



“FOOD SECURITY: CONCERNS AND COMFORTS IN FOOD PROCESSING”

28th Inaugural Lecture

of the Federal University of Technology,
Owerri (FUTO), Imo State.

Delivered On
Wednesday, April 27, 2016

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INAUGURAL LECTURER



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28TH INAUGURAL LECTURE OF THE
FEDERAL UNIVERSITY OF TECHNOLOGY,
OWERRI, NIGERIA

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1.0 INTRODUCTION

The Food Processor “GIRL”

The quest to participate in the provision of comfort in food issues sprang up in me many years ago, precisely at the age of six. As a little girl then I wondered why my mother should be buying crystal sugar (cubes) in the market when we had sugar cane plants in our farm. So secretly I planned on how to help, and to give my mother a surprise by providing sugar for the family. Then, one day I harvested our sugar cane plant, and the processing began. I ground the stems, extracted the juice and started to boil. My greatest disappointment came when the juice dried up and the paste/flakes became brown in colour instead of white like the commercial ones. I was not satisfied with my product because it was brown in colour. It was a pitiful situation for me as my plan to manufacture sugar cubes for my family was not successful and no one could offer me the reason why I did not succeed. However, I licked my brown sugar paste and hoped to get the answer in future. Similar incidences followed up one after another, eventually leading to my choice of Food Science and Technology as course of study in the University.

2.0 ORIGIN OF FOOD PROCESSING

Some public opinions on “**processed foods**” in the media/internet seem to suggest, by and large, that processed foods are harmful to health and should be avoided. Why have processed foods garnered such criticism? Let me first of all shed some light on the origin of food processing and why foods are processed.

Food processing dates back to the prehistoric times, when food processing involved fermenting, sun drying, salting, and various types of cooking, such as roasting, smoking, and steaming. These were often referred to as “crude” methods of food processing. Modern food processing technology emerged in the 18th and 19th centuries essentially to serve military needs. In the 1790s, Napoleon Bonaparte offered a prize to the scientist who could develop best

ways to preserve foods for the armies of France; the competition prompted the discovery of safe canning and hermetic bottling practices by **Nicolas Appert** in 1809. Although initially expensive and somewhat hazardous due to the lead used in cans, canned goods would later become a staple around the world. In 1864, **Louis Pasteur** discovered a means of preserving the quality of wine, beer, and milk via heating, the process which was later known as **Pasteurization** (Ensminger, *et al.*, 1994) was named after him. In the 20th century, World War II, the space race and the rising consumer society in developed countries including USA significantly contributed to the growth of food processing with such advances as spray drying, juice concentrates, freeze drying and the introduction of artificial additives such as sweeteners, colourants and preservatives.

3.0 WHAT IS A PROCESSED FOOD?

Food processing involves any type of value addition to the agricultural produce, starting at the post harvest level. Hence “**processed foods**” are defined as any foods other than raw agricultural commodities, and can be categorized by the extent or degree of changes occurring in the foods as a result of processing. All processed foods do not undergo the same degree of treatment. There are three categories of processed foods. These are minimally processed food, processed food ingredients and highly processed food. Though there is no universally accepted method of classifying processed foods, it makes sense to make the distinction between such foods like **toaster pastries**, which are highly processed; **flour**, which is a processed food ingredient; and **akamu**, which is generally considered minimally processed. These distinctions allow for a more nuanced discussion of processed food.

Minimally or primary processed food: Fruits, vegetables, legumes, nuts, meat and milk are often sold in minimally processed forms. Foods sold as such are not substantially changed from their raw, unprocessed form and they retain most of their nutritional properties.

Minimal forms of processing include washing, peeling, slicing, juicing, drying, fermenting and removing inedible parts. Some minimally processed foods and beverages may be exposed to controlled amounts of heat, or in some cases radiation, to inactivate pathogens. Milk, for example, is commonly heat pasteurized. After purchase, consumers may cook these foods and mix them with other ingredients as part of their preparation.

Processed food ingredients: Processed food ingredients are rarely eaten alone; they are typically used in cooking or in the manufacture of highly processed foods. Examples include flours, oils, fats, sugars, sweeteners, starches, films, vegetable oil, margarine, and other ingredients. To create these ingredients, starting materials such as grains and oil seeds may be milled, refined, crushed or exposed to chemicals. Unlike minimal forms of processing, these techniques radically change the nature of the original raw materials. Processed food ingredients tend to be **nutrient-poor**, and high in **calories** relative to the amount of vitamins, minerals and other key dietary nutrients (Udeogu, *et al.*, 2014).

Highly processed foods: Highly processed foods are made from combinations of unprocessed food, minimally processed food and processed food ingredients. Many are designed with consumer convenience in mind. They are often portable, can be eaten anywhere (while driving, working at the office or watching TV). They require little or no preparation. It is plausible to assume that discussions of “**processed foods**” in the popular media often refer to products in this category. Highly processed foods include snacks and desserts, such as cereal bars, biscuits, chips, sausage (e.g., gala) cakes and pastries, ice cream and soft drinks; as well as breads, pasta, breakfast cereals and infant formula, canned, salted and cured meats.

4.0 WHY ARE FOODS PROCESSED?

The main focus of processing food is value addition. In a nut shell, food processing offers many comforts by transformation of primary agricultural products into what could be called “finished”

agricultural products. Some of the benefits of processed foods are outlined as follows.

Preservation: Historically, the most important reason for processing foods has been to make them last longer before **spoiling**. When perishable products have longer shelf life, consumers can enjoy them for a greater part of the year, distributors can ship them over greater distances, and retailers can stock them for extended periods.

Safety: Processing and preserving foods can make them safer to eat by destroying toxins, removing anti-nutrients and eliminating or inhibiting pathogens.

Variety: By modifying the flavors, textures, aromas, colors and forms of foods and raw ingredients, food processing can create wider varieties in our food supply. Grains, for example, can be milled into flour, which is then used to make a wide variety of products. In 1860, Dr. Kellogg invented a form of granola-like cereal designed to fit the austere diets of Seventh Day Adventists; he and his brother later founded the company that bears his name (Ensminger, *et al.* 1994). Today, a trip down the breakfast aisle of a supermarket reveals a tremendous variety of products that are derived, in part, from wheat, rice, corn and several other grains. Breakfast cereal manufacturers achieve these varieties by adding flavors, cooking, drying and toasting. The shapes of cereal grains are altered by processes like shredding, flaking (flattening them in a roller), puffing (expanding them with pressure) and extruding (using high temperatures and pressures to force slurry of grains through a hole). Changing the qualities of foods in these and other ways can make products more appealing to consumers.

Convenience: Food processing can create products that require little or no preparation on the part of consumers. Examples include baby food, canned foods, bottled juices and ready-to-serve cakes, cookies and pies. Many countries of the world, including Nigeria, are urbanized more than yesteryears which coincide with rising demand for processed and packaged foods; the working population now gets

fewer calories at home and more from packaged food and fast-food restaurants (Onyeka, *et al.*, 2010). These trends reflect a growing demand for convenient foods.

Nutrition: Enrichment and fortification are two of the ways that processing can restore or raise nutrient levels in food. **Enrichment** means the restoration of some of the nutrients that are lost during certain forms of processing. **Fortification** goes a step further; it means adding certain nutrients above the levels that naturally occur in a food. It is also used more generally to refer to any addition of nutrients to a food. In the 1830s, French chemist, Jean Boussingault, advocated adding iodine to table salt to prevent goiter (enlarged thyroid glands) as a way to prevent nutrient deficiencies frequently caused by iodine deficiency (Ensminger, *et al.* 1994). Today, not only is table salt fortified with iodine, many other foods are typically fortified with varied nutrients. Examples are milk (with vitamin D) and sugar (with vitamin A). These additions have helped prevent nutrient deficiencies in the general population (FAO, 2001).

Specialty: Modern food processing also improves the quality of life of people with in-born error of metabolism such as allergies, diabetics, and other people who cannot consume some common food elements. Examples of such foods are diet coke, Ezekiel bread and tofu.

5.0 STATUS OF NIGERIA IN FOOD SECURITY

According to FAO (2001), food security exists when “all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life”. Hence food security means that all persons will have access to culturally acceptable and nutritionally adequate food via non-emergency sources at all times. The implication of this definition is that food must be available to the people to meet some acceptable level of nutritional standards, in terms of nutrients which the body needs, the possession of the means by the people to acquire it (i.e. access) and reasonable continuity and

consistency in its supply (Davies, 2009). Food security is one of the important conditions that must be achieved for an individual to be nutritionally secure and to maintain good health. Household food security is the application of this concept to the family level, with individuals within households as the focus of concern. Essentially food security is a phenomenon relating to individuals.

Food Security addresses one of mankind's most fundamental needs and indeed human right, namely, access to a nutritious and adequate diet. The United Nations in its Universal Declaration of Human Rights on 10th December 1948 (Article 25) included food security as a fundamental right (Eide, 1999). Human Right is defined as a common standard of achievement for all peoples and all nations. International human rights law has thus firmly established that everyone has a right to adequate food and a fundamental right to be free from hunger. These rights are assumed to be universal, though clearly they are not yet globally enjoyed.

The three pillars of food security are "availability of food", "food access" and "food use". At the global and national levels, food security is expressed mainly in terms of food available for consumption, but at household or individual level, the emphasis shifts from simple "availability of food" to a more complex system of "food access" and "food use". A school of thought has it that there is enough food in the world to feed the population but the only problem is distribution. As at today the problem of food distribution and availability is being waned up by the rising trend in global trade. However food security should not be seen only from the perspective of availability either in quantitative or qualitative terms. Food hygiene and safety should also be given important consideration in order to protect the health of the people.

Food, for instance, may be available but the source from which the food is processed may be unhygienic or that the chemical substances used to produce or preserve the food may constitute a health hazard. Health and safety considerations therefore become important in food production and security. Hence there is also the need to address the

problem of reliability of use in food security. A key ingredient in a secure food system at household level is that the consumer's confidence that the food being eaten is safe is not betrayed. Nigeria and indeed many other countries of the world are yet to solve the problems of food access and food use.

The proposal and pretension of Nigeria as overcoming these aspects of food security is affecting our food sector development. According to the **Global Food Security Index** published by **The Economic Intelligence Unit (EIU) in 2015**, Nigeria is ranked 91st with an average of 37.1 index among 109 countries of the world (www.Naji.com news). The first position in the rating was held by the US with 89.0 total score. The second, third and fourth positions belonged to Singapore, Ireland and Austria with 88.2, 85.4 and 85.1 indices respectively. Among Sub-Saharan African countries, Nigeria is ranked 12th of 28 countries. The country is followed by Sudan, Niger, Chad, and Zambia in that order. The first place in the region was taken by South Africa with 64.5 index score.

The Global Food Security Index is rated by the level of food sector development considering the core issues of availability, affordability, quality and safety across a set of 109 countries globally. The report observed however that for the last 4 years, Nigeria has improved its index by 3.2 points. Despite pretensions to the contrary, Nigeria is yet to be completely food secured. A country should be considered as food-secured when food is not only available in the quantity needed by the population and consistent with decent living, but also when the consumption of the food should not pose any health hazard to the citizens (FAO, 2001).

