Sudan University of Science and Technology
College of Graduate Studies

Quality Attributes, Minerals and VitaminsContents Of FishPatties

خصائص الجودة ، محتويات المعادن والفيتامينات لكفتة الأسماك

A Thesis Submitted In PartialFulfillment Of The Requirements Of The Degree Of M.Sc. In Fish ScienceAndTechnology

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استهلال

قال تعالي:(وهو الذي سخر البحر لتأكلوا منه لحما طريا وتستخرجوا منه حليه تلبسونها وتري الفلك مواخر فيه ولتبتغوا من فضله ولعلكم تشكرون)

صدق الله العظيم

(سورة النحل الآية 14)

Dedication

To the soul of my mother
To my father
To my brothers
To my beloved husband

EnasDifalla

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First of all I am indebted to Allah who gave me the help to run this study. I am gratefulto the soul of my beloved mother Zahra Ali Baja, to my father DifallaHashim and to my beloved brothers Alrasheed, GreepAllah and Hashim.

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ABSTRACT

This study was conducted to assess the effect of fish species and water environment on chemical, physical, mineral, vitamin and organoleptic properties of fish patties *Malpetrauselectriccus*(A) and *Tetradonfahaka*(B), which were usedin the study. Samples were collected from three different water environments River Nile, White Nile and Blue Nile.

After collected the fresh fish patties were formulated as two groups(A and B) .

The chemical analysis showed that, the protein, moisture, ash content and ether extract (E.E) percentages showedsignificant differences($p< 0.05$), between samples in the twogroups(A and B).

The pHshowed no significant difference between the two groups ($p>0.05$) in the three water environments, but there was significant difference ($p< 0.05$) in cooking loss.

Minerals(Calcium and Sodium)were notsignificantly different among the treatments at ($p>0.05$) of the samples within the three water environments, but phosphorous, magnesium and potassium showedsignificantdifference ($p< 0.05$)among the treatments of the samples within the two groups (A and B).

Vitamin {C}showed no significant difference among the treatments($p> 0.05$) of the sample within the three water environments, but in Vitamins {A and E}showed significant difference among the treatments ($p< 0.05$) of the sample within the three water environments .

Theorganoleptic test for the (color, flavor, texture and juiciness) reported significant difference among the treatments($p< 0.05$) of the sample within the three water environmentsby the panelists.

المستخـــــــــــــــــــــــــــلص

أجريت هذه الدراسة لمعرفة تأثيرنوع الأسماك والبيئات المائية المختلفة علي الخصائص الكيميائية ، الفيزيائية ، المعادن ، الفيتامينات والاختبارات الحسية للكفتة المصنعة من سمكتي البردة (أ) والتامبيرة (ب) اللتان استخدمتا في التجربة ،وجمعتا من نهر النيل ،النيل الأبيض والنيل الأزرق .

وبعد جمع الأسماك الطازجة تم تصنيع الكفتة من المجوعتين(أ)و(ب) ، حيث أوضح التحليل الكيميائي أن هنالك فروقاً معنوية في كل من البروتين ,الرماد,الرطوبة و الدهون في البيئات المائية المختلفة للمجموعتين (أ)و(ب).

سجل الأس الهيدروجيني أنه لاتوجد فروقاًمعنويةفي البيئات المائية المختلفة للمجموعتين (أ)و(ب) ولكن هنالك فروق معنوية في نسبة فاقد الطبخ.

المعادن(الكالسيوم والصوديوم)لاتوجد فروقاً معنوية في البيئات المائية المختلفة للمجموعتين(أ)و(ب) ولكن الفسفور, الماغنسيوم والبوتاسيوم قد سجلواأن هنالك فروق معنويةفي البيئات المائية المختلفة للمجموعتين(أ)و(ب)

فايتمين(ج) أوضح انه لاتوجدفروقاً معنوية في البيئات المائية المختلفة للمجموعتين (أ)و(ب) حيث سجل فايتمين (أ) و(ه) أن هنالك فروقاً معنويةفي البيئات المائية المختلفة للمجموعتين (أ)و(ب).

الاختبارات الحسية (اللون,النكهة,القوام والعصيرية)سجلت ان هنالك فروقاً معنوية في البيئات المائية المختلفة للمجموعتين (أ)و(ب) بواسطة المتذوقين.

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CHAPTER ONE
INTRODUCTION

Water constitutes about 71.0% of the earth's surface and has always been an important actual and potential source of food. There is an increasing demand for aquatic resources and fish products as dietary protein source around the World **(Feldhusen, 2000**). Fish are the most numerous vertebrates, with at least 20,000 known species, and more than half (58%) are found in the marine waters environment. They are most common (some8000species) in the warm parts of the continental shelves (**Banwart,1979).**

Recent world fish production amounts to 116 million tons ,almost 50.5 of total world landing are estimated to be from small–scale capture fishery, and most of the production is used for direct human consumption.Aquaculture production is estimated at 16million tons of fish which constitute 23% of total food fish supplies**(FAO,1997)**

Fish has been one of the main human foods for many countries ,and still constitutes an important part of the international trade, currently worth more than 50 billion **$**US, indicating increasing consumer interest in the commodity since 70% of the Earth's surface is covered by water ,there are plenty of sources to harvest**(Samakupa,2003)**

Estimates indicate that about 96% of fish captured in Sudan, comes from fresh water fisheries, of which 55% is from the White Nile, Blue Nile, Atbara River and Lake Nubia**(Carleton and Pena,1982).** Sudan is endowed with diversified surface, underground water sources and resource and arable lands suitable to support vigorous capture fisheries and aquaculture industry. Currently, capture fisheries activities are centered aroundthe River Nile and its tributaries, and the territorial waters of Sudan on the Red Sea**(FAO, 1999).**

With the over-growing world population and need to store and transport food, fish preservation becomes necessary to supply the distant market, to produce a range of products with different flavors and textures and creation of conditions unfavorable to the growth or survival of spoilage organisms **(Gracey, 1986, Yohanna *et al.*, 2011)**. The principle fish processing methods in Sudan are smoking ,salting ,sun –drying, fermentation, grilling and frying. The predominant type of fishery products in any particular country are closely related to the food habits and purchasing power of the population. Specific types of fishery products are best suited as the local staple food. Furthermore, due to the lack of a good transport infrastructure for the transportation of fresh fish to towns and villages, lack of (modern) preservation techniques cured fish is the most convenient in which fish can be sent to such areas**(Ali,1994).**

Methods are available for fish preservation, quality improvement and consumer convenience and/or to increase their market value. Cooking has the additional benefits of inactivating endogenous enzymes and stopping microbial growth**(Aubourg,2001).**

Fish processing can be subdivided into fish handling, which is the preliminary processing of raw fish, and the manufacture of fish products. Another natural subdivision is into primary processing involved in the filleting and freezing of fresh fish for onward distribution to fresh fish retail and catering outlets, and the secondary processing that produces chilled, frozen and canned products for the retail and catering trades (**Royal Society ofEdinburgh, 2004).**

Fish industry has been developing processed or minced fish products such as fish burgers, fingers and sausages, which add cooking convenience to nutritional benefits**(Mohammed,*.et al*. 2007).**

The objectives of this study are: to increase the current economic value of fishes ,which have cheapest price or undesired by consumers, to investigate the suitability of pattiesprocessingfrom flesh of (*maleptruruselectricus*and *Tetrodonfahaka)* and their nutritive values (physical, chemical, vitamin, macro-mineral, and organoleptic test) in different water environments i.e. River Nile, White Nile and Blue Nile.

CHAPTER TWO
LITERTURE REVIEW

2.1Fish flesh

The advantages of fish as food aretheir easy digestibility and high nutritional value.The range of fish products is very large and includes foods prepared using abroad spectrum of both traditional and modern food technologies. Although fish production potential in Sudan is high and the need for protein supplementation for people is extreme, fish production is unfortunately not fully utilized. Many factors contribute to poor utilization like primitive processing techniques which have their effects on the shelf life of the product and its acceptability by consumers. Another factor is fish being highly perishableandspoil rapidly especially under Sudanese tropical conditions. Only recently Sudanese have adopted a taste and acceptance of fish as food**(Ali,1994)**.Today even more people are turning to fish as health alternative to red meat. Fish fat is characteristically high in poly-unsaturated fatty acids, making them important in diets for people requiring keeping low levels of cholesterol in the blood**(Clucas and Ward, 1996).**Fishes are rich in Omega-3 fatty acids which plays very important role for normal growth particularly for the blood vessels and the nerves as well as keeping skins and other tissues youthful. Research studies have revealed that in populations that consume large quantities of fish, with a high utilization of Omega3s, showed a reduced risk of heart diseases. Fish is important in the diets and livelihoods of many poor people suffering from vitamin and mineral deficiencies **(Toft, 2001**).

