The Federal Polytechnic, Ilaro
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Who Will Bring Back Chicken to the Table for These People?

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An Inaugural Lecture delivered at the International Conference Centre, the Federal Polytechnic, Ilaro on Wednesday, December 12, 2018

By

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The Rector,
The Deputy Rector,
Other Principal Officers of the Polytechnic,
Dean, School of Pure and Applied Science,
Deans of other Schools and Service Directors,
Distinguished Chief Lecturers, Scholars, and Colleagues,
Distinguished Guests,
Ladies and Gentlemen.

Introduction

Let me start this presentation in the name of ***Allah***, Most Gracious, Most Merciful, and with loads of appreciation to Him for sparing our lives and for making today a reality. Praise be to Him, the Cherisher and Sustainer of the worlds. I have longed for long to present an inaugural lecture even though it was not a tradition to do so in the Polytechnic system. I so much desired it when I was about 10 years old as a Chief Lecturer. Then, I believed that I had garnered sufficient teaching and research experience in the field of nutritional biochemistry to be able to present a lecture on this aspect of the topical issue – **finding sustainable solution to global food insecurity**.

As soon as I was granted the approval to present this inaugural lecture, I had the challenge of crafting outcomes of my research activities to fit into the train of thoughts earlier expressed by many distinguished scholars in the field. Thinking deeply, however I realized that I needed only to align my thoughts with the established knowledge and to find a little hole in the train to plug my research contribution. Thence I became relaxed and decided to deliver a lecture on **'Who Will Bring Back Chicken to the Table for These People?'** By so doing I will be contributing to the national and international discussions on strategies for ensuring adequate protein nutrition among the teeming world population, which is expected to reach 9.6 billion by 2050 (UN FAO, 2013).

Consequently, this lecture has been structured into five main sections viz, the description of the vulnerable Nigerians suffering the effect of food protein deficiency; the nutritional problems associated with shortage of animal food protein supply; strategies for bridging the gap between protein foods demand and supply; my research intervention; and concluding remarks on the future of research in poultry nutrition. But first, I will begin this presentation with the description of my humble beginning in the journey of academic life.

In the beginning

I began my career in academics in this Polytechnic on August 1, 1980, with the assistance of Prince (Dr.) SA Makanjuola and the approval granted by Chief (Dr.) TA Ogunbadejo. I started as a Lecturer lll, the lowest level in the lecturer cadre at the time; and rose steadily to the position of Chief Lecturer in 1995 under the tutelage of Chief (Dr.) KO Jibodu, the pioneering substantive Head of my Department. These great men mentored and gave me direction in leadership and academics, and for which I am most grateful. At near maturity in my career, Prince (Prof.) SA Olateru-Olabgegi and Prince (Dr.) SA Makanjuola ignited the star in me in academics and management by assigning me with challenging tasks in the Polytechnic. Incidentally, all these great men excepting Chief (Dr.) KO Jibodu were former Rectors of this polytechnic. Meanwhile, Dr. Jibodu was a former Rector of Moshood Abiola Polytechnic, Abeokuta. I bless God for serving under them, and for the coaching and mentoring that I received from them all. The collective efforts on the direction in academics, which I received from all of them has culminated in the presentation of this inaugural lecture, and for which I am grateful. Finally, I am most grateful to Dr. OO Aluko, the current Rector of this Polytechnic for supporting, granting approval, and providing enabling environment for my inaugural lecture to come up at this time. It will go down in the history of this institution that **FPI Inaugural Lecture Series** began in his time. Congratulations. More grease to his elbow.

Mr. Rector Sir, I will now proceed quickly to my inaugural lecture, the main business of the day.

Who are these people?

Those being referred to as **'these people'** in this inaugural lecture are depicted in Plates 1 - 4. The pictures show the teeming hustling ordinary Nigerians, the undernourished children, and a seriously protein deficient child plagued with kwashiorkor.

These are the ordinary Nigerians whose per capita income is low, and can barely afford three meals a day. The cheaper high-carbohydrate foods in the forms of cereals and tubers characterized their diets. High-quality animal protein foods such as egg, fish, and meat are beyond their reach for the simple reason of cost. They are vulnerable to all sorts of clinical disorders associated with dietary protein deficiency and micronutrient malnutrition. Obesity, diabetes, kwashiorkor, marasmus, etc. are prevalent among this group because of over-dependence on low protein-high carbohydrate foods.

Unfortunately, too, these are a group of people with large family sizes and their children show stunted growth, wasting, and poor brain development (Müller and Krawinkel, 2005). Also, this low-economy class and undernourished Nigerians transcends all ethnic, geographical, regional, sociocultural, and religious boundaries in the society, and they constitute the vast majority of the population. This category of Nigerians has access to balance diets only on festive occasions and when they attend lavish social parties organized by the rich elite class either as invited or unwelcome guests. On such occasions, highly nutritious assorted foods are served with exotic drinks. The lucky among them will have delicious three-course meals on that occasion at least. On the other hand, the well-nourished elite class is characterized by small family size and is in the minority in the Country.

Plate 1. Photo showing samples of 'these people'

Plate 2. Photo of under-nourished children

Plate 3. Photo of some under-nourished children

Plate 4. Photo of a seriously protein deficient child

What are proteins and why should we be concerned with the supply of animal-derived protein to these people?

Proteins consist of chains of amino acids called polypeptides. The chains fold into a three-dimensional structure to constitute a functional protein (Figure 1).

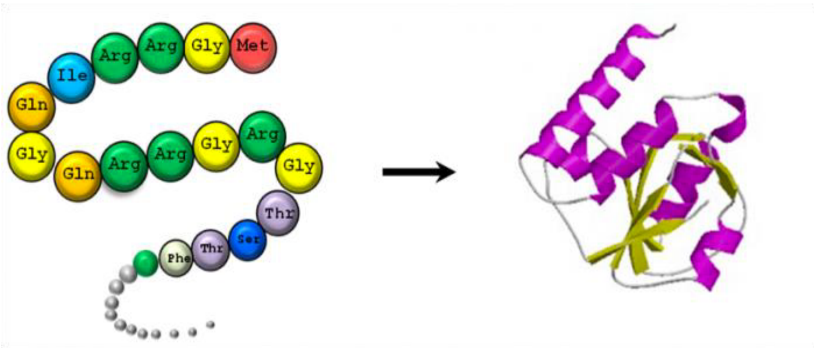

Figure 1. A typical protein structure

Proteins constitute an essential part of the human diet, and it should account for about 12% of the total caloric intake. They are essential construction elements of the organism. Together with lipids proteins constitute the membranes of the cells. They give structure and shape to the cell (e.g. collagen). Specific proteins assume defense functions against infection and disease (e.g. antibodies). Blood serum proteins assume transport functions. They carry molecules through barriers and throughout the body. The respiratory system of vertebrates is based on the oxygen binding properties of specific iron-rich proteins present in the blood and the muscles (e.g. haemoglobin, myoglobin). As specific enzymes, certain proteins have catalytic activity thus enable and control metabolism on the cellular level (e.g. pepsin, alcohol dehydrogenase). Some proteins function as hormones regulating metabolic processes at the tissue and cellular level (e.g. insulin). Proteins as food are the major sources of dietary nitrogen needed for protein synthesis in the body (i.e. tissue repair, growth, and replacement) and energy production. Protein deficiency is, therefore, a very serious problem and is clearly incompatible with normal physical and mental development of the growing infants. Indeed, deficient children show stunted growth, kwashiorkor, marasmus, wasting, etc. depending on the depth of deficiency. Adequate protein intake is decisive for health and disease prevention in adults (Nestec, 1987).

Different protein sources vary in their ability to provide us with the essential amino acids we need for growth and repair. Animal sources, and some plants like food legumes, provide the full range of essential amino acids needed by humans in sufficient quantities. Many plant protein sources lack one or more amino acid in sufficient quantity to fulfill human needs, but this can be addressed by regularly consuming a combination of different proteins, including plant-based sources (Mcdougall, 2002).

The recommended daily protein intake for an adult varies from 40 to 60g depending on body weight. While it is difficult to meet this recommended dietary protein intake in the developing countries, the situation is different in the industrialized countries where intake is higher than the recommended level.

According to the report on the world's food and agricultural production published by Food and Agriculture Organization (FAO) of the United Nations, Nigeria ranked second after Ethiopia in the league of African countries with the highest number of undernourished people. Also, the country ranked twelfth among the highest 20 countries in the world having children under 5 affected by wasting (FAO, 2015).

At the global stage, an estimated 14% of the world's population is hungry with many more people having inadequate protein intake, contributing to impaired growth and suboptimal health. For example, globally 165 million children under five years of age are stunted. These numbers could increase significantly; as the United Nations projected that the world population will reach 9.6 billion by 2050 (FAO, 2013). The report concluded with an urgent call for finding sustainable solutions to food insecurity, particularly the availability of high-quality food proteins for human consumption. The reasons being that world's demand for animal-derived protein is expected to double and that the demand will be driven by increasing population, emerging economies, increasing urbanization, recognition of protein's role in a healthy diet, and increased need for protein in the elderly.

Contrary to the general call for increased global demand for animal-derived protein Popkin *et al* (2012) observed that the high demand for protein foods of animal origin was applicable to the low- and medium-income countries, and that the demand picture differs in the high-income developed countries. The authors noted lesser demand for animal-derived protein in the developed countries because of increased awareness of the negative impact of increased animal production on the environment (i.e. emission of greenhouse gases, GHG) and land use on the one hand, and health issues associated with its consumption on the other. Health concerns arise with over-consumption of protein, particularly when linked with saturated fatty acids and over-consumption of processed meats (Henchion *et al.*, 2017).

The United Nations puts the Nigeria's current population and the yearly percent change at 193,544,472 and 2.61%, respectively for January 2018; and the projected population and growth rate for 2050 at 410,637,868 and 2.04%, respectively. Nigeria's National Bureau of Statistics (2016) described unemployment rate as a measure of the number of people actively looking for a job as a percentage of the labour force, and subsequently, puts the country's unemployment rate as 14.2% in 2016. In absolute term, estimated 11.549 million people were jobless. The unemployment rate was higher for persons between 15-24 years old (25.2%), women (16.3%) and in rural areas (25.8%).

