

Contributions of Government Fish Farms to Farm Management and Rural Development in Kenya

Odwor Paul Okelo
School of Economics, University of
Eldoret, P.O.Box 1125, Eldoret, Kenya.
okeloodwori@gmail.com

Ipara, Hellen
Department of Wildlife
Management, University of
Eldoret, P.O.Box 1125, Eldoret,
Kenya

Kimanzi, Johnstone
Department of Wildlife
Management, University of
Eldoret, P.O.Box 1125,
Eldoret, Kenya

Muya W, J
Department of Fisheries and Aquaculture, University of Eldoret, P.O.Box 1125,
Eldoret, Kenya

ABSTRACT

Government fish farms in Kenya were started with an aim of promoting aquaculture in the country through production of quality seeds, conducting research, as farmers training facilities, production of fish feeds, to increase fish production and to offer extension services to farmers. Currently there are fifteen Governments owned Fish Farms in Kenya. These fish farms have led to immense farm and rural development. First, the farms offer extension services to farmers which has played a great role in promoting aquaculture production in the country to over 900 tonnes annually; Second, increased job opportunities have resulted - the Government has employed over 200 skilled and 2,000 unskilled labourers; Third, improvement in infrastructure has resulted - electricity and tap water have now been fixed, roads have been improved and maintained which has also enhanced transportation of other farm produce to markets; Fourth, the regional and national food security has improved from consumption of the fish products; Fifth, the resultant fish farming is providing income to farmers and revenue to government amounting to over US\$ 2,153,000 annually; Last but not least, the fish farms provide sites for students from Institutions to conduct research and field studies. This paper documents the contributions of Government fish farms to farm management and rural development in Kenya with a view to enhance this practice where possible and lead to establishment of more private fish farms.

Key Words: Fish farm, Farm management, rural development

BACKGROUND

Government fish farms in Kenya were started with an aim of promoting aquaculture in the country through production of quality seeds, conducting research, as farmers training facilities, production of fish feeds, to increase fish production and to offer extension services to farmers (Muthoni, 2013; Ngugi, 2007).

Aquaculture is defined as the farming of aquatic organisms, that is some form of production intervention implied in the rearing process to enhance production, (such as regular stocking, feeding, protection from predators), plus individual or corporate ownership of the stock is implied (FAO, 2005).

According to FAO (2010), total aquaculture production in 2004 was 41.9 million tonnes, 44.3 million tonnes in 2005, 47.4 million tonnes in 2006, 49.9 million tonnes in 2007, 52.5 million tonnes in 2008 and 55.1 million tonnes in 2009.

Compared to conventional livestock and crop farming, aquaculture is much more diverse and varied. There are many diverse species cultured. The different species have different biology and therefore different ecological requirements. They will therefore have different feeding, breeding and water quality requirements. Coupled with different management and intensifications levels used, aquaculture production is very varied and diverse (Karen, 2001; Naylor, 2000).

In Kenya, resources have been spent to promote aquaculture development through various aquaculture projects over the last few decades. The promotion started in the early 1920s by the white settlers as a means of supplementing protein sources in the rural areas. This was a non-commercial approach and it was promoted only as

a family subsistence activity. This has however changed over the years and many entrepreneurs have now invested in commercial aquaculture ventures (Balarin, 1985; Beveridge, 1987).

Majority of aquaculture activities in Kenya involves the production of various species of tilapia (mainly *Oreochromis niloticus*), the African catfish (*Clarias gariepinus*) and the Rainbow trout (*Oncorhynchus mykiss Walbaum*). The tilapines and catfish production is mainly done as mono or polyculture of the two under semi intensive systems using earthen ponds while the Rainbow trout production is done in intensive raceways and tank systems. The Tilapine species constitute about 90% of aquaculture production in Kenya. Although most of the production targets the food fish market, there has been an increasing demand for baitfish for the Nile Perch capture of Lake Victoria (Mbugua, 2008). Several entrepreneurs have started producing the catfish juveniles for this market. Ornamental fish production is also gaining interest and several producers are engaged in the production of gold fish and koi carp among other ornamental species. There are Private Fish Farms which are fully involved in culture of ornamental fish only (Karen, 2001; Pillay and Kutty, 2005).

Aquaculture production like any other production is done at different intensifications; hence production systems have been developed to meet both the economic needs of the farmer and the requirements of the species to be cultured. Generally most of the production systems are non- mechanized (Carole, 2006, 2005; Curtis, 1993).

There are fifteen Governments owned Fish Farms in Kenya. These farms are: Sagana Fish Culture Farm in Kirinyaga; Kiganjo Trout Farm in Nyeri; Chwele Fish Farm in Bungoma; Kabonyo Fish Farm in Nyando; Wakhungu Fish Farm in Funyula (Busia); Siaya Fish Farm in Yala; Mwitokho Fish Farm in Vihiga; Lutonyi Fish Farm in Kakamega; Kisii Fish Farm in Kisii; Ngomeni Fish Farm in Kilifi; Muranga Fish Farm in Muranga; Geta Fish Farm in Nyandarua; Rumuruti Fish Farm in Laikipia; Kithima Fish farm in Maua (Imenti North); and Kinondoni Fish Farm in Chuka (Tharaka-Nthi) (Muthoni, 2013; Ngugi, 2007).

These government fish farms have made tremendous contributions to farm management and rural development in Kenya in various ways such as creating more employment opportunities, improving infrastructure, contributing to National food security, and providing income to farmers and revenue to government.

Employment Creation

The numbers of skilled and unskilled labour employed by the different fish farms are as shown in table 1.

Table 1: Skilled and Unskilled labour employed by the Fish Farms

FISH FARM	SKILLED	UNSKILLED
Sagana	22	1200
Kiganjo	27	20
Chwele	22	670
Kabonyo	15	7
Wakhungu	24	10
Siaya	10	7
Lutonyi	12	20
Kisii	18	25
Ngomeni	10	17
Muranga	20	15
Geta	13	10
TOTAL	200	2001

In Kenya the number of full-time employees in aquaculture is over 400. The work of extension is performed mainly by the staff of the Fisheries Department (Fisheries Officers, Assistant Fisheries Officers, Fisheries Assistants and Fish Scouts). The Lake Basin Development Authority, a semi-public organization, also has fisheries field staff who are answerable to a Technical Officer. Although thinly spread along the Lake Victoria Basin, they are better trained than other extension staff. The Kenya Marine and Fisheries Research Institute has opened up outpost stations for conducting aquaculture research and offering limited services to fish farmers. Universities such as Moi University, which has a Department of Fisheries, also offer technical assistance to the farmers.

Infrastructural Improvement

The improvements in infrastructure are as shown in table 2 and table 3.

Table 2: Infrastructural improvements

FISH FARM	Electricity	Tap Water Piped Water	School	Internet facility
Sagana	Fixed	Fixed		
Kiganjo	Fixed	Fixed	Enhanced	
Chwewle	Fixed			
Kabonyo	Fixed			
Wakhungu	Fixed	Fixed		
Siaya	Fixed	Fixed		
Lutonyi	Fixed			Fixed
Kisii	Fixed			
Ngomeni	Fixed			
Muranga	Fixed			
Geta	Fixed			

Table 3: Improvements in roads

FISH FARM	Tarmac	Gravel	Murram All Weather
Sagana		Fixed	
Kiganjo	Fixed		
Chwewle			Fixed
Kabonyo		Fixed	
Wakhungu			Fixed
Siaya			Fixed
Lutonyi			Fixed
Kisii			Fixed
Ngomeni			Fixed
Muranga			Fixed
Geta			Fixed

The fish farms have contributed to the promotion of infrastructure within the farms and the neighbouring villages and towns. This has been of great help to the community by improving general welfare of community members and also facilitating efficient transport of farm produce.

Contribution to National Food Security

In Kenya, socio-economics are changing rapidly. The population is about to rise from 41 to 55 million by 2020 and the nations GDP (USD) is about to grow in this same period from 35 to 59 billion. Local suppliers are unable to meet the growing food demand and, consequently, prices are rising. The need for animal protein and protein rich food is intensifying, as well as the nutritional deficiency levels among a significant part of the Kenyan population. Fish farming seems to offer a solution (Muthoni, 2013).