The principle of fish preservation is the prevention of self–decomposition, microbial decomposition and prevention of damage due to insects **(frazier,1958)**.The prevention of fish from spoilage means keeping fish acceptable for consumption for some length of time by using the methods needed to prevent deterioration**(Maar,*et.al*.,1996).**

In many parts of the world there is no access to refrigeration or ice, this places stress on the physical, chemical and biological processes that lead to spoilage and deterioration of freshly caught fish. Reducing moisture content throughdrying, smoking or curing will result in stable source of protein that can be transported to communities with limitedaccess to fresh fish. Smoking, drying and curing of fish either as a means of prolonging shelf life, or to produce desiredflavors and texture has been practiced by many societies for centuries. In tropical countries there are many traditionalmethods including direct sun drying with the fish placed either directly on the ground or on mats or racks**(Doe,2003).**

2.2 Species descriptions

2.2.1 *Malapteruselectricus*

Scientific classification

Kingdom: *Animalia*
Phylum: *Chordata*
Class: *Actinopterygii*
Order: *Siluriformes*
Family: *Malapteruridae*
Genus: *Malapterurus*
Species: *M. electricus*

Those species grows to a length of 122 centimeters (48 inSL) and they are important for subsistence fisheries and as a gamefish. This is also the most common of the electric catfish to appear in the pet trade.(**Froese, and Pauly,. 2011).**

*Malapteruselectric*us the *genus malapteus* is found throughout western and central tropical Africa and the River Nile.They occur in all the major fresh water system in Africa. *Malapteruselectrius* is restricted in to Nile and lake Chad**(Moller ,1995).**

2.2.2 *Tetraodontidae*

Scientific classification

Kingdom: *Animalia*
Phylum: *Chordata*
Class: *Actinopterygii*
Order: *Tetraodontiformes*
Family: *Tetraodontidae*
Genus: *Tetraodon*
Species: *T. lineatus*

The *Fahaka* pufferfish, also known as the Nile puffer, Globe fish, Lineatuspuffer(*Tetraodonlineatus*), is a tropical freshwaterpufferfishfound in the River Nile and other river basins of Africa.(**Froese andPauly**, **2009**)The *Family Tetraodontidae*owes its name to the word "Tetraodon", which in Greek means "four teeth" (**Talwar and Jhingran, 1991**). Fishes family possess characteristic jaws wherein the teeth are fused into a beak-like dental plate with a median suture on each jaw **(Talwar and Jhingran, 1991)**, thereby giving the appearance of four heavy, powerful teeth, two in each jaw **(Shipp, 2003)**. These fishes lack pelvic fin and their body is generally covered with spiny patches on their back, sides and belly **(Talwar and Jhingran, 1991; Froese and Pauly, 2010)** The*Tetraodontidae* is a large group comprising one hundred and eighty seven species belonging to twenty nine genera **(Froese and Pauly, 2010).**

2.3 Chemical Composition of fish

Proximate composition of fish involves the determination of moisture, lipid, protein and ash content. Carbohydrate is determined by difference. The proximate composition of fish is affected by a diversity of factors such as: size, sexual maturation, temperature, salinity, exercise, ration, time and feeding frequency, starvation, type and amount of dietary ingredients (**Shearer, 1994).**

Knowledge of the proximate composition of fishes is essential toestimate their energy value and to plan the most appropriate industrialand commercial processing**(Hanna, 1980)**. Generally, composition of live-weight whole fish is 70 to 80% water, 20 to 30% protein, and 2 to 12% lipid **(love, 1980)**. However, in different environmental conditions, the composition of the fish may differ in relation to the differences in water quality, feeding conditions, sex, and state of maturity, (**Brett, *et al*1969. Javaid, *et.al*.,1992)**.The chemical composition of fish varies greatly from one species and one individual to another depending on age, sex, environment and season **(Simopoulos*et al*. ,1991). (Banwart,1979)**side that the variation in the chemical composition of fish is closely related to feed to food intake, migratory ,swimming and sexual changes in connection with spawning .**Siham, (1999)**studied on the chemical composition of three fish species *(Protopterusaethiopicus* , *Malapateruruselectrics* and *Tetradonfahakh*) from Almawrada fish market , revealed that the protein percentages of the three fish species were as follows:20.89%,20.4% and 20.6 % respectively, the fat content was 0.15%, 2% and 0.36% respectively, ash content was 2.89%, 1.56% and 0.51% respectively.

2.3.1 Proteins

Fish is known to be the best and cheapest source of animal protein of very high digestibility and nutritive value. In general the biochemical composition of the whole body indicates the fish quality. Therefore, knowledge on biochemical composition of fish finds application in several areas. Due to an ever increasing awareness about health foods, fish is finding more acceptances because of its special nutritional qualities. Fish is one of the most important components of feed for animals and human beings, because of their excellent nutritional profile and easily digestible characteristics**(FAO., 1986)**,also one of our most valuable sources of protein; about 25% of animal protein is obtained from fish and shell fish. About (35%) of all fish is eaten fresh, chilled or frozen**(FagbenroandAdeparusi., 2003**). Fish is one of the most important sources of animal protein available in the tropics and has been widely accepted as a source of high quality protein and other elements for the maintenance, of healthy body **(Ojewola*et .,al* 2006).**There are various reasons for the merits of eating fish. One such reason is that fish is

less tough and more digestible when compared with beef, mutton, chicken and bush meat. This is possible because of the greater ratio of muscles protein to connective tissues in fish in relation to other animals thus making fish acceptable by infant and adults. Because of its greater digestibility, fish is usually recommended to patients with digestive disorders such as ulcers (**Eyo, 2001**). Fish product has a nutrient profile superior to all terrestrial meats of beef, pork and chicken etc., being an excellent source of high quality animal protein and highly digestible energy. It is a good source of sulphur and essential amino acids such as lysine, leucine, valine and arginine. It is therefore suitable for supplementary diets of high carbohydrate contents **(Amiengheme, 2005**)

Fish are on import part of healthy diet since they contain high quality protein, but typically present allow fat percent when compared to other meat. Most fish contain omega3-fatty acid and other essential nutrients. Although fish is broadly similar in composition and structure to meat there are a number of distinctive features .Protein content in fish fillet varies typically from 16-21%. **(Huss ,1995**).

The majority of the sarcoplasmic protein are enzyme participating in the cell metabolism, such as the anaerobic energy conversion from glycogen to ATP . If the organelles within the muscle cells are broken, this protein fraction may also contain the metabolic enzymes localized inside the endoplasmatic reticulum, mitochondria and lysosomes. The fact that the composition of the sarcoplasmic protein fraction change when the organelles are broken was suggested as a method for differentiating fresh from frozen fish, under the assumption that the organelles were intact until freezing (**Rehbein*etal*., 1998, Rehbein,1997, salfi*et al.*, 1985)** However ,it was later stated that these methods should be used with great caution, as some of the enzymes are liberated from the organelles also during iced storage of fish **(Rehbein*et al.*, 1997**)the proteins in the sarcoplasmic fraction are excellently suited to distinguishing between different fish species, as all the isoelectric focusing method. The method was successfully introduced by (**Lundstrom*et al.*, 1998**) and has been used by many laboratories and for many fish species. A review of the literature is given by **(Rehbein 1997**).

2.3.2 Lipids

The lipids content of fillets from lean fish is low and stable whereas that from fatty species varies considerably however, the variation in the percentage of fat is reflected in the percentage of water, since fat and water

normally constitute around 80 percent of the fillet. As a rule of thumb, the amount of fat can be estimated from an analysis of the water content in the fillet **(Huss**, **1995)**. In terms of quantity, lipid is the third major constituent in fish muscle. Variation in the fat content is much wider than that of protein. Fat content varies between species, and also between different organs within species. Fish with fat content as low as 0.5% and as high as 18-20% are common. In many species there is a build-up of fat during feeding season and its proportion decreases substantially after spawning. As far as the type of lipid in fish muscle is concerned, triacylglycerol and phosphoglycerides both containing long chain fatty acids are the major components. Squalene and wax esters are other components found in unusually high concentrations in a few fish meat.

It is generally accepted that the chemical composition of fish is not constant**,(FAO, 2005**)). Attention has been focused recently on the relationship between fish consumption and reduced incidence of cardiovascular diseases. The benefit has been attributed to the nature of the fats in fish. Unlike other fats in other foods, it is the only type of fat that supplies omega-3 poly-unsaturated fatty acids (PUFA) (**Al-Jedah*et al.*, 1999)**. PUFAs are essential in lowering blood cholesterol level and high blood pressure. It is able to migrate to alleviate platelet of (cholesterol) aggregation and various arteriosclerosis conditions in adult population. It helps in prevention of asthma, arthritis, psoriasis, and sonic type of cancer (**Ward, 1995)**

Also **Borgstrom (1962)** referred to the differences in fat content between lean and fatty fish to range between 0 – 0.7 % for lean, (3 – 10 % semi – fat), and (12 – 20 %) fatty fish. The lipidconcentration in fish can contribute to the spoilage process infish. The fats in fish aremainly unsaturated fatty acids that are easily oxidized by oxygen from the atmosphere.High temperature or exposure to light can increase the oxidation rate. For fatty fishpreserved in ice, spoilage due to rancidity is mainly caused by oxidation. Thisproduces a bad and unpleasant odor as well as a rancid taste (**Hobbs andHodgkiss,1982).** Fat fishspecies like herring, mackerel, and salmon are mostly affected by rancidity. The leanfish fat content is about 0.1-0.9% and the fat fish fat content is higher than 0.9**%(Love,1982)f**ish and mammalian lipids differ mainly in that fish lipids include up to 40 percent of long-chain fatty acid (14-22 carbon atoms) which are highly unsaturated. (**Huss, 1995**)

2.3.3.Ash content

Most of the known inorganic elements or minerals can be detected in the human and fish body, but only fifteen of those known to be essential to man need to be derived from food **(Clucas and Ward, 1996).** According

to Ahmed , E.O.et al. (2011) the ash content of the fresh fish range between 1.1 - 1.7%

2.3.4 Moisture content

moisture content of fish body does not seem to be constant in view of the inter-relationship with many biological and physiological factors. (**Parker and Vanstone, 1966).Clusas and Ward (1996)** reported that flesh form healthy fish contains(70-80% water).

2.3.5 N-containing extractives

The N-containing extractives can be defined as the water-soluble, low molecular weight, nitrogen-containing compound of non-protein nature. This NPN-fraction (non-protein nitrogen) constitutes from 9 to18% of the total nitrogen intolerests. The major components in this fraction are :volatile bases such as ammonia and trimethylamine oxide (TMAO), creatine, free amino-acids, nucleotides and purine bases, and, in the case of cartilaginous fish, urea(**Shewan,1999**).

2.4 .Vitamins and Minerals

Fish and fishery products are highly nutritious, in addition to thehigh percentages of animal protein, they provide several other nutrientssuch as vitamins A and B especially in the liver, and E and K vitamins, and they are good sources of some minerals like calcium, phosphorus and iron (**Lunven, 1982**).The amount of vitamins and minerals is species- specific and can also vary seasonally .In general, fish meat is a good source of vitamin B and also the A and D vitamin, in the case of fatty species .some fresh fish such as carp have high thyminase activity so that thymine content in these species is usually low.