6.0 CHALLENGES OF FOOD PROCESSING IN NIGERIA

The largest market for processed food in Sub Saharan Africa can be found in Nigeria where a booming urban population is fueling demand for convenience foods such as pastries and savoury snacks as well as fast foods. While the urbanization (and modernization of urban consumer taste) and rising income are attractive prospects for

food companies, provision of nutritious healthy and well packaged convenience food is a challenge to Nigerian food processors. The nature of the current food processing industry in Nigeria can have a negative impact on food safety, the economy and the environment. Addressing these problems will require concerted efforts on the part of consumers, workers, businesses, policymakers and other stakeholders in the food sector. Some of the challenges to tackle include the following.

6.1 Use of Artificial Food Additives

The use of artificial additives in food processing represents a safety concern. [Food additives are substances added intentionally to foodstuffs to perform certain technological functions, e.g., sweeteners, preservatives, stabilizers]. The big challenge here is to retain the nutritional value, aroma, flavor and texture of foods, and presenting them in near natural form with added conveniences. Today's consumer, more than ever before, wants to have food that is as close as possible to the natural food while in a convenient form. Since people must depend on processed food for their daily energy consumption, because of job schedules, food processing in the 21st century must make the processed food as natural as practicable, by eliminating artificial additives.

Conventionally, in the European Union, only food additives permitted at specified levels by European Food Safety Authority (EFSA) are approved for use in food products. Approved additives receive an E number (E for Europe). As the effects of chemical additives are clearly known and understood, changes to laws and regulatory practices are made to make processed foods safer. Today, we know there is need to extend the shelf-life of both the food product and the "food eater" (consumer). And a fresh review of the "Generally Regarded As Safe (GRAS)" chemicals has begun by concerned stakeholders (www.IFT.org/food_technology/newsletter). The concern is to free processed food of all artificial chemicals including trans-fatty acids. Some countries like USA and Canada have re-evaluated the approved food additives (GRAS) and have removed

preservatives with questionable safety from the list of approved food grade chemicals. For instance, the U.S Food and Drug Administration (FDA) has eliminated in processed foods, partially hydrogenated oils (PHOs), the primary dietary source of artificial *trans*-fat, from the list of “generally recognized as safe” chemicals for use in human food. Companies have already started complying as illustrated in the following excerpt.

*Pizza Hut, Taco Bell to remove artificial ingredients. Yum Brands is the latest in a growing list of foodservice companies to announce its plan to phase out artificial ingredients. The company's Pizza Hut and Taco Bell restaurant chains will remove artificial flavors and colors. For Pizza Hut, the removal will be complete by the end of July and Taco Bell expects the transition to be complete by the end of 2015. ... For more than a year, the Pizza Hut culinary team has been working alongside its suppliers to reformulate its menu and removing many of the artificial additives. The company has already eliminated added **trans-fats** and **MSG**, and is actively working to lower the sodium in its pizzas. The company has already removed additives such as **BHA BHT**, **HVPs**, **MSG**, and **azodicarbonamide** from its food in recent years.*

IFT News Bulletin, May 2015

Across the world researchers are working hard to remove artificial food additives in processed food. To what extent are we doing same in Nigeria? Are we ready to follow the new rhymes of food processing music and free our processed food of artificial additives? Can we process our foods without artificial additives such as unnatural MSG, *trans*-fatty acids, sodium benzoate and all other “cosmetic” food additives (unhealthy colorants and flavorants)? This is our challenge! We have abundant natural preservatives (additives) to harness food processing. There is no gainsaying that food safety and quality, secured through effective food quality control at all stages of production, processing and handling, influence nutritional

well-being. And this is one of the challenges facing food processing in the country.

6.2 Metal Contamination

Another safety concern in food processing is leaching of food contact surfaces into food. Food processing is typically a mechanical process that utilizes large mixing, grinding, chopping and emulsifying equipment in the production process. These processes inherently introduce a number of contamination risks. As a mixing bowl or grinder is used over time, the food contact parts of the equipment will tend to fail and fracture. This type of failure will introduce into the product stream small to large metal contaminants (Audrey *et al*, 2006). Food manufacturers have the need to utilize industrial metal detectors to automatically detect and reject any metal fragment, so as to reduce risk to consumer health.

6.3 Dietary Concern

The practices and ingredients used in some highly processed foods raise dietary concerns. Although highly processed foods are not inherently unhealthy, but many foods in this category are high in added sugar, sodium, saturated fats or trans-fats and contain little dietary fiber. Breads and snack foods are often made with **refined grains**—grains that have been processed to remove the bran and germ, which contain important nutrients. “Premium” versions of highly processed products exist, such as those with less sugar, fat or salt; no trans-fats, no added preservatives and various fortifications (Monteiro *et al*, 2011). Today consumers are bending towards “green” food with fewer chemicals, so the food industries, including those in Nigeria, are faced with the challenge of designing and formulating food and food products to align with this public demand. Fortunately some companies have started to adjust their formulations in this regard. For instance the new product of Coca-Cola, Pulp Juice, has a claim of no added preservatives.

6.4 Level of Government Participation

Food Processing Industry is of enormous significance for Nigeria's development because of the vital linkages and synergies that it holds

between the two pillars of the economy, namely Industry and Agriculture. The Food Processing Industry is a thrust area for development. Vice Chancellor, Sir, in the 40s and early 50s, Nigeria did not have to contend with the problem of food insecurity. The system was able to feed her citizens and even export the surplus food items. Every region of the country specialized in the production of one or two major crops, whether food or cash crops, and together the country was relatively self-sufficient in food production. Nigeria had the groundnut pyramids in the North, the cocoa mountains in the west, oil palm and kernel heaps in the East and the rubber plantation in the mid-west (Tell Magazine, 2009). Though we had surplus food in the early 1950s we did not have the skill to process and preserve them. When oil was discovered in 1956, things changed; indefinite holidays were declared for *hoes and machetes*. As oil prices rose tremendously, interest in agriculture waned and “the man with the hoe” was disregarded, thus marking the beginning of decline of our country into the abyss of food insecurity. The attendant effects of the decline we all know. So then lack of adequate processing and preservation made it impossible for agricultural products to compete with oil.

Successive administrations have tried to ameliorate the food security problem through programs like “Operation Feed the Nation (OFN)”, “The Green Revolution”, Directorate of Food, Roads and Rural Infrastructure (DFRRI) and the likes. Yet Nigeria is still not food secured. Food processing in Nigeria is a viable business, but there are too many challenges plaguing the sub-sector; from lack of funds, lack of adequate and consistent government policies, and lack of infrastructures like road and electricity supply. Other constraints include lack of adequate quality control and testing infrastructures, inefficient supply chain, seasonality of raw material, high inventory carrying cost, high taxation, and high packaging cost. It suffice to highlight that inadequate support infrastructure is the biggest bottleneck in expanding the food processing sector, in terms of both investment and exports. These problems increase postharvest losses and promote food insecurity.

A lot of wastage of farm produces due to lack of adequate storage facilities cost the nation billions of Naira. Although the last administration made some notable push in the area of local food processing, there remains more grounds to be covered in order to boost the food industry sector in Nigeria. It is my humble wish that the present administration will continue on what the last administration did in terms of local food processing. It is an acknowledged fact that when we add minimum value to primary agricultural products, we maximize the economic value of the crop. This is the secret of agribusiness, a corner stone of industrialization and attainment of food security. At present small players dominate the Nigerian food processing industry but with adequate government support, we believe that the number of food processors in the country would have been doubled in the next two years and Nigeria can export a good number of processed foods. Maybe food will soon become our new "oil" and the Agribusiness would then become the bedrock of our economy, if Government participation is increased beyond the current level.

6.5 Lack of Effective and Encompassing Food Safety Policy

One of the major challenges of food security in Nigeria, no doubt, has been lack of well-defined food safety policy. Over the years what public policy makers pursue is merely an agricultural policy. The differences between agricultural and food policy need not be ignored. While agricultural policy is targeted at an expanded food production, food policy is geared towards minimum multinational standards that will guarantee food security. While expansive agricultural policy is being pushed, there is also the need for a national food safety policy to be enacted so that all citizens can have access to food supply that is reasonably priced, relatively safe, and adequate in quantity and quality. Presently, there is little appreciation of the contemporary role of Nutrition and Food Safety law to promote self-sufficiency in food production (Ojo and Adebayo, 2012). To put the matter in perspective, Food Safety and Nutrition policy properly formulated will encompass diet policy that shows the relationship of good diet

with good living. With the current knowledge of human nutrition and nutrigenomics, such policy will be guided by what the human body requires, and which particular available food items can provide it. The government needs to provide evidence-based healthy eating guide. Adequate dietary (Nutrition) guideline is a pre-requisite for effective food choices by the people; and good food promotes good health. Therefore it is about time our food sector rallied together and creates a new paradigm to make healthful choices to be easy, accessible, affordable and normative.

A country that lacks effective food safety policy to provide safe food for her citizenry cannot be listed among those that have achieved food security. It is against this background that the agency, National Food and Drug Administration and Control (NAFDAC) was established in 1993. However, much as this agency is working hard, there are still some uncovered aspects due to the fact that its emphasis, in terms of operations and laboratory facilities, has been in ridding the country of fake, substandard and expired drugs, manufactured in or imported into the country. Again the agency does not beam its search light on the production, sale and distribution of foods as much as it tirelessly does on fake and expired drugs. Expired and inadequate food, just as expired drugs, can cause great harm to the body. It is therefore imperative that Nigerian food sector focuses both on food quality and quantity. This may go a long way in boosting life expectancy and reduction of common debilitating diseases.

6.6 Regulation of Food Quality

Corruption which has been a serious problem in the country has not left food processing industry untouched. As such devising an efficient way to make food industries comply to rules and regulations has been a major challenge for Nigeria. What do you think about the authenticity of a laboratory result of a food product when the visit of the investigating agents to the industry was announced weeks ahead and the samples they would analyse were prepared specially for them?. Our present day practice of food surveillance might not give us authentic report from food regulating agencies. And this is a

Report finds extra virgin olive oil products may be mislabeled. The National Consumers League (NCL) has released a report finding that 6 of 11 national brands of extra virgin olive oil (EVOO) failed to meet EVOO standards when evaluated by an Australian lab. In January 2015, the consumer group purchased 11 different varieties of olive oil, all labeled extra virgin, from four major Washington, D.C., area retailers. Of those 11 products, 6 failed to meet International Olive Council (IOC) standards required to be considered extra virgin quality; only five were found to be true extra virgin olive oils. "One of NCL's priorities is to assess whether the food in our supermarkets are accurately labeled,..." IFT News Bulletin, May 2015.

challenge to Nigerian Food industries at large. Nigeria needs to borrow a leaf from other countries of the world. A sample of a product survey report in USA is included above for illustration.

Food packaging and nutrition fact labeling in Nigeria need to be revised and regulated especially in the areas of added ingredients. Correct nutritional labeling of packaged food and food ingredients should show **all** the ingredients used. This is of paramount importance to guide unsuspecting consumers and to avoid manufacturer's bogus claims which deceive consumers. Consumers on their part should develop the habit of reading label before buying in order to know both the expiring date and the ingredients of product.