Further, through the establishment of a fully integrated aquaculture value chain, production could be improved. Compared to livestock, farmed fish are efficient in terms of water usage, feed conversion and greenhouse gas emissions. This healthy source of animal protein offers substantial opportunities to improve food security, when produced in a sustainable manner. On top of this, investing in the underdeveloped Kenyan fish farming industry could result in an increased fish production and farming productivity, improved infrastructure and technical capacity, more efficient markets and encourages local entrepreneurship, thereby benefitting both commercial and small-scale subsistence farmers (Muthoni, 2013).

Aquaculture has lately become a source of healthy animal protein in many parts of Kenya. It has now spread to parts of the North Rift, Central and Eastern Provinces, which initially were not fish growing areas.

Contribution to Farm Development and Enhanced Rural Economic Base

Until six years ago, aquaculture in Kenya had stagnated at an annual production of around 1 000 tonnes. This situation was further exacerbated by poor extension services and inadequate reporting and documentation. Since 1999, however, through consistent efforts in on-farm research and training, Kenya's aquaculture production has risen and is currently likely to be almost 1 500 tonnes. The focus is now on encouraging the development of private, commercial large-scale aquaculture, which is likely to increase Kenya's production to about 12 000 tonnes in the next three years. This development follows the efforts of the Department of Fisheries to promote aquaculture as one of the means to eradicate poverty and hunger. During the preparation of the Poverty Reduction Strategy Paper in 2000, the Government identified aquaculture development as a core activity for funding through the current Medium Term Expenditure Framework budgeting system. The last six years have been marked by aggressive research, training and private sector involvement in aquaculture. Production in real terms has doubled and is set to grow by over 1 000 percent (ten times) in the next three years. The prevailing conditions combine good prices and high demand, which are likely to boost fish production from aquaculture.

According to the current data available there are 7 790 fish farmers who are owners of aquaculture production units (Fisheries Department, 2003). The actual numbers benefiting from aquaculture will only be available on completion of the national aquaculture inventory which is being carried out by the Fisheries Department, and which includes as one of its parameters the number of household members.

In 2003 total production of the three main fish species farmed in Kenya (Nile tilapia, rainbow trout and North African catfish) amounted to 948 tonnes. The value of production for 2003 came to US\$2 153 000

Figures 1, 2, 3 and 4 show growth in total aquaculture production and increased adoption of fish farming in Kenya.

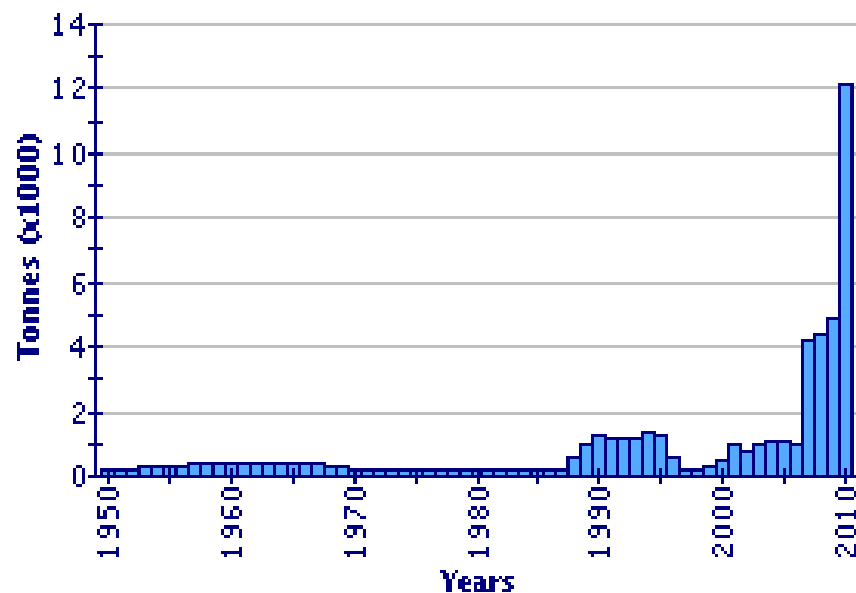


Figure 1: Aquaculture production in Kenya (from 1950) (Source: FAO Fishery Statistics)

