"POLY-FUNCTIONAL EGG: HOW CAN IT BE REPLACED?"

BY

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INTRODUCTION

PROTOCOL:

The Vice Chancellor, Professor Chinedu Ositadinma Nebo;
Deputy Vice Chancellors,
Former Inaugural Lecturers present,
Fellow Academics,
Distinguished Ladies and Gentle Men,
Lions and Lionesses

THE INAUGURAL:

Professor P. Emeka Nwabueze, Professor of Theatre Arts, in delivering "is Inaugural Lecture at the University of Nigeria, Nsukka on Thursday, 30th June, 2005, exactly 3 years ago, said:

> *The Inaugural Lecture is an opportunity for the occupant of the chair to profess his knowledge before a diverse and erudite assembly, on a topic whose matter and manner is off necessity, not restricted to the Ivory tower.*

Professor Onyechi Obidoa, Professor of Nutrition and Toxicological Biochemistry, University of Nigeria, Nsukka, also in delivering his inaugural Lecture on September 12th, 2007 emphasized not only the importance which is, to inform or educate the audience on the raison d'etre of the Lecturer in the Ivory Tower but also to inspire and motivate our younger colleagues and students in the academic enterprise inspite of its dwindling features and self esteem. To Professor Obidoa, it is essentially a very personal account of research experiences and apparent contributions to knowledge and suggestions on further work and how to uplift the total academic enterprise.

Today, I will not redefine the concept of Inaugural Lecture. Ladies and Gentlemen, permit me to capitalize on the all encompassing picture painted by our two previous Inaugural Lecturers. I find their definitions very useful.

The topic of my inaugural lecture is "POLY-FUNCTIONAL EGG: HOW CAN IT BE REPLACED?"

Egg Technology is one of my research areas and it is within my area of specialization. However, this topic is preferred to any other as its choice is philosophical and will empower me to meander beyond my discipline which is agriculture - specifically Meat, Fish, Poultry and Egg - into the Social Sciences (indeed psychology and religion) and confidently too, into business (entrepreneurship).

Today, the 15th of October 2008 in your esteemed presence, distinguished Ladies and gentlemen, I humbly wish to present some of my contributions to the world of knowledge and to civilization. I desire to take all of us into a stage that will traverse many disciplines in the world's intellectual arena. "I shall strive to inform, inspire, motivate, encourage, and hopefully educate this august assembly" in October. Today I am enabled by the words of Henri J.M. Nouwen as emphasized in his poem:

Fulfilling a Mission

When we live our lives as missions, we become aware that there is a home from which we are sent to which we have to return. We start thinking about ourselves as people who are in a faraway country' to bring a message or work on a project, but only for a certain amount of time. When the message has been delivered and the project is finished, we want to return home to give an account of our mission and to rest from our labours.

One of the most important spiritual disciplines is to develop the knowledge that the years of our lives are years "on a mission "4

CHAPTER TWO
MY BACKGROUND

Information pertaining to my background are as contained in my book “Saved by Grace" published in 2001.

CHILDHOOD:

I was born at Port Harcourt into the Ikeme family of Ogbeozalla village Onitsha, Anambra State, Nigeria. My late father, Mr. Alexander Muofunanya Ikeme, was then a Produce Inspector. My mother, also late, then an elementary school teacher. My father obtained his London Matriculation Examination Certificate from Christ the King College. (C.K.C.), Onitsha. My mother had, at that time, a Lower/Higher Elementary Certificate from St. Monica's Teachers' Training College, L Ugwuoba and Women Training College (W.T.C.), Umuahia respectively. I am the second of three children. My elder brother, Mr. Onyechi Ikeme, an accountant is married to Chinwe Ifejika, and they are blessed with three children. My younger sister, Chineze Anwah, once a staff of the University of Nigeria, Nsukka, but now a qualified nurse in the United S-3tes of America, is married to Dr Nnamdi Anwah, (late), an electrical engineer/computer analyst. They have five children.

PRIMARY SCHOOL:

My parents later traveled to the United Kingdom in 1957. My father became a law student and my mother a student of a higher degree in Education, University of Edinburgh. During this period we lived with our grandmother, Mrs. S.I. Megafu at No. 7 Oguta Road Onitsha. Sarah Megafu was the first wife of Dum Daiki, the Omodi of Onitsha. It was my grandmother who registered me in kindergarten class in St Christopher's Primary School, Onitsha. In my first days at school we had in my class a severe 'stammerer'. As I watched him talk, I assumed that stammering was the normal-way of talking and started copying him. I later became one of the worst 'stammerers' in the school despite all my grandmother's effort to stop me. I thank our Heavenly Father that I stopped stammering much later in Purdue University, U.S.A. when I was pursuing a Ph.D. Degree. With God all things are possible.

My grandmother brought us up well. She was a devout Christian and an active member of Jmmanuel Church, Inland Town, Onitsha. I am

delighted to write about her. The documentary below was lifted from 'Saints Triumphant', a publication oflmmanuel Church, Onitsha, page 18;

> *Madam Sarah Ifenu Megafu was born about the year 1892 and died in February 1972 at the age of 80 years. She was a faithful Christian who dedicated her life to the service of God and humanity. She was a member of both Mothers ' Union and Diocesan Women's Guild. She was a leader of Group 3 in the Church/or many years. She was Immanuel Church delegate at the Diocesan Women Conference for many years...*

My mother finished her course in 1959 and returned to Nigeria. My father qualified as a lawyer and returned later. My days in St. Christopher were very uncomfortable. I became a very quiet child because I found it extremely hard to talk, since I stammered. My mother took over from where my grandmother stopped. We continued to live at No. 7 Oguta Road but we had to move from my grand mother's house into 'Elephant house' owned by my late uncle, D.D. Megafu, Ononenyi. 'Elephant House' was one of the best houses in Onitsha then. It is still there.

My mother later became a civil servant with the Ministry of Education, Eastern Nigeria, and was posted to Government School **Uyo.** My father had returned and decided to practice law. Onitsha people at that time had a mania for the law profession. Jfyou were a mother and not referred to as 'Nne Lawyer' translating into "mother of a lawyer", you have really not arrived. Law was 'Ebe ano.^...My father died later in 1961 at the age of 39, my mother became a widow at the age of 35.

I continued my primary education in Uyo. It was in Uyo that my potential as a brilliant child blossomed. My mother, then a class three teacher would always come to Class J to take me so that I would explain difficult issues to her students, be it Arithmetic or English. Apart from Uyo we lived in other towns. We accompanied our mother to wherever she was posted. It was usual then to be transferred with or without one's consent. I was consequently a student in Government School Awka; St. Paul's Primary School Awka, and finally Methodist School Uwani, Enugu. My inability to talk however made me very quiet but brilliant. When offended, I would be very angry and could throw stones.

I sat for my First School Leaving Certificate in elementary five but this would not have been the case if my mother had not gotten a scholarship to study Social Work at the Michigan State University. She had encouraged me to sit for the examination to enable me secure admission into secondary school. I did not make a very good result. In pervious examinations I was either 1st or 2nd.

THE SECONDARY SCHOOL:

My mother prepared for our going into boarding school and left for the Michigan State University. She was consoled by the fact that with me and my brother in the same school, I would be in safe hands.

My first year in Union Secondary School, Awkunanaw, Enugu was very difficult and challenging. I tried all I could to adjust. I was determined to survive. My first and second term results were very poor. My usual position was 54 out of 60. I was relatively too young to be in secondary school.

My brother was among the first 18. He no doubt merited the A class. In those days there were only two classes (A & B). Students in A were academically superior to those in B. My house prefect, Japhet Ogbata, now a surveyor, from Udi, was worried about my poor results. On questioning me, I told him I did all I could to pass, including reading "till day break" (T.D.B,) but in vain. He then counseled me and gave me important tips that would improve my performance. I thanked him and went to work. That was a turning point in my academic life. The third term examination proved it all. I successfully came within the first 10 and was promoted to class 2A. Since then I have always found myself among the best students. My mother returned from the U.S.A and joined in thanking God for my progress.

In my second year in Union Secondary School, the older boys organized a riot that had the girls in the neighboring school beaten up. Following this ugly incident, there was an identification parade in the boys' school by the injured girls. A Divisional Police Officer w^ith his men and principal of the school, Mr. J.C Kong Dumabey conducted the identification exercise. Unfortunately, one of the girls thought she recognized me. A big commotion started when all identified boys were told to enter a 'Black Maria'. Every other person obeyed the command except I, Ikechukwu Ikeme, a little boy in class 2A. I strongly refused to

comply.

This led to struggle between the principal and I. On intervention by the A.S.P (Assistant Superintendent of Police) I explained that I was not part of the riot. My proof was that the wife of the principal and a tutor in the school saw me hiding in a bush, very close to the principal's house. Names of the students *who* did not go to the girls' school were taken by the tutor. My name was the first on the list and my brother's name was the last. We were only ten boys. My mother had taught us well, and my brother and I were good ambassadors. Praise God! That year and in the subsequent years, even in different schools, I continually received school prizes for the best well-behaved student and also for academic excellence.

ACADEMIC FOUNDATION:

Finishing my school certificate examination (WASC) - after the civil war, with a division 1 (1971) as St. Anthony 's College Ubuluku's best student, my academic career in the University of Nigeria Nsukka started in September, 1972 when I was admitted to study Animal Science. I graduated in June 1976, with Second Class Upper Division. Prof. F.C. Obioha was my project supervisor and Prof. C.C. Nwosu my mentor. My B.Sc. project was on the "Effect of Peletting and Varying Protein Levels on Growth of Rabbits in the University of Nigeria Farm". This research focused on the use of meat from Rabbits in supplementing the other sources of meat protein. I am happy to inform that this B.Sc thesis scored 'A' by an external examiner from the University of Ife, now Obafemi Awolowo University, was publishable. Excepts from my work read:

> *An important point in favour of the domestic rabbit is that it compares favorably with the other meat-producing farm animals in its efficient conversion of feed into meat for human consumption. This characteristic would suggest the probability that the domestic rabbit can successfully serve as one of the sources of meat to the people of this country, especially as human population continues to increase and competes to a greater extent with the monogastric animals for the cereal grains. The rabbit meat is white, fine grained, delicately flavoured, nutritious and appetizing. It is high in meat protein (20.8%) and low in its fat and calorific content. Only about 20% of the dressed carcass is bone, so the meat yield is high compared with that of many meat animals. To*

reduce the present meat shortage in the country, the Federal Military Government imported chilled meat from Brazil. No doubt thousands of Naira was spent on this project. This was a step in the right direction. However the solution to our present meat shortage must come from within and not outside Nigeria. To quote the New Nigerian editorial of Tuesday, 14th October, 1975 on "Importing Meat" it said. "with the current annual cattle take-off rate of 9% as compared to the growth rate of less than 2%, our total cattle population of 8.5 million only will diminish to zero % by 1980 if we just rely on importation in order to conserve our herds of cattle. " We must therefore, find alternative and effective mef/iods of increasing the production from the smaller farm animals, hence the need to pay attention to the rabbit industry. This will also be appreciated if it is remembered tliat the cash outlay for stock, housing and equipment is modest. "....

However, may I add for sake of our students that I would have read medicine or law but was however incapacitated by a speech defect.

Afraid of being an object of ridicule, I decided to study Animal Science, where in my opinion the animals would never realize the severity of my speech handicap. Prof C.C. Nwosu (then Dr. C.C. Nwosu) had actually devoted his time organizing a speech therapy class to enable me face my superiors and colleagues.

After my one year National Youth Service I proceeded to the United States for a Masters Degree in Food Science in the University of Arkansas, Fayettville, in September 1997. My research topic was on "The Effect of Nitrite Content and Smoking on Yield, Shelf - Life and Palatability of Cornish Game Hens". This research was financially supported by Arkansas Agricultural Experiment Station. Our smoked chicken found its way in to the U.S market. Thanks to my supervisor Dr. Tommy Goodwin and Tyson Foods. Excerpts from the thesis read:

Two experiments were conducted to determine effects of nitrite content and smoking on yield, shelf-life and palatability of Cornish Game Hens. Birds were either injected and soaked (A), soaked (B) or Injected (C) with a 6.98% picketing cure before smoking. Cooking temperatures were 46"C for two 2 hours and 9 3" C for 5 additional hours. Smoke was generated for the last 5 hours. The percent (%) yield, nitrite content, salt content,

rancidity development and palatability were determined. Growth of microbial population of cured and uncured smoked birds was monitored at 3"C and 25"C... General acceptability and flavor of white meat in treatment A was rated higher whereas dark meat from B was rated better. TBA values for file three treatments were not significantly different from each other. Data indicated smoked chicken could be stored at 3"C for 7 weeks. Percent yield for smoked chicken in the two experiments averaged 85%. Chicken from treatment A yielded the most desired product with meat from treatment C least acceptable.

In September 1979, I proceeded to Purdue University for a Ph.D degree in Food Science. Purdue University is very highly rated. The slogan of the University "Purdue Leads- others follow" fascinated me. Only two of

us in the University of Nigeria, Prof. C.C Okogbue and I, had the opportunity of being transformed in Purdue University. My stay in Purdue was actually for a four year programme; however, I obtained my Ph.D within two years (1979 -1981). My thesis topic was "Extending The Shelf -Life of Chicken Broiler Meat with Minimal Refrigeration". In sum taking a close look at my thesis/ topics (B.Sc. - Ph.D) reveals that my interest had centered on making life better for my people in Nigeria by making available more protein for the masses. In reality, I have always focused on contributing my quota to the upliftment of the community, nutritionally and otherwise. A healthy Nation is a Wealthy Nation, they say. My goal then was undoubtedly to create a healthy nation by making available animal protein, much needed for growth and performance. Specifically my field of specialization is: Quality Evaluation, Processing and Preservation of Meat, Fish, Poultry Meat, and Egg. Recently, other areas have been added.

CHAPTER THREE

CAREER IN THE UNIVERSITY

My career in the University will be discussed under four major headings.

- RESEARCH/TEACHING
- ADMINISTRATION
- WEALTH CREATION (ENTREPRENEURSHIP)
- PROFILE (SKILLS ACQUIRED)

RESEARCH/TEACHING

For the purpose of this Lecture I have focused our research on four main areas:

Quality Evaluation, Processing, and Preservation of:

- Shell Eggs
- Poultry Meat
- Fish
- Meat

SHELL EGGS - The Polyfunational, Incredible Edible Egg.

Our Research on Eggs started in earnest on my arrival in Purdue University. A Chicken Egg is a special kind of cell. It has a hard shell to protect the egg. The egg is the most complete food available in nature. It is the most widely used natural ingredient for food processing. Egg protein is of such high quality that it is used as the standard by which other proteins are compared. Eggs have a biological value (efficacy with which protein is used for growth) of 93.7%. Comparable values are S4.5% for milk, 76% for fish, and 74.3% for beef. Eggs are the best protein money can buy, and they have many other valuable vitamins and minerals too.

The excellent nutritional profile of the incredible edible egg is summarized in Table 1

Table 1: The Nutrient Content of a Large Egg.

NUTRIENTS	WHOLE EGG	ALBUMEN	YOLK
Calories (Kcal)	75.00	17.00	59.00
Protein (g) ?	6.25	3.25	2.78
Total lipid (g)	5.01	0	5.12
Total carbohydrates (g)	0.6	0.3	0.3
Fatty acids (g)	4.33	0	4.33
Saturated fat (g)	1.55	0	1.55
Monounsaturated fat (g)	1.91	0	1.91
Polyunsaturated fat (g)	0.68	0	0.68
Cholesterol (mg)	213.00	0	213.00
Thiamin (mg)	0.031	0.002	0.028
Riboflavin (mg)	0.254	0.151	0.103
Niacin (mg)	0.036	0.031	0.005
Vitamin B6 (mg)	0.070	0.001	0.0069
Folate (mcg)	23.5	1.0	22.5
Vitamin B 12 (mcg)	0.50	0.07	0.43
Vitamin A (IU)	317.5	0	317
Vitamin E (mg)	0.70	0	0.70
Vitamin D (IU)	24.5	0	24.5
Choline (mg)	215.1	0.42	214.6
Biotin (mcg)	9.98	2.34	7.58
Calcium, Ca (mg) .	25	2	23
Iron, Fe (mg)	0.72	0.01	0.59
Magnesium, Mg (mg)	5	4	1
Copper, Cu (mg)	0.007	0.002	0.004
Iodine, I (mg)	0.024	0.001	0.022
Zinc, Zn (mg)	0.55	0	0.52
Sodium, Na (mg)	63	55	7

Energy Value of Eggs

A medium egg has an energy value of 78 kilocalories (324 kilojoules) and the consumption of one egg daily would contribute only around 3% of the average energy requirement of an adult man; 4% for an adult woman. With their significant protein, vitamin and mineral content and relatively **low saturated fat content;** eggs are a valuable component in a healthy diet.

Protein

Eggs are an excellent source of protein. Egg protein is of high biological value as it contains all the essential amino acids needed by the human body. Eggs therefore complement other food proteins of lower

biological value by providing the amino acids that are in short supply in those foods. 12.5% of the weight of the egg is protein and it is found in both the yolk and the albumen. Although protein is more concentrated around the yolk, there is in fact more protein in the albumen. **On the evaluation scale most commonly used for assessing protein, egg is at the highest point - 100, and is used as the reference standard against which all other foods are assessed.**

Vitamins

Eggs contain most of the recognized vitamins with the exception of vitamin C. The egg is a good source of all the B vitamins, plus the fat-soluble vitamin A. It also provides useful amounts of vitamin D, as well as some vitamin E.

Minerals

Eggs contain most of the minerals that the human body requires for health. In particular eggs are an excellent source of Iodine, required to make the thyroid hormone, and phosphorus, required for bone health. The egg provides significant amounts of zinc, important for wound healing, growth and fighting infection; selenium,' an important antioxidant, and calcium, needed for bone and growth structure and nervous function. Eggs also contain significant amount of iron, the vital ingredient of red blood cells, but the availability of this iron to the body is uncertain.

Carbohydrates and dietary fiber

Eggs contain only traces of carbohydrate and no dietary fiber.

Fat

11.2% of the egg content is fat. The fat of an egg is found almost entirely in the yolk; there is less than 0.05% in the albumen.

Approximately 17% of an egg's fatty acids are polyunsaturated, 44% monounsaturated and only 32% saturated.

Cholesterol

Cholesterol and Lecithin are fat-like substances and are essential to the structure and function of all cells in the body. Cholesterol helps to maintain the flexibility and permeability of cell membrane and is also a raw material for the fatty lubricants that help to keep the skin supple.

Cholesterol is essential for the production of sex hormones, cortisol, vitamin D and bile salts.

Lecithin is involved in general lipid transportation in the blood and in the metabolism of cholesterol.

The polyfunctional nature of egg is better pictured in the table shown on the next page;

Function	Description
Adhesive Properties	Adheres ingredients such as seeds and grains to food products.
Aeration and Structure Improvement Binding	Egg proteins create foam in products resulting in lighter and airier products.
Browning	Provides desirable brown color to baked products
Clarification	Egg whites inhibit enzymatic browning and prevent clouding in beverages.
Coagulation and Gelation	Egg white and yolk proteins change from fluid state to gel. ,
Coating	Locks in flavor and aroma.
Color	Xanthophylls pigments in egg yolk contribute yellow color to many foods.
Crystallization control	Egg white protein prevents crystallization of sugar and promotes smoothness of chocolate.
Emulsification	Phospholipids and lipoproteins serve as surface active agents stabilizing oil in water emulsions.
Finish/Gloss	Used universally in baking to improve product appearance. Egg wash gives surface gloss and shine.
Flavor	Carries and enhances some flavors, and imparts desirable egg flavor.
Freezability	Improves texture and acceptability of products going through freeze/thaw cycle.
Humectancy	Holds moisture in food products to help increase shelf life.
Insulation	Keeps products from turning soggy.
Mouth feel Improvement	Provides substantial body and smoothness to foods.
PH	Stable pH.
Shelf Life Extension	Keeps starch molecules moist and fresh.
Tenderization	Tenderies foods naturally giving a soft surface feel.
Texture Improvement	Finns up the texture of food products and provides crumb improvement.
Thickening	Thickens sauces, gravies and adds body to achieve product improvement.

The fact that is being highlighted today is now even more glaring, eggs can perform more than twenty distinct functions in processing of food - many of which can only be duplicated by substitute additives and ingredients.

RESEARCH ON EGGS

Research on egg is a very important one, as the egg has been found to be a very valuable food item. Its use in manufacturing can also not be overemphasized. Many products claim to be egg replacers, **but Polyfunctional Eggs cannot be replaced with a single ingredient.**

To duplicate the functions of eggs: aeration, emulsification, coagulation, and the addition of color, and flavors, many ingredients have to be added to the ingredient declaration. Eggs more importantly too, are natural. Consumers want to purchase products containing wholesome natural ingredients. Our first research was published in Poultry Science (1982) 61:388-391. The objective of this study was to determine the technical feasibility of packaging hard cooked eggs in retortable pouches for distribution through retail stores. Attempts have been made to preserve hard cooked eggs by canning. A United States patent was issued to Trelease et al. (1952), but eggs in cans did not become a common grocery store item. In 1977, some merchandisers attempted to retail hard cooked eggs in clear plastic bags. Consumers were interested but poor handling in the retail outlets and by consumers resulted in bulged packages. The expanded bags were observed to be the result of gas production by bacteria as well as expansion of air in the non-evaculated packages when they were placed in warm environments.

In our Purdue Food Science Laboratory, peeled hard cooked eggs were held in .1 normal citric acid containing .2% sodium benzoate at 4°C for four days. Organic acids or other chelating compounds such as phosphates were necessary to minimize or eliminate discoloration on the yolk surface of many hard cooked eggs. The value of chelating compounds in preventing ferrous sulfide discoloration in eggs was confirmed by Gossett and Baker (1981). Ball and Saffones (1972) found that because of slow acid penetration into the yolk, pH equilibrium of hard cooked eggs and acidic solution took from 4 to 10 days. In our experiment, the eggs were packed in sealed metal cans and in retortable pouches in a dilute organic acid. They were retorted for 15 minutes at 121°C. Other eggs in retortable pouches were immersed in boiling water for 15 minutes. The pouches wereHcm by 17.5cm made from a Mylar, aluminum foil, polypropylene laminate. The previously hard cooked eggs endured the stresses of retorting or immersion in boiling water with no detectable changes in sensory characteristics.

Microbiological examination of thermally processed eggs after one week, four weeks, three months, and five months storage at 4°C or 21°C gave no evidence of growth of microorganisms. Hard cooked eggs can be packaged and thermally processed without harm to sensory qualities. Such eggs would be merchandised with or without refrigeration. It is worth mentioning that after several months' storage at 21 or 38°C, the

texture of the white canned eggs was the same as that of a freshly boiled egg, the color of the white was a light tan when the eggs were stored for 30 days at 38°C or for eight months at 22°C. Flavor was comparable to a hard cooked egg held for several days in a refrigerator but not to the flavor of a freshly cooked egg. Yolk color was normal.

Microbiological evaluation of eggs stored in pouches after one week of storage indicated no bacterial growth in any package irrespective of solutions or storage temperature. After five months at 22°C storage, the color of albumen was normal and flavor was not different from freshly packaged eggs. Acid solution plus care to minimize contamination during pouch packaging resulted in non-heat processed products keeping for over five months with no evidence of spoilage. It is also important to mention that this work was supported in part by a grant from the American Egg Board.

On return to Nigeria, in our Food Science Laboratories, we investigated on**:**

"Effects of oil treatment, storage temperature and duration on quality of shell eggs". Excepts from our publication in Nigerian Food Joumal(1984) Vol.2.'\o.2,pg. 162-165, inform:

Quality deterioration of eggs is one of the biggest problem facing poultry' farmers in the developing countries, especially in those locations with inadequate or no electric power supply. Cold storage, the most important single treatment which can be used for preserving eggs cannot be practiced widely in Nigeria and other developing countries because of prohibitive refrigeration cost and inadequate electric power supply. Eggs are usually held at room temperature and deteriorate in quality rapidly. These conditions emphasize the necessity/or adoption of non-refrigeration methods for preservation of eggs. Previous workers, Swanson (1958) el al, Froning and Swanson (1964). Goodwin (1962), Sabrani and Payne (1978) and others using colorless, odorless, paraffin base mineral oils, reported improved keeping quality of eggs treated and stored under cold temperatures. Knowing very well that mineral oil may be unavailable in Nigeria and its importation may be a serious handicap to the ordinary

Nigerian farmer, and considering cost and availability, locally available vegetable oil was used in this study. The study was conducted to investigate quality changes during storage of liens eggs treated with vegetable oil and stored at room and refrigeration temperatures...

High quality bleached and deodorized palm oil was used to study the effect of oil treatment of shell eggs on the quality of eggs stored for thirty two days at 10°C or at 25-32°C. Shell eggs were dipped in oil for 60seconds, drained for 30 seconds and then packed in egg crates for subsequent storage. Untreated eggs served as controls. Quality parameters studied include yolk index, height of thick albumen pH of albumen and weight loss of eggs. Oil treated eggs stored at 25-32°C and untreated eggs stored at 10°C retained a high proportion of their initial albumen and yolk quality and maintained an acceptable quality throughout the storage period. Untreated eggs stored at 25-32°C showed a sharp decline in Haugh units and yolk index and a marked increase in weight loss and pH of albumen.

The study indicated a *sharp* rise in pH of albumen between the zero and fourth day of storage. The results of the study show that untreated eggs had the highest rise in pH. The rise in pH is associated with chemical reactions. The drying of the egg cuticle, the resulting increase in the calcium pores and the subsequent increased rate of carbon dioxide loss from the albumen cause the breakdown of weak carbonic acid in the albumen and supply more Co2. Since oil treatment seals the pores of the shell, pH alteration in the albumen are checked due to arrest of Co_2 escape. High pH levels are associated with thinning of albumen and a decrease in the strength of the vitelline membrane or a general decrease in egg quality.

In sum, we can confidently inform that oil treatment is an effective method of preserving eggs under tropical ambient conditions. In further studies, we looked at the effect of oil treatment and storage temperature on some selected physical and functional properties of shell eggs. As we tried to preserve the quality of shell egg we are mindful of the fact that the polyfunctional egg may loose its ability to function effectively. The importance of this study cannot be overemphasized. The unique physicochemical properties of egg account for the variety of roles that eggs play in food preparation. In continuation of our study on the use of oil treatment as method of preserving shell eggs, specific foam volume,

drainage and emulsion stability of oil treated eggs and untreated eggs stored for seven weeks at room (25-30°C) and refrigeration (8-10°C) temperatures were determined as indicators of functional properties. Yolk index and height of thick albumen were studied as indicators of physical quality...

Foaming power is often attributed to low surface tension. This quality allows the creation of a large surface which is essential to foaming. Elevation of temperature results in lowering of surface tension. Thus albumen foams more and easily attains greater volume at room temperature than at refrigeration temperatures, hence higher foam volume recorded for untreated eggs stored at room temperature. High quality egg-whites make the best cake because of their stable foams (low drainage). Oil treatment apparently reduces foam stability.

POULTRY

In the Food Science Laboratory of University of Arkansas, precisely between 1977 and 1979 my colleagues and I worked on Improved Processing and Utilization of Poultry Products. Sponsored by the Arkansas Agricultural Experiment Station, I started and concluded an M.Sc. research on "Effect of Nitrite Content and Smoking on Yield, Shelf life and Palatability of Cornish Game Hens."

Our publication in Poultry Science (1979) 60: 679-682 informs:
Carcasses were either A) injected, B) soaked, or C) injected and soaked with a 6.98% pickling cure before smoking. Cooking temperature were 46°C for two hours and 93°C for five additional hours during which smoke was generated. Yield, nitrite content, salt content, rancidity development and palatability were determined. Result of this study revealed:

- Treatments influenced the juiciness, saltiness, flavor and general acceptability of white and dark meat. There were no differences in rancidity.
- Salt and nitrite content were higher in both white and dark meat from injected and soaked birds (Treatment C).
- Chicken from treatment C yielded the most desired product.

- Meat from treatment A (only injected) was least acceptable.

  Percent yield for smoked chicken averaged 88%

- Smoked chicken could be stored at 3°C for seven weeks without any deterioration from bacteria.

- Mold became a problem by the fourth week.

- Keeping quality of smoked chicken deteriorates rapidly if not refrigerated

- For a 6.98% pickling cure as used in this study, chemical analysis indicate that nitrate content of meat from injected soaked birds average 83.42ppm, very well below the GRAS level (Generally Recognized As Safe).

Historically, the smoking of meat has been used to increase shelf-life. The smoking process accomplishes this by introducing various bacteriostatic compounds, more of which are aromatics, to the meat surface and also by drying the surface to some extent.

While this is a desirable attribute, smoking as practiced in developed countries is done primarily to flavor the product rather than to extend its shelf-life.

Collaborating with Prof. C.C. Nwosu of the Department of Animal Science, I ventured into genetics and animal breeding. Two studies were carried out in this regard:

- Meat evaluation of the Nigerian local chickens and their crosses**.**
- Effects of Genotype, Age and Egg size on measures of shell quality of local and crossbred hens.

Whereas, previous workers compared local and exotic in respect of meat yield our research had the major objective of evaluating the meat potential of crossbred cockerels. The results of the research revealed that Genetic Stock significantly ($P<0.01$) influenced eviscerated weights. The mode of inheritance of carcass yield judging from the performance of the crossbred groups indicates additive effect of genes. **In sum, results of this study show that the crossbreds were improved only in breast meat thereby indicating that the exotic chicken has greater use in the**

development of the meat potential of the breast muscle of the local chicken. The crossbred superiority also confers much commercial utility to the indigenous fowl. Results from the second collaborative research reveal that the local chicken favourably competed with the other improved groups, including the exotic in shell thickness and as such it does not need improvement in shell thickness but in egg size.

FISH

On arrival at University of Nigeria, Nsukka in January 1982, I was assigned to teach fish technology, an area that I had previously received no formal training. In my usual manner of accepting challenges, I embarked on this task only to find out that herein lies the goldmine. I am happy to inform this August assembly that 75% of the publications used in accessing me to the rank of Professor of this esteemed University is on Processing, Preservation and Quality Evaluation of Fish: My active participation in "pisces arena" gave me the opportunity of presenting papers during:

- Ninth Annual Conference of the Nigerian Society of Animal production, held at the University of Nigeria, Nsukka, March 25-29,1985.

- FAO Expert Consultation on Fish Technology in Africa, Lusaka,
- Zambia, January 21 -25, 1985.

- Workshop on Post-Harvest food losses and their control. Centre for Rural Development and Cooperatives, University of Nigeria, Nsukka, April 14-22, 1986.

- A two week National Training course for Fish Farmers and Extension Staff. Centre for Rural Development and Cooperatives, University of Nigeria, Nsukka, January 11-12, 1988.

- FAO Expert Consultation on Fish Technology in Africa, Abidjan, Cote d' Ivoire, April 25-28, 1988.

- FAO Expert Consultation on Fish Technology in Africa, Accra, Ghana, October 22-25, 1991.

- FAO Expert Consultation on Fish Technology in Africa, Cairo, Egypt, 1991.

- FAO Expert Consultation on Fish Technology in Africa, Kisimu Kenya, August 26-31, 1996.

For my hard work, The Food and Agricultural Organization of United Nations (FAO) accepted me as a consultant and recognized University of Nigeria, Nsukka as a Centre of Excellence. Indeed FAO financed some of these researches. University of Nigeria, Nsukka through the Senate Research Grant was very valuable and supportive and indeed financed my first research, published in 1985, which served as a stepping stone to our other researches.

In my studies on fish I collaborated with many of my colleagues and assisted in bringing them on board the "FAO Train". The list is endless but include:

- Mosumola Carew, then my student (1984-1985)
- Dr. (Mrs.) A.C. Uwaegbute <• C.S. Bhandary

- Prof. Zak A. Obanu

- Dr. R.I.N. Awachie

- Prof. H.C. Gugnani

- Prof. J.O. Igene of University of Benin

- Dr. O.J. Abolagba of University of Benin

- Dr. T. Coker

- M.O. Akabuike

- Charles Ishiwu

- Clement Diarua

Indeed in all my work (United States of America and Nigeria), I have always adhered to the concept of being "equally yoked" as expected of God's children as we labour together for the benefit of all. A few of my studies need special mentioning:

Control of Lipid Oxidation in Smoked Mackerel by Hot Water Onion Extract.

Excerpt from this publication are contained herein:

> *"Fish lipids oxidation is an important factor lowering the quality of smoked fish, particularly during storage. The most commonly used antioxidants, such as butylated hydroxyl toluene (BHT) and butylated hydroxyl anisole (BHA), are not readily available to the average Nigerian food processor. An experiment was conducted to determine the effectiveness of a hot-water onion extract in controlling rancidity in smoked mackerel. The onion extract was prepared by boiling appropriate quantity of onion in water for five (5) minutes. The quantity of onion in these experiments was either 20 percent or 50 percent of onion in water w/w. After boiling the mixture is-filtered and the liquid mixed with other components used for treatment. Results indicated that peroxide values of samples dipped in a solution composed of citric acid, potassium sorbate, sodium chloride and 50 percent hot-water onion extract did not significantly ($p < .05$) differ from those of samples dipped in a similar formulation composed of citric acid, potassium sorbet, sodium chloride and BHT. With regard to overall organoleptic acceptability, panelists did not find much difference in products dipped in the two different formulations at the end of an eight-week storage period. These experimental results show that the locally prepared 50 percent onion extract could be used in the treatment solution to retard the oxidation of smoked fish lipids to the same extent as does the important chemical anfioxidant, butylated hydroxyl toluene...*

SIGNIFICANCE OF STUDY

> *...Fish is an extremely perishable foodstuff. In previous studies, Ikeme and Carew (1984) and Ikeme (1985) reported that citric acid - potassium sorbate - sodium chloride - BHT solution was effective in arresting fungal infection, bacterial decomposition*

and oxidative rancidity of high moisture (over 20% water) smoked mackerel (Scomber Sombrous). Synthetic compounds, such as BHT, BHA and propyi gallate, commonly used as anfioxidants in food industries are not generally available. The widespread use of onion (Allium cepa) as a flavoring agent is well known. According to Arun et al. (1979), it is also known to have medicinal properties. As in many other countries, onions are often used in Nigeria as an added ingredient in many cooked foods. There is no report in the literature showing that vegetable products have been successfully used to control lipid oxidation of foodstuffs stored at ambient temperature (25 - 30oC). This study was designed to provide such information...

- **"Characterization of traditional smoked-dried fish in Nigeria"**

Excerpts from this publication are as follows:

"Traditional smoked-dried fish were obtained from a local market in Onitsha and from a production site at Asaba near the Niger River. They were organoleptically inspected for insect attack, mould infestation and tendency to fragment. Proximate composition and sodium chloride content were determined. Water activity and moisture content of stored samples were determined at 2-day intervals during a 4-week storage period. Results obtained showed that protein content of all fish samples ranged from 60% to 80%, fat 6% to 15%, moisture content 7% to] 9%) and water activity 0.70 to 0.85. The research implicates Aspergiiliis flavus, A. fumigafus, A. niger, penicillion spp., Mucor spp., Rhizopus spp, and cladosporium spp, as some oftlie most likely genera of mould that cause spoilage of smoked dried fish..."

SIGNIFICANCE OF STUDY

In previous FAO Expert Consultation on Fish Technology in Africa and indeed other conferences, scientists in Africa have used to a greater extent the percentage of moisture content as a basis for describing

available water. In the last Expert Consultation held in 1988 in Abidjan, all participants agreed that the use of water activity (Aw) should be encouraged. Water activity (Aw) is the basic parameter used to technically describe all the classic cured fish products (salted-dried, dried and smoked) and to assess their stability regarding micro-organisms, enzymatic activity, hydrolytic reactions and rancidity developments (Lupin, 1986). Within certain limitations it also provides useful information about insect infestation (e.g. minimal Aw for fly to lay eggs). The Aw is important because it gives a quick estimate on safety, stability and problem associated with cured food. Extensive tables giving the minimal Aw values at which deteriorative micro-organisms can develop have been published (Lupin, 1986).

The idea of characterization of traditional smoked-dried fish in Nigeria is new. Not much has been reported in this regard. Motawani (1970) reported that all the 160 species offish identified in Niger-Benue system, 44 are commercially important. These include *Alestes spp., Arius spp., Auchenoglaria spp., Bagrus spp., Tilapia spp., Citheridium spp., Lates spp., Gnathoremus spp.,Schilbe spp., Gymnarchus spp., Sardinella spp., Clarias spp., Ethmalosa spp., Heterosis spp., Chrysichthys spp., Clupisudis spp., Synodontis spp., ans Hhdrocynus spp,.* Species in Kainji Lake are very similar to those listed above except that, according to Turner (1971), the *Citharinidae* especially *Citharinus citharus* tends to dominate the catch in most seasons of the year. In Lake Chad the species are also much the same as in Kainji and the Niger-Benue complex, but the individual fish tend to be much larger than those in other areas.

The objective of this study are:

To determine the technical characteristics of traditional smoked-dried fish in Nigeria. In particular the proximate composition (protein, fat, water and ash), and the Aw.

- To determine the degree of insect attack, mould infestation and tendency to fragment.
- To utilize the result obtained to rationalize the knowledge on smoked-dried fish for training purposes.

Results

The results obtained are shown in Tables 1 to 4. Insects were not observed in freshly smoked-dried fish. Insects appeared later during storage, transit or in the market. The degree of fragmentation of the traditional smoked-dried fish is a function of the level of moisture in them. The higher the moisture content of the fish the lower the degree of fragmentation. As a result, freshly smoked-dried samples from the production site with higher moisture contents have relatively less tendency to fragment than the market samples that have lost much moisture, particularly due to re-drying by the traders. Maintaining high moisture content in the products counters fragmentation, although the fish would be readily attacked by moulds.

The proximate composition and sodium chloride contents of the traditional smoked-dried fish samples both depend on the degree of dryness of these fish. Quantitatively, they are inversely related to moisture and also vary with species of fish.

Provided they are freshly smoked-dried and intermittently re-dried, it is rare to observe mould growth visually on smoked-dried fish from the production site and even from the market. However, when freshly smoked-dried fish with high moisture content are stored under ambient conditions, mould growth becomes the major cause of spoilage. The moulds identified provide an indication of the genera most likely to be responsible for the spoilage of smoked-dried fish.

Conclusion

The data on **Aw** provides better criteria for assessing the stability of the smoked-dried product. Moulds grow on products with **Aw** as low as 0.70. The determination of **Aw** using a filament hygrometer is less

cumbersome and the results are more reliable when compared to moisture content. There is a need to characterize all commercially important species and also to conduct this research in various parts of the country at different seasons of the year.

Table 1: Proximate composition, sodium chloride content and water activity of traditional smoke-dried fish samples obtained from the production site.

Species	% Protein	% Fat	% Ash	% NaCI	%H,0	Aw
ChiyPstchtys nigrodigitatus	63.85(73.91	11.86(13.73)	10.68(12.36	0.76	13.61	0.83
Clarotes	65.96(74.61	12.15(13.74)	11.95(13.52	0.48	11.59	0.77
Alestes nurse	61.06(71.22	13.75(16.04)	10.92(12.74	0.351	14.27	0.85
Synodontis Glorias	62.41(69.39	12.94(14.39)	12.60(14.33	0.39	12.45	0.79
Dischodus rustrutus	64.40(71.10	10.00(11.00)	14.95(16.40	0.72	9.4	0.72
Hyper opt us bebeocciden	67.90(74.40	8.00(8.80)	14,45(15.90	0.61	8.7 '	0.81
Lates niloticiis	68.40(76.20	14.00(15.60)	15.00(16.70	0.67	10.2	0.82
Labio senegalensis	66.60(71.70	12.00(12.90)	12.72(14.50	0.87	7.1	0.75
Claiias lazera	67.86(77.50	12.98(14.83)	6.8	0.82	12.50	0.760
Tilapia nilotica	70.05(80.33	12.85(14.74)	5.2	0.73	12.80	0.762
Ethmalosa dorsal is	69.69(79.92	13.95(16.00)	5.8	1.11	12.80	0.762
Heterotis n Hot tens	69.69(78.48	12.30(13.85)	11.15	1.02	11.20	0.752
Gymnarchus niloticus	59.81	9.00	10.25	0.35	19.25	0.77
Channa obscura	58.58	15.00	11.65	0.94	12.35	0.75
Hepsetus odoe	59.00	10.50	13.90	0.94	14.60	0.76
Malaptems electricus	56.83	16.00	6.00	1.43	15.70	0.76
Citharinus citharus	64.27	10.75	16.63	0.35	8.00	0.70
Bagriis bay ad	65.32	13.25	14.32	0.37	7.75	0.70
Pseiidotolithiis senegalensis	62.52	11.75	16.84	0.39	8.50	0.70
Protopferus annectens	68.65	12.40	13.00	0.37	9.20	0.71

Figures between brackets: percentage expressed on dry weight basis

Table 2: Proximate composition, sodium chloride content and water activity of traditional smoked-dried fish samples obtained from the market.

Species	% Protein	% Fat	% Ash	% NaCI	% HsO	Aw
Chrysicht\'s iiigrodigitatus	71.01(77.24	10.50(11.4	10.73(11.70)	0.983	8.06	0.60
Clarotes	70.50(77.60	11.10(12.2	11.51(12.70)	0.624	9.15	0.64
Alestes nurse	78.90(87.30	14.70(16.3	10.62(11.80)	0.551	9.62	0.65
Synodontis Clarias	79.71(86.90	13.02(14.2	12.25(13.40)	0.761	8.32	0.63
Dischodus rustratus	69.60(74.40	12.50(13.4	11.67(12.60)	0.99	6.53	0.67
Hyperopius bebeocciden	74.10(78.90	20.00(21.3	12.77(13.70)	0.72	6.10	0.68
Lutes niloticus	70.90(76.80	10.50(11.4	15.90(17.20)	0.95	7.70	0.67
Labio senegalensis	72.70(77.10	13.50(14.3	12.90(13.70)	0.63	5.65	0.67
Clarias lazera	79.00(89.24	8.60(9.71)	7.20	0.64	11.48	0.75
Tilapia nilotica	85.11(96.42	11.50(12.8	5.30	1.11	10.50	0.75
Ethmalosa dorsalis	73.73(84.26	13.15(15.0	6.00	1.11	12.50	0.76
Heterotis niloticus	71.36(79.73	11.35(12.6	12.68	0.79	1.0.5	0.75
Gymnarchus niloticus	70.76	8.00	6.98	0.73	7.85	0.65
Channa	60.51	9.00	9.33	0.67	8.35	0.78
Hepsetus odoe	60.505	9.75	8.50	1.73	8.28	0.74
Malapterus electricus	59.64	5.75	8.43	1.46	8.13	0.76
Citharinus citharus	62.52(72.70	6.48(7.54)	14.90(17.33)	0.35	14.00	0.74
Bagrus bayad	64.05(75.00	7.78(9.11)	12.70(14.87)	0.37	14.60	0.74-
Pseudotolithus senegalensis	60.86(72.41	7.10(8.45)	13.80(16.42)	0.40	15.95	0.75
Protopterus annectens	65.00(75.98	7.10(8.30) .	11.05(12.92)	0.37	14.45	0.74

Day and relative humidity of the air		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
Day	%RH	%H2O	Aw	%H2O	Aw	%H2O	Aw	%H2O	Aw	%H2O	Aw	%H2O	Aw	%H2O	Aw	%H2O	Aw	%H2O	Aw	%H2O	Aw
1	85	24.75	0.84	15.50	0.79	23.10	0.85	20.40	0.81	20.81	0.79	22.20	0.80	[illegible]	0.81	40.98	0.79	24.50	0.86	[illegible]	0.79
3	92	22.14	0.86	15.51	0.78	22.42	0.84	19.46	0.80	20.62	0.80	22.41	0.81	[illegible]	0.82	19.89	0.79	24.35	0.85	[illegible]	0.80
5	88	21.90	0.85	13.19	[illegible]	21.50	0.83	19.19	0.79	20.34	0.81	21.94	0.82	[illegible]	0.84	19.36	[illegible]	24.20	0.81	[illegible]	[illegible]
7	73	18.76	0.83	17.11	0.76	17.20	0.81	18.00	0.78	19.94	0.80	[illegible]	0.87	[illegible]	0.84	18.01	[illegible]	24.10	[illegible]	[illegible]	[illegible]
9	84	16.30	[illegible]	[illegible]	[illegible]	[illegible]	0.79	17.72	[illegible]	19.65	[illegible]	21.51	0.83	[illegible]	0.84	18.00	[illegible]	24.00	0.76	[illegible]	[illegible]
11	87	20.15	0.84	[illegible]	[illegible]	[illegible]	0.82	19.80	0.79	19.25	[illegible]	20.88	[illegible]	[illegible]	0.83	17.26	[illegible]	21.90	0.74	[illegible]	[illegible]
13	93	18.35	0.86	11.23	[illegible]	[illegible]	0.78	18.40	[illegible]	18.84	[illegible]	[illegible]	0.81	[illegible]	0.82	15.21	[illegible]	23.02	[illegible]	[illegible]	[illegible]
15	90	17.30	[illegible]	13.98	[illegible]	[illegible]	0.79	16.36	[illegible]	18.40	[illegible]	[illegible]	0.80	[illegible]	0.83	16.07	0.74	22.48	[illegible]	[illegible]	[illegible]
17	81	14.60	[illegible]	11.06	[illegible]	12.00	[illegible]	13.42	[illegible]	18.01	[illegible]	[illegible]	0.79	19.84	0.80	15.22	0.73	22.20	[illegible]	22.0	[illegible]
19	73	13.75	[illegible]	10.95	[illegible]	11.95	0.76	11.08	0.74	17.62	[illegible]	18.30	0.78	[illegible]	0.79	15.82	0.73	20.10	0.72	[illegible]	[illegible]
21	78	13.20	[illegible]	10.73	0.73	11.30	0.75	10.95	[illegible]	16.77	0.74	17.84	0.78	18.84	0.80	15.03	0.72	19.26	0.71	18.43	0.72
23	78	13.20	[illegible]	10.71	0.73	11.20	0.75	10.98	[illegible]	16.09	0.74	17.56	0.77	17.32	0.79	14.88	0.72	18.44	0.76	[illegible]	[illegible]
		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		Bagelas bacudi		[illegible]		[illegible]	
1	85	12.18	[illegible]	[illegible]	[illegible]	19.28	[illegible]	20.90	0.80	19.80	[illegible]	21.88	0.70	[illegible]	0.84	[illegible]	[illegible]	21.80	0.84	[illegible]	[illegible]
3	92	18.14	[illegible]	17.45	[illegible]	[illegible]	0.81	[illegible]	[illegible]	[illegible]	0.84	24.00	0.84	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	88	20.38	[illegible]	[illegible]	[illegible]	[illegible]	0.80	[illegible]	0.84	[illegible]	[illegible]	[illegible]	0.82	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.81	[illegible]	[illegible]
7	72	21.08	[illegible]	[illegible]	[illegible]	[illegible]	0.82	24.90	0.84	21.38	0.83	[illegible]	0.83	[illegible]	0.84	21.40	[illegible]	[illegible]	0.84	[illegible]	[illegible]
9	[illegible]	20.50	[illegible]	[illegible]	[illegible]	[illegible]	0.83	24.90	[illegible]	[illegible]	0.84	[illegible]	0.83	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
11	87	20.08	[illegible]	[illegible]	[illegible]	18.15	0.78	16.90	0.80	[illegible]	0.82	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.81	[illegible]	[illegible]
13	93	19.38	[illegible]	18.06	[illegible]	18.65	0.77	14.80	[illegible]	14.80	0.77	20.00	0.82	[illegible]	0.81	20.60	[illegible]	21.90	0.80	[illegible]	[illegible]
15	90	18.90	[illegible]	[illegible]	[illegible]	[illegible]	0.76	12.65	[illegible]	18.25	0.80	18.40	0.82	[illegible]	0.82	21.07	0.80	20.50	0.81	[illegible]	[illegible]
17	87	18.80	[illegible]	17.43	0.74	10.65	0.75	11.93	[illegible]	17.75	0.79	17.00	0.80	[illegible]	0.80	19.50	[illegible]	20.90	0.81	[illegible]	[illegible]
19	73	18.38	[illegible]	12.36	[illegible]	10.15	0.74	10.00	0.74	16.68	0.76	17.33	0.76	[illegible]	[illegible]	20.00	[illegible]	19.90	[illegible]	[illegible]	[illegible]
21	78	17.00	[illegible]	17.20	[illegible]	[illegible]	[illegible]	9.00	[illegible]	16.15	0.74	[illegible]	[illegible]	[illegible]	[illegible]	19.50	[illegible]	[illegible]	0.81	[illegible]	[illegible]
23	78	17.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.00	[illegible]	16.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	19.50	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 4: Mould Identification

Fish species	Moulds identified
Chrysichthys nigrodigitatus	*Rhizopus spp*
Clarotes laticeps	*Penicillium spp* *Aspergillus rubber*
Alestes nurse	*Aspergillus niger*
Synodontis clarias	*Aspergillus candidus*
Dischodus rustratus	*Aspergillus candidus* *Aspergillus ustus* *Penicillium spp*
Hyperopius bebeoccidentalis	*Penicillium spp* *Aspergillus fumigatus*
Lates niloticus	*Aspergillus nidulans* *Aspergillus wntii* *Rhizopus spp*
Bagrus bayad	*Aspergillus niger* *Aspergillus flavus* *Cladosporium spp*
Pseudotolithus senegalensis	*Aspergillus niger* *Rhizopus spp* *Penicillium spp*
Protopterus annectens	*Mucor spp* *Penicillium spp* *Aspergillus fumigants*

Fish species	Moulds identified
Labeo senegalensis	*Aspergillus candidus*
Clarias lazera	*Penicillium spp* *Rhizopus spp*
Tilapia nilotica	*Penicillium spp* *Aspergillus candidus* *Rhizopus spp*
Ethmalosa dorsalis	*Rhizopus spp* *Penicillium spp*
Heterotis niloticus	*Aspergillus ruber* *Aspergillus candidus*
Gymnarchus niloticus	*Rhizopus spp*
Channa obscura	*Mucor spp*
Hepsetus odoe	*Aspergillus spp*
Malopterus electricus	*Penicillium spp*
Citharinus citharus	*Aspergillus fumigants* *Mucor spp* *Rhizopus spp*