Of course, this statistics is suggestive of a low economic power of the people and their inability to afford expensive quality animal protein foods. Indeed, the FAO statistics (FAO, 2015)) revealed that 3-year average protein supply had dropped from 66 g/capita/day in 2006/2008 to 57 g/capita/day in 2011/2013. Also, the number of undernourished Nigerians has been on the increase since 2005/2007, reaching an estimated 14 million in 2014/2016 (FAOSTAT, 2017).

Unfortunately, the ever-increasing Nigeria population is exerting more pressure on the demand for food, and more importantly food protein. Also, if the government successfully revamps the economy, the average income of the citizenry improves, and then Bennett's law applies (Bennett, 1941). The law states that **'there is an inverse relationship between the percentage of total calories derived from cereals and other staple foods and per capita income'**. This means that the ratio of starchy foods in the diet falls as income rises. Simply, the implication is that while the low-income earners eat more starchy foods e.g. grains and root crops, the wealthy class eat more meat, fruit, and vegetables. This scenario is typical of the developing countries or emerging economies of the world.

If the teeming Nigerian population is harnessed for economic strength as it is done in China, then this scenario suggests the future of our nation's economy lies with the poor and malnourished class, and it is bleak! The antidote, therefore, is to address the problem of malnutrition among this vulnerable group who holds the key to the future economic prosperity of our dear nation. All efforts must be geared towards making available high-quality animal protein foods to the ordinary Nigerians at cheaper and affordable rates, among other strategies. This picture actually stimulated my research interest in Nutritional Biochemistry. I have dedicated my research work to finding a sustainable solution to food insecurity with reference to the availability of high-quality food proteins for human consumption.

How can we deliver high-quality protein foods to the plates of these ordinary Nigerians?

The major sources of food protein include cereal, meat, milk, fish and seafood, vegetables, pulses, and eggs. The contribution of these sources to the world protein food supply is shown in Figure 2. The statistics show that plant-derived proteins dominated global protein supply (57.2%), while animal-derived protein (37.7%), and other sources (5.1%) making up the balance. Also, variability in the type and proportion of essential amino acids supplied by the different food protein sources and indeed the protein qualities raises a question of their usefulness in human nutrition. Two key issues, therefore, became matters of concern in human nutrition. First, the poor quality or low biological values of the proteins of plant origin, and second, is the current and future demand for food protein, especially in the face of population explosion by 2050 when it has been projected to reach 9.6 billion.

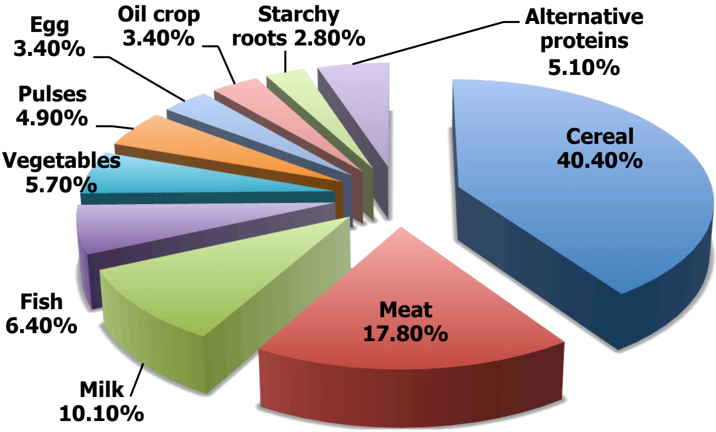

Figure 2. World Protein Supply

Consequently, the Forum for the Future, an independent non-profit organization that works globally with business, and government to solve complex sustainability challenges convened a conference of partners and collaborators to address The Future of Protein. The conference worked on the theme 'The Protein Challenge 2040: Shaping the future of food'. The group examined what constitutes protein and then focused on globally significant protein sources i.e. those whose value chains have greatest scale and impact, now and in the future (Table 1). The collaborators and partners at the conference were from the animal, plant and novel protein industries and global environmental and health organizations. The protein system was examined and the group concluded that the areas of innovation highlighted in Table 2 would address sustainability question as to the supply of protein to the envisioned 9.6 billion people.

My research contribution/intervention

My research intervention falls within innovation areas 1, 2 and 4 highlighted in Table 2. The three innovation areas address strategies for ensuring sustainable animal-derived protein supply through increased land farmed animal production. That is, increasing meat, egg, and milk production.

Table 1. Sources of food proteins

Animal proteins	Plant proteins	Alternative proteins
▪ Red and white meat	▪ Pulses	▪ Microalgae
▪ Dairy	▪ Nuts	▪ Bacteria
▪ Eggs	▪ Seeds	▪ Mycoprotein
▪ Farmed and wild-caught fish	▪ Legumes	▪ Synthetic or laboratory-grown meat
▪ Insects	▪ Grains	

Table 2. Innovation areas addressing the sustainable protein supply question

Innovation area 1	Increasing the proportion of plant-based protein consumption with consumers
Innovation area 2	Scaling up sustainable feed innovation to meet demand for animal protein
Innovation area 3	Closing the protein nutrient loop
Innovation area 4	Developing indigenous plants as protein sources for local communities
Innovation area 5	Scaling up sustainable aquaculture for food and animal feed
Innovation area 6	Restoring soil health

As indicated earlier in this presentation, United Nation FAO (2013) statistics on global food demand and supply showed that as people become wealthier, average meat consumption per capita is expected to increase by 29% from 40.0 kg in 2013 to 51.5 kg in 2050. Also, a corresponding increase in global meat production from 288 million tons in 2013 to 494 million tons in 2050 is needed. The implication is that production of farmed animals including ruminants (beef cattle, sheep, and goat), and monogastric (swine and poultry) must be scaled up.

Animal feed has proven to be a key input factor in the production of livestock in Nigeria where housing is simple and not elaborate because of the prevailing hot climatic condition of the country. Indeed, the cost of feeding accounts for about 70% or more of the total production cost in the case of monogastric animals. In addition, they compete with humans for food because of the simplicity of their digestive systems and the similarity with that of man. Cereal grains and soybean constitute the major ingredients in their feeds. Meanwhile, global supply of these ingredients is expected to be relatively stagnant between 2013 and 2050 (FAO, 2013).

The feeding of the ruminant animals is a different scenario where the animals are capable of consuming human inedible plants such as pasture grasses in the fresh and ensiled forms and agricultural byproducts and wastes such as soybean hulls, beet pulp, brewers dried grains, and distillers dried grains. They, therefore, have the advantage of converting low-quality grasses and agricultural waste materials to high-quality animal products. The problem of ruminant feeding in this country is mainly non-availability of the pastures all the year round. The problem is more pronounced in the dry arid regions of the country.

The picture of livestock production using low-quality forages and feed ingredients as summarized by Wu et al. (2014) is illustrated in Figure 3. Also, the illustration explains Intervention area 2, which is the 'Scaling up sustainable feed innovation to meet the demand for animal protein'. The figure therefore serves a useful purpose for the description of an aspect of my research contribution, which will be explained shortly.

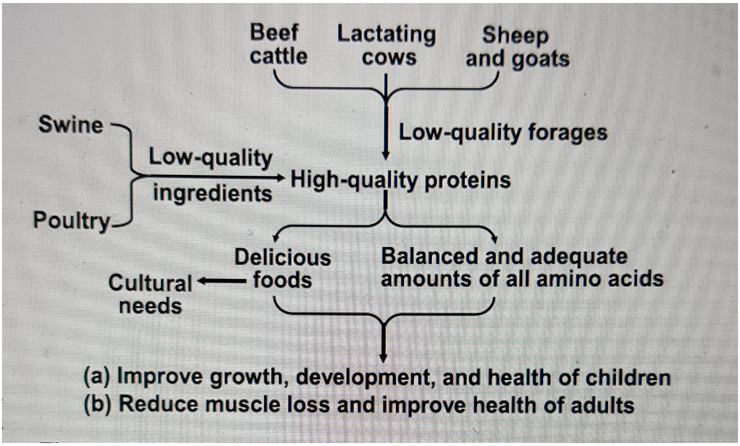

Figure 3. Nutritional perspectives of land-based production of animal Protein (Wu, et al., 2014)

My research contributions towards improvement in the supply of quality protein to the teeming Nigerian populace can be described under the following:

1. Search for indigenous plants with potentials for being protein sources for local communities;
2. Use of Physic nut (*Jatropha curcas*) and Palm kernel meal as sources of protein hydrolysates (amino acids) in foods;
3. Reduction of production cost through the use of cheaper, locally available, and lesser-known feeding stuff in animal feeding (i.e. sourcing of cheaper alternative feeding stuffs for livestock production); and
4. Optimizing utilization of cheaper alternative feeding stuffs in broiler chickens feeding through vitamin supplementation.

1. Search for indigenous plants with potentials for being protein sources for local communities

Legume seeds offer protein cost advantage over animal protein in human nutrition particularly in countries, including Nigeria, where animal protein is expensive and is in short supply (Nestec, 1987). Therefore, as part of the efforts made to solve the problem of low protein intake in Nigeria, nutritionists have advocated increased consumption of food legumes, such as cowpea (*Vigna unguiculata*) and soybean (*Glycine max*) in the campaign. Yet unexploited is the utility of the seeds of pigeon pea (*Cajanus cajan*), whose cultivation is well supported by the soil and prevailing climatic conditions of the western region of Nigeria. Indeed, in this geographical zone of the country, the seeds are boiled and eaten by natives (Oyenuga, 1968; Kay, 1979).

Like other legumes, the need for dealing with the anti-nutritional principles in pigeon pea has been noted in earlier studies (Batra et al., 1986). Legume seeds contain anti-nutritional factors, such as enzyme inhibitors, phytates, oxalates, saponins and polyphenolic compounds, all of which, limit their utilisation (Liener, 1980). However, remarkable improvements in the nutritive value of the seeds have been achieved by dehulling, heat treatment, partial hydrolysis by proteolytic enzymes, and germination (Bansal et al., 1988; Barroga et al., 1985; Batra et al., 1986; Elemo et al., 1998; Haider, 1981; Shastry & John, i991).