6.7 Research

The Scientific and Technological Know-how in our country seems to go down, year in year out. Many schools in Nigeria do not even have Science Laboratories where the equipment are **functional**. Hence, majority of the students rather theorize sciences than put it into practice.

7.0 HEALTH ISSUES ABOUT FOOD – NIGERIAN CASE

Nigeria offers the biggest market for the sale of drugs, supplements and all other brandished health caring outfits/technologies. A glance around the number of depot points for each of these health caring outfits for each country will confirm this claim. Almost every major city in Nigeria is a liaison office for each of them, while in many other countries they exist (if at all) only in the country *capital city*. We patronize these outfits not because we are too buoyant financially but rather desperate to regain our health and vibrancy.

On a lighter mood, but informative any way, a quick look around our religious institutions gives a beeline to this claim because whosoever that promises to heal sickness will have a larger crowd. Why are many people, including Nigerians, so uncomfortable in their health conditions? Probably because too many things, real and imaginary, are after our health and vibrancy, and these include mosquitos, dirt, chemicals, insecurity, and others. How can food processing help to alleviate this situation? Can food processing offer us some comfort? This is my salient question and desperation. This question bothers me a lot and maybe it bothers you too!

HIPPOCRATES, A GREEK SCIENTIST, THE FATHER OF MEDICINE (460 BC) USED TO TEACH: **“LET YOUR FOOD BE YOUR REMEDY, LET YOUR REMEDY BE YOUR FOOD.”** FOOD CAN HEAL AND FOOD SHOULD HEAL.

Mr. Vice Chancellor Sir, eminent scholars, distinguished ladies and gentle men, let me now attempt to highlight some of my modest efforts towards achieving food security via reliable food processing.

8.0 VERIFICATION OF GLYCEMIC INDEX OF SOME STARCHY STAPLE FOODS IN NIGERIA

With a view to proffer comfort for those of us whose body make-up are not efficient in sugar management, my research team and I used a scale known as glycemic index (GI) to determine the ability of some of our common starchy foods to spike blood sugar (Onyeka, 2007;

Onyeka *et al*, 2007). Our aim was to find out the most suitable food for such individuals knowing that the staple foods in this part of the world are starchy. GI measures the rise in blood sugar level after one consumes a carbohydrate-containing meal. *GI* is considered to be a valid index of the biological value of dietary carbohydrates (FAO/WHO, 1997). Further in the investigation we used one drivers of *GI* known as glycemic response (*GR*), to study how quickly glucose is absorbed, how blood sugar rises and how it returns to normal within two hours after a meal. *GI and GR* of food depend on harvest time, cultivar, processing and cooking method, nutritional profile, physiological state of the consumer and many other variables (FAO/WHO, 1997; Jenkins *et al*, 2002; Miller, 2002).

In our study, we assessed the physicochemical and physiological properties of five commonly consumed cowpea cultivars in Nigeria. The cultivars examined were Sokoto, Patasko, Iron-beans, Isocha and Ife-brown. We discovered that the cowpeas had glycemic responses ranging from 131.4 to 227.5 mg/dL against 369.5 mg/dL for white bread. The blood glucose curve for Ife-brown was not only the smallest but also had a well-defined sigmoid shape; a sinusoidal curve (Fig 1.). The meaning of this is that the increase in blood sugar by Ife-brown was both small and gradual. It was not sharp (sudden).

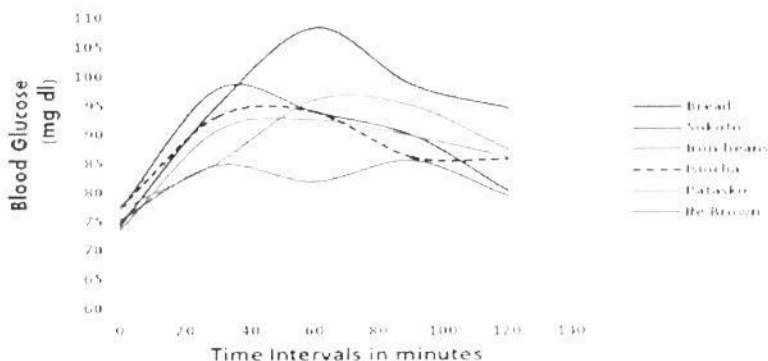


FIG.1. THE GLYCEMIC RESPONSE OF COWPEA CULTIVARS COMPARED TO WHITE BREAD

A sharp rise in blood sugar after a meal is one of the major causes of metabolic disorder arising from inability of the body to manage blood sugar (Miller, 2002; Montonen, *et al*, 2003). This indicated, within the limit of the experiment, that the Ife-brown cultivar exerted the least stress on metabolic blood sugars of volunteers. Ife-brown was therefore considered the best in terms of managing physiological changes in blood sugar. We also discovered that Ife-brown had the most interesting physicochemical properties. It had the highest blue value index of 51.2, highest emulsion capacity of 3.5 g/g and the shortest cooking time of 40 min. The values for the glycemic index (GI) of the cultivars were on the low side (0–55) with the exception of Patasko, which had an intermediate GI of 61.57 (Fig2)

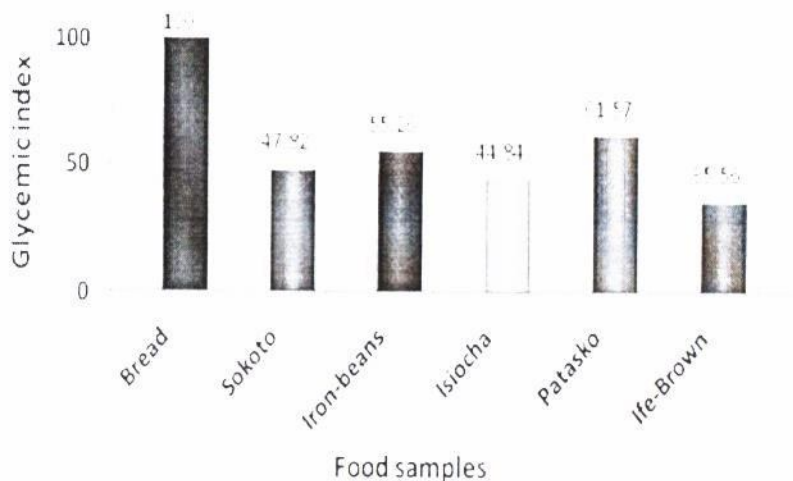


FIG. 2. THE GLYCEMIC INDEX (GI) OF THE INGESTION OF 50g CARBOHYDRATE OF FIVE COWPEA CULTIVARS AND WHITE BREAD

Our study, in essence, shows that there are varietal differences among the commonly consumed cowpea cultivars in Nigeria. These differences are in the areas of total and available carbohydrate, total dietary fiber, glycemic response, and GI. Other areas of variation

included emulsion capacity, BVI and cookability. The summary is that the cowpea cultivars do not have the same physiological role and would affect human health differently. Conclusively, the Ife-brown has the most health beneficial qualities among other cowpea cultivars. This could be because of its starch type and content, its unique brown color, a combination of the two or any other factors.

The practical application of our findings and contributions here is that the information provided by this research will help in selection of the common cowpea cultivars in terms of their physiochemical/ glycemic potentials. Consumers as well as food processors, no doubts, have a lot to benefit from this work. Food processors, in particular, would be able to utilize the functional characteristics of the different cowpeas in food formulations.

The import of this study is clearly seen at a time like this when the awareness of the general public in relation to health foods is on the rise and people are looking for the right type of food for various health conditions. Blood sugar management is pivotal for those of us who are prone to diabetes. In diabetes type 2, for example, there is a deficiency of insulin which results in improper and slow breakdown of food leading to sugar level spikes immediately after a meal, which can be harmful. High blood sugar, if left untreated, can cause dehydration and electrolyte imbalance over short term and retinopathy and nephropathy over long term. This is an acute problem faced by all diabetes. Hence, diabetes must have food and meal which have slow release rate of sugar to circumvent blood sugar spike. And our research here has provided significantly guiding information in this regard.

We also observed that GI and amylose content are inversely related (Table 1.). This means that when amylose is high, the rate of starch breakdown is slower, which prevents the blood sugar hike just after a meal. Amylose is a type of resistant starch, meaning it is not well-digested and absorbed in the small intestine. Instead, it is fermented by bacteria in the large intestine and may have some benefits, such as

limiting spikes in blood sugar levels and lowering cholesterol (Montonen, *et al*, 2003). Unlike amylose, amylopectin is quickly broken down and absorbed. All the cowpea tested contained high levels of amylose in the range of 31-45% and high dietary fiber (up to 40%) confirming their qualification as a health food.

TABLE 1. The GI, Starch distribution, dietary fiber and protein content (%) of some staple food in Nigeria

FOOD	AMYLOSE	AMYLOPECTIN	STARCH	GI	PROTEIN	DF
White bread (wheat)	8.2	91.8	91.93	100	8.41	4.02
Wheat grain	21	89	88	71	9.68	8.45
Sprouted wheat	15	85	80	65	10.6	12.44
White Rice	24.23	75	91.93	62	17.46	15.73
Brown Rice	35.40	85	81.85	76	20.41	17.30
Cassava (flour)	17.00	83	92	NA	1.2	2.12
Isiocha	70.41	69.59	91.93	44.84	15.3	35.02
Iron beans	33.40	66.60	88.30	55.26	22.8	38.65
Sokoto	35.42	63.58	62.96	47.82	17.5	30.00
Ife brown	35.62	61.38	89.74	35.66	22.5	28.69
Patasco	39.76	60.24	86.39	61.57	21.7	28.04
Maize (not waxy)	28	72	74	81.00	5.5	NA
Bambara G/Nut	22.52	77.48	61.9	58.00	22.21	18.45
Sprouted Bambara	24.55	75.45	88.12	56.22	26.34	18.45

GI – Glycemic index, DF – Dietary fiber, NA – Not available

9.0 USING SPROUTING TO ENHANCE NUTRITIONAL BENEFITS OF GRAINS

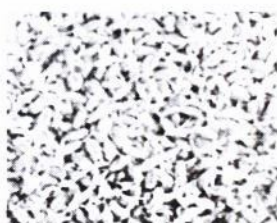
VC Sir, I have during my stay in this citadel of learning verified the nutritional and functionality impact of sprouting on cereals and legumes including wheat (Onyeka and Dibia, 2002; Onyeka and Obeleagu, 2013). In the various studies, changes of nutritional ingredients, anti-nutritional components, chemical composition, and antioxidant activities of grains over various periods of germination were investigated. The grains were sprouted at atmospheric conditions (30°C, 75%RH) over a period of 6h, 12h, 18h and 24h.

With germination, the contents of crude protein, reducing sugar and total phenolics increased significantly, while the levels of crude fat, carbohydrate, phytic acid, and the activity of trypsin inhibitor decreased. The flour made from sprouted grains provides more protein (up to 35% increase), vitamins and minerals than those of refined flours (Table 2). In some aspects of the research, the sprouted grains were used to produce weaning foods (Onyeka and Dibia, 2002) and speciality bread (Onyeka and Obeleagu, 2013) using adaptable technologies. Twelve to Twenty-four hour sprouting was discovered to be the best for sprouting of many local grains for flour production. When bambara nut (okpa) was sprouted (Plate 1c) it gave an energy bar (moi-moi) that was light (not heavy), free of any trace of bitterness and of course easier to digest. We also discovered that sprouted maize used in preparing akamu took little quantity of hot water to gel (more energy/nutrient dense). The process of changing seeds into sprouts (little plants) is easy, but the changes that happen inside the seed are huge. These findings of ours agree with the work of Ge Zhang *et al.* (2015) who worked recently on germination of buckwheat. Ge Zhang and his research team observed significant increases in phenolic compounds, and in flavonoid which they claimed might have led to significant enhancement of the antioxidant activities of germinated buckwheat. According to them germinated buckwheat had better nutritional value and antioxidant activities than ungerminated buckwheat, and it represented an excellent natural source of flavonoids and phenolic compound.

PLATE 1: SPROUTED GRAINS



(a) Sprouted wheat grain



(b) Over sprouted wheat grain



(c) Sprouted bambara nut

TABLE 2: Effect of sprouting period on nutrient and functional properties of mixed-grain bread^a

SP	Proximate (g100g ⁻¹ DM)				TDF (g100g ⁻¹)	Energy (KJg ⁻¹ DM)	
	Carb	Protein	Fat	Ash		Total	Protein
Control	67.67	5.44	9.55	11.13	5.36	1452.79	24.93
6h	60.17	6.42	9.01	20.50	8.33	1452.04	43.76
12h	44.51	14.10	8.18	20.82	15.07	1323.50	68.30
18h	39.04	15.51	7.16	21.62	18.16	1210.49	82.77
24h	37.17	16.55	2.85	15.78	21.65	1148.62	94.03
LSD	1.03	0.09	0.35	0.21	0.57	121.12	1.96

^a SP = sprouting period; Control = market white bread; Carb = carbohydrate; TDF = Total dietary fiber; LSD, least significant difference.

Ladies and gentle men, another momentous benefit of sprouting, as revealed from our studies and research, is the reduction of gluten (lectin) in grains including wheat. And we are bold to state that the three fold health problems associated with wheat, namely, high gluten content, high glycemic index and high content of anions (acid forming food), can all be ameliorated through sprouting. The good news here is that our findings together with those of other eminent researchers (Ge Zhang *et al.* 2015; Shipard, 2005) confirm that sprouting offers some relief against gluten problems.

Firstly, sprouting reduces lectin activity of wheat (Fig. 3). Secondly sprouting reduces gluten content of wheat flour (Plate 2). The reduced lectin activity of sprouted wheat is most likely as a result of the reduced gluten content. These reductions, coupled with **lower glycemic index** are good news for those who are gluten-sensitive. Sprouting therefore is a simple way to avoid the many health problems associated with ingestion of wheat products. However, sprouted wheat is not recommended for celiac patients or those with true gluten allergies.

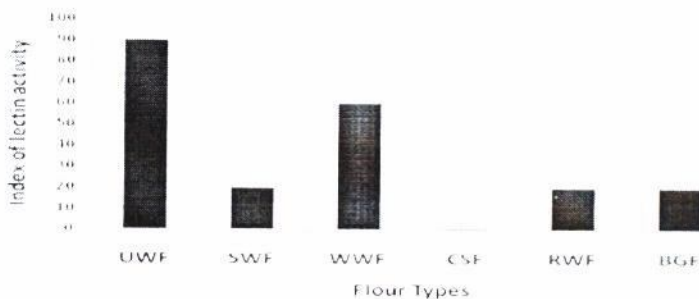


FIG.3. LECTIN INDEX OF SPROUTED AND UNSPROUTED GRAINS AND CASSAVA FLOUR

UWF= refined white wheat flour, SWF Sprouted wheat flour, WWF= whole wheat flour, CSF= cassava flour, RWF= White rice flour, BGF= Bambara nut flour

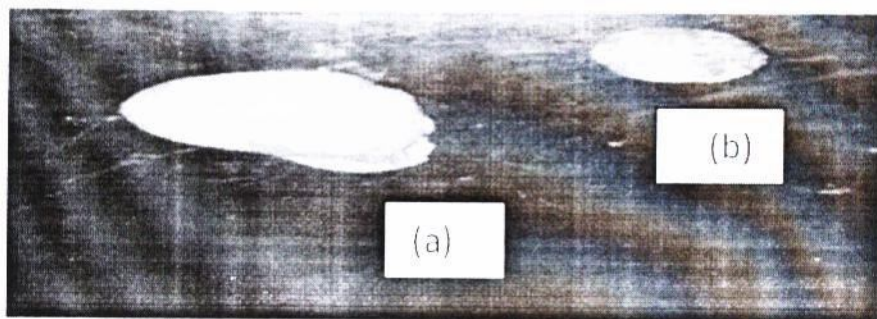


Plate 2. Gluten extracted from (a) unspouted and (b) sprouted wheat flour

Now, relating our works with those of other researchers, it is pertinent to state that a grain is considered “sprouted” right after it has started to germinate (Plate 1). At this stage the outer bran layer is split open, and the beginnings of a young shoot is visibly peeking out of the grain. During this stage, some of the starchy portions of the grain would have been digested by the young shoot to fuel its awakening. The secret behind the benefits of sprouted grains therefore lies in the enhanced biochemical reaction as the dormant seed plans to sprout (Shipard, 2005). Once germination begins, dormant seed starts to

become a live plant as anti-nutrients and enzyme inhibitors are neutralized and the seed changes inside and out, releasing many nutritional advantages locked up by anti-nutrients. For instance, phytic acid found in an unsprouted grain binds with calcium, magnesium, iron, copper, and zinc, making it difficult to absorb these minerals. Phytic acid also irritates the digestive system. Sprouting generates enzymes that modify the heavy molecules such as protein and complex sugars by *in vivo* hydrolysis into soluble proteins, amino acids, peptides and sugars to feed the growing shoots and roots (Osuji, *et al*, 2011). Shipard (2005) claimed that sprouting of grains can circumvent the use of artificial additives and chemicals to achieve improved nutrient content. By sprouting, the grain/seeds are assisted to become a more alkaline forming food. So, in a sense, consuming sprouts is more like eating a plant or vegetable, therefore more alkalizing to the body.

Literature also reveals that gluten causes inflammation, a systemic process that has harmful effects across all the organ systems in the body including the brain, heart, joints, eyes and digestive tract. Inflammation does not only precede all degenerative diseases like diabetes, cancer, stroke, glaucoma, arthritis and Parkinson's disease, but also fuels their insidious progression (Osteman *et al*, 2005; www.orangenewsonline). Gluten consumption has also been linked to many psychiatric and neurological diseases including depression, schizophrenia, dementia, nerve damage, epilepsy and autism (Ge Zhang *et al*, 2015).

Basically, our studies helped to give credence to the fact that unsprouted wheat and its associated products cannot be an alternative food for diabetics, aged persons and health conscious individuals. This awareness has to be spread to avert the prevalent consumption of wheat by diabetics. It is true that wheat and its products are everywhere; bread, biscuits, noddles, chin-chin, beverages, buns, cake, sausage, meat-pie, pizza, bulgar to mention just a few. Wheat products are almost unavoidable especially in snacks. My suggestion and recommendation, essentially, is that sprouting

process, just as it is done for barley and sorghum in breweries, should be applied to wheat for bread and other wheat-base products. By so doing the issue of cassava incorporation into wheat flour may be reverted and cassava may be used for other industrial purposes. This will also re-adjust our food security positively as chronic diseases may reduce in the country. Even God, in *Ezekiel 4:9*, approved and directed sprouting of some grains for bread production.

On the part of the government as well as food processing industries, it is important to note that grain sprouting could be utilized to improve the nutritional status of people especially the aged since the sprouts have low sugar content and a claim of high digestibility (Shipard, 2005; Ostman, *et al.*, 2005; Ge Zhang *et al.*, 2015). This is particularly needed and useful in developing countries like Nigeria where consumption of white bread and unsprouted grains is significant. And the technology used in this research is not difficult to adopt even at local (village) set-up. Conclusively, grain sprouting is a comfortable viable option for improving nutritional value of locally made grain foods including bread and it is an inevitable process for achieving sustainable food security.

10.0 EFFECT OF COOKING POT ON METAL AND NUTRIENT CONTENT OF COOKED FOOD

Mr. Vice-Chancellor, Sir, another significant area of my research works I would like to mention here bothers on the effect of cooking pots on metal and nutrient contents of cooked food. Located at the end of the chain of food preparation, cooking utensils can contaminate food based on materials used in their production. Although information on the possibility of metal leaching from cook ware has gained great interest in recent times, the leaching of metals into food from food contact surfaces is not covered by the occurrence dataset used to estimate metal dietary exposure (WHO, 2001). Hence I decided to channel part of my research thrust to evaluating the metal toxicity of our common cook wares and their impact on bioaccessibility of food nutrients, and our findings in this regard were

quite impressive. The first aspect of this research was to know the dominant cook ware and maintenance culture of cook wares by Imo State dwellers using structured questionnaire. Afterwards the cook wares were evaluated for metal leaching capability as well as their impact on nutrient content of cooked food. The available cook wares are displayed on Plate 3.



PLATE 3. COOKWARES AVAILABLE IN NIGERIA.

10.1 COMMON COOK WARES AND REASONS FOR CHOICE OF COOK WARES

A look at the food pipe line reveals the vital role of food cooking/preparation on “food use” – one of the pillars of food security. There are rising evidences that certain cooking pots can provide an important avenue for metals to enter food and consequently to consuming human bodies (WHO, 2001; Shelton *et al*, 2003; Karbouji, 2007; Mohammad *et al*, 2011; Kurtus, 2012; Kamerud *et al*, 2013). The awareness of the dangers of metals from cooking utensil is of growing concern to public health given that contamination is one of the deterrents of food quality. We are aware that the impact of food to the human body does not only depend on the nutrient during harvest but also on what happens to the food before it

gets into the mouth. A naturally nutrient-dense food can be turned on its head to become poison-dense through wrong preparation. Several factors including the cook wares influence the losses and changes associated with food nutrients during cooking (Greger, 1985; Cheng and Brittin, 1991). All materials give off atoms and molecules when heated and when immersed in an acidic or alkaline solution (Greger, 1985; Cheng and Brittin, 1991). Therefore every cooking material may leach metal into food, especially under high temperatures so it is good to know the type of metal and chemicals that could be leached out by the tools we use to cook our foods; and this was what we set out to do through our research works.

Our survey on the dominant cook ware and maintenance culture of cook wares by Imo State dwellers revealed that 60% of Imo State dwellers use aluminum cook ware to cook their food (Fig. 4) and their choice of cook ware depended on popularity, economy, durability of the ware and fate. We included the term "fate" because over 90% of those who use aluminum pot to cook use it on the grounds that they inherited or received it as token (wedding gift) and not necessarily by original choice of theirs. Glass and titanium cook wares were uncommon. The data in Table 3 show that the extent to which respondents use inherited cookware is 2.98 which is above the expected value of 2.50 on a 4-point Likert scale. Therefore, the number and proportion of respondents whose reasons for choice of cookware as inherited or token property is above average. These cook wares are often inherited from relations (both living and dead) or received as wedding gift/souvenir, and a lot of people do not bother to change them many years thereafter. Similarly the choice of cookware by respondent as influenced by the price of the cookware has a rating score of 2.7 which is greater than the expected value of 2.50 on a 4-point Likert scale (t - statistic = 2.211 and p -value = 0.015). However, and unfortunately too, the extent to which the choice of cookware by respondents is influenced by health factors is 1.98, which is below the expected average value of 2.50 on a 4-point Likert scale. This shows that among the respondents, the number and proportion of those that have their reason for choice of cookware

based on healthy considerations is below average. And this further shows that under normal circumstances people do not consider health factors when purchasing cook wares, the educational level of the respondents notwithstanding.

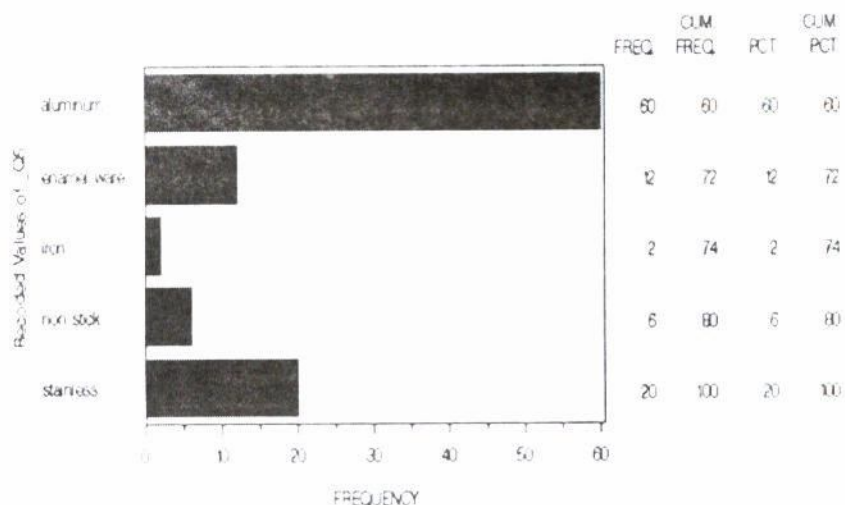


Fig 4. Bar-chart showing the distribution of cookware use among Imo State dwellers

Table 3. T-Test Results analysis on the reasons for the choice of type of cookware use by Imo State Dwellers

Reasons	N	Mean	Std. Dev	Std. Error	Statistics	Prob>t
Inherited	150	2.98	1.01	0.10	4.730	<0.0001
Easily available	150	2.14	0.92	0.09	-3.907	0.9990
Cheap price	150	2.70	0.90	0.09	2.211	0.0147
In vogue	150	2.44	0.81	0.08	0.741	0.7700
Healthy	150	1.98	0.86	0.09	-6.016	1.0000

The above results explain the continued patronage of aluminum cookware by vast number of respondents. These findings tally with the observation of Ukanwa (2002) and Dan and Ebong (2013), that the most commonly used cooking pots in Nigeria are those made of aluminum and stainless steel and that the choice of these pots is because they are the most popular and economical cookware commonly found in Nigerian markets. In addition they are easy to clean, have unique surfaces that cannot crack easily, difficult to rust and also have high life expectancy. Remember, Imo dwellers are not essentially Imo indigenes. So it is plausible to extrapolate that the use



Plate 4. Heavily burnt Aluminium pot

(Table 4). The extent of maintenance of cookware by abrasive washing using sand, ash and leaves is 2.56, which is above the expected value of 2.50 on a 4-point Likert scale. Unfortunately some of these unconventional means like using sand and ash could cause abrasive effect on the surface of the pots which could lead to corrosive pitting. We also discovered that Imo dwellers and indeed Nigerians do not have the culture of discarding pot, no matter the age and how badly burnt or damaged the pots could be. (See Plate 4).

of aluminum cookware is common among Nigerians, using dwellers in Imo state as a case study.

Our study further revealed that the most common maintenance culture among respondents is abrasive washing

Table 4. Maintenance culture of Cookware by Imo State Dwellers

MAINTENANCE TECHNIQUE	Mean	Std. Dev	Std. Error	Statistics	Prob>
Sand/ash/leaves	2.56	1.05	0.10	0.573	0.284
Iron sponge/soap	1.94	0.86	0.09	-6.493	1.000
Sponge & soap alone	2.06	0.68	0.07	-6.480	1.000
Non scratch stain remover	2.20	0.85	0.09	-3.518	0.999
Soaking indefinitely	2.06	0.68	0.07	-6.480	1.000

10.2 THE LEVEL OF METAL LEACHING OF THE VARIOUS COOKING POTS.

After identifying the common cookware in use by Imo State dwellers, we proceeded further in our research to investigate the level of metal leaching of the various cooking pots in use in the State. The various cooking pots were used to boil water for six minutes under the same heat intensity. We discovered that the highest iron leaching (0.0058mgFe/L) occurred in cast iron pots while aluminum pots leached the highest quantity (0.0046mg Al/L) of aluminum metal (Table 5). Nickel leaching occurred most in stainless pots. A general trend showed that old cook wares (especially aluminum and stainless) seeped more metals than their new versions probably because new pots have nonporous surfaces. Enamel and titanium cook wares did not produce leacheates. None of the cook wares leached high doses of lead, copper, mercury and arsenic.

When the pots were used to prepare foods (different major food groups were represented namely vegetables, fleshy, tubers, cereals and legume) we discovered that cooked food samples had higher content of the metal elements compared to control (raw food). And the concentrations of metals in cooked food samples were higher than their values in boiled water samples. This affirms that the cooking pots leached higher amounts of metals during cooking of food compared to when they were used to boil only water. From this data it

could be asserted that there is a reaction between food and materials used to forge the cook wares. Expectedly some of the pots maintained a pattern of metal leaching irrespective of the food they were used to cook while others were affected by food type. For example, boiling of tomato sauce for 6 min in an aluminum pot resulted in an increase of aluminum metal content of the tomato sauce from 0.00mgAl/100g to 0.053 mg Al 100g for raw and cooked samples respectively. While for titanium and stainless cook wares the concentrations of aluminum increased from 0.00 mgAl/100g to 0.01 and 0.041 mgAl 100g respectively (Table 6).

Irrespective of the food cooked, old aluminum pot leached more aluminum ions than the new ones, implying that pitting and scratching (Plate 5) do increase leaching of such pots. These observations are in agreement with some previous works which demonstrate that increased concentrations of complexing ions (organic acid, fluoride ions, or OH, etc) significantly enhance the release of aluminum ions (Bi, 1992; Gbolade *et al.*, 2003) into the food being cooked, and that aluminum leaches most easily from worn or pitted inferior pots and pans (Gbolade *et al.*; Hughes 1992; Rojoma *et al.*, 2010; Blair 2012). Greger, *et al.* (1985) added that the amounts of aluminum that accumulate in foods during preparation also depend on the length of cooking periods, intensity of heat and the types of utensils. They reported that tomatoes heated in aluminum pans for 5min accumulated only 0.02-0.03 mg Al 100g, while tomato cooked for 3h in aluminum pans accumulated 5.7mg Al 100g. Hence we propose that long periods of cooking in aluminum pots should be discouraged and leftover foods should not be kept in aluminum pans. This is to avoid excess aluminum ion intake and the resultant health effects on organs of the body.

TABLE 5. Leacheates from different cooking pots when used to boil water

COOKING POT	Metals ($\times 10^{-2}$ mg/L)						
	Aluminum	Copper	Iron	Nickel	Arsenic	Lead	Mercury
Unboiled water	0.4 ^a	1.8 ^a	0.73 ^a	0.61 ^a	0.49	0.40 ^a	0.020 ^a
Titanium	0.1	1.8	0.28 ^a	0.61 ^a	0.49	0.40 ^a	0.020 ^a
Enamelware	0.15	1.8 ^a	0.22 ^a	0.63	0.50	0.47 ^a	0.022
Stainless	0.26	2.3	0.35 ^a	0.98 ^a	0.53 ^a	0.46 ^a	0.024
Cast Iron	0.23	2.2 ^a	0.58 ^a	0.71 ^a	0.53 ^a	0.50 ^a	0.024 ^a
Clay	0.23	3.0 ^a	0.36	0.68 ^a	0.54 ^a	0.52 ^a	0.039 ^a
Aluminum	0.46	2.2 ^a	0.38	0.62	0.53 ^a	0.49 ^a	0.026 ^a
<i>MTL (mg/L)</i>	0.2	1.0	0.3	0.02	0.01	0.01	0.001

+Unboiled water served as control.

MTL: Maximum Tolerable Level (WHO, 2011) in drinking water.

Table 6. Effect of cooking pot on quantity of aluminum ions migrated into cooked foods

Cooking Pots	Quantity of Aluminum ions (mg/100g) migrated into cooked food					
	Tomato	Beans	Yam	Rice	Meat	MEAN
Control (raw)	0.003	0.014	0.15	0.01	2.14	0.468
Titanium	0.026	0.024	0.14	0.00	2.14	0.461
Enamelware	0.014	0.017	0.14	0.00	2.14	0.462
Stainless	0.41	0.016	0.13	0.012	2.15	0.544
Cast Iron	0.027	0.018	0.11	0.013	2.16	0.511
Clay	0.027	0.024	0.25	0.013	2.19	0.509
Aluminum	0.053	0.015	0.15	0.040	2.54	0.603

Allowable Daily Intake (WHO, 2011, EFPA, 2015) 1mg/Kg/day

Table 7. Effect of cooking pot on quantity of iron migrated into cooked food

Cooking Pots	Quantity of Iron ions (mg/100g) migrated into cooked Food					
	Tomato	Beans	Yam	Rice	Meat	MEAN
Control (raw)	0.125	2.41	0.44	4.43	1.8	1.84
Titanium	0.125	2.43	0.43	4.12	1.76	1.77
Enamelware	0.133	2.44	0.42	3.87	1.78	1.73
Stainless	0.138	2.42	0.42	3.62	1.74	1.67
Cast Iron	0.211	2.85	0.48	4.65	2.10	2.06
Clay	0.139	2.49	0.41	4.48	1.82	1.87
Aluminum	0.150	2.52	0.41	3.56	1.63	1.65

Allowable Daily Intake =18-30mg/day (EFSA, 2015)

Table 8. Effect of cooking pot on quantity of nickel migrated into cooked food

Cooking Pots	Quantity of nickel ions (mg/100g) leached into cooked food					MEAN
	Tomato	Beans	Yam	Rice	Meat	
Control (raw)	0.021	0.033	0.084	1.62	0.08	0.37
Titanium	0.023	0.035	0.084	1.58	0.07	0.36
Enamelware	0.025	0.040	0.084	1.56	0.11	0.36
Stainless	0.045	0.125	0.12	1.96	0.12	0.48
Cast Iron	0.028	0.017	0.085	1.52	0.12	0.35
Clay	0.026	0.030	0.086	1.53	0.06	0.35
Aluminum	0.031	0.020	0.084	1.50	0.06	0.34

Tolerable Daily Intake = 2.8 micrograms per kg body weight { EFSA, 2015 }

Continuing our research on the level of metal leaching from the various pots on the basis of a 2-way ANOVA (Fig.5) experimental design, a defined metal seeping pattern was observed to exist between the five (5) food samples and eight (8) cooking pots considered in the study. We actually confirmed that there were higher traces of aluminum in foods cooked with aluminum pots, higher traces of nickel in foods cooked with stainless pot and higher traces of iron in foods cooked with iron cast pots, while titanium and enamel wares leached insignificant traces of metals in all cases of cooking. Therefore, our work has demonstrated and shown that the problem of metal leaching is more or less arising from the pot; though food type affected the concentrations of metals leached by each pot.

Recall that cooking pots are made with metals and these metal substances under heat melt and undergo Brownian movement which allows them to be free and they can easily disperse into the food (Greger, *et al*, 1985; Gbolade, *et al*, 2003; Audrey, *et al*, 2006). A school of thought believes that Aluminum pans do not pose a health risk to their users, even if they are scratched or pitted (Plate 6) and that the amount of aluminum that leaks into food is negligible, and far less

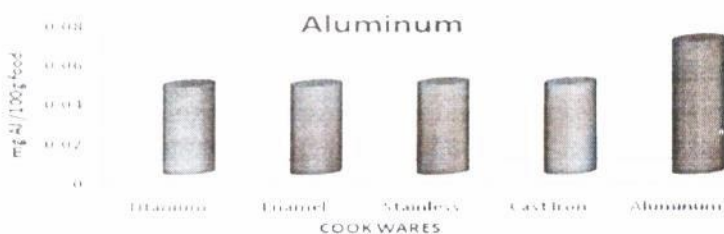


Plate 5. Surface of Pitted and patched aluminum pot (unsafe for cooking)

than that consumed through other methods. VC sir, Ladies and gentle men, my take on this is that exposure to aluminum is hazardous if not today then tomorrow since it can accumulate in the body (Greger, *et al.* 1985; Semwal et al 2006). This is true because the effects of exposure to any hazardous substance including aluminum depend on the dose, the duration, how one is exposed, personal traits and habits, and whether other chemicals are

present or not. The fact is that aluminum can build up in the body when the body detoxification mechanism is weak or overworked.

If aluminum utensils are coated anodized, there is no leaching of the metal during cooking as long as the coating is intact. But problem arises when the coating is old or is scratched off during washing resulting in pitting.



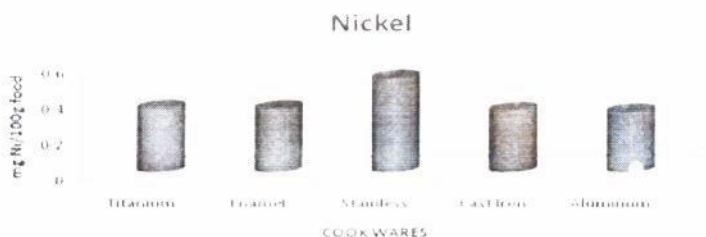


Fig 5. Summary of the effect of cookware on quantity of aluminum, iron and nickel ions leached during cooking (irrespective of food type)

10.3 EFFECT OF COOKING POT ON DAILY INTAKE OF METALS FROM COOKED FOOD

How much of metals do cooking pots contribute to daily intake of metals from cooked food? Part of our research works was devoted to answering this question. The calculated daily metal intake was based on the assumption that an average individual eats 600g of staple per meal. Under normal conditions an individual eats three times a day, which gives us an estimate of 1800g staple per day. Therefore multiplying the quantity of metal (per 100g) by the quantity of food consumed per day gives us the estimated values displayed on Table 9. The obtained values will increase when we add the metals that will come from other food ingredients (such as meat, spices) eaten along with the staples. Our study has evidence that aluminum do migrate from cooking utensil into food. However, the quantities of aluminum seeped into food were not above the maximum permissible levels (WHO, 2001). But like we said earlier, more aluminum will come into the food via other ingredients used in preparing the staple. However aluminum that may migrate from aluminum utensil is probably not a major source of this element to the body. The point here is that we should not lose sight of the fact that there is more aluminum ions in foods cooked with aluminum pots compared to other pots. In the same vein there is more nickel ions in the foods cooked with stainless pot compared with other cook wares (Fig. 5).

TABLE 9. ESTIMATED DAILY CONSUMPTION OF ALUMINUM FROM DIFFERENT COOKING POTS

FOOD STUFF	Quantity of Aluminum ions (mg) consumes in a day						
	Uncooked	Titanium	Enamel	Stainless	Iron cast	New Aluminum	Old Aluminum
Rice	0.18	0.00	0.00	0.23	0.23	0.54	0.72
Tomato*	0.09	0.08	0.23	0.74	0.49	0.90	0.95
Beans	0.16	0.25	0.27	0.29	0.40	0.53	0.63
Yam	3.24	2.52	2.52	2.34	1.98	5.22	5.40
MEAN	0.95	0.74	0.76	0.90	0.78	1.80	1.93

Provisional Tolerances Weekly Intake (PTWI) of aluminum is 7 mg/kg body weight i.e. 1 mg Al/kg per day. The acceptable dosage is therefore not more than 60 mg/day for a person weighing 60 kg.

*** Not a staple**

Minimal exposure of aluminum to our bodies may not be a problem as human bodies can excrete small amounts very efficiently (JECFA, 1989). But unfortunately due to many reasons, most of us get exposed to and ingest more than what our bodies can handle (Diamond, 2005; Hidden hunger, 2015). It should be noted that these recommended levels are for healthy persons with good renal functions. In cases where the renal system is not efficient the aluminum that migrated into cooked food (no matter how little) will represent a health risk. Some researchers are still maintaining that aluminum present in food utensils can expose humans to the ingestion of big quantities of aluminum (Greger, 1985; Karbouji, 2007; Al Juhaiman 2012; Odulara *et al*, 2013), especially in the case of acidic dishes. In that case, our research findings that aluminum from cook wares do migrate from cooking utensil into food should be taken seriously by both food consumers and cookware manufacturers.

Aluminum is regarded as a neurotoxin agent because its salt can be absorbed by the gut and accumulated in various human tissues including bone, liver, parathyroid, and brain. The high

concentrations of aluminum have been detected in the brain tissue of patients with Alzheimer's disease, Parkinson disease and dialysis encephalopathy (WHO, 2001; EFSA, 2015). The most notable symptoms of aluminum poisoning are diminishing intellectual function, forgetfulness, inability to concentrate and, in extreme cases, full blown dementia and Alzheimer's disease. In human body, aluminum ion can inhibit different metabolism processes by competition reactions with other ions such as iron, magnesium, calcium, phosphorus, fluoride, and others. Various reports have suggested that high aluminum intakes may be harmful to the elderly, and patients with bone diseases or renal impairments (WHO, 2001; Soni *et al*, 2001).

Following the 30th reports of the Joint FAO WHO Expert Committee on Food Additives that accumulation of aluminum ions was increased in individuals with chronic renal disease and that aluminum is implicated in the etiology of certain neurotoxic disorders, (WHO, 2001) many developed countries including Germany, France, Belgium, Great Britain, Switzerland, Hungary and Brazil banned the sale and use of aluminum cook wares (Hidden Hunger, 2015). And some African countries including Ghana have mandated the use of anodized aluminum for cook ware making. Unfortunately, Nigeria is yet to queue in. In Nigeria, ladies and gentle men, it is regrettable and shameful to find that every pot is saleable and useable. The Nigerian public is ignorantly and constantly acquiring to our own health detriment cook wares already rejected by other countries for health reasons.

Aluminum cooking utensils are light, fairly soft and will release more molecules into the food than harder metals used in making other cook wares. Extremely high heat is capable of disintegrating the framework of an aluminum pot (Plate 6). Anodization, an electro-chemical



Plate 6. Aluminum pot disintegrated by heat

process that seals (locks in) the aluminum ions in aluminum cook wares can prevent leaching in aluminum pans (www. ehow.com). Anodized aluminum cookware is a popular alternative to plain aluminum though anodization can break down over time. The leaching of aluminum even with acidic foods does not happen with anodized aluminum cookware because anodized pan has a very hard surface that is corrosion resistant and durable (www. ehow.com) Unfortunately the common aluminum pots marketed *today in Nigeria are unanodized*. We therefore recommend the use of anodized aluminum pots instead of unanodized aluminum pots, which should be minimally used and discarded once they become fairly old.

On cast iron pots, we discovered that using cast iron pots to cook can expose consumers to high intake of iron metal. Since many people have iron deficiencies due to inadequate intake of iron, one might jokingly suggest that all cooking utensils be iron. But that is not the end of the story. The reality is that ions from cast iron cooking pot is in ferric form (Fe^{3+}), a transition element (hydrated form) which undergo progressive hydrolysis to yield insoluble ferric hydroxide ($Fe(OH)_3$). Actually iron exists in two forms: ferrous Fe^{2+} and ferric - Fe^{3+} . Ferrous form is more soluble in water at physiological pH. Ferrous iron is what makes blood red and comes from foods. Iron is used by the metabolic reaction only when it is in reduced form (ferrous state Fe^{2+}) but it is stored and transported in the body as ferric iron (Fe^{3+}). The body cannot assimilate properly the ferric form of iron (from a cast iron pan) so the ingested ferric iron gets treated by the body as a heavy metal and ends up getting stuck in the liver and kidneys (Ekalobi, 2008). It should be noted that ferric form of iron is stored in the body, so it can accumulate over time, contributing to joint pain/arthritis, digestive troubles, depression, impotence, early menopause, and other issues associated with iron toxicity (Chen and Brittin, 1991; Yaquat *et al*, 2000). Since cast iron is a toxic inassimilable kind of iron, it then means that a cook ware that leaches a large amount of Fe^{3+} constitutes health danger and not healthy as some people erroneously believe. Urinary and fecal iron excretion is very low, thus, apparent iron absorption will practically equal

apparent iron retention (Weink *et al.*, 199). And our research findings reveal there are higher traces of iron in foods cooked with iron cast pots.

When it comes to nickel the focus is not on permissible levels but rather on sensitivity since nickel can cause allergic reactions in sensitive individuals. People that are allergic to nickel might have issues with the leaching of nickel from stainless steel cookware. According to some workers (Hidden Hunger, 2015) abrasive washing of stainless steel can cause small amounts of chromium and nickel to be released into food. Toxicological studies indicate that a single oral dose of Ni as low as 67µg can cause Allergic Contact Dermatitis (ACD), eczema flare up, and might even lead to systemic dermatitis in individuals sensitive to nickel (Kamerud, *et al.*, 2013; NickellInstitute, 2015). Here again, our research findings show there are higher traces of nickel in foods cooked with stainless pot.

By way of emphasis and summary, the three metals we discovered to have high leaching from the various pots are aluminum, iron and nickel. The leaching of other metals such as arsenic, mercury, cadmium, lead and copper from the various cook wares were more or less insignificant.

10.4 INFLUENCE OF COOKING POT ON LOSS OF NUTRIENTS IN COOKED FOOD

Ladies and Gentle men, aside producing leacheates into food, another threatening issue about some cooking pots is their interaction with food nutrients during cooking. As evidenced in my research work (Tables 10 - 12 and Figures 7 & 8), cooking reduced the level of micronutrients in foods as equally reported by some authors (Ojiakolam, 2010; Dan et al, 2012). My investigations in this area revealed that titanium cookware offered better retention (protection) of micronutrients while old aluminum pot offered the least retention. In the course of our investigations we noticed that Titanium and enamel wares required lower quantity of water in cooking and they caused the lowest loss of nutrients (Fig 7, 8). According to Schrrle (2006), Titanium pot cooks food under vacuum (low pressure),

making it possible for water therein to boil below 100°C. This may be as a result of the low thermal heating rate of convection associated with the cookware types (Ross 2015). The use of less water and less oil to cook (as a result of the non porous surface of the pot) may impact better taste of food since the food will be nutrient-dense and not flooded with water. High food nutrient protection by titanium cookware, as evidenced in high ash content (Fig. 9), can be related to its waterless cooking mechanism (Schrle, 2006). This explains why the moisture content of food cooked in Titanium ware was considerable lower than others (Table 12.).

Table 10. Effect of cook ware on quantity of vital trace elements of a beans meal

POT TYPE	VITAL TRACE METALS (mg/100g)			
	SELENIUM	ZINC	POTASSIUM	MAGNESIUM
CONTROL/RAW	3.26 ^a	5.65 ^a	767.75 ^a	189.57 ^a
TITANIUM	2.90 ^b	5.04 ^b	655.68 ^b	165.21 ^b
ENAMELWARE	2.79 ^c	5.04 ^b	643.21 ^c	161.79 ^c
STAINLESS	2.36 ^d	4.46 ^{cd}	588.76 ^d	146.01 ^d
IRON CAST	2.26 ^e	4.27 ^d	565.01 ^e	143.62 ^e
CLAY	2.56 ^{cd}	4.60 ^c	627.30 ^d	160.08 ^c
NEW ALUMINUM	2.04 ^e	4.26 ^{cd}	548.13 ^e	139.25 ^f
OLD ALUMINUM	2.04 ^e	4.13 ^e	548.13 ^e	139.21 ^f
LSD	0.09	0.24	7.23	1.86

Table 11. Effect of cook ware on quantity of vital trace elements of tomato sauce

POT TYPE	VITAL HEALTH TRACE METALS (mg/100g)			
	SELENIUM	ZINC	POTASSIUM	MAGNESIUM
CONTROL/RAW	18.62 ^a	1.37 ^a	42.12 ^a	100.1 ^a
TITANIUM	14.36 ^b	1.26 ^b	37.89 ^b	90.27 ^b
ENAMELWARE	14.22 ^c	1.25 ^b	37.67 ^c	88.05 ^{bc}
STAINLESS	13.84 ^{bc}	1.19 ^c	36.25 ^d	88.19 ^{bc}
IRON CAST	13.84 ^{bc}	1.17 ^c	36.24 ^d	87.62 ^{bc}
CLAY	14.14 ^{cd}	1.22 ^b	37.53 ^c	88.22 ^c
NEW ALUMINUM	13.73 ^c	1.14 ^e	36.22 ^{de}	87.53 ^{bc}
OLD ALUMINUM	13.12 ^f	1.13 ^f	36.02 ^e	87.46 ^d
LSD	0.22	0.021	0.20	0.74

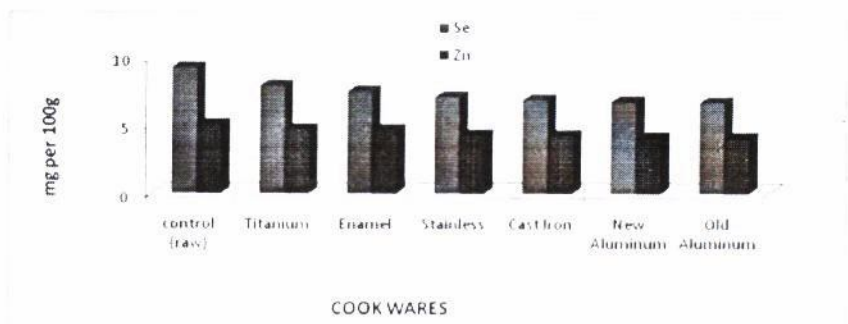


Fig 7. Retention of selenium and zinc in food cooked with various cook wares

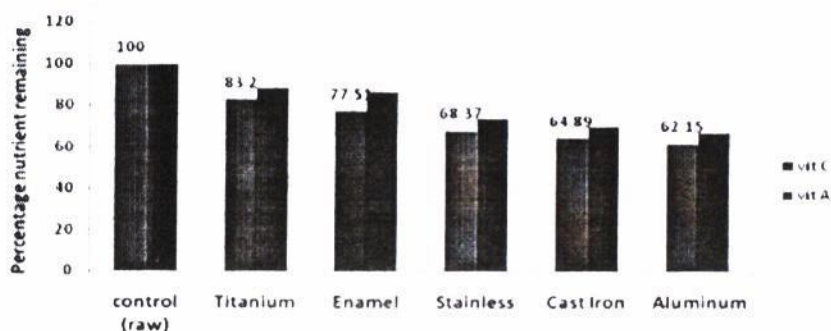


Fig 8. Effect of cookware on vitamins A and C content of cooked food (irrespective of food type)

It is worthy of note that the recent report of Alice et al., (2015) who investigated the impact of cooking process at different pressures on the molecular and sensory profile of a vegetable broth is in agreement with our research findings. They discovered that cooking food at high altitude, where pressure is lower, helped to intensify the flavors, colors, and aroma, as well as potentially improve the nutrient quality of food. The lower boiling point of water at high altitude and low pressure allows food to cook more gently, at a lower temperature. At 3,600m, for example, water boils at just 85°C. According to them this process maintains the food's natural amino acids, carbohydrates, and organic acids, as well as volatile compounds, such as aromas. Having

these elements preserved in the components of a finished dish makes the flavors, colors, and aromas more intense, without the addition of a single flavor enhancer or additive, or even salt. In this way, the researchers established that imitating the conditions of mountain cooking through low-pressure boiling might be used to enhance the flavor profile of culinary preparations. Therefore low-pressure cooking according to them is an alternative to both the traditional ambient and high-pressure cooking to provide food with enhanced organoleptic properties. Their results showed that low-pressure cooking (80°C/0.48 bar) would preserve the most heat labile volatiles likely because of the lower water boiling temperature and the reduced level of oxygen.

What our research has evidenced, on our own part, is that cooking utensil can have a strong impact on people's morbidity. Some utensil as we have discussed can aggravate hidden hunger, that is, micronutrient malnutrition. Hidden hunger is a subtle enemy that drains away health and vitality unnoticed until it is too late to reverse (HarvestPlus, 2015). Often, the signs of this form of malnutrition are 'hidden', as individuals may 'look alright' on the outside but suffer extremely negative impacts on health and general wellbeing. The highpoint of our research findings is that cooking, generally, reduces food nutrients (Onyeka, 2013) but the losses are influenced by among other factors the type of cookware used in cooking the food. This is a piece of information that is quite vital and beneficial to food consumers, manufacturers of cook wares and operators and key players in the food processing industry.

Table 12. The proximate composition of food stuff as affected by cook ware

POT TYPE	Proximate content of food (mg/100g)		
	Moisture	Protein	Ash
CONTROL/RAW	47.67 ^a	11.51 ^a	1.5 ^a
TITANIUM	69.45 ^b	8.63 ^b	0.95 ^b
ENAMELWARE	68.03 ^b	7.95 ^b	0.91 ^b
STAINLESS	73.91 ^b	6.75 ^b	0.77 ^b
IRON CAST	74.26 ^b	6.57 ^b	0.74 ^b
NEW ALUMINUM	76.53 ^b	6.57 ^b	0.65 ^c
OLD ALUMINUM	76.72 ^b	6.51 ^b	0.59 ^c
LSD	14.01	0.021	0.20

Average of five different food stuffs

It is important and crucial to state here that my observations and research findings, recently complemented and in agreement with those of Alice et al., (2015) have turned on its head the previous idea of using pressure pot to cook food. Pressure pot mounts “pressure” on the nutrients of food which is not desirable and in the best interest of the food consumer. Our recommendation, therefore, is the use of titanium cookware which, according to our research findings, offer better retention (protection) of micronutrients than other cook wares could do and achieve in this regard.

Kindly permit me, Mr. Vice Chancellor, Sir, to state without further extensive discussions, some of my other modest contributions to the development of Food Science and Technology in Nigeria and beyond, which are as follows:

1. My research team and I investigated the nutritional and physicochemical properties of *Trichosanthes cucumerina* (snake gourd), a lesser-known fruit and compared it with pear-shaped tomato. The pulp of ripe fruit of snake gourd contained more protein (28%), potassium and calcium than pear-shaped tomato. However the content of carbohydrate, total acidity and ascorbic acid were lower than those of snake gourd puree. My assertion is that the fruit of snake tomato is an excellent dietary source of lycopene, Betacarotene and potassium. *Onyeka E.U and O.S Eke, 2004*

2. My research team and I also investigated the effects of roasting and steaming pretreatments on yield, composition and characteristics of oil from the seed and pulp of African black pear. Roasting gave higher oil yield than steaming treatment. Heat treatment decreased iodine content, peroxide content and saponification value of both seed and pulp oils. Our results corroborate the fact that African black pear is a good source of vegetable oil for both domestic and industrial uses.

Onyeka E.U, Onuegbu, N, Onuoha, N.U and Ochonogor, F. (2005).

3. We also conducted a research that looked into the adoption profile of the utilization methods of cooking banana and the factors that may have influenced it. The major factors which have strongly influenced the adoption process were the level of educational attainment, social status, primary occupation, intensity of training received, availability of commercially-produced plantain products in the market area, trial ability as well as the number of desirable attributes of the utilization methods. Trial ability of innovation and possession of desirable attributes greatly influence technology adoption process. Innovations that result in desirable characteristics, and which can be tried in bits are readily adopted by the target group. Thus, the development of innovations and technologies that possess desirable attributes that fit into the people's farming and consumption systems, and which present alternatives for trial are of crucial importance in decisions regarding technology generation and transfer.

J.I Lemchi, M. Tshiuza, E.U. Onyeka and A. Tenkouano (2005).

4. In another research, we assessed the potential of eight common green leafy vegetables (GLV) in the raw and cooked forms as natural source of phytochemical. The vegetables studied were the common ones found in SouthEast Nigeria and they included *Ugu, Nchanwu, Okazi, Utazi, Oha, Nturuksa, Ahihara, and Onugbo*. The phytochemical content of the vegetables varied significantly ($P < 0.05$) among the GLV. *Onugbo* had the highest

steroid content of 0.27g/100g while *Nchanwu* had the lowest (0.07g/100g). *Oha*, followed by *Ahihara*, was the most enriched with respect to the tested phytochemicals. Differences in phytochemical content between raw and cooked GLV were not significant ($P>0.05$), with the exception of flavonoid and alkaloids. Alkaloid contents of the GLV were more in the raw than cooked ones. The assessed GLV offer a cheap but rich source of a number of phytochemicals having health protective properties. The production and consumption of a mixture of GLV was recommended.

Onyeka E.U. and Nwambekwe I.O (2007).

- 5 We also conducted a research in which flour were prepared separately from defatted and undefatted dika nut, *Irvingia gabonensis* var. *excelsa*, locally known as *ogbono*. The study was aimed at examining the effects of partial defatting, chemical treatment and ambient storage on functional properties and shelf-stability of *ogbono* (*irvingia gabonensis*) flour. Defatting reduced the rancidity rate of the *ogbono* flour, that is, it improved the shelf-life of the flour. Interestingly, the defatted *ogbono* flour maintained their functionality including drawability throughout the period of storage. Neither defatting nor the chemical preservatives reduced the functionality of *ogbono* flour. Production of defatted *ogbono* flour is recommended on the basis of convenience, shelf-stability as well as healthier heart benefits.
Onyeka E.U and O.J Emenogu (2008).

- 6 One of my research works, which I later presented at an International Conference in Kenya in 2009, assessed the potential consumer safety and satisfaction at fast food outlets in Owerri urban area, Nigeria. The survey data revealed that the extent to which consumers were satisfied with the services and perceived safety of these fast food outlets were above average ($P<0.0001$), indicating that consumers do not generally perceive any health dangers with these fast food outlets. On the contrary, our laboratory study revealed that the microbiological safety of these

fast food outlets was questionable. Aerobic mesophilic organisms, Coliform bacteria, and *Escherichia coli* were found to be present in some food samples. The levels of pathogenic organisms in the food samples exceeded the safety levels (0-10cfu/g) specified by the National Agency for Food and Drugs Administration and Control (NAFDAC), and the growth patterns of coliform bacteria were found to vary significantly ($P < 0.001$) between food samples. Among other recommendations is the suggestion that NAFDAC should conduct routine checks on the wholesomeness of finished food products served at the fast food outlet. **Onyeka, E.U., Mbonu A.R and Onyeka A.C (2010).**

- 7 In another research, we determined the phytochemical, nutrient and anti-nutrient content of the green leaf of treadssoftly, *Cnidoscuros aconitifolius*. Our research efforts revealed that this leaf is particularly rich in protein (5.95%) and contains more phytochemicals than many other culinary vegetables, explaining its use as a medicinal herb. There are more nutrients in the younger leaves of this plant, and that this leaf needs cooking before eating since it is higher in HCN (0.75%) compared to ugu fluted pumpkin leaf (0.38%). **Onyeka E.U, Agha, J.C and Nwanjo, A.C (2010).**
- 8 In 2011, I examined three varieties of soyabean which we sprouted separately in batches for 6h, 12h, 24h, 36h and 48h and were used to produce soyamilk. Whey was produced from each soyamilk using citric acid. We discovered that soyabean variety did not affect the volume yield of whey but pH of coagulation did. More goagulation occurred at pH 4.5 than other pH tested. β -glucanase treated soyamilk had the highest ($P < 0.05$) whey volume (89.07%). Gel electrophoresis (SDA-PAGE) electrophoregram showed that most proteins in the control diminished after sprouting. The Visible Coagulation Time (VCT) of soyamilk whey was > 7 months. The conclusion was that development of soyamilk whey for food and beverage production is feasible. **Osuji C.M, Onyeka E.U, Onuegbu N.C**

and Udofia U.S (2011).

9 I also carried out a research in which the microorganisms and compounds influencing the organoleptic properties of Ugba were studied. *Staphylococcus saprophyticus*, *Bacillus pumilus*, *Bacillus subtilis* and *Bacillus licheniformis* were the organism involved in the fermentation. Ugba prepared by mixed starter culture were liked most among others. Nineteen compounds were found in unfermented ugba, out of which 11 were found only in fermented ugba. The best ugba were found to contain ethanol, ethyl stearate, ethyl oleate, ethyl linoleate, ethyl phenol and ethyloctanoate. These compounds influenced the perceived ugba flavor but had no direct influence on colour and texture. *Kabuo N.O, Uzuegbu J.O, Ubbuonu C.N and Onyeka E.U (2013).*

10 We also conducted a research where Cowpea (*Vigna unguiculata*) was blended with wheat (*Triticum vulgare*) flour at various ratios and used in noodles production. Variations in the levels of wheat flour substitution with cowpea affected nutritional, physicochemical properties as well as the consumer acceptability of the noodles. Noodles made from cowpea-wheat flour blends were found to be significantly ($P < 0.01$) higher in protein and fibre contents than those from 100% wheat flour. This was considered a significant health benefit. The summary of this research point is that the use of cowpea in noodles production could be explored by the pasta/noodles industries, and that cowpea noodles may be successfully introduced into the Nigerian market. *Udeogu, E, Onyeka, E.U and Umelo, M.C (2014).*

11.0 HUMAN CAPACITY BUILDING

My highly respected Vice-Chancellor, Sir, I have been involved in teaching, research and public service in this University for more than seventeen (17) years now. Part of what I have accomplished during these years is human capacity building. In addition to having served as Head of Department, external and internal assessor of both graduate and undergraduate students' thesis, Class Adviser and member of various University committees, I have specifically and

successfully supervised over fifty (50) students at both undergraduate and postgraduate levels. These include four (4) Ph.D and six (6) M.Sc. students. The Ph.D graduates are Dr. (Mrs.) N.O Kabuo, Dr (Mrs) Chinyere Ibebuchi, Dr (Mrs). Ann Peter-Ikechukwu and Dr. (Mrs) Chidi Julian Ibeawuchi. It gives me great joy to know and recall that I have been part of the making of these great scholars of this University.

12. CONCLUSION AND RECOMMENDATIONS

Mr. Vice-Chancellor, Sir, Ladies and Gentlemen, my concluding remarks are as follows:

- Food processing and processors have indispensable role to play in our attaining sustainable household food security. Government commitment and participation expressed through effective and encompassing food safety policy will ensure that Nigerians eat safe and nutritious food.
- All carbohydrates are not equal in their physiological roles and do not affect human health equally. The common cowpea cultivars in Nigeria, for example, do not have the same physiological role and would affect human health differently. Ife-brown among others has the most beneficial health qualities.
- The practice of sprouting grains, including wheat, is an avenue for consumers to derive immeasurable nutritional benefits from grains. Sprouting hydrolyzes complex sugars in grains, releasing flatus gases before it is consumed. Sprouted grains could be used as functional foods for health promotion more so as the technology is adaptable even at a village set-up.
- Some cooking pots are likely to expose consumers to intake of metals exceeding the allowable dose recommended by WHO in 1989 and 2001. Porous and pitted/corroded surfaces exacerbate leaching of cookware, therefore raises health risk.
- Avoidance of abrasive and corrosive cleaner is one of the ways to

avoid metal toxins. When a pot is rusting or showing signs of pitting/corrosion, the only healthy option is to replace the pot because it is probably leaching those metals into food.

- Titanium Steel pot does not only protect (retains) more food nutrients than other pots tested but also does not leach metals into cooked food. Enamel, as long as it has no scratch is as good as titanium.
- Aluminum pots are not friendly with food nutrients and they also add aluminum metals to food, which may exacerbate food related nutritional disease such as cardiovascular disease, obesity and diabetes in the food consumers.

My sublime recommendations, therefore, are as follow:

- ✓ A nutrition and food safety policy that is more encompassing and effective is urgently needed in the country to serve as a road map for good diet choice. For an instance, glycemic index should be part of every carbohydrate food label because of the pivotal role of sugar in human metabolism. Every additive involved in the course of food processing must be shown on the label, none should be left out. The food industry and policy makers must innovate and renovate to make the healthy eating choice the easy choice for Nigerian public.
- ✓ Our regulating agencies could do better by being more proactive. We need not wait until people start dying of one or the other food poisoning before we act. Ideally, samples of products should be collected from the retail shops not factory. Factory visit should be for equipment and environmental surveillance.
- ✓ Sprouting process should be applied to wheat for bread and other wheat-based products. This will re-adjust our food security positively as chronic diseases may reduce in the country. By so doing the issue of cassava incorporation into wheat flour may be

reverted and cassava may now be used for other industrial purposes.

- ✓ Given the widespread use of relatively inexpensive aluminum cooking pots throughout Nigeria, we strongly recommend that aluminum pot surfaces be anodized so as to offer sufficient protection of food nutrients and reduction or even elimination of high concentration risks of metal leaching.
- ✓ Our data suggest that vital food nutrients ingestion when using aluminum pot is insufficient to meet the daily nutrient requirement of aluminum pot users. It is therefore advised that a change in cooking pot by such persons be sought or sources of these nutrients be taken in large quantities so as to prevent hidden hunger and the associated health risks.
- ✓ The Nigerian Government, through relevant agencies, should look into the composition and types of cook wares allowable in the country. It is high time Nigeria stopped serving as a dumping ground for substandard and obsolete cook wares. Let the country arise and protect our health.
- ✓ We should throw away and discard, as early as possible, aging (old, pitted and worn) aluminum cook wares since more aluminum ions will dissolve out of them. If and when you replace your old pans, consider upgrading to anodized aluminum pans or titanium ones in the interest of improved food safety for your family members and loved ones.

**The greatest discovery is to discover who
and what has always been there!**

Thank you for listening and God bless!

ACKNOWLEDGMENTS

First and foremost I want to thank the Almighty God who made it possible for me to stand and address this great audience. The God I am talking about lifted me from the dust and gave me wonderful privileges in life.

I want to thank my amiable and fatherly Vice-Chancellor, Professor Chigozie C. Asiabaka, who approved my request for this presentation, and who made this event to be possible. And the same token of appreciation goes to my VC's wife, Professor (Mrs.) Ihuoma Asiabaka. I would also like to acknowledge all the past VC's of FUTO for contributing in laying the foundation of this important tradition of the academia.

My indebtedness also goes to my late parents, Chief Ezeanyiwara and Mrs. Felicia Chukwu who taught me early in life to embrace honesty and dignity in labor. My brothers, Honourable Christian Chukwu, Kenneth, Edison and Earnest, and other members of my maiden family too numerous to mention here, are hereby acknowledged for being part of the success story of my life. My parents-in-law, Sir and (late) Lady T.U Onyeka are very dear ones to me. It is soothing to find a new set of parents and relations in the place (marital home) a woman is married to; and in this regard, I acknowledge the friendship and encouragements of Barrister Vin Onyeka, Nnamdi, Ijeoma and other members of Onyeka's family. I will forever remain indebted to my maternal Uncle, Dr. and Lady E.E Okafor, CMD, Bex Memorial Hospital Onitsha for his love and financial support, and for helping me to appreciate the value of education. My thanks also go to Mr. Davidson Okafor, Mr. Lambert Okafor and other members of Okafor's family (my maternal family) for all their encouragement and support to me.

I would like to appreciate my teachers namely Prof. F. Madubuike, Prof. E.C. Nwanekezi, Prof. A.O. Olorunda, Prof. J. Akingbala and Prof. N. Nsofor. