/l, 0.04 – 1.77mg/l and 35.0 – 45.5mg/l respectively. The BOD values ranged from 4.0 – 7.0mg/l, DO ranged 5.0 – 6.0mg/l while COD ranged from 12.2 – 16.0mg/l.

The concentration of magnesium, copper, zinc and iron levels ranged from 3.71 – 7.5mg/l, 0.001 – 0.003mg/l, 0.76 – 1.33mg/l and 0.40 – 1.20mg/l respectively. All these values were within the permissible/ recommended limits prescribed by FMEnv and WHO. Manganese concentration levels were slightly high and ranged from 0.29 – 0.77mg/l. lead, chromium, vanadium, cobalt and mercury were not detected in all rivers within the study area.

CONCLUSION

Assessment of water quality is essential to checkthe suitability of a water source for the designateduse. Several water quality parameters were assessedand compared with their standard values todetermine the acceptability of the source of water. From the results, the ground water in the study communities could be good for drinking with a little treatment to correct the acid, turbidity, ammonia, iron and manganese levels. The surface water in the area is good for irrigation especially for non- vegetable plants. However, the presence of coliform and heterotrophic bacteria makes the water unfit for vegetable irrigation because of the health implications. It is the recommendation of the authors that government agencies and aid organizations should institute policies that will make safe drinking water accessible to the populations in the rural areas. This will promote healthy living and the overall attainment of the Sustainable Development Goals (SDGs).

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