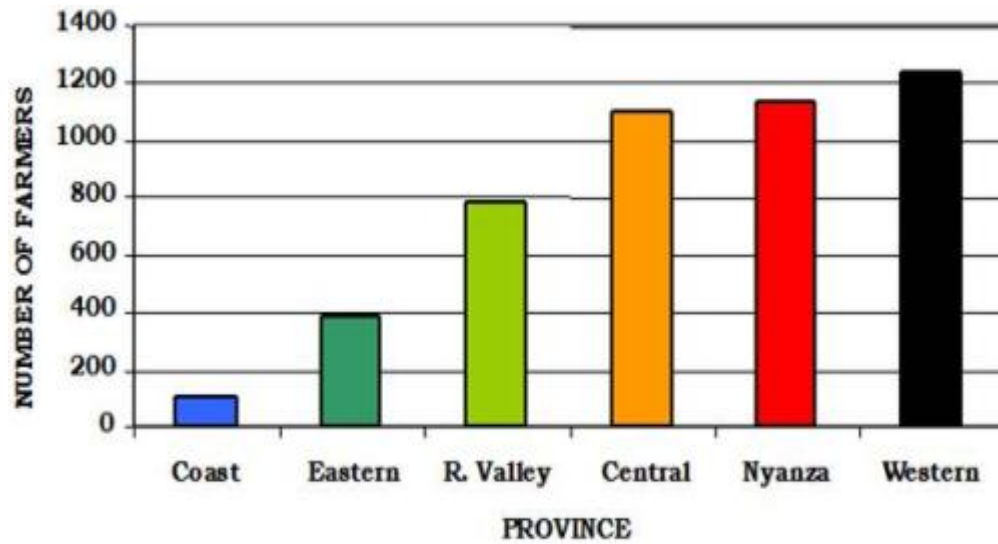


Figure 2: Number of fish farmers by Province in Kenya (Source: Mbugua, 2008).

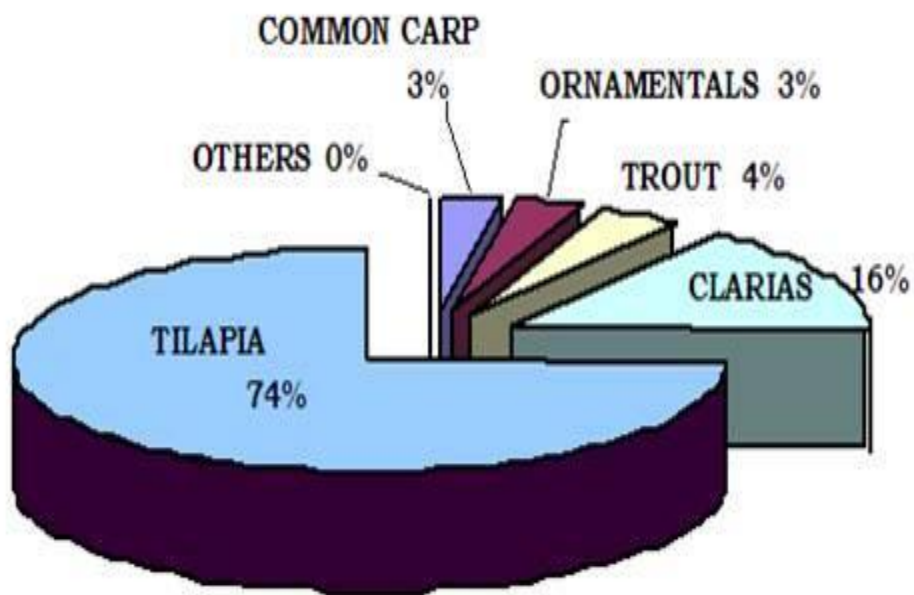


Figure 3: Percentage production of fish by species (Source Mbugua, 2008).

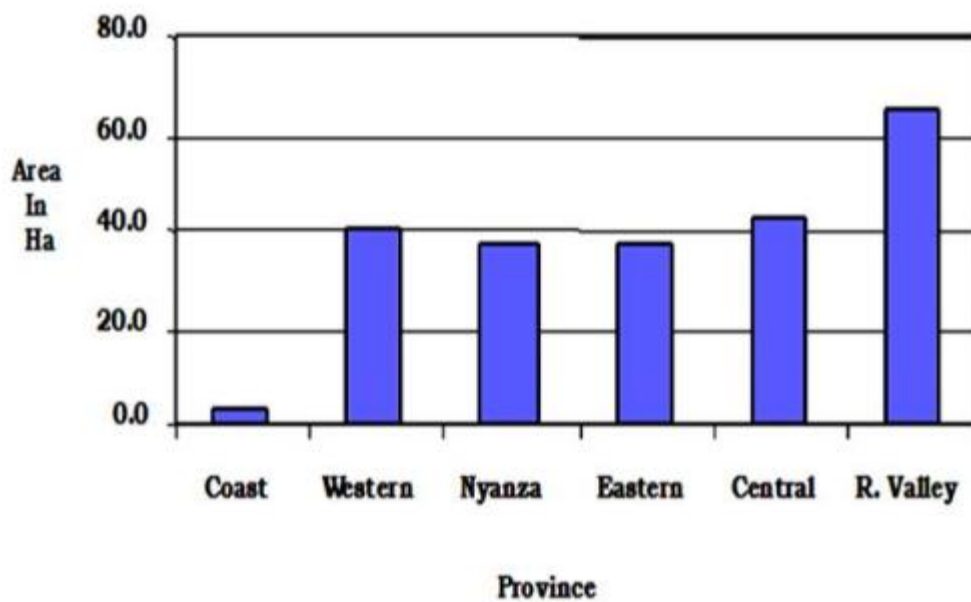


Figure 4: Area under aquaculture by province (Ha)
(Source: Mbugua, 2008)

The fish farming systems used vary from Intensive to semi-Intensive systems as shown in Figures 5, 6, 7, 8, 9, 10, 11, 12 and 13.



Fig. 5: Fish culture cages (Source: Ngugi, 2007)



Fig. 6: Small Scale Fish Farm (Source: Ngugi, 2007)



Fig. 7: A well fertilized pond in an ornamental fish farm in Kenya (Source: Ngugi, 2007)



Fig. 10: Tilapia and Catfish farming integrated with poultry (Source: Muthoni, 2013)



Fig. 11: Pig house with fish pond (Source: Muthoni, 2013)



Fig. 12: Earthen fish ponds at a fish farm in Kenya (Source: Muthoni, 2013)



Contribution to Rural and National Incomes

The domestic market for farmed fish is quite promising. Prices are as high as Kshs 140/US\$ 1.86 per kg in Eldoret and other parts of the country and there is consumer awareness of the health benefits of eating fish as well as quality assurance of farmed fish. This combination of good prices and high demand becomes a real boost for aquaculture. Currently prices are getting even better than those on the world market for whole tilapia. Almost all major towns in Kenya where aquaculture is practiced in the surrounding areas constitute an assured market. This now includes most towns in Western, Central, Eastern, Rift Valley, Coast, Nairobi and Nyanza provinces. The market for food fish is still mainly confined to whole fish except for North African catfish fillet for which there is a high demand in some parts of the Central Province. The distribution chain is mostly short, characterized by farm-gate pricing, although lately there are increasing numbers of middlemen, especially in the fast-growing bait fish market for catfish fingerlings. Prices in the bait market vary widely from Kshs 3/US\$ 0.04 from fish farmers to as much as ksh10/US\$ 0.13 paid by Nile perch longline fishermen.

A number of fish farmers who were farming at subsistence level have turned into small-scale commercial fish farmers earning as much as Kshs 450 000 (US\$ 6 000) per acre of water surface. Some of the commercial farmers who are starting production want to produce both for the local and export markets. Thus, it is likely that in the next three years aquaculture will make a significant contribution to both food security and foreign exchange earnings in Kenya.

CONCLUSIONS

Government fish farms have made tremendous contributions to farm management and rural development in Kenya in various ways such as creating more employment opportunities, improving infrastructure, contributing to National food security, and providing income to farmers and revenue to government.

RECOMMENDATIONS

The government needs to increase extension services in order to reach out to many farmers, educate them and equip them with the necessary skills required for optimal fish farming. This will ensure farmers to reap maximum from fish farming and the community will benefit in a variety of ways.

REFERENCES

- Balarin, J.D. 1985. Reviews for aquaculture development in Africa: Kenya. FAO Fish Circ., (770.7):96 p.
- Beveridge, M. (1987). Cage Aquaculture, Fishing News Books, Oxford.
- Carole, R.E. and Ivano, N. (2005). Tilapia Farm Business Management and Economics. A Training Manual. Arkansas: Aquaculture/Fisheries Centre.
- Carole, R.E., Kwamena, Q. (2006) Aquaculture Marketing. United Kingdom: Blackwell Publishing. ISBN 0-8138-1604-1
- Curtis, M.J. and Howard A. C. (1993). Economics of aquaculture. New York: Food Product Press, ISBN 1-56022-020
- Central Bureau of Statistics & Ministry of Planning and National Development. 2002a. The 1999 Population and Housing Census. Vol I. Government of Kenya.
- Central Bureau of Statistics & Ministry of Planning and National Development. 2002b. The 1999 Population and Housing Census. The Popular Report. Government of Kenya.
- Central Bureau of Statistics & Ministry of Planning and National Development. 2004. Statistical Abstract. Government of Kenya.
- Central Bureau of Statistics & Ministry of Planning and National Development. 2005. Economic Survey. Government of Kenya.
- Department of Fisheries. 2000. Aquaculture Annual Report - 2000. Government of Kenya.
- Department of Fisheries. 2001. Aquaculture Annual Report - 2001. Government of Kenya.
- Department of Fisheries. 2002. Aquaculture Annual Report - 2002. Government of Kenya.
- Department of Fisheries. 2003. Aquaculture Annual Report - 2003. Government of Kenya.
- Department of Fisheries (DoF) (2006). Fisheries Statistical bulletin. Nairobi: Department of Fisheries.
- FAO. 2005. Aquaculture production, 2004. Year book of Fishery Statistics - Vol.96/2. Food and Agriculture organization of the United Nations, Rome, Italy.
- FAO. (2005). Fishery Information, Data and Statistics Unit. FAO, Rome. Source of Fishstat Plus Software. URL: <http://www.fao.org/fi/statist/FISOF/FISHPLUS.asp>
- FAO (2006). FAO Training Series: Simple methods for aquaculture CD-Rom. ISBN: 9789250056128
- FAO. (2006). *The state of the world fisheries and aquaculture 2006*. FAO Fisheries and Aquaculture Department. Rome, Italy.
- FAO. (2010). *The state of the world fisheries and aquaculture 2010*. FAO Fisheries and Aquaculture Department, Rome, Italy.
- Karen L.V. (2001). Aquaculture Handout For Farmers. Sagana: Sagana aquaculture Centre.
- Mbugua, H. M. (2008). Aquaculture in Kenya: Status, Challenges and Opportunities. Aquaculture Development Division.
- Muthoni, A. (2013). Fish for food security in Kenya? A publication of Larive International
- Ministry of Agriculture. 2004. Strategic Plan of the Ministry of Agriculture (2005-2009) – Final Report. Government of Kenya.
- Ministry of Finance & National Planning. 2002. Development Plan 2002-2008. Government of Kenya.
- Naylor, R. L. *et al.* (2000). Effect of aquaculture on world fish supplies. Nature, 405, 1017- 1024. State Department of Fisheries Statistical Archive, Kenya.
- Ngugi, C. C., Bowman, J.R. and Omolo, B. O. (2007). A new guide to fish farming in Kenya. ISBN 978-0-9798658-0-0
- Pillay, T.V. and Kutty, M.N. (2005). Aquaculture Principals and Practices United Kingdom: Blackwell Publishing. ISBN: 1-4051-0532-1

Comparative Study of the Inhibitory Activities of *Ocimum gratissimum* and *Nepeta cataria* against *Salmonella Enterica* Serovar Typhi and their Larvicidal Effect against *Anopheles Gambiae*

Iheukwumere, I.H.
Department of Microbiology
Chukwuemeka Odumegwu Ojukwu University
Uli, Anambra, Nigeria
ikpower2007@yahoo.com

Ejike, C.E.
Department of Medical Microbiology
Chukwuemeka Odumegwu Ojukwu University
Uli, Anambra, Nigeria
chinwe.ejike@yahoo.com

ABSTRACT

This study was carried out to evaluate the antibacterial and larvicidal activity of *Ocimum gratissimum* and *Nepeta cataria* against *Salmonella enterica* serovar Typhi (*S. Typhi*) and *Anopheles gambiae*. *S. Typhi* was isolated from raw egg using *Salmonella Shigella* Agar (SSA), characterized and identified using Gram staining, colonial description and biochemical characteristics. The phytochemical constituents of the leaves extracts were determined quantitatively using spectrophotometric method. The antibacterial activity was carried out using agar-well diffusion method. Tube dilution method was used to determine the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) using double-fold serial dilution at concentration 25mg/ml to 400mg/ml. The larvicidal activity of the leaves extracts was carried out by subjecting *A. gambiae* larvae to varied concentration of the leaves extracts using in vitro assay at room temperature for 72 h. The phytochemical analysis of the leaves extracts revealed the presence of tannins, saponins, alkaloid, flavonoids, steroids, glycosides, phenolics and essential oil. The antibacterial activities of the leaves extracts showed that ethanol and aqueous extracts of *N. cataria* (16.30mm, 8.30mm) exhibited slightly higher activity than *O. gratissimum* (15.70mm, 7.67 mm) and their activities differed significantly ($p \leq 0.05$) from that of ciprofloxacin (21.30 mm). The result of MICs and MBCs of the leaves extracts of *N. cataria* and *O. gratissimum* showed that the *N. cataria* leaf extract exhibited more inhibitory activities against the tested organism. The larvicidal activities of the leaves extracts at doses (0.1ml and 0.2ml) showed that *O. gratissimum* (40%, 46.67%) differed significantly by ($p \leq 0.05$) from *N. cataria* (33.3%, 46.67%) at their lower doses. The result of LT_{50} and LT_{90} of *O. gratissimum* (70,116) and *N. cataria* (71,117) revealed their pronounced larvicidal activities against *A. gambiae*. This study suggests that *O. gratissimum* and *N. cataria* leaves extracts could be used as alternative therapy for typhoid fever, and as pesticides for *A. gambiae* larvae.

Key words: Phytochemical, Antibacterial, Larvicidal, Typhoid Fever and Pesticide

INTRODUCTION

The occurrence of malaria and typhoid fever in the tropics, mainly in the developing nations of the world particularly in Africa remains a major concern. Malaria remains the most complex and overwhelming health challenge facing the world mostly in the tropical and subtropical regions with about 300 to 500 million cases and over 2 to 3 million death per year (Iheukwumere, Nwachukwu, and Kanu, 2013). Although, preventable and treatable, but has been a cause of severe maternal and childhood morbidity and mortality. Beside health impact it is a major impediment to socio-economic development (Iheukwumere *et al.* 2013). In contrast to developed nations, typhoid fever remains an important cause of illness in the developing countries with highest endemicity in the south-east Africa and south-central Asia with low rate of disease in other developing countries. However, typhoid fever is a major cause of morbidity in many regions of the world with an estimate of 12 to 33 million cases occurring annually (Crum, 2003).

In most developing countries, 90% of death occurring annually is usually attributed to malaria which is caused by *Plasmodium falciparum* the most infectious of the four human malaria parasites (*Plasmodium falciparum*, *Plasmodium ovale*, *Plasmodium malariae* *Plasmodium vivax*) with an estimated number of 1.4 to 2.6 million deaths per year. It is often transmitted by a malaria vector *Anopheles gambiae* (Iheukwumere *et al.* 2013). Typhoid fever a global health problem with an approximately 17 million cases and 600,000 deaths occurring annually and is often caused by *S. enteric* serovars *Typhi* a pathogenic, motile, Gram negative rod shaped bacterium which is transmitted by the ingestion of feacally-contaminated food and water with an incubation period of 10 to 14 days. It occurs with symptoms such as low-grade fever, malaise, headache, constipation in infected individuals and sometimes spleen and liver enlargement rose spot in skin of the infected persons (Dada and Komolafe, 2013).

In order to combat these disease the use of combine therapy of synthetic drugs and insecticide such as fluoroquinolone (e.g. Ciprofloxacin, Ofloxacin) used as a drug of choice for the treatment of typhoid fever and insecticide used in the control of malaria. But the major impediment to this effective chemotherapy is the ever increasing number of resistance strains of *S. typhi* therefore imposing public health problem (Cabrera *et al.*, 2004). According to Das, Goswani, and Rabha, (2007) stated that the repeated use of synthetic insecticide resulting in the development of resistance mosquito species, undesirable effect on non-target organisms and also environmental and human health concern. This problem coupled with the high cost of the insecticide and drugs have revived interest in exploiting disease control potential plants. In this regard an alternative arsenal drugs in terms of medicinal plant based mosquitocidal and antibactericidal agent with effectual mode of action is needed. The identification and the use of these indigenous medicinal plant is much more employed as it is readily available and economical for use in the control of disease (Cabrera *et al.*, 2004).

O. gratissimum an herbaceous and *N. cataria* an herbaceous mint plant widely distributed has been found to contain certain phytochemical such as alkaloid, saponins, flavonoid etc. with antimicrobial properties and are stored in varying concentration in the plant cells and has been found useful in treatment of bacterial infection and also toxic secondary metabolites from the plants were extracted, tested and were found effective against mosquito larvae (Okigbo, Okeke and Madu, 2010). Although many herbs have been used to investigate several disease and a considerable number of studies have emphasized the research and development of herbal substance in the control of diseases by previous researchers (Tsao, Roman, Peterson and Coast, 2002; Sukurmar, 1991; Abubakar, 2009; Adebolu, Adeoye, and Oyetaye, 2005) but only a few work has been done to investigate the antimicrobial and larvicidal activity of these plants extract. In respect to this, the inhibitory and larvicidal activity of *O. gratissimum* and *N. cataria* against *S. Typhi* and *A. gambiae* were evaluated.

MATERIALS AND METHODS

Sample Collection: The fresh leaves of *Nepeta cataria* and *Ocimum gratissimum* were collected from Obodo family of Ndemereaku Village in Uli, Ihiala Local Government Area, Anambra State.



Figure 1: Whole part of *Nepeta cataria*



Figure 2: Whole part of *Ocimum gratissimum*

Preparation of Sample for Extraction: The leaves of *Nepeta cataria* and *Ocimum gratissimum* were plucked off and dried under shade at room temperature for 14 days. The dried samples were pulverized using manual blender weighed and kept ready for extraction of active ingredients (Nwobu, Uzochukwu, and Okoye, 2010).

Extraction Procedure: A 10g portion extracted by maceration in 200 ml of ethanol and water respectively for 3 day. The resulting extracts were subsequently filtered using Whatman No.1 filter paper. The extracts were evaporated to dryness at room temperature in a steady air current (Nwobu *et al.* 2010).

Preparation of Test Sample: In this study, concentration of 400 mg/ml of the extract was used to screen for the antimicrobial activity. This was done by using the modified method NCCLS (2000). Here, 2.5 g of the extract was dissolved in each of the extracting solvents.

Isolation and Identification of Test Organism: The test organism used in this work was collected from an egg (layer's egg). The egg shell were swabbed using 70% alcohol and perforated using sterile fork and the inner fluid (albumin) sample were collected using 2 ml syringe and the sample was shaken vigorously. The sample were plated on Salmonella Shigella agar (SSA) and then incubated at 37°C for 24 h. The pure culture of the test organism was identified using (slide agglutination reaction), colonial description and biochemical reactions (Iheukwumere and Umedum, 2013).

Maintenance of Test Organisms: The isolated test organism was used for the antibacterial sensitivity testing. Prior to the test, the organism was subculture on nutrients agar plate at 37°C for 24 h. Then after 24 h, the culture was transferred into nutrient broth and incubated at 37°C for 24 h (Iheukwumere and Umedum, 2013).

Sensitivity Testing Using Agar-Well Diffusion Method: This was carried out using the modified method of Iheukwumere and Umedum, (2013). Each labelled plate was uniformly inoculated with the test organism using pour plating method. A sterile cork borer of 5 mm diameter was used to make well on the medium. One tenth millilitre (0.1ml) of various concentrations of the extracts were dropped into each labelled well, and then incubated at 37°C for 24 h. Antibacterial activity was determined by measuring the diameter of the zones of inhibition (mm) produced after incubation. Ciprofloxacin (500mg/ml) was used as control.

Determination of Minimum Inhibitory Concentration (MIC): This was carried out using the modified method of Iheukwumere and Umedum, (2013). Here, various concentrations of the extract were obtained using double-fold serial dilution. Each dilution was assayed against the test organism using tube dilution method. One millilitre of the test organism was added into each dilution and incubated at 37°C for 24 h. The MIC was defined as the lowest concentration able to inhibit any visible bacterial growth. This was determined and recorded.