Consequently, Oloyo (2002) subjected raw seeds of pigeon pea to soaking, cooking, autoclaving, and germination and then analysed the raw and processed seeds for proximate composition, calcium, magnesium, phosphorus, manganese, iron, copper, structural carbohydrates, nutritive and non-nutritive matter and certain anti-nutritional factors (phytic acid, total oxalate, tannins, total phenolics and trypsin inhibitor activity) in order to determine the effects of processing methods on the nutritional potential on the seeds. The results in Table 3 indicated that soaking, cooking, and autoclaving improved the calorific value of the seeds, and that cooking and autoclaving significantly lowered the levels of anti-nutritional factors in the seeds.

The results of a further study conducted by Oloyo (2004) on pigeon pea (Table 4) indicated that germination significantly altered the nutrient composition of the seed, causing a marked increase in the calorific value. Crude protein, soluble carbohydrate, cellular and organic cellular contents, cellulose, lignin, non-nutritive matter, total oxalate and phytic acid contents of the seed were negatively correlated with germination, whereas the reverse was the case with the seed's contents of fat, crude fibre, total ash, soluble ash, acid-insoluble ash, cell wall carbohydrate, hemicellulose, iron, manganese, calcium, magnesium, copper, phosphorus, food energy; digestible energy, tannins, total phenolics, and trypsin inhibitory activity. It was concluded that the increased contents of tannins,

Table 3. Effect of processing techniques on the nutrient composition and nutritional quality of Pigeon pea (*Cajanus cajan*)⁺

Constituent	Processing method				
	Raw	Soaking	Cooking	Autoclaving	±SEM**
CP, %	21.85	21.32	21.69	21.01	0.189
Fat, %	2.70	2.28	2.23	2.42	0.105
Fibre , %	8.30	7.85	7.25	7.85	0.215
Ash, %	4.60	3.20	3.40	4.15	0.326
NFE, %	62.55	65.35	65.43	64.57	0.670
Energy, Kcal/100g	361.90b*	367.20a	368.55a	364.10a	1.503
Ca, mg/100g	140.00a	127.00b	118.20c	138.65a	5.159
Mg, mg/100g	88.86a	79.62b	66.98c	87.26a	4.992
P, mg/100g	290.00a	268.75b	251.10c	288.38a	9.190
Mn, mg/100g	2.94	2.92	2.54	2.87	0.094
Fe, mg/100g	5.52	5.16	5.32	5.30	0.074
Cu, mg/100g	1.06	1.05	0.99	1.03	0.015
DE(Kcal/100g)	368.33b	368.90ab	368.77ab	371.34a	0.679
Phytic acid, mg/100g	810.50a	126.68b	132.52b	127.02b	170.445
Oxalate, %	15.40a	4.15b	5.42b	5.36b	2.622
Tannins, mg/100g	2.23a	0.42c	0.96b	1.02b	0.362
Total phenolics, μg/100g	22.75a	24.05a	4.25b	3.79b	5.602
TIA	15.42a	16.86a	0.00b	0.00b	4.668

*Mean values denoted by different subscripts in a row differ significantly (P>0.05)
**SEM, standard error of the mean
⁺Oloyo (2002)

total phenolics and trypsin inhibitory activity of the seed during the progressive germination might limit its nutritive quality. A way out of this problem, therefore, is the application of a combination of treatments on the pigeon pea seeds prior consumption.

In another study conducted on two different cultivars of pigeon pea developed at the Institute of Tropical Agriculture, Ibadan, Oloyo (2004) noted that protein fractions of the seeds of both cultivars were not significantly different except in the glutelins contents where

Table 4. Effect of germination on the nutrient composition and nutritional quality of Pigeon pea (*Cajanus cajan*)[+]

Constituent	Germination (days)						
	0	1	2	3	4	5	±SEM**
Crude protein, %	21.9a*	20.4a	18.8b	17.3b	16.5c	15.3d	1.02
Fat, %	2.70d	3.58d	4.99c	5.35c	6.63b	7.98a	0.790
Fibre, %	8.30	8.61	8.80	9.36	9.26	9.46	0.190
Ash, %	4.60c	4.86c	5.94b	6.55b	7.56a	7.82a	0.548
NFE, %	62.6a	62.5a	61.5b	61.5b	60.0c	59.5c	0.518
Energy, Kcal/100g	362.0c	364.0bc	366.0b	363.00c	366.0b	370.78a	1.27
Ca, mg/100g	140c	142c	164b	170a	172a	170a	6.01
Mg, mg/100g	88.9b	89.0b	92.0b	100ab	104a	108a	3.34
P, mg/100g	290d	290d	298c	310b	319a	321a	5.17
Mn, mg/100g	2.94	3.10	2.98	3.16	3.11	3.15	0.037
Fe, mg/100g	5.52d	5.55d	6.63c	7.18c	8.51b	9.69a	0.678
Cu,mg/100g	1.06	1.09	1.14	1.13	1.12	1.14	0.013
DE, Kcal/100g DM	364b	368ab	368ab	372a	372a	374a	1.53
Phytic acid (mg/100g)	811a	748b	575c	485d	306e	237f	94.20
Total oxalate, %	15.4a	12.3ab	10.3b	7.18c	3.08d	2.06d	2.142
Tannins, mg/100g	2.23b	0.50c	0.42c	1.89b	2.56b	4.28a	0.587
Total phenolics, μg/100g	22.8e	31.7d	57.1c	85.4b	114.0a	115.0a	16.3
TIA	15.4d	16.0d	19.3c	23.6b	25.3b	39.8a	3.68

*Mean values denoted by different subscripts in a row differ significantly (P>0.05)
**SEM, standard error of the mean
[+]Oloyo (2004)

CITA-2 contained a significantly higher amount. The proteins are similar to those of cowpeas (*Vigna unguicuilata)*, lentil (*Lens culinaris*), pea (*Pisum sativum*), lima bean (*Phaseolus lunatus*), chickpea (*Cicer arietinum*), *Vigna capensis*, and *Vigna sinensis* in that they contain more globulins plus a small quantity of albumins (Kay, 1979; Mohan and Janardbanan, 1993).

Indeed, the composition of the proteins of the seeds of pigeon pea cultivars investigated in the study compared favourably with those of Vigna capensis and Vigna sinensis (Mohan and Janardhanan, 1993). Also, there was no remarkable difference in the physical properties of the cultivars. Ranges of seed weight and volume of pigeon pea cultivars were similar to those reported for soybean and cowpea (Kay, 1979), but less than those of chickpea and lima bean (Kay, 1979; Attia' et al., 1994) and higher than those of lentil (Kay, 1979). While the seeds of pigeon pea and lima bean had similar apparent density, the latter had higher hydration and swelling coefficients (Attia et al., 1994). The seed coat (as a percent of the whole seed) of pigeon pea was similar to that of lima bean, but lower than that of cowpea, and was about twice that of chickpea (Kay, 1979; Attia et al., 1994). The results are presented in Table 5.

Table 5. Physical properties and protein fractions of the pigeon pea cultivar⁺

Parameter	**Pigeon pea cultivars**		
	CITA-2	**CITA-3**	**±SEM****
Physical properties			
100 Seed weight, g	10.60	10.65	0.025
100 Seed volume, cm^3	9.00	9.03	0.015
Apparent density, g/ cm^3	1.18	1.18	0.000
Seed coat, %	7.95	8.12	0.085
Hydration coefficient	178.00	181.00	1.500
Swelling coefficient	206.00	211.00	2.500
Protein fractions, g/100g DM			
Total (true) protein	17.99	18.52	0.265
Albumins	3.48	3.58	0.050
Globulins	12.19	13.14	0.475
Prolamins	1.16	1.19	0.015
Glutelins	1.16a*	0.59b	0.285

*Mean values denoted by different subscripts in a row differ significantly (P>0.05)
**SEM, standard error of the mean ⁺ Oloyo (2004)

The research findings revealed that pigeon pea can be added to the list of legumes such as cowpea and soybean that have been earlier targeted in the campaign for increased consumption to prevent the incidence of protein malnutrition among the populace. However, the acceptability of pigeon pea seeds as ingredients in prepared foods requires knowledge of its physical and functional properties. Consequently, Oloyo and Akoja (2003) investigated the intrinsic physicochemical properties of pigeon pea seeds with a view to providing information that will assist in predicting useful applications of the seed flour in prepared foods. The results in Table 6 indicated that although pigeon pea seed weight, volume, and density were in the range reported for some commonly consumed seed legumes, the seed exhibited lower hydration and swelling coefficients. The seed flour was a good gel-forming agent, more hydrophobic but less lipophilic in nature, and it had poor foaming qualities and poor emulsion stability. Furthermore, its protein showed the least solubility at pH 4.0.

Table 6. Functional properties of pigeon pea seed flour[+]

Parameter	Mean	±SD*
Least gelation concentration, %	8.00	0.592
Water absorption capacity, %	409.00	12.098
Oil absorption capacity, %	251.00	9.162
Foaming capacity, %	9.81	1.827
Emulsion capacity, %	20.93	1.021
Emulsion stability, %	42.50	2.010

**SD, standard deviation
[+] Oloyo and Akoja (2003)

The pigeon pea seed flour, being a very good gel-forming agent, will find useful application in the preparation of 'ogi' where it will aid gelling of the maize powder. Besides, its amino acids contents will complement those lacking in the maize powder thus improving the protein quality of 'ogi' – a high carbohydrate-low protein food. Also, being hydrophobic in nature, the pigeon pea seed flour when mixed with the dry 'ogi' powder will aid drying and thus extend the keeping quality. The improvement in the content and quality of protein in 'ogi' due to pigeon pea flour inclusion will be of great significance in the improvement of protein nutrition of the undernourished children. 'Ogi' is a staple food of this group of Nigerians.