Fish is widely consumed in many parts of the world by humansbecause, it has high protein content, low saturated fat and also containsomega fatty acids known to support good health. Marine foods are very rich source of minerals components. The total content of minerals in theraw flesh of marine fish and invertebrates is in the range of (0.6–1.5%wet weight). Minerals as sodium, potassium, magnesium calcium, iron, phosphorus and iodine are important for human nutrition.(**Sikorski, *et al.*, 1990)**.

Mineral content in fish is roughly estimated by ash determination, where minerals are in the form of oxides, sulfates, phosphates, nitrates and chlorides. Minerals are deposited in fish flesh from the aquatic environment and nutritional sources (**Haard 1992 Miller, 1996DeMan,1999)**. Minerals can be classified depending on their essentiality to humans: Essential macro minerals (required amount > 100 mg/day): calcium; potassium; sodium; magnesium; chloride and phosphorus. Other major salts present in food are: sulfate and

bicarbonates (**Mayes, 1993; deMan, 1999**).The macro-elements calcium, magnesium, sodium potassium and phosphorus are essential to human health**(Przyby and Koligot 1997b).**The amount of vitamins and mineral is species- specific and can also vary seasonally .

Minerals play an important role in maintaining bodyfunctions because they set enzyme work, maintain acid-base balance, and help bond formation (hemoglobin formation) (**Almatsier, 2004**).Essential mineral elements in the bodyconsist of two categories: macro minerals and microminerals. The macro minerals are necessary for the formationof body organ components, while the micro minerals areneeded in very small amounts which are generally found intissues with very small concentrations (**Arifin, 2008**).Mineral elements are basic requirement of all living organisms. Some minerals are essential elements but these essential metals may be toxic at their high concentration in the body of animals **(Tyrrell *et al*., 2005)**

2.5. Physical characteristic

Among the various methods of processing fish, application of heat is one of the most important methods available for fish preservation, quality improvement and consumer convenience and/or to increase their market value. Cooking has the additional benefits of inactivating endogenous enzymes and stopping microbial growth. Although fish in India are commonly consumed as pan-fried, the consumer has minimum or no knowledge about the nutritive values of raw and cooked fish. In the canning industry, cooking is used mainly to reduce excess moisture, so that the total exudates released in thermal canned /retort products are minimum, thereby improving the sensory, physical and chemical qualities of the product and increasing the shelf life(**Aubourg, 2001).**

2.5.1.pH

The pH of the muscle tissue of live fish is close to neutrality. Due to the post-mortem anaerobic formation of lactic acid, PH decreases usually within the first day of death. During the later post-mortem change, ph is more less constant or slightly increased due to the formation of basic compounds**(Huss, 1988**) increase in the pH indicates the bacterial growth, loss of quality and possible spoilage. In general, the pH drops from around 6.8 to 6.1–6.5**(Robb, 2002**(..**Alminshawi,(2007)**stated that, the seasonal variation in p H of the meat is to some extent related to the energy reservoir of the fish e.g. liver and muscle glycogen however much of the glycogen is split hydrolytically into glucose after death, so there is no direct correlation between glycogen content and post-mortem PH. Post mortem ph may vary considerably (pH 5.4-7.2).

2.6.Organoleptic test

Sensory assessment has always played a key role in quality and freshness evaluation in the fish industry. The various sensory characteristics, such as outer appearance, odor and color are still very important in the quality systems in the fish processing industry. Sensory inspection of processed fish is used in the fish industry to find defects that have occurred during handling and processing(**Oehlenschlanger, (1998).**

Fish is a highly perishable commodity that undergoes spoilage as soon as it is harvested. Once spoilage set in, the odor/flavor, texture, color and sometimes the chemical composition changes (**Gupta and Gupta, 2006**).

2.6.1.Color

It is an important factor particularly for the buying consumer, and is dependent upon the quantity and oxidation states of muscle. There is no myoglobin in fish muscle and the color is white or grayish color(**Hood and Riordan ,1971)**

2.6.2. Flavor

The flavor development is an important result of the cooking process. The nature and intensity of meat flavor depends in part on the type, length of time, and temperature of cooking(**Price *et., al.,* 1978**).

2.6.3.Texture

Texture depends on the deformation resulting from the application of pressure and for surface properties such as toughness, smoothness or stickiness estimated by sense of touch, while consumer develops some idea of texture by handling the meat, it determines most of the coarseness of food **(Yeoman *et., al.,* 2009).**

2.6.4.Juiciness

Good quality meat is more juicy than that of poor quality, the difference being at least partly attributable to higher content of intramuscular fat in the former. On the other hand there are some suggestion that juiciness reaches aminimum when the pH level of the meat is about 6.0 (**Howard and Lawrie, 1956).**

2.7 Fish processed techniques

Processed meat products are defined as those products of which the properties of fresh meat have been modified using one or more procedure such as grinding or chopping addition of seasoning, alteration of color, or

heat treatment .these modifications contribute to preservation convenience, appearance and palatability (**Aberle and Elyon2001).**

Increasingly, seafood is being used as the dish of choice owing to its healthy image and delicious taste. In particular, the fish industry has been developing processed or minced fish products such as fish burgers, fingers and sausages, which add cooking convenience to nutritional benefits (**Mohammed, Humaid, Nujib and Stefan ,et.al., 2007)** Fish flesh can be used as raw material for sausage production because muscle protein can form gel and act as an emulsifying agent (**YadaandJackman 1994)**fish products include fried sausage, sliced sausage , smoked sliced sausages , frankfurter sausages, fish crisps, fish chips, and savory fish fingers **(Sheviclo, 1997).**

CHAPTER THREE
MATERIALS AND METHODS

3.1**Study Site**

This study was carried out during the period 10th - 31th of October2016 using the meat Science laboratory facilities of the College of Animal Production Sciences and Technology, Department of Meat Science and Technology. Two fish species (*Malapterus electrics*and *Tetrodonfahaka)*wereselected from River Nile, White Nile and Blue Nilefor the study.

3.2. Patties formulation

3.2.1.Fishpreparation

Fresh fish meat 3Kg of species *Malapteruselectricus(A)* and 3Kg of *Tetrodonfahaka(B),* were collected from three different water environment (River Nile and White Nile, Blue Nile), three replications for each species were done during October Month.

River Nile samples were collected from River Nile(Shampat), White Nile collected from Jubal Awliaa Dam andBlue Nile sample were collected from East Blue Nile (ElGeriaf Market), showedin Plate(1)and (2).during transportation, fresh fish werepreserved in an insulated box by using crushed ice at 5c^0. Fish was filleted thoroughly with proper methods and after that washed and chilled prior to processing which are done under good hygienic condition .

3.2.2.Patties preparation

Two Species of fish(A and B) were taken from the three different environments (River Nile White Nile and Blue Nile) .One Kgof fish flesh from each species used in patties preparation .The fish was ground through0.25 inchplate of electrical meat grinder.Plate(3). Each batch was chopped separately. The chopped was started after the minced meat of fish and then potatoes was chopped, and half of the recommended ice water were added and uniformly dispersed, then the binder (skimmed milk) and seasoning(Cinnamon, Mace, Cardamom, Coriander and Black paper) were added together ,with the remainder of the recommended ice water. Then the patties were manually formulated in cylindrical shape about 4 inch in length. After that the product immediately stored in refrigerator (4 c^0) waiting different test. ShowedPlate(4).

Three patties link were taken randomly from each treatment sample and then approximately analyzed in the Central Veterinary Research Laboratory (Soba), on the 4th of November 2016.

Ingredients	Quantities / g	Percent%
Fish meat	1000	66.05
Bread crumbs	100	06.61
Ice-water	150	09.91
Garlic paste	5	.33
Coriander	3	.20
Cinnamon	3	.20
Salt	18	1.19
Potato	200	13.21
Mace	2	.13
Skimed milk	30	1.98
Cardamom	2	.13
Black paper	1	.00006

3.3. Chemicaldetermination

3.3.1. Moisturedetermination

The samples were weighted at first (initial weight), then dried in electric oven at 105 c^0 between 24 – 30 hours to obtain a constant weight. The moisture content was calculated as follow :

$$\text{Moisture \%} = \frac{\text{Initial weight – dry weight}}{\text{initial weight}} \times 100$$

3.3.2. Crudeproteindetermination

The Kjeldahl method for estimation of nitrogen was applied . Nitrogen content was converted to protein by multiplying 6.25 as follow

$$\text{Protein \%} = \frac{(V_a - V_b) \times N \times 14 \times 100 \times 6.25}{1000 \times wt}$$

Where :

V_a= volume of HCL used in titration

V_b = volume of NaoH of known normality used in back titration.

0.014 = conversion factor of ammonium sulfate to nitrogen .

6.25 = conversion factor of nitrogen to protein

Wt = weight of tissue sample .

3.3.3. Fatdetermination

Fat content (ether extract) of each sample was determined according to Soxhlet method, using 2g of fish sample. The extraction continued for 5 hours at 100 c^0.Plate(5).

$$\text{Fat \%} = \frac{\text{Extraction fat weight}}{\text{initial weight}} \times 100$$

3.3.4. Ashdetermination

Ash was determined by heating 1g at 55 c^o in a muffle furnace until a constant weight was obtained. Ash content percent was calculated by the following formula :

$$\text{Ash \%} = \frac{\text{Ash weight}}{\text{sample weight}} \times 100$$

showed in Plate(6).

3.3.5. TheNitrogen –freeextraction(NFE)

NEF % = 100 – (Dry matter

or (moisture% + protein% + fat% + ash%)

3.4. Physical determination

3.4.1 pH

The pH was determined by blending 5g of fish patties sample with 40ml of distilled water at high speed stirrer for one minute. The pH was determined by using ph meter (microprocessor pH meter-HANNA model pH210)that had been calibrated with standard buffers (ph7.0), showed in Plate(7).

3.4.2 Cooking Loss

Cooking loss was calculated by the difference in known sample before and after cooking as percentage .

$$\text{Cooking loss} = \frac{\textit{Wt of sample before cooking} - \textit{wt of sample after cooking}}{\textit{wt of sample before cooking}} \times 100$$

3.5.Mineral determination

3.5.1. Determination of sodium and potassium in the sample using spectrophotometer

The samples were ashedand dissolved in hydrochloric acid (2.5 n).sulfate was precipitated by adding barium sulfate. Then the solution was filtered and run in flame photometer and compared with standard that were compensated for the average amount of sodium and potassium in the solution of ash (**Chapman and Pratt, 1961)**

3.5.2 Total calcium

Two grams of the sample wereashed in a silica dish at temperature of 550c^o until the ash is nearly white. The ash from the heating was covered with a watch glass, 20 ml of cold distilled water carefully were added the dish cooled, followed by the addition of 2 to 3 ml of 6N hydrochloric acid. When the reaction ceases , the spray on the watch glass was washed in to the silica dish, the content of the dish were filtered in to 200ml volumetric

flask, and the filtrate residue washed and the second filtrate was added to the first filtrate in the volumetric flask. After that the contents of the flask were cooled, and diluted to volume 100ml, the total calcium was measured by titration diluted volume with EthileainDiamine Tetra acid (EDTA) (**Chapman and Pratt, 1 961**)

3.5.3 Total magnesium

One gram of sample was dried in muffle furnace at 550c^{o} in silica dish. After that was cooled and 20 ml of distilled water and 3 ml of 6n hydrochloric acid were added. Then the components were filtered in to 200 ml volumetric flask.after the content of the flask were cooled and diluted to 100 ml, the total magnesium was measured by titration diluted volume with EthileainDiamine Tetra acid (EDTA) (**Chapman and Pratt, 1961)** showed in Plate(8).

3.6. Vitamin determination

3.6.1 Vitamin AandVitamin E

HPLC-grade.NaOH solution was prepared by dissolving 500g of NaOH in 1L of double-distilled water. The 10 g/L ascorbic acid solution was prepared as follows: Dissolving 1.0 g of ascorbic acid in 4 ml of hot distilled water, then diluted to 100 ml with ethanol (made up just before using). The phenolphthalein indicator was prepared by dissolving 10 g of phenolphthalein in ethanol then diluted to1L. Mineral ether was sulfonated by concentrated sulphuric acid as follows: 100 ml mineral ether was added to aseparating funnel with volume of 150 ml, and washed twice with 10 ml of concentrated sulphuric acid, then washed with saturated solutions composed of 10% sulphuricacid and KMnO4 until the purple color in water layer keep constantly, then washed twice with distilled water. The washed mineral ether was dried with anhydrous calcium chloride for 1h and then distilled. The ultrapure water and nitrogen gas (99.9%) was used. The other reagents used were analytical reagent.

3.6.2 Vitamin C

Five grams were taken from the sample centrifuged at 300 rpm for 20 min, take 0.3ml of mid zone.After that Add 1.2 m of 5%TACand vortex 15 centrifuge 10 min, take 0.9 ml of super natty.Add 0.4 ml ofDTC(3gm of 2.5 dinitrophenyl hdrozire,0.4 gmthiourea and 0.05 gm. copper sulphate dissolved in 100 ml of 9N sulphuric Acid.) and centrifuged and incubated at 60c^{0} for 60 min in water bath .Immediately cooled in Ice-cold water.**A**dded 1.6 ml of 65% H_2SO_4 gradually. stored in room-temp for 30 min. then read at 520 nm**..**

3.7. Sensory evaluation

Sensory evaluation of fish patties from group A and group B was assessed by 10 semi trained panelists. Fish Patties were cooked in oven under 100c^{o} for 20 minutes. Panelists scored for color, flavor, texture and juices and general acceptability parameters using an 8 point hedonic scale according to(**Cross and Stafield (1978**).

Statistical analysis 3.8

The data of this study were analyzed statistically using computer statistical package for Social Science (SPSS version 21). General Linear Model - Two - way analysis of variance (ANOVA) and regression line as described .by **Zar, J. H. (1984)**

CHAPTER FOUR
RESULTS

The study included processing of sample of patties from two species *Maleptruru selectricu*s (A)and *tetrodon fahaka*(B)in different Water environment RiverNile,White Nile and Blue Nileand the chemical, physical, macro mineral, some of the Vitamins and sensory evaluation of above samples were conducted.

4.1. Chemical composition

Protein, ash, moisture content and ether extract (E.E) percentage showed significant differences($p< 0.05$) among treatments of the samples within the twogroups A and group Bin table (2).

Table 2: Means and their standard deviation values forchemical composition of fish patties in (River Nile, White and Blue Nile)

Water supply	Species	%Moisture	%protein	%Ash	%Dm	%E.E	%N.F.E
River Nile	Group(A)	77.33±4.04^{a}	232.31.30±^{b}	251^{a}.1.76±	21.66±2.52^{b}	230^{b}.6.13±	38.77±3.270^{a}
	Group(B)	79.66±1.52^{b}	30.5±4.175^{a}	665^{b}.2.56±	20.33±1.53^{a}	208^{a}.5.84±	40.73±1.935^{b}
	Mean	78.500±3.02^{b}	468^{a}.30.39±	2.100±2.0^{b}	21.00±2.00^{a}	256^{a}.5.985±	37.75±2.635^{a}
White Nile	Group(A)	78.00±1.00^{b}	402.30.74±^{b}	500^{a}.2.50±	22.00±1.00^{a}	208^{a}.6.37±	38.59±1.330^{b}
	Group(B)	76.33±2.52^{a}	175^{a}.29.37±	435^{a}.2.50±	23.67±2.52^{b}	305^{a}.6.34±	37.66±2.315^{a}
	Mean	77.167±1.94^{a}	474^{a}.30.19±	419.2.500±^{b}	22.33±1.94^{b}	234.6.350±^{b}	38.13±1.175^{b}
Blue Nile	Group(A)	84.00±3.61^{a}	410^{a}.30.65±	208^{a}.1.83±	26.00±3.61^{b}	152^{b}.6.26±	661^{a}.35.30±
	Group(B)	80.0±0.10^{b}	132.31.13±^{b}	022^{b}.2.00±	20.00±1.00^{a}	115^{a}.5.93±	40.33±11.19^{b}
	Mean	404^{a}.77.00±	468^{a}.30.86±	204^{a}.1.916±	23.00±4.05^{c}	204.6.100±^{b}	37.90±3.724^{a}

.a,b,c mean superscript within the same column are significance different at level ($p<0.05$)

Figure 1:Protein contents of fishes from River Nile, White Nile and Blue Nile.

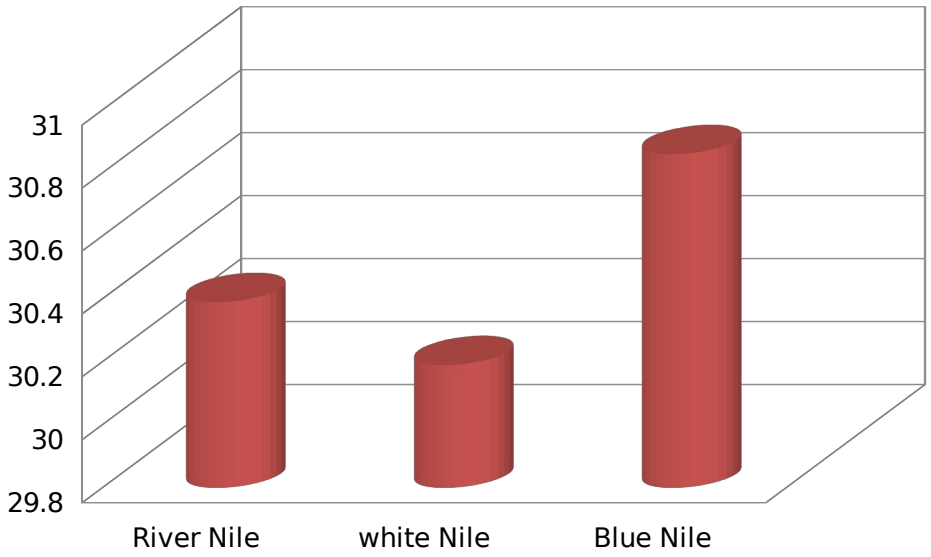
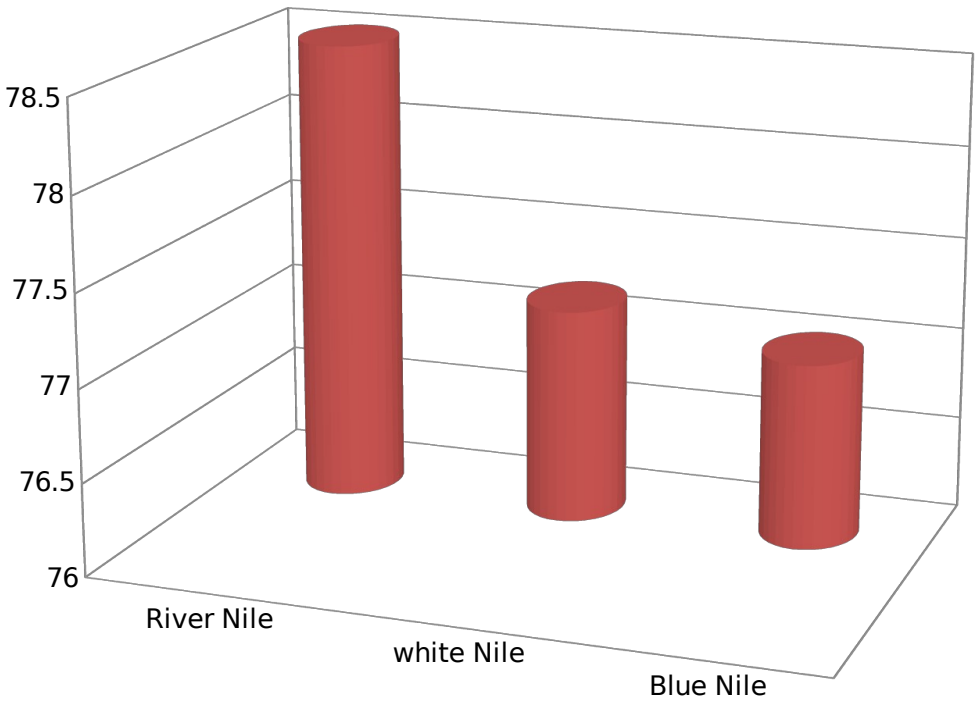
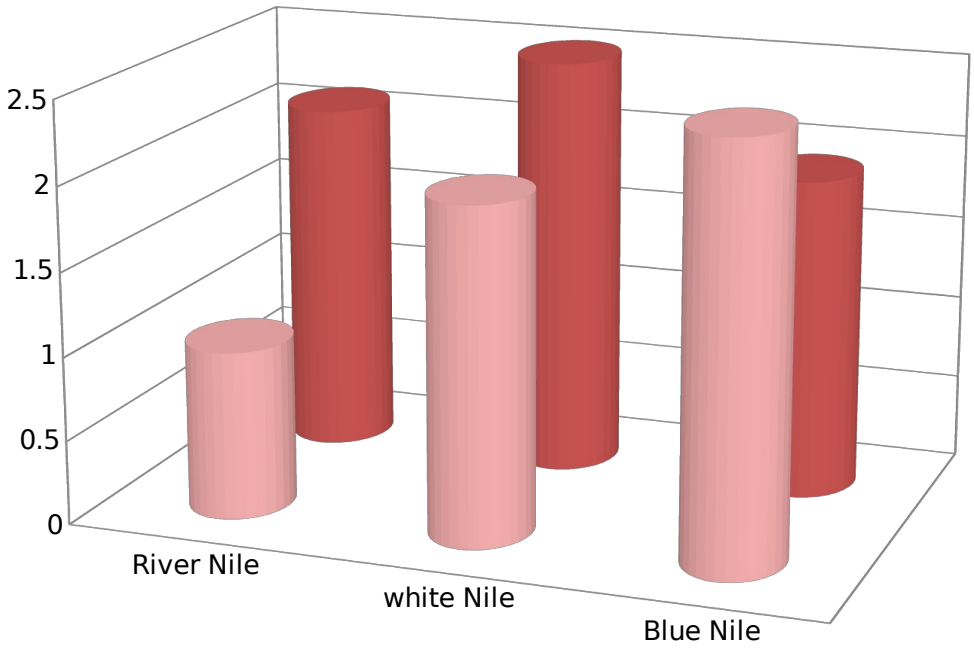


Figure 2: Moisture contents of fishes from River Nile, White Nile and Blue Nile.



Moisture content in group (B) with Blue Nile high compare between River Nile and White Nile.

Figure 3: Ash contents of fishes from River Nile, White Nile and Blue Nile.



4.2. physical analysis

The results of pH recorded no significant difference among the treatments($p>0.05$)of the samples within the three environments Table (3) table (3) for Cooking lossthere were significant differenceamong the treatment ($p<0.05$) table (2)

Table (3): Means and their standard deviation for pH and cooking loss of fish patties from (RiverNile White, and Blue Nile)

Environment	Species	PH	Cooking loss
Rive Nile	*Group(A)*	$057^{a}.6.03\pm$	36.00 ± 2.48^{b}
	Group(B)	$017^{a}.6.06\pm$	32.00 ± 2.48^{a}
	Mean	$055^{a}.6.05\pm$	34.66 ± 2.70^{b}

White Nile	Group(A)	0577[a].6.13±	28.00±2.48[a]
	Group (B)	057[a].6.16±	35.00±2.48[a]
	Mean	035[a].6.150±	31.83±6.40[a]
Blue Nile	*Group(A)*	011[a].6.11±	33.00±2.48[a]
	Group(B)	054[a].6.230±	38.00±2.48[b]
	Mean	022[a].6.10±	±5.78[c] 35.00

a,b,c mean superscript within the same column are significance different at level ($p < 0.05$)

Figure 4: pH contents of fishes from River Nile, White Nile and Blue Nile.

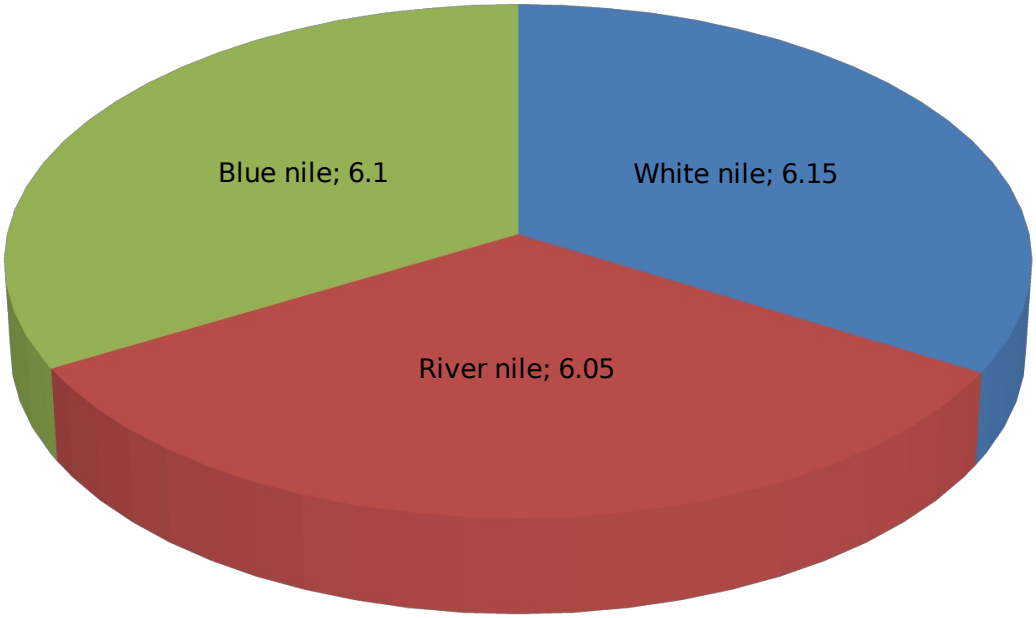
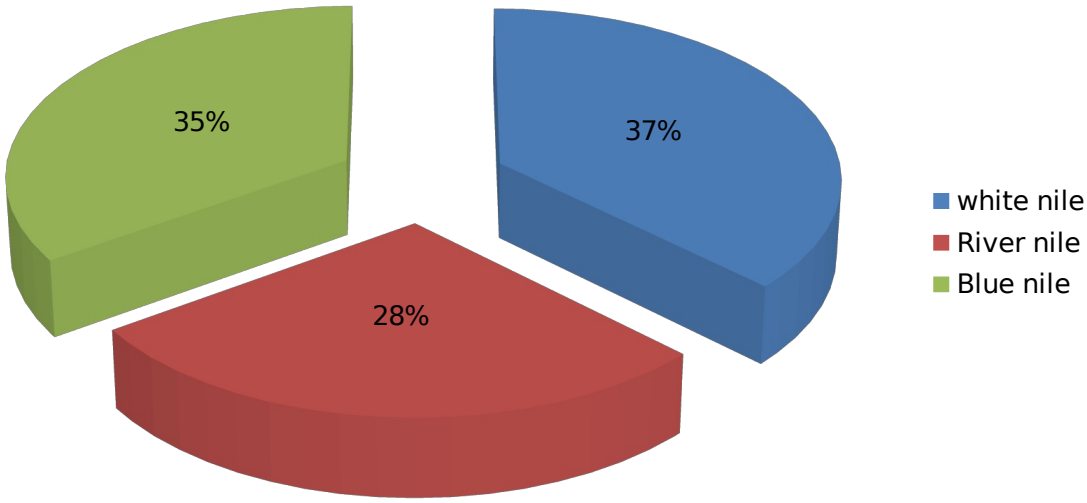


Figure 5: Cooking loss contents of fishes from White Nile. River Nile and Blue Nile.



4.3.Mineral elements of the fish patties in (River Nile, White and Blue Nile)

The concentration (mg/l) ±St.D as percentages of mineral content(Calcium and sodium) in the two species with the variable environment showedno significant difference ($p>0.05$) for phosphorous, magnesium and potassium in group (A),But there were significant differences($p<0.05$) among the treatment of the samples(B), using general linear model (two-way ANOVA) showed table (4) .

Table 4: Means and their standard deviation values for Mineral elements of the fish patties in(River Nile, White and Blue Nile)

Environment	Species	Phosphorous (P)	Magnesium (Mg)	Potassium (Ca)	Calcium (k)	Sodium (Na)
	Group(A)	05[illegible]3.32±	148[a].2.94±	066[a].4.92±	097[a].4.56±	014[a].4.12±
	Group(B)	066[a].3.19±	073[b].3.07±	540[b].5.34±	512[a].4.49±	056[a].4.22±
	Mean	09[illegible]3.252±	131[a].3.00±	414[a].5.13±	332[a].4.527±	062[a].4.168±
	Group(A)	10[illegible].4.38±	016[a].3.23±	165[a].5.77±	049[a].4.93±	171[a]4.22±.
	Group (B)	063[a].4.19±	018[a].3.29±	150[a].5.89±	099[a].4.93±	023[a].4.30±
	Mean	132[b].4.289±	037[a].3.263±	071[a].5.83±	71[a].4.931±	054[a].4.26±
	Group(A)	77[illegible].3.79±	298[a].3.08±	620[a].5.66±	368[a].4.87±	087[a].4.25±
	Group(B)	049[a].4.31±	138[a].3.38±	070[b].6.47±	046[a].4.85±	019[a].4.34±
	Mean	85[illegible].4.00±	34[a].3.243±	203[b].6.38±	376[a].4.972±	045[a].4.312±

a,b means with different superscripts within the same column are significantly different at level ($p < 0.05$)

Figure 6: Phosphorus contents of fishes from River Nile, White and Blue Nile.

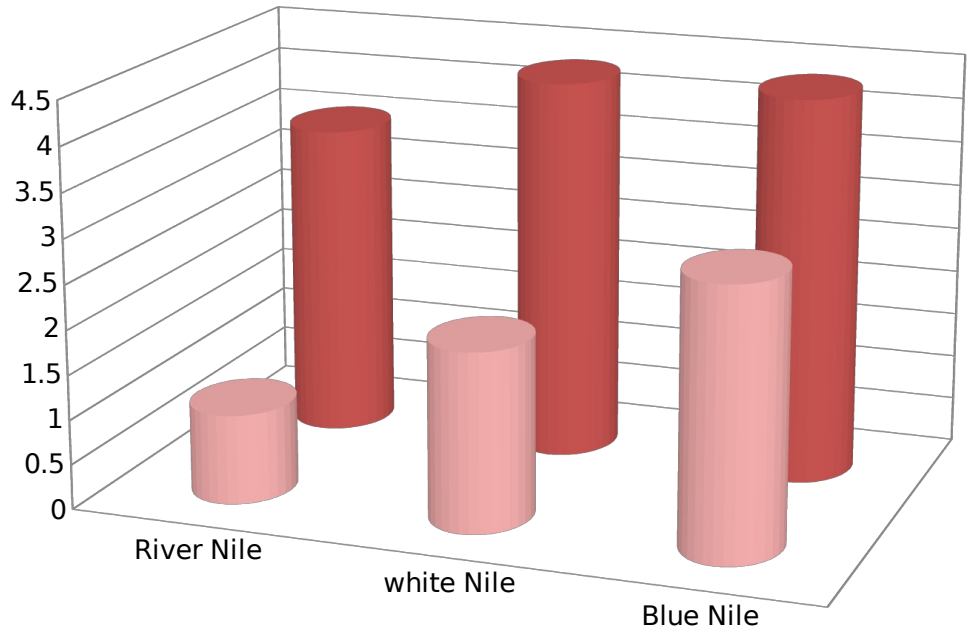


Figure 7: Magnesium contents of fishes from River Nile, White Nile and Blue Nile.

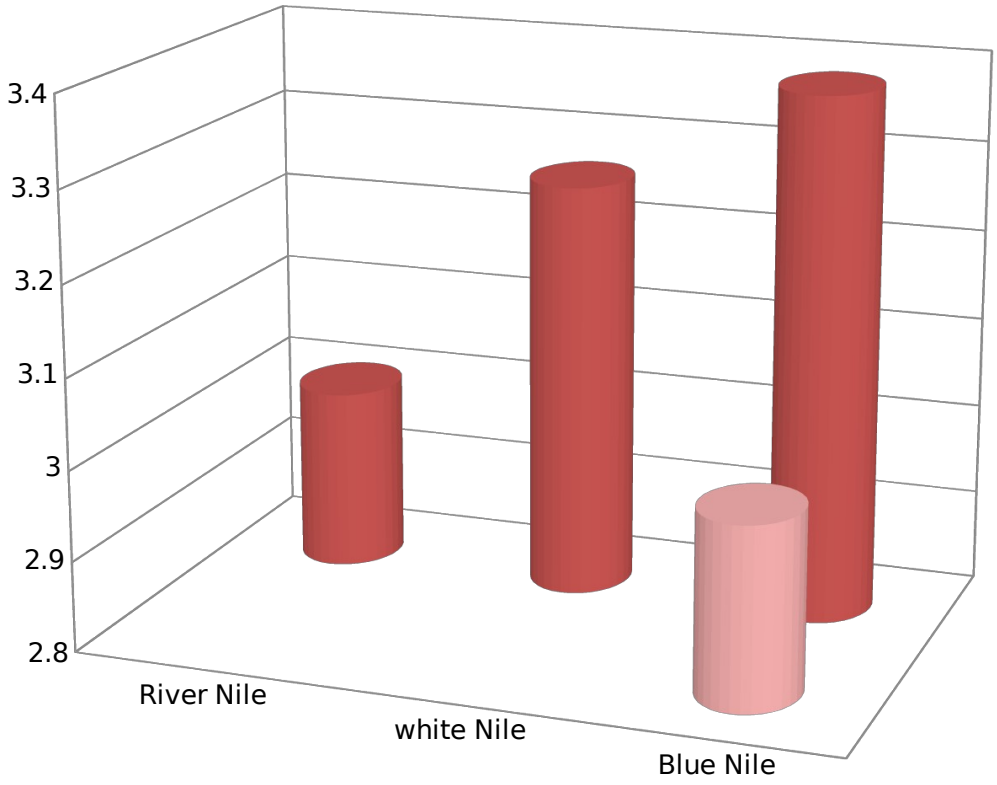


Figure 8: Potassium contents of fishes from River Nile, White Nile and Blue Nile.

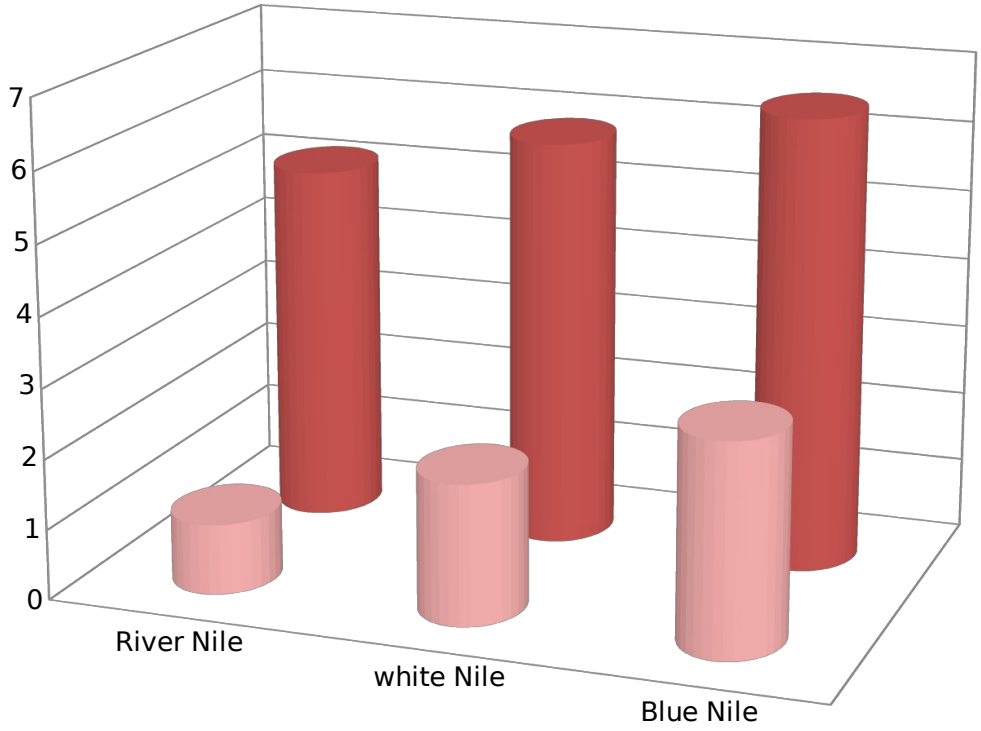


Figure 9: Calcium contents of fishes from River Nile White Nile and Blue Nile.

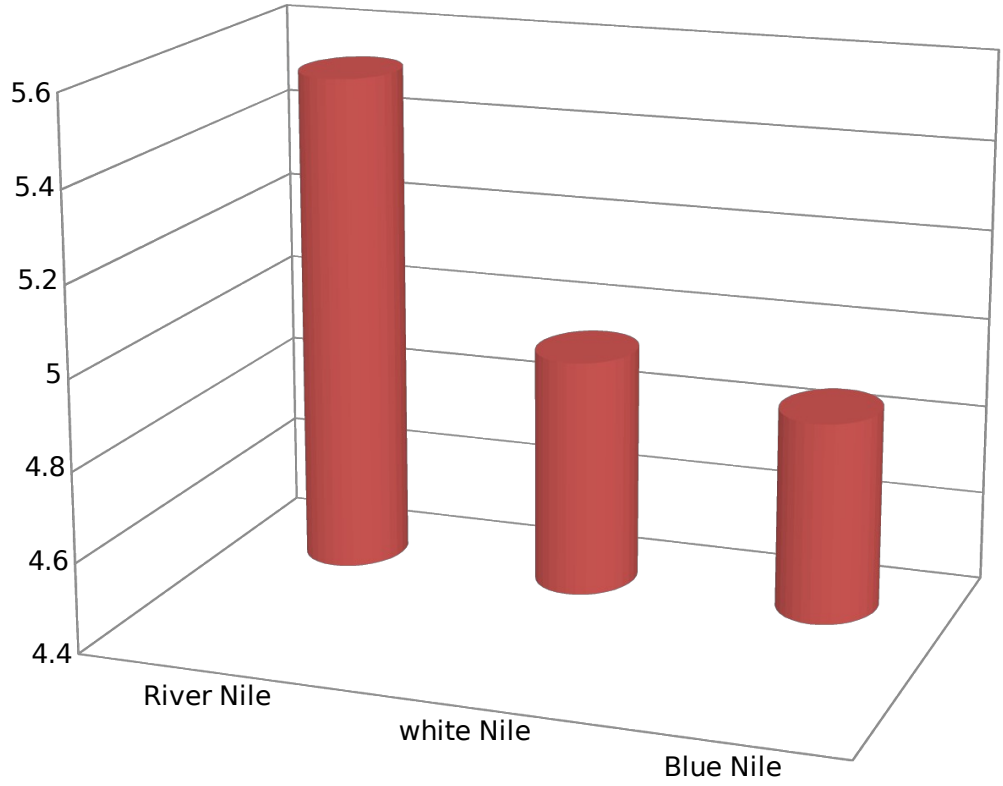
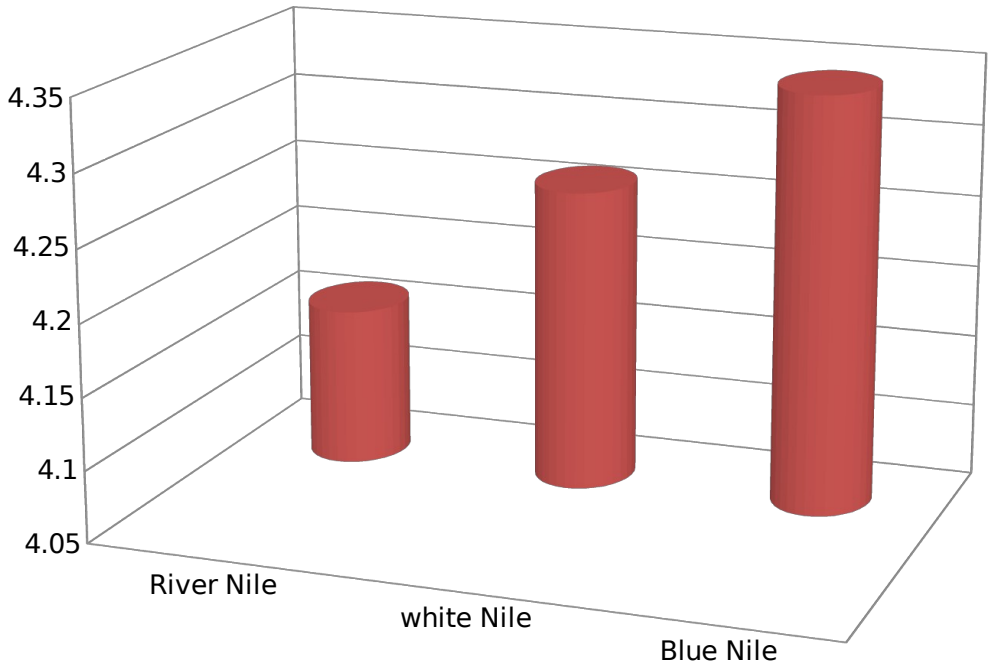


Figure 10: Sodium contents of fishes from in River Nile, White Nile and Blue Nile.



4.4. Vitamin in fish patties from (River Nile, White and Blue Nile.

Vitamin E in fish patties from group (A) and (B) there wasa significant difference($p < 0.05$)among the treatments of the samples within the two groups A and B.

For vitamin A there was no significant difference in group(A) and group(B) in different Water environments ($p > 0.05$) in River Nile, but in Blue Nile and White Nilethere was significant difference ($p < 0.05$)among the treatment of the samples within the two groups A and B .

For Vitamin C there was no significant difference in two groups (A)and (B) in the different water environments ($p > 0.05$) Table (5)

Table5: Means and their standard deviation values of Vitamins in group (A)and group (B) in (River Nile,White and BlueNile)

Vitamin C (mg\dl)	Vitamin A(mcg\L)	Vitamin E (mg\dl)	Species	Environment
3.05±.007[a]	11.500±.707[a]	38.200±.848[a]	Group(A)	River Nile
3.22±.049[a]	11.55±.494[a]	39.00±.565[b]	Group(B)	
3.14±.743[a]	11.600±.102[a]	38.200±.494[a]	mean	
3.200±.071[a]	12.500±.353[b]	39.80±.284[b]	Group(A)	White Nile
3.47±.169[a]	10.500±.707[a]	37.65±.636[a]	Group(B)	
3.33±.1885[a]	11.37±1.100[a]	38.72±.304[a]	Mean	
3.59±.219[a]	12.35±.949[a]	40.15±.494[b]	Group(A)	Blue Nile
3.54±.636[a]	12.60±.284[a]	36.35±.919[a]	Group(B)	
3.57±.134[a]	12.35±.353[b]	40.15±1.998[b]	mean	

a,b means with different superscript within the same column are significantly different at level (p˂0.05)

Vitamin Efound high inBlue Nile while there is no significant difference (p˂0.05) in Nile river White Nile shown figure (11)

Figure 11: Vitamin E of fish from River Nile, White Nile and Blue Nile.

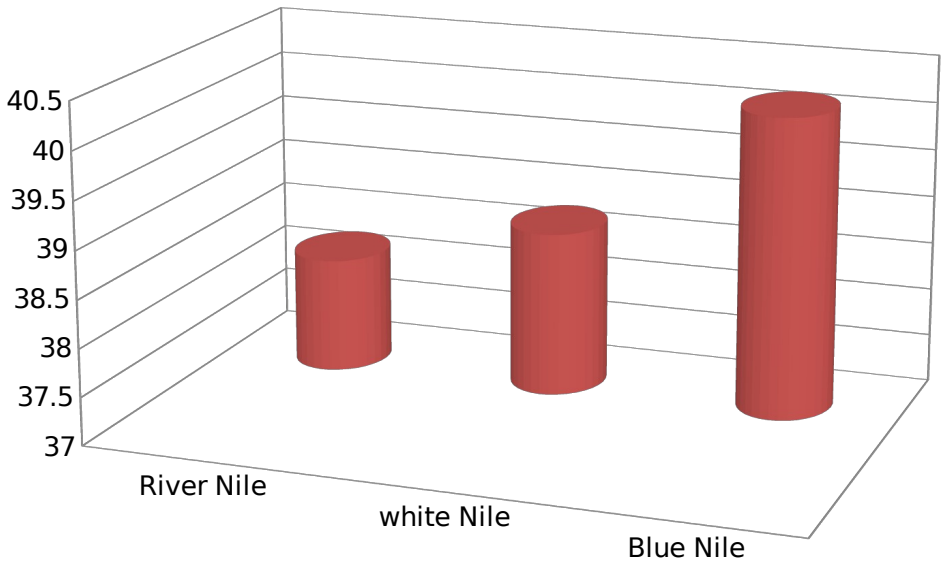


Figure 12: Vitamin A contents of fishes from River Nile, White Nile and Blue Nile.

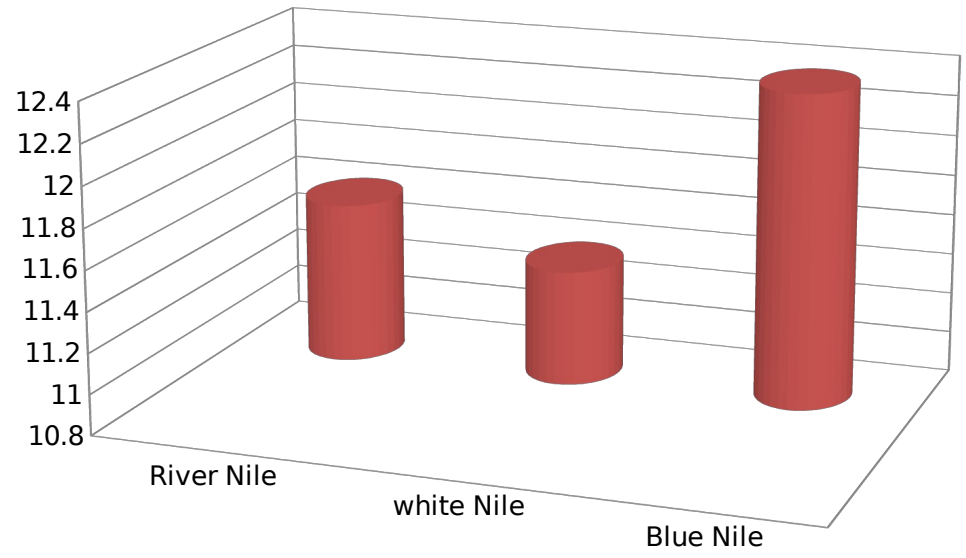


Figure 13: Vitamin C contents of fishes from in River Nile, White Nile and Blue Nile.

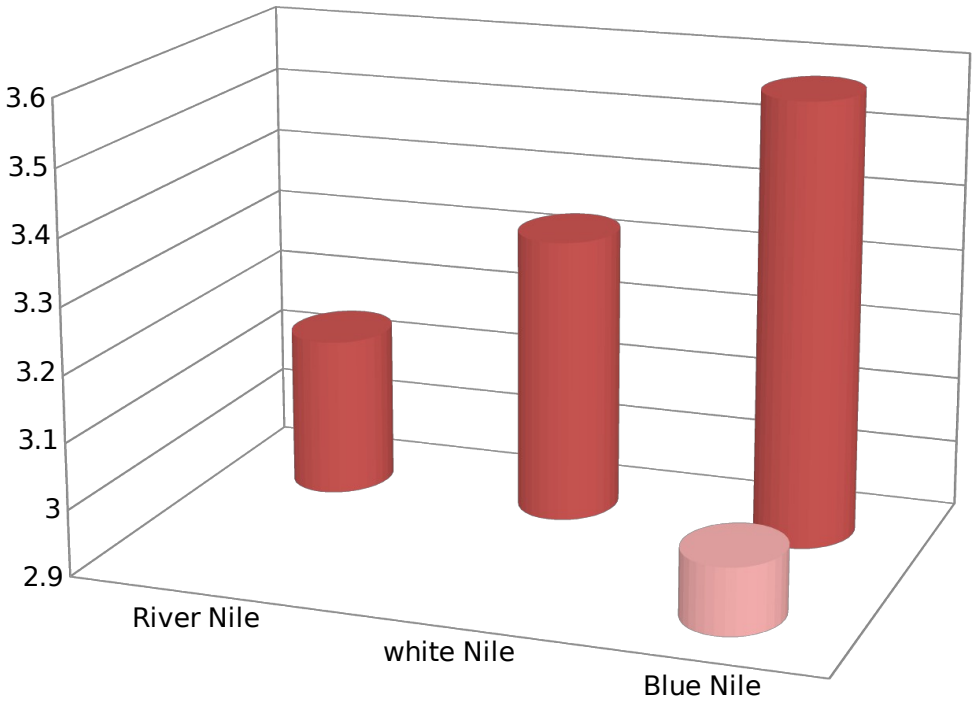


Table6: Means and their standard deviation values forsensory evaluation of the fish patties

Juiciness	Texture	Flavor	Color	Species	Environment
4.96±.195	5.16±.192	5.10±.192	4.87±.188	Group(a)	**River Nile**
4.90±.192	4.73±.192	4.76±.192	4.70±.192	Group(b)	
5.11±.135	4.72±.166	4.90±.192	4.83±.192	Group(a)	**White Nile**
4.66±.192	4.63±.192	4.89±.195	4.67±.188	Group(b)	
5.02±.192	5.00±.2.35	5.10±.192	4.93±.192	Group(a)	**Blue Nile**
4.76±.192	4.70±.192	5.10±.192	4.80±.192	Group(b)	

4.5. Sensory evaluation of the effect of various water environmentson sample (A)and sample(B)as assessed by panelists

Table (6)Color, flavor,Texture and Juiciness values for sample (A)and (B) in various water environments were significantly different($p < 0.05$) using (two-way ANOVA) .

CHAPTER FIVE
DISCUSSIONS

The main objectivesof this study is to manufacture patties at low cost of specially noncommercial species.

The result of chemical composition analyzed protein, moisture, dry matter and ash. There was significant difference($p<0.05$)between group (A) and group (B) as shown in table (1) . Protein was not incorporated with the study conducted by(**Abdelmajid, 2008**)who study the chemical composition of kofftaand his finding of protein was (19-22%),and also this study was differ from study which conducted by (**Rafiaa,2008**) who studied the chemical composition of sausage from*T.fahaka*and found the protein range was (18-28%). Thisdisagreement maybe dueto the difference in formulation.

Moisture content in groups (A) and (B) recorded(74-78)%,(76-80)% respectively This result agrees with the study which conducted by (**Alaa, 2013**) who studied the chemical composition of sausage *T.fahaka* and found moisture content (77.60%) and also disagree with the study conducted by**(Abdelmajid, 2008**)who found the moisture content in koffta range (71-73%).

As for ash content there were significant different ($p<0.05$) (2.50)% between the two groups which agree with (**Ahmed ,2011**). Who found ash percentage in sausage (2.5-3.2)%.

For the result of pH there were no significant difference ($p>0.05$) between the two species and among the differentWater environment(Blue, River and White)Nile . This result agrees with the study conducted by (**Sourkaty 2012**).who found the pH in minced and burger at the same range.

As for cooking loss there was high significant different($p<0.05$) between the two groups (A) and (B) in different water environment which may be due to the deferent environment which affect in moisture content. In addition to the chemical and physical studysome macro mineralslike phosphorus, sodium, potassium, magnesium and calcium were analyzed. Sodium and calciumthere was no significant difference ($p>0.05$) in different waterenvironments,but there was significant difference ($p<0.05$) in potassium,magnesium and phosphorus among the treatments of the samples within the two groups A and B table (4).

From the results of mineral we could conclude that fish patties from two samples could be better source of minerals.

Vitamin E in fish patties madefrom sample (A)record 38.20, 39.80 and 40.15 in River Nile, White Nile and Blue Nile respectively. there were significant difference ($p<0.05$).

In comparison of group (A) with (B) the study recorded high percentage of vitamins in Blue Nile which was differed from sample (B)which has lower percentage in Blue Nile. And this could be attributedto the species because they are all from one area.

Vitamin Apercentage was 11.50, 12.25 and 12.35in group (A)form River Nile, White Nile and Blue Nile, respectively. There were significant difference ($p < 0.05$).Also11.56, 10.50 and 12.60 form River Nile, White Nile and Blue Nile respectively was significantly difference ($p < 0.05$) fromgroup (B).

Percentage of Vitamin C was 3.05, 3.200 and 33.59 in group (A)and 3 .22, 3.47 and 3.54 in group (B) that for River Nile, White Nile and Blue Nile respectively, and therewas no significant difference between the two groups ($p>0.05$). And finally we could say Vitamin C was lower than vitamin E.

Sensorystudy was conducted to determine the level of acceptability of all fish patties groups with specific consideration to color, flavor, texture and juiciness. Range 4-5 there were significant differencein two species from different environment ($p < 0.05$) this result was agree with **(Sourkaty,2012).** On the other hand group A in all environments was better in sensory evaluation than group B.

CHAPTER SIX
CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSIONS

Selection of twofish species *Maleptruruselectricus*and *Tetrodonfahaka*, theywas considered as low fish grade (grade three) and unfavoured by consumers. It could be compete with high grade after processing of flesh fish as patties.

The Blue Nile fish patties revealed high percentage of vitamin E than the other two environments i.e. 40.15±1.998

6.2. RECOMMENDATIONS

1. More study is needed about other unpreferablespecies of fish, must be processed as sausages, burger, etc. …
2. Encourage consumer behavior towards fish processing i.e. patties, sausages, etc….
3. Addition of spice and skimmed milk (casine), plant protein, etc... could be lead to increase of patties protein in products of *Maleptruruselectricus* and *Tetrodonfahaka*, and were highly acceptable by panelist.
4. Low cost formulation of patties, was observed that , the additives lead to extend shelf life time.

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APPENDIX(1)

GRADING CHART FOR PATTIES

Evaluate this sample for color, flavor, texture and juiciness.

For each sample, use the appropriate scale to show your attitude by checking at the point that best describes your feeling about the sample. If you have any question please ask. Thanks for your cooperation.

Name…….

date……...

Juiciness	Texture	Flavor	Color	Sample code
				( )
				( )
				( )

By:

Juiciness	**Texture**	**Flavor**	**color**
6.extremely desirable. 5.very desirable. 4.Moderately desirable 3.slightly desirable 2.slightly un desirable 1.moderately undesirable	6.extremely desirable. 5.very desirable. 4.Moderately desirable 3.slightly desirable 2.slightly un desirable 1.moderately undesirable	6.extremely desirable. 5.very desirable. 4.Moderately desirable 3.slightly desirable 2.slightly un desirable 1.moderately undesirable	6.extremely desirable. 5.very desirable. 4.Moderately desirable 3.slightly desirable 2.slightly un desirable 1.moderately undesirable

APPENDIX(2)

Chemical value for (A) and (B) in the different water environments

Environment	Species	moisture	protein	ash	Dm	E.E	N.F.E
White Nile	Group (A)	77	30.63	2.0	23	6.6	37.77
		78	30.89	3.0	22	6.2	37.91
		79	30.10	2.5	21	6.3	40.01
River Nile		81	31.06	1.5	19	6.4	42.04
		78	31.41	1.8	22	6.0	38.79
		73	31.5	2.0	27	6.0	35.05
Blue Nile		70	30.28	2.0	30	6.0	31.42
		77	30.45	1.9	23	6.3	38.55
		75	31.6	1.6	25	6.1	35.94
White Nile	Group(B)	74	29.4	2.2	26	6.4	35.36
		76	29.66	2.3	24	6.6	37.64
		79	30.01	3.0	21	6.4	39.99
River Nile		80	30.36	3.0	20	6.0	40.74
		78	30.71	2.9	22	5.9	38.97
		81	30.54	1.8	19	5.6	42.66
Blue Nile		80	30.98	2.0	20	6.0	41.02
		81	30.15	2.2	19	6.0	41.85
		79	30.25	1.8	21	5.8	39.96

Where A=*Malapteruselectricus*,B=*Tetrodonfahaka.*

APPENDIX(3)

Physical analysis values for (A)and(B) in the different water environments

Environment	**Species**	**PH**	**Cooking lose**
White Nile	Group(A)	6.1	40
		6.2	44
		6.1	30
River Nile		6.6	30
		6.1	42
		6.0	33
Blue Nile		6.0	31
		6.2	32
		6.1	35
White Nile	Group(B)	6.2	37
		6.2	30
		6.1	32
River Nile		6.1	22
		6.0	32
		6.1	32
Blue Nile		6.2	36
		6.3	36
		6.2	35

Where A=*Malapteruselectricus*,B=*Tetrodonfahaka.*

APPENDIX(4)

Vitamin values for (A)and(B) in the different water environments

Environment	Species	Vitamin E	Vitamin A	Vitamin C
White Nile	*Group (A)*	40.0	12.5	3.15
		39.6	12.0	3.25
River Nile		38.8	11.9	3.06
		37.6	11.2	3.05
Blue Nile		40.5	12.0	3.75
		39.8	12.7	3.44
White Nile	*Group(B)*	37.2	11.0	3.59
		38.1	10.9	3.35
River Nile		39.4	11.3	3.19
		38.6	12.0	3.26
Blue Nile		36.2	12.8	3.59
		37.5	12.4	3.50

Where A=*Malapteruselectricus*,B=*Tetrodonfahaka.*

APPENDIX(5)

Mineral contentsvalues for (A)and(B) in the different water environments

Environment	Species	Na	K	Ca	Mg	P
White Nile	Group(A)	4.220	4.927	5.61	3.214	4.493
		4.196	4.884	5.77	3.237	4.282
		4.229	4.982	5.94	3.245	4.389
River Nile		4.100	4.554	4.90	2.912	3.277
		4.109	4.465	4.86	3.091	3.382
		4.128	4.659	4.99	2.798	3.294
Blue Nile		4.310	4.629	6.48	3.436	4.390
		4.226	5.704	5.98	2.504	4.410
		4.327	4.961	6.40	3.353	4.268
White Nile	Group(B)	4.333	4.15	5.74	3.309	4.119
		4.298	4.93	5.98	3.297	4.225
		4.389	4.991	6.04	3.272	4.232
River Nile		4.305	4.758	5.05	3.213	3.115
		4.228	4.822	5.96	3.116	3.217
		4.238	3.904	5.00	2.994	3.222
Blue Nile		4.344	4.7933	6.52	3.793	4.336
		4.352	4.865	6.15	3.404	4.254
		4.315	4.979	6.39	3.381	4.342

Where A=*Malapteruselectricus*,B=*Tetrodonfahaka.*

List of Plates

,Plate NO(1) *Malapteruselectricus*

Plate NO(2) *Tetrodonfahaka.*

Plate No(3)Grindingmachine

Plates No(4).Patties dishes

Plates No(5) Soxhlet Apparatus

Plates No(6)Muffle furnace oven

Plates No(7) pH Meter

Plates No(8) Spectrometer