Bread, a wheat-based product, is another staple food highly cherished by children and the hustling Nigerians. Fortification of its protein content and quality may represent a route to improve the protein nutrition of the people. Unfortunately, pigeon pea seed flour may not be useful in bread baking because of its poor foaming quality. The particles of the latter are heavy and do not give effervescence. However, the flour may improve protein quality of doughnut, another wheat flour-based products because of the high lipophilic character of the former. Oil frying is involved in the preparation of doughnut.

2. Use of Physic nut (*Jatropha curcas*) and Palm kernel meal as sources of protein hydrolysates (amino acids) in foods

Protein hydrolysates obtained from both animal and vegetable protein sources find useful application in the food industry where they are utilized as condiments and amino acid sources in diets (Meister 1965). The high production cost of hydrolysates associated with animal protein sources particularly in the developing countries including Nigeria where animal production is low has made popular the use of vegetable sources (Pham and del Rosario, 1983). Our intervention here concerned investigation of the possible use of physic nut and palm kernel meal as cheaper vegetable sources of the protein hydrolysates. In several trials, we determined optimum conditions for the acid hydrolysis of palm kernel meal and physic nut meal proteins (Oloyo and Ilelaboye, 2003). The vegetable protein sources selected were chosen in view of their relatively high availability in the country and the low-cost protein advantage that they offer.

Physic nut tree (*J. curcas*) is an oleaginous shrub that grows spontaneously and under cultivation in dry tropical countries and in humid equatorial regions. Although it prefers cool soils, it grows vigorously with little or no care on arid escarpments and can adapt to long periods without rain. The seed is a good source of curcas oil used as fuel oil and for the manufacture of soap, illumination, and lubricating in the wood industry. In Nigeria, the tree is planted only as hedging plant for demarcating boundaries in the households and as a windbreak and barrier against erosion on farmlands (Nir 1988).

Kernels and seeds of freshly harvested palm fruits and J. curcas fruits, respecively were oven dried at 80°C for 24 h, milled, defatted, and subsequently subjected to hydrolysis trials conducted to determine optimum conditions for production of protein hydrolysates. Results in Table 7 show the regression equations describing the relationship between the yield of hydrolysates and conditions of acid hydrolysis. We achieved hydrolysis of physic nut seed protein with minimal amino destruction using 6 moles dm^{-3} HCl at 95°C for 18 h or with to 8 moles dm^{-3} H_2SO_4 at 95°C for 18 h. Optimum hydrolysates yield (g amino acid-N/100g) was obtained from hydrolysing palm kernel meal protein with 8 moles dm^{-3} HCl at 110°C for 24 h or with 10 moles dm^{-3} H_2SO_4 at 110°C for 18 h. The choice of the hydrolyzing acid, for all practical purposes, will depend on the availability and cost (Oloyo and Ilelaboye, 2003).

3. Reduction of production cost through the use of cheaper, locally available, and lesser-known feeding stuff in animal feeding (i.e. sourcing of cheaper alternative feeding stuffs for livestock production)

Smallholder producers of ruminants, particularly sheep and goats in Nigeria rely on unimproved natural pasture as the main feed source, backed up with crop residues after harvest. The animals are confined, tethered or closely herded during the crop-growing season, but graze and browse more freely once the food crop has been harvested. This problem of inadequate nutrition is further aggravated particularly in the dry season when grassland productivity is low.

However, supplementary feeding with either concentrates or browse plants has been advocated as a remedy for improving animals' nutrition (Reynolds and Jabbar, 1994). Indeed, Reynolds and Ekurukwe (1988) noted that protein-rich supplements improved the nutrition of sheep in smallholder grass-based systems and increased resistance to diseases such as trypanosomiasis, but farmers do not have access to the feed or are unwilling to spend cash on supplements. The use of cheaper, lesser-known and unconventional supplements were thought to represents the low-cost route to the improved animal performance. In this regard, many attempts have been made, with some level of success, to evaluate the chemical

Table 7. Regression equations (lines) illustrating the relationship between yield of hydrolysates (Y) and conditions of acid hydrolysis – concentration, temperature, and duration of hydrolysis+

Sample/Parameter	Regression equation	R^{2*}	r^*
Jatropha curcas			
Yield & acid concentration, [ ]	Y = 14.825 Ln [HCl] + 68.745	0.9409	0.8885
	$Y = 30.782[H_2SO_4] + 32.747$	0.9608	0.9192
Yield & temperature, θ	$Y = -0.0344\theta^2 + 7.8158\theta - 339.66$ (in HCl hydrolysis)	0.9806	0.8929
	$Y = -0.0332\theta^2 + 7.64\theta - 335.67$ (in H_2SO_4 hydrolysis)	0.9764	.9025
Yield & time, t	$Y = 0.1007t^2 + 4.7684t + 46.188$ (in HCl hydrolysis)	0.9659	0.8332
	$Y = -0.1006t^2 + 4.764t + 45.918$ (in H_2SO_4 hydrolysis)	0.9512	0.8268
Palm Kernel Meal			
Yield & acid concentration, [ ]	Y = 17.4[HCl] + 61.244	0.9598	0.9150
	$Y = 36.471 \ln[H_2SO_4] + 11.123$	0.9898	0.9907
Yield & temperature, θ	$Y = -0.0193\theta^2 + 5.144\theta - 237.95$ (in HCl hydrolysis)	0.9166	0.9323
	$Y = -0.0026\theta^2 + 2.00538 - 105.51$ (in H_2SO_4 hydrolysis)	0.9374	0.9677
Yield & time, t	$Y = 0.1218t^2 + 6.1019t + 24.382$ (in HCl hydrolysis)	0.9234	0.8580
	$Y = -0.1054t^2 + 5.4897t + 24.722$ (in H_2SO_4 hydrolysis)	0.9890	0.9100

+Oloyo and Ilelaboye (2003)
*Significant at $P<0.05$

composition and nutritional potentials of some common legumes and browse plants as feed supplements (Akinsoyinu and Onwuka 1988; Oduguwa et al., 1997). The results of our investigation of the proximate composition and the feeding values of the seeds of *Jatropha curcas*, *Trichosanthes cucumerina*, *Annona mericulata*, and

Citrullus vulgaris shown in Table 8 revealed that with the exception of *Annona mericulata,* all seed samples were potentially good sources of dietary energy and protein supplements for ruminants (Oloyo and Ilelaboye, 2002).

Table 8. Proximate composition, energy values, and digestible protein of the lesser-known seeds+

Constituent	Seed sample				
	Jatropha cucas	*Trichosanthes cucumerina*	*Annona mericulata*	*Citrullus vulgaris*	± SEM**
Crude Protein, g/kg	315.8a*	324.5a	113.1b	307.4a	50.8
Fat, g/kg	364.8b	483.3a	381.0b	474.2a	30.8
Crude Fibre, g/kg	60.4b	48.8b	296.8a	29.3c	63.0
Ash, g/kg	29.8	34.8	32.7	37.8	1.7
Carbohydrate, g/kg	222.8a	111.9c	173.1b	151.3b	23.1
Total Energy, GE (MJ/kg)	22.9b	25.6a	19.2c	25.6a	1.5
Digestible Energy, DE (MJ/kg)	20.1a	19.5b	9.0a	21.9a	2.9
DE/GE (%)	87.9a	76.0b	46.9c	85.5a	9.42
Digestible Protein (g/kg)	261.1a	269.4a	66.5b	253.0a	48.8

*Mean values denoted by different subscripts in a row differ significantly (P>0.05)
**SEM, standard error of the mean
+Oloyo and Ilelaboye (2002)

While consolidating on our earlier findings, Ilelaboye and Pikuda (2009) investigated the minerals composition (i.e. copper, zinc, manganese, potassium, sodium, phosphorous, iron, magnesium, and calcium) and anti-nutritional principles (i.e. tannin, saponin, oxalic acid, phytic acid, nitrate, and nitrite) in the crop seeds namely, *Jatropha curcas, Trichosanthes cucumerina,* and *Citrillius vulgaris*. The objective of the work was to ascertain the adequacy of the crop seeds for mineral elements and the possible effects of anti-nutritional factors on the availability of the required nutrients. The results are presented in Table 9. The researchers concluded that the seeds are deficient in all the mineral elements excepting magnesium, hence are unable to meet the animal dietary requirement for these mineral elements. Furthermore, high levels of the natural toxicants, especially saponin, in the seeds pose a potential health hazard to the animal. Consequently, it was recommended that some form of processing was required as a pretreatment prior inclusion in the animal feed and that this needs to be investigated.

Table 9. Mineral elements and anti-nutritional factors of some-lesser known crops seeds[+]

	Jatropha curcas	*Trichosanthes cucumerina*	*Citrulis vulgaris*
Mineral element (mg/Kg DM)			
Copper	16.00c*	29.00b	43.00a
Zinc	45.00a	37.50b	33.00c
Manganese	51.70c	63.00a	58.50b
Potassium	8812.23b	8704.15b	9246.33a
Sodium	170.00c	206.13a	189.00b
Phosphorus	322.20b	338.50b	411.60a
Iron	147.00b	187.00a	113.00c
Magnesium	2376.00a	1896.00b	2394.00a
Calcium	1534.00a	164.00b	1826.00a
Anti-nutritional factor (mg/100g DM)			
Tannin	7.50c	25.30a	18.60b
Saponin	1100.00b	2097.00a	1300.00b
Oxalic acid	25.73b	17.40c	40.65a
Phytic acid	1657.50b	480.03c	2012.12a
Nitrate	9.00b	28.70a	24.60a
Nitrite	50.03b	56.40a	57.30a

*Mean values denoted by different subscripts in a row differ significantly ($P>0.05$)

[+]Ilelaboye and Pikuda (2009)

4. Optimizing utilization of cheaper alternative feeding stuffs in broiler chickens feeding through vitamin supplementation

Of all the land-farmed meat-producing livestock, chicken appears to be the most cherished worldwide for its meat. The meat is the most commonly consumed because it is a great protein source. It comes in a variety of cuts, including breasts, thighs, wings, and drumsticks. The cuts differ in their contents of protein, fat, and calories. A skinless, cooked chicken breast (172 grams) contains 54 grams of protein. This is equal to 31 grams of protein per 100 grams. One skinless, boneless, cooked chicken thigh (52 grams) contains 13.5 grams of protein. This is equal to 26 grams of protein per 100 grams.

The chicken leg has two parts — the thigh and the drumstick. The drumstick is the lower part of the chicken leg, also known as the calf. One chicken drumstick without the skin or bones (44 grams) contains 12.4 grams of protein. This is equal to 28.3 grams of protein per 100 grams. Chicken wings consist of three parts — the drumette, the wingette and the wing tip. They are often consumed as snacks or bar food. One chicken wing without the skin or bones (21 grams) has 6.4 grams of protein. This is equal to 30.5 grams of protein per 100 grams.

Broiler, the meat-type chicken, grows very fast and attains market weight in 6 to 8 weeks (Plate 5). Actually, it represents the fastest route to meeting meat supply shortages. Land space requirement for intensive production of broiler chicken is relatively lower than the requirement for cattle, sheep, goat, and pig.

Unfortunately, the ever-increasing cost of feeding has continued to pose a major threat to the development of poultry industry in Nigeria. Under the intensive system of poultry production, cost of feed, as a percentage of the total cost of production is a major item as it represents about 70% of the total cost of production. This percentage may even be higher in Nigeria where prices of feed ingredients are always on the increase, labour is relatively cheap and housing does not have to be very elaborate. This problem of high feed costs, therefore, calls for a search of alternative ingredient sources for poultry diets. However, substitution of the unconventional ingredients for the conventional ones in the diets of birds may alter micronutrients requirements of the birds. This may be due to the physical nature, and nutrient composition, digestibility and availability, as well as their effect on the gut microflora of the bird (Oloyo, 1988). This, therefore, suggests that there is the possibility that nutrient requirements of the chicken will be altered when fed with diets based on the unconventional feed ingredients.

Plate 5. Some meat-type chickens (broilers)

Inadequate supply and the high cost of vegetable protein sources, for example, groundnut cake (GNC) and soybean meal (SBM) in practical diets of chickens had been fingered as being responsible for the high feeding cost in this country. Hence research attention had continued to focus on finding suitable but cheaper alternative dietary vegetable protein source in poultry feeds. However, while finding suitable alternative cheaper feed ingredients, care must be taken to ensure optimum nutritional and health wellbeing of the chicken. It must be ensured the birds receive the required nutrients, more so that feedingstuffs differ in physical nature, chemical composition, and digestibility.

Trials with PKM and Sunflower Seed Meal (SSM) as Vegetable Protein sources in broiler ration

The low cost and relative availability of palm kernel meal (PKM) make popular its use as a substitute for GNC and SBM in the poultry feed formulation in recent times. PKM offers significant protein cost advantage in the diets. However, it is more fibrous in nature and hence its use as replacement for GNC and SBM in the chicken diets raises the question as to the B vitamins requirements of the bird (Misir and Blair, 1984). The workers observed alteration of the bird's gut microflora, which adversely affected microbial biosynthesis of B vitamins in the gut.

The vitamin/mineral premixes being used in the formulation of commercial broiler rations are expected to meet the micronutrients requirement of the bird. Their compositions and formulations have been based on estimated vitamin requirements figures obtained from small-scale laboratory experiments using purified diets supplemented with the pure vitamins. However, Whitehead & Bannister (1978) noted that the requirement figures might be modified under practical conditions. In many studies involving practical diets, the basal vitamin content and bioavailability are uncertain hence leading to variation in vitamin requirement values in the literature. Experimenting with practical feed ingredients such as maize and guinea-corn as energy sources, and palm kernel meal and sunflower seed meal as the major vegetable protein sources will provide the estimation of the actual vitamin requirement for broiler chicken in areas where the ingredients are available. Hence under the Nigerian condition, cheaper feed formula using locally available and relatively cheaper ingredients will be optimized for broiler production using the appropriate vitamin/mineral premix based on the results of studies involving the use of maize and guinea-corn as energy sources, and palm kernel meal and sunflower seed meal as the vegetable protein sources.

Hence it is imperative that the appropriate vitamin/mineral premix should be used in the feed formula incorporating cheaper and locally available feed ingredients for the optimization of broiler production in the country. My humble research intervention has been targeted at providing answers to the question of the appropriateness of vitamin/premix broiler rations having maize, guinea-corn, palm kernel meal, and sunflower seed meal.

Experimenting with maize and palm kernel meal inclusion in the practical ration, broiler chicken requirements for biotin (Oloyo and Ogunmodede, 1989; 1990; 1991 & 1996) and niacin (Oloyo, 2000) were established. The requirements for the vitamins were established based on biochemical, productive, and health performance of the chicken as shown in the results presented in Tables 10 and 11.

Table 10. Performance of broiler chicks fed maize-PKM based ration supplemented with graded levels of biotin at 28 days[+]

Parameter	Biotin, µg/Kg feed				
	80	120	160	200	±SEM**
Productive performance					
Daily Feed intake/bird, g	34.88	39.39	38.96	40.34	0.86
Daily weight gain/bird, g	9.25b*	11.85a	10.91a	10.95a	0.04
Feed efficiency	0.27b	0.30a	0.28a	0.27a	0.01
Carcass weight, g	258.59	332.36	314.53	343.40	14.10
Dressing %	64.46b	68.92a	66.62a	69.23a	0.96
Total meat, g	165.61bc	212.85a	206.23ab	230.58a	10.03
Total bone, g	91.78	116.16	106.08	111.83	4.18
Meat : Bone ratio	1.81	1.84	1.95	2.05	0.04
Health performance					
Dermatitis, %	45.0b	10.0c	2.5d	2.5d	10.16
FLKS mortality, %	7.5b	5.0c	0.0d	0.0d	1.88
Incidence of leg deformities, %	5.0b	2.5c	0.0d	0.0d	1.20
Size of hock joint, cm	4.4	4.5	4.5	4.6	0.07
Tibia weight, g	3.5ab	3.9a	3.7a	3.8a	0.17
Tibia length, cm	6.1	6.3	6.3	5.9	0.06
Tibia ash, %	39.5bc	38.7c	38.9c	39.5bc	0.39
Biochemical performance					
Liver, g	9.11	8.29	7.90	8.00	0.274
Liver, % of live weight	3.33a	2.70b	2.59b	2.78b	0.165
Liver lipid, mg/g	254.14b	169.95c	160.95c	163.05c	22.455
Kidney, g	3.51	3.09	3.14	3.13	0.098
Kidney, % of live weight	1.29a	1.01b	1.03b	1.09b	0.064
Kidney lipid, mg/g	332.55a	189.73b	196.28b	187.39b	35.404

*Mean values denoted by different subscripts in a column differ significantly (P>0.05)

**SEM, standard error of the mean

[+]Oloyo and Ogunmodede (1989, 1990, 1991 & 1996)

Table 11. Performance of broiler chicks fed maize-PKM based ration supplemented with graded levels of niacin at 42 days+

Parameter	Niacin, mg/Kg feed					
	22.5	30.0	37.5	45.0	52.5	±SEM**
Feed utilization						
Body Wt, g	1204.1b*	1279.5b	1590.4a	1552.8a	1569.6a	96.85
Daily Feed intake/bird, g	88.0b	91.2b	117.0a	112.6a	113.8a	6.60
Daily weight gain/bird, g	27.6b	29.4b	36.8a	35.9a	36.3a	2.31
Feed efficiency	0.31	0.32	0.31	0.32	0.32	4.949E-03
Carcass						
Carcass wt, g	759.8b	835.5b	1094.2a	1073.0a	1087.7a	82.64
Dressing %	63.1b	65.3ab	68.8a	69.1a	69.3a	1.38
Total edible meat, g	484.0bc	566.5b	745.2a	732.9a	735.3a	62.69
Meat, % of carcass Wt	63.7b	67.8a	68.1a	68.3a	67.6a	1.03
Total bone, g	246.9b	243.1b	326.0a	317.6a	330.6a	21.62
Bone, % of carcass Wt	32.5a	29.1b	29.8b	29.6b	30.4b	0.67
Meat : Bone ratio	1.96b	2.33a	2.29a	2.31a	2.22a	0.08
Abdominal fat pad, g	28.9a	25.9ab	23.0b	22.5b	21.8b	1.31
Abdominal fat, % of carcass Wt	3.8ab	3.1b	2.1c	2.1c	2.0c	0.41
Deficiency symptoms						
Dermatitis,%	4b	0c	0c	0c	0c	1.77
Leg deformity, %	2b	0c	0c	0c	0c	1.05
Nutrient utilization						
Nitrogen retention, %	54.8b	65.6a	67.8a	66.2a	66.7a	2.76
ME, Kcal/kg	2774.2b	2884.6a	2865.5a	2890.4a	2876.0a	27.04
Calcium retention, %	67.4b	72.9a	72.6a	74.8a	73.2a	1.65
Phosphorus retention, %	58.6c	64.8b	74.1a	72.5a	72.6a	3.62

*Mean values denoted by different subscripts in a column differ significantly (P>0.05)
**SEM, standard error of the mean; +Oloyo (2000)

In other feeding trials, guinea-corn was used to replace maize as the energy source in broiler practical ration because maize is the energy source in the southern region of the country, whereas guinea-corn is the most common energy source in the northern part. Meanwhile, I retained PKM as the vegetable protein source in the ration for obvious reason. Consequently, I was able to establish the broiler chicken requirement for biotin Oloyo (1991), niacin (Oloyo, 1997), folic acid (1999), and pyridoxine (Oloyo, 2001) with practical ration formulated with guinea-corn and PKM. The results of the feeding trials are presented in Tables 12, 13, 14, and 15, respectively.

Table 12. Performance of broiler chicks fed guinea corn-PKM based ration supplemented with graded levels of biotin at 42 days+

Parameter	Supplemental Biotin, mgkg^{-1} feed					
	0.08	0.12	0.16	0.20	0.24	±SEM**
Biotin-related features						
Dermatitis, %	50.0ab	10.0bc	2.5c	0.0c	0.0c	11.21
FLKS mortality, %	10.0ab	7.5b	5.0bc	0.0c	0.0c	1.94
Leg deformities, %	7.5ab	5.0bc	5.0c	0.0c	0.0c	1.81
Feed utilization						
Daily Feed intake/bird, g	85.58b	92.00b	93.72b	109.86a	109.28a	4.10
Daily weight gain/bird, g	22.26b	25.76b	25.30b	32.90a	31.60	1.62
Feed efficiency	0.26	0.28	0.27	0.30	0.29	0.005
Carcass						
Carcass weight, g	561.0b	581.0b	689.0a	706.8a	678.4a	28.04
Dressing %	62.6b	63.5b	68.8a	69.0a	68.9a	1.36
Total edible meat, g	363.4b	375.8b	447.2a	471.2a	454.4a	19.71
Meat, % of carcass weight	64.8b	64.7b	64.9b	66.7a	66.1a	0.29
Total bone, g	197.6b	205.4b	241.8a	235.6a	233.0a	8.44
Bone, % of carcass weight	35.2a	35.3a	35.1a	33.3b	33.9b	0.29
Meat : Bone ratio	1.84b	1.83b	1.85b	2.00a	1.95a	0.02
Biochemistry						
Pyruvate carboxylase activity, units/g liver	6.7bc	11.1ab	14.3a	14.8a	14.5a	2.00

*Mean values denoted by different subscripts in a column differ significantly

(P>0.05)
**SEM, standard error of the mean
+Oloyo (1991)

Table 13. Responses of broiler chicken fed guinea corn-PKM based ration to supplemental niacin, mg/Kg feed from 1-42 days of age+

Parameter	Niacin, mg/Kg feed					
	7.5	15.0	22.5	30.0	37.5	±SEM**
Feed utilization						
Body Wt, g	1120.8b	1150.1b	1183.3b	1540.9a	1549.1a	101.95
Daily Feed intake/bird, g	84.8b	84.2b	91.7b	110.6a	112.1a	6.23
Daily weight gain/bird, g	25.7b	26.4b	27.2b	35.7a	35.9a	2.43
Feed efficiency	0.30	0.30	0.30	0.32	0.32	0.32
Carcass						
Carcass Wt, g	687.1c	694.7c	824.8b	1081.7a	1072.0a	90.88
Dressing %	61.3b	60.4b	69.7a	70.2a	69.2a	2.14
Total edible meat, g	442.5c	442.5c	570.8b	744.2a	739.7a	70.12
Meat, % of carcass wt	64.4b	63.7b	69.2a	68.8a	69.0a	1.28
Total bone, g	219.7b	228.2b	228.8b	312.9a	307.3a	21.28
Bone, % of carcass wt	32.0a	32.8a	27.7b	28.9b	28.7b	1.05
Meat : Bone ratio	2.01b	1.94b	2.49a	2.38a	2.41a	0.12
Abdominal fat pad, g	24.9	24.1	25.2	24.6	25.0	0.24
Abdominal fat, % of carcass wt	3.6a	3.5a	3.1a	2.3b	2.3b	0.89
Health						
Dermatitis, %	4.0b	0.0c	0.0c	0.0c	0.0c	1.46
Leg deformities,%	2.0b	2.0b	0.0c	0.0c	0.0c	1.03
Nutrient utilization						
N retention,%	52.6b	53.7b	60.4ab	67.6a	68.2a	3.39
ME, Kcal/kg	2770.6b	2752.3b	2816.1a	2858.7a	2846.5a	23.90
Ca retention, %	64.0b	66.1b	72.6a	74.2a	73.4a	2.16
P retention, %	52.6c	54.8c	68.2b	73.5a	74.1a	4.69

*Mean values denoted by different subscripts in a column differ significantly (P>0.05)
**SEM, standard error of the mean; +Oloyo (1997)

Table 14. Effect of folic acid supplementation on growth, leg disorders, haematology, nutrient utilization, and carcass characteristics of broilers up to 42 days of age+

Parameter	Supplemental folic acid, ppm					
	0.25	**0.50**	**0.75**	**1.00**	**1.25**	**±SEM****
Feed utilization						
Live weight, g	1122bc	1164b	1534a	1550a	1546a	102.79
Daily weight gain/bird, g	25.8b	26.8b	35.6a	36.0a	35.9a	2.45
Daily Feed intake/bird, g	78.3b	81.1b	110.7a	108.6a	112.6a	7.77
Feed efficiency	0.33	0.33	0.32	0.33	0.32	2.42E-03
Carcass						
Carcass wt, g	712.5b	802.0b	1061.5a	1057.1a	1066.7a	83.26
Dressing %	63.5b	68.9a	69.2a	68.2a	69.0a	1.42
Edible meat, g	446.0c	542.2b	723.9a	723.1a	726.4a	62.73
Meat, % of carcass wt	62.6b	67.6a	68.2a	68.4a	68.1a	1.02
Total bone, g	266.5b	259.8b	337.6a	334.0a	340.3a	21.07
Bone, % of carcass wt	37.4a	32.4b	31.8b	31.6b	31.9b	1.02
Meat : Bone ratio	1.67b	2.09a	2.14a	2.16a	2.13a	0.09
Health						
Leg disorders, %	2.5b	2.5b	0c	0c	0c	1.24
Haemoglobin, $g/100cm^3$	4.58b	8.10a	8.26a	8.00a	8.21a	0.93
PCV, %	13.1b	28.9a	28.5a	29.4a	29.6a	4.00
RBC, $10^6/mm^3$	0.64b	2.19a	2.17a	2.20a	2.17a	0.36
Nutrient utilization						
Nitrogen retention, %	59.8b	65.9a	65.6a	67.8a	66.2a	2.10
Lipid retention, %	66.4b	78.1a	82.3a	79.0a	81.5a	3.16
ME, Kcal/kg	2738b	2854a	2852a	2846a	2856a	23.70

*Mean values denoted by different subscripts in a column differ significantly (P>0.05)
**SEM, standard error of the mean
+Oloyo (1999)

Table 15. Effect of dietary supplemental pyridoxine on feed utilization, nutrient retention, carcass characteristics, and health performance of broiler chicks at 42 days

Parameter	Pyridoxine, mg/Kg feed					
	4.5	5.0	5.5	6.0	6.5	±SEM**
Feed utilization						
Live weight, g	914.4c*	976.4bc	1053.0bc	1313.4a	1300.8a	84.66
Daily weight gain/bird, g	20.7b	22.2b	24.0b	30.2a	29.9a	2.01
Daily Feed intake/bird, g	81.8b	83.5b	87.8b	98.6a	100.6a	4.18
Feed efficiency	0.25b	0.27b	0.27b	0.31a	0.30a	9.9E-03
Carcass						
Carcass weight, g	567.8b	603.4b	688.7b	895.7a	898.9a	72.15
Dressing %	62.1b	61.8b	65.4a	68.2a	69.1a	1.49
Edible meat, g	359.4b	379.0b	442.1b	595.7a	599.5a	53.13
Meat, % of carcass weight	63.3b	62.8b	62.4ab	66.5a	66.7a	0.85
Total bone, g	208.4b	224.5b	246.5b	300.1a	299.3a	19.14
Bone, % of carcass weight	36.7a	37.2a	35.8ab	33.5b	33.3b	0.85
Meat : Bone ratio	1.72b	1.69b	1.79b	1.99a	2.00a	0.07
Health & Biochemistry						
Mortality, %	5.00a	2.50b	0.0c	0.0c	0.0c	1.23
Haemoglobin, g/100cm^3	2.90c	4.76b	7.89a	8.20a	8.24a	0.97
PCV, %	7.2c	12.8b	27.4a	28.1a	28.0a	3.93
Aspartate aminotransferase activity, units/cm^3 in:						
Serum	118c	121bc	172a	174a	182a	12.42
Liver	243b	239b	396a	314a	311a	16.10
Nutrient retention						
N retention, %	54.6b	55.2b	56.5b	62.9a	62.08a	1.94
Lipid retention, %	69.2c	74.1b	80.8ab	83.1a	82.9a	2.56
ME, Kcal/kg	2750.2b	2755.0b	2784.4b	2849.1a	2843.5a	20.89

*Mean values denoted by different subscripts in a column differ significantly (P>0.05)
**SEM, standard error of the mean
+Oloyo (2001)

The fibrous, gritty, and dry nature of PKM limits its inclusion in the diets of simple-stomached animals. It renders the diets unpalatable and caused a considerable increase in salivation during chewing. Consequently, in our research, attempts were made to reduce the grittiness, dryness, and dustiness of the PKM-based ration by the inclusion of palm kernel oil (PKO) prior determination of the vitamin requirement of broiler chicks. More so that available literature is suggestive of dietary fat affecting vitamin B requirements of the chicken (Oloyo and Ogunmodede, 1998a).

In a feeding trial conducted to study the effect of feeding supplemental PKO on the biotin requirement of broiler chicken fed with maize-PKM based ration, Oloyo and Ogunmodede (1998b) observed that 2% supplemental PKO affected the minimum biotin requirement and the appearance of biotin deficiency symptoms. The incidence of dermatitis, mortality due to fatty liver and kidney syndrome, and leg deformities were lower in presence of the oil supplement. A lower amount of biotin (120 µg/Kg feed) was required in the presence of supplemental PKO as compared with that needed (160 µg/Kg feed) to prevent biotin deficiency symptoms in chicks fed rations without supplemental oil. Feed utilization data indicated that 120 µg/Kg feed was required to promote better feed intake and body weight gain whether or not supplemental PKO was fed. The results of the study are summarized in Tables 16 and 17.

Table 16. Performance of broiler chicks fed graded levels of palm kernel oil and biotin at 28 days of age⁺

Parameter	PKO main effect*		Biotin main effect⁺⁺ / level, µg/Kg feed			
	0%	2%	80	120	160	±SEM**
Biotin-deficiency						
Dermatitis, %	20.0e	13.8f	37.5a	6.3b	2.5c	6.05
FLKS mortality, %	3.3e	1.7f	5.0a	1.3b	0.0c	1.04
Leg deformities, %	2.5e	1.7f	5.0a	1.3b	0.0c	0.71
Feed utilization						
Live weight, g	287.3e	259.7f	251.8b	298.0a	283.8a	7.24
Daily Feed intake/bird, g	27.90e	24.33f	23.42b	27.40a	27.07a	0.70
Daily weight	8.83e	7.84f	7.57b	9.22a	8.71a	0.25

gain/bird, g						
Feed efficiency	0.32	0.32	0.33	0.34	0.32	3.62E-03
Biochemistry						
Liver, g	8.42	7.28	7.81	7.90	7.62	0.228
Liver lipid, mg/g	201.1e	173.0f	218.7a	168.8b	163.4b	12.09
Kidney, g	3.23	3.08	3.16	3.28	3.20	0.068
Kidney lipid, mg/g	240.9e	192.2f	263.5a	179.2bc	191.5b	16.29
Blood free fatty acid, mg/l	0.60f	0.68e	0.73a	0.55b	0.53b	0.048
Blood glucose, mg/ml	0.76f	0.86e	0.69c	0.76b	0.87a	0.040

*PKO main effect means in a row with no common subscripts differ significantly (P>0.05)

++Biotin main effect means in the same row with no common subscripts differ significantly (P>0.05)

**SEM, standard error of the mean

+Oloyo and Ogunmodede (1998b)

Table 17. Carcass characteristics of broiler chicks fed graded levels of palm kernel oil and biotin at 42 days of age+

Parameter	PKO main effect*		Biotin main effect++ / level, μg/Kg feed			
	0%	2%	80	120	160	±SEM**
Carcass Wt, g	311.90	292.46	258.59b	332.36a	314.54a	14.10
Dressing %	66.08	67.12	64.46bc	68.92a	66.62ab	0.96
Total edible meat, g	199.49	188.88	165.61b	212.85a	206.23a	10.03
Meat, % of carcass wt	65.36	64.49	63.46	63.88	65.71	0.51
Total bone, g	102.86	101.65	91.78c	116.16a	106.08ab	4.18
Bone, % of carcass wt	34.07	34.83	36.01	35.10	33.84	0.46
Meat : Bone ratio	1.93	1.89	1.81	1.84	1.95	0.04

*PKO main effect means in a row with no common subscripts differ significantly (P>0.05)

++Biotin main effect means in the same row with no common subscripts differ significantly (P>0.05)

**SEM, standard error of the mean

+Oloyo and Ogunmodede (1990)

The consistently and significantly lower levels of liver weight and lipids in liver and kidney in groups of birds fed diets with added oil indicated reduced lipid deposition in these organs. Hill et al. (1958) reported that as little as 2.0%fat in the diet resulted in measurable depression of lipogenesis in rat livers as measured by the incorporation of acetate into fatty acid. Depression in hepatic lipogenesis in the rat by fat feeding was identified to be enzymatic in nature and thus indicated that the block was localized at the step involving the carboxylation of acetyl CoA (Bortz et al. 1963). Whitehead et al. (1978) reported that liver pyruvate carboxylase, a biotin-dependent enzyme, activity was low in birds fed diet causing a high incidence of FLKS, but the addition of fat to this diet reduced the metabolic need for lipogenesis; this, in turn, reduced the activity of another biotin-dependent enzyme, acetyl CoA carboxylase. This enzyme seemed able to sequester biotin preferentially, thus a decrease in its activity allows more biotin to be available for pyruvate carboxylase. This explains why the oil inclusion, in the ration reduced the dietary biotin requirement of the chicken. Consequently, 120mcg biotin/kg is needed in the presence of 2% dietary palm kernel oil, whereas 160mcg of the vitamin is needed when no supplementary oil is added to the ration. The use of oil and the level of biotin to be fed will depend on the relative cost and availability of both of them.

Significantly higher vitamin requirement values obtained when guinea corn replaced maize, as the energy source in broiler chicken was consistent with the findings of Ogunmodede (1978); and it might be due to the differences in the physicochemical properties of both cereal grains. Although guinea corn contains more protein, the grain is smaller, harder, and more fibrous.

Sunflower (*Helianthus annuus*) is cultivated globally for their nutritious edibles oil. Usually, the seed contains about 46-52% edible oil. Robinson et al. (1975) observed along with soybean, peanut, and rapeseed, sunflower is one of the world most important annual crops grown for edible oil. The oil is superior to other vegetable oil because of its high linoleic acid content. Besides, it seeds oilcake is rich in protein and is used for livestock feeding.

The plant is a member of the Asteraceae family. It is an annual, herbaceous, erect, and broadleaf (rough on both surfaces) plant with a strong taproot. When fully grown, it reaches up to 4 to 6 feet tall and three flower heads are up to 5 inches across and have yellow, pleated rays and a red-brown central disk (Plates 6 and 7). Generally, a single head produces 400-20000 seeds. Sunflower seeds are pointed at base and round at the end. Seeds colour varies from black to white (Some seeds may be found in brown/striped colour as well (Plate 8).

Plate 6. Sunflower plant

Plate 7. Sunflower

Plate 8. Sunflower seeds

The plant, although a temperate crop, has been found to fit well into Nigeria farming systems. It was introduced to Nigeria as an alternative oil crop to existing oil crops. However, each cultivar of the plant has different best sowing dates in southern Nigeria, referred to as cultivar and sowing dates interaction. For instance, "Peredovik" produced its best yield when sown in early July as a late-season crop, whereas "Russians Giant" yielded most when sown during the first week of August. (Ogunremi, 1979a,b).

Oloyo (1994) experimented with Sunflower Seed Meal (SSM) as the vegetable protein source in the practical broiler ration. In this case, dehulled and non-dehulled SSM were used in combination with maize as the major energy source. With our experience on the effect of dietary fibre on the micronutrient requirements of the chicken, I started experimentation with the determination of biotin requirement of broiler chicken when fed practical rations containing dehulled and non-dehulled SSM. Results obtained are presented in Tables 18a,b. Estimation of the live weights, live weight gain, feed intake, blood glucose and free fatty acid concentrations, lipid contents and weight of liver and kidney, and liver pyruvate carboxylase activity, and the records of incidence of dermal lesions, fatty liver and kidney syndrome mortality, and leg deformities indicated that in the case of dehulled SSM, dietary biotin of 160 µg/Kg feed was marginal while at least 200 µg/Kg feed appeared to be needed for optimum performance of the birds. When non-dehulled SSM was incorporated in the diet, 200 µg/Kg feed was found to be the lowest dietary level needed. However, as it seems that better results could be obtained with higher level, 240 µg biotin/Kg feed with non-dehulled SSM is being recommended.

Table 18a Performance of broiler chicks fed either dehulled on non-dehulled SSM based ration supplemented with graded levels of biotin from 1 to 28 days – SSM main effect (Oloyo, 1994)

Parameter	SSM main effect+	
	Dehulled	**Non-Dehulled**
Biotin-deficiency		
Dermatitis, %	7.9y	13.9x
FLKS mortality, %	3.9y	7.1x
Leg deformities, %	3.9y	6.4x
Feed utilization		
Live wt, g	542.8x	450.3y
Daily Feed intake/bird, g	48.8x	41.0y
Daily weight gain/bird, g	17.3	17.6
Feed conversion	2.82	2.80
Liver		
Weight, g	17.44	18.25
Total lipid, mg g^{-1}	204.8y	225.9x
Triglyceride, mg g^{-1}	120.4y	138.5x
Kidney		
Weight, g	6.76	6.80
Total lipid, mg g^{-1}	133.3y	152.4x
Triglyceride, mg g^{-1}	74.7y	89.6x
Biochemistry		
Glucose, mmole l^{-1}	4.99	4.71
Free fatty acid, mmole l^{-1}	2.19	2.42
Liver pyruvate carboxylase activity, units/g liver	11.2	10.1

+Means in a row with no common subscripts differ significantly (P>0.05)

Table 18b. Performance of broiler chicks fed either dehulled on non-dehulled SSM based ration supplemented with graded levels of biotin from 1 to 28 days – Biotin main effect[+]

Parameter	Biotin main effect, µg/Kg feed[+]					
	40	80	160	200	240	±SEM*
Biotin-deficiency						
Dermatitis, %	37.5a	23.8b	2.5c	1.3c	0.0c	3.81
FLKS mortality, %	13.8a	12.5a	5.0b	0.0c	0.0c	1.60
Leg deformities, %	12.5a	10.0a	5.0b	1.3c	0.0c	1.32
Feed utilization						
Live wt, g	404.7	418.0	513.4	538.4	544,7	18.56
Daily Feed intake/bird, g	35.5b	36.7b	47.9a	50.5a	51.0a	2.05
Daily weight gain/bird, g	13.0b	13.5b	16.9a	17.7a	18.0a	8.63
Feed conversion	2.73	2.73	2.84	2.86	2.84	0.021
Liver						
Weight, g	19.85a	19.46a	17.58ab	16.17b	16.27b	0.443
Total lipid, mg g^{-1}	290.4a	275.2a	203.2b	159.0c	161.7c	15.02
Triglyceride, mg g^{-1}	211.5a	194.1a	113.0b	73.3c	76.1c	15.42
Kidney						
Weight, g	8.56a	8.35a	6.81b	5.21c	5.29c	0.393
Total lipid, mg g^{-1}	221.8a	209.2a	134.3b	83.5c	87.4c	15.73
Triglyceride, mg g^{-1}	155.9a	142.2a	74.2b	24.9c	26.7c	15.27
Biochemistry						
Glucose, mmole l^{-1}	3.67b	3.85b	5.36a	5.40a	5.46a	0.204
Free fatty acid, mmole l^{-1}	3.35a	3.21a	1.78b	1.90b	1.79b	0.188
Liver pyruvate carboxylase activity, units/g liver	2.6c	5.9b	13.9a	14.1a	14.4a	1.22

[++]Biotin main effect means in the same row with no common subscripts differ significantly (P>0.05)
**SEM, standard error of the mean
[+]Oloyo (1994)

Mr. Rector, vitamin requirement values obtained in our various studies are summarized in Table 19. The practical implication of the findings in commercial broiler chicken production is that the Feed Millers must base the choice of Vitamin-Mineral Premix intended for use in ration formulation on the available feed ingredients. Certainly, Vitamin-Mineral Premix will change in composition as the feed ingredients change. In addition to preventing vitamin deficiency, the use of appropriate Premix will promote efficient nutrient utilization, good health, and optimum growth performance of the chicken.

From the foregoing, it is imperative to establish requirement values of all the B-group of vitamins when unconventional feed ingredients are used in the diets of broiler chicken. Also, because the search for alternative low-cost unconventional feed ingredients is on-going, concerted research efforts are necessary to ensure that birds fed with such ingredients are adequately nourished. So far, requirement values for a few of the B-vitamins have been established for broiler rations formulated with Palm Kernel Meal and Sunflow Flower Seed Meal as vegetable protein sources and either of maize or guinea corn as the energy source. Therefore, it is necessary to determine the required values for the other vitamins in order to develop an appropriate Vitamin-Mineral Premixes for such broiler rations.

Table 19. Estimated requirement values of some B vitamins for broiler chicken*

Vitamin	**Maize-PKM based ration**		**Guinea corn-PKM based ration**		**Maize-SSM based ration**	
	Without PKO	**With PKO**	**Without PKO**	**With PKO**	**Dehulled SSM**	**Non-dehulled SSM**
Niacin	-	37.5 mg/Kg feed	-	30.0 mg/Kg feed	-	-
Folic acid	-	-	-	0.75 ppm	-	-
Pyridoxine	-	-	-	6.0 mg/Kg feed	-	-
Biotin	160 µg/Kg feed	120 µg/Kg feed	-	200 µg/Kg feed	200 µg/Kg feed	240 µg/Kg feed

*Oloyo and Ogunmodede (1991, 1998b), Oloyo (1991, 1994, 1997, 1997, 2000, 2001)

Conclusion and Recommendation on Poultry production research in the future

There is no doubt that investigation will continue, in the near future, on the exploitation of the full potentials of unconventional feed ingredients, particularly crop residues and wastes that has proven useful. Unfortunately these residues are usually characterized by their high contents of cell wall carbohydrates that are poorly or partially digested by broiler chickens. The complex cell wall carbohydrates can serve as energy sources in the animal feeds, only if the inherent energy is unlocked as in the ruminant animals. Utilization of the energy by ruminant animals is possible by the microbial degradation of the cell wall to produce volatile fatty acids, which in turn serve as the energy sources for the animals. I expect, therefore, that research will apply the ruminant nutrition concept in finding solution to the poor digestibility problem in broiler chicken. That is, researchers will consider the inclusion of microbial-synthesized enzymes in the diets of broiler chicken when the diets are based on the unconventional crop residues or wastes. Success in this research venture will serve dual purpose. First, conversion of low quality agricultural wastes and crop residue to high quality animal food protein, thus reducing the cost of animal food protein production. Second, the recycling of wastes that otherwise would cause environmental pollution because of poor waste management scheme in our towns and cities.

Furthermore, successful inclusion of the agricultural wastes, crop residues, and other unconventional feed ingredients in the rations of broiler chicken, therefore, will change nutrition of the birds. Specifically, the bird's requirements for the vitamins that will prevent deficiency symptoms, mortality, and promote good health and productive performance will change. I expect, therefore, that future research will focus on the establishment of vitamin requirements of broiler chicken when fed with the agricultural wastes, crop residues, and unconventional feed ingredients.

Finally, I submit that with all these research efforts at reducing the production cost of broiler chicken, the market price of the meat-type chicken will crash before long. By implication, these people – the teeming ordinary hustling Nigerians will once again have the chicken return to their table.

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I must express my deep appreciation to F. Hoffmann-La Roche & Co., AG, Basel, Switzerland for supplying the animal feed grade of the vitamins and relevant literature materials used in my research. The use of the vitamins lends the results of my research to practical application in commercial broiler production.

I acknowledge with thanks, contributions of my research collaborators who started work with me as my students in the Department of Science Laboratory Technology and today are my colleagues. Notable among them are NOA Ilelaboye and SS Akoja. Others include Tawakalitu Adelotan, Olasumbo Adefulu, and Salau Adams. Worthy of recognition among my colleagues is Prof. MT Adetunji who showed me publication outlets at the international level early in my career, and that encouraged me to take advantage of such outlets for my journal articles. Dr KO Jibodu, the pioneering substantive Head of my Department and a great mentor introduced the teaching of Research Methodology into the SLT curriculum at the HND II level, and because he believed in my ability assigned the teaching of the course to me. My lecture notes for more than two decades was the foundation on which I built the publication of my textbook – **Research Methodology for Social and Applied Sciences**. The textbook earned me more Google Scholar citations than any of my scholarly journal publications.

Other colleagues in the Department that I will ever be grateful for the fond memories of foundation faculty of the Department and with whom I shared offices, assignments, and friendship in time past are Prof. AA Onilude, Dr WG Okunade, Mr OA Oduwobi, Dr FB Aiyeleye, Mr FG Adedoyin, Prof. NO Olawore, Mr TOB Oke, Mr JI Akamike, Mr AT Ojenike, Mr EOA Ajiwo, Mr Fred Egbamuno, Mrs OO Pikuda, and Prof. (Mrs) BI Olu-Owolabi.

My achievements in academics are attributable to the training and support I received first from my Secondary School Principal, Chief TA Adesoye, and second, from Prof. BK Ogunmodede of the Department of Animal Science, University of Ibadan. The Professor painstakingly supervised my postgraduate research work and ensured I finished the PhD programme in a record time of two and a half academic sessions. The Professor made it a wedding gift for me. The high quality of the research work was the reason for my quick climbing of

knowledge ladder and for reaching the peak of my academic career in the Polytechnic in a record time.

The saying, **'When the going gets tough, the tough get going'**, can be likened to the situation with academic progression in the early years of the Polytechnic when postgraduate degrees particularly Doctor of Philosophy was not a prerequisite for teaching in the system. Undertaking postgraduate study without permission from the polytechnic authorities was a very serious offence. If by commission or omission you acquired the certificate you dare not present such for upgrading your record! Otherwise, you would have to explain why disciplinary action should not be taken against you. However, some of us were audacious enough to go ahead and acquire additional qualifications. I drew courage and strength from the support received from lion-hearted true friends in the persons of Surv. KA Adeleke, Mr & Chief (Mrs) B Ogunyinka, and Mr MB Olufowobi.

The situation changed for better soon after I had bagged the Doctorate in 1988. Thanks to the timely Government's approval of the University Salary Scale (USS) and the corresponding Conditions of Service for the polytechnic sector. At this juncture, I must appreciate and thank Prof. SA Olateru-Olagbegi, the then Rector of the Polytechnic for the recognition and acceptance of my Master and Doctorate Degrees' certificates for upgrading my records. It was a big relief. Thenceforth I had the confidence to forge ahead with my career in academics – both in teaching and research.

Looking back in time, I cannot but appreciate the fond memories of some valuable people who came across my way in the course of rising through the ranks in the Polytechnic. All of them are my jolly good friends up till date. They include Mr CO Adebari, Mr & Mrs JA Mokuolu, Engr & Mrs OA Osore, Engr (Mrs) MO Balogun, Mr & Mrs TOB Oke, Alh R Ola Bello, Alh RO Egbeyemi, Mr EA Daniel, Dr AB Ajayi, Mr DA Durowaiye, Mr FA Babalola, Mr Tunde Ojo, Mr SO Somorin, Mr CK Obiri, Lawyer S Obeng, Chief VA Adebayo, Mr JO Scott, Mr SO Ojuawo, Mr O Arulogun, Surv. & Mrs AA Fayemi, Mr & Mrs OO Babatola, Dr & Mrs OO Feyisitan, Ven. (Dr) & Mrs O Obadina, and Mr AA Olatunji. They all contributed in one way or the other to my humble achievements in this Polytechnic. They all believed in my ability and they supported me in their personal and official capacities.

I am most grateful to Prof. CK Ayo, the immediate past Vice-Chancellor of Covenant University, Ota for accepting me on sabbatical at the University. I am proud of the teaching and research experience I had in the foremost private university where I saw the proprietors making genuine efforts at attaining academic excellence. I am certain the University will achieve the much-desired 1 of 10 in 10, the prophetic declaration! The fond memories of working with the faculty, staff, and students of the Department of Biological Sciences will linger for a long time to come. They were all wonderful people to work and associate with. I acknowledge the support received from Professors E Maduagwu, EJ Iweala, IS Afolabi, Mrs. O Ogunlana, H Adebayo, and C Omonhinmin, Dr (Mrs) OE Omotosho, and Dr O Rotimi. They made my stay at the University worthwhile.

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I acknowledge with thanks the discipline, training, parenting, and legacies inherited from my wonderful parents. Though they were not lettered, they ensured I was given first, home training and second, western education so that I can be useful to society. Finally, they taught me the way of Islam. Whatsoever you are able to make of my inaugural lecture is just a bit of what they invested in me. May Allah grant their souls eternal rest, forgive their shortcomings, and grant them *Al Jannah Firdaus.* Amen.

At this juncture, I must acknowledge immensely the support and encouragement received from my spiritual leaders and fathers in Islam. In this connection therefore, I take the liberty to appreciate Imam FB Umar (FPI), Imam G Ejalonibu (Molipa, Ijebu Ode), Imam

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Lastly, I will like to end this presentation the way I started it by appreciating Allah for making this inaugural lecture a success. The Merciful Allah gave me Grace for knowledge, wisdom, and guidance to be research-active throughout my academic career – beginning from Lecturer III to Chief Lecturer. Furthermore, I could contribute to knowledge and could deliver this lecture because of the Grace I received from the Creator of Heaven and Earth. Praise be to Him, the Cherisher and Sustainer of the worlds. (Quran 1: 2).

The Rector, Distinguished Chief Lecturers, Scholars & Colleagues, Invited Guests, and Gentlemen of the Press, Ladies & Gentlemen, as the saying goes – Anything that has a beginning must have an end. Sir, I have to end the lecture now so that I do not continue to take your time the more. **Thank you for your presence and attention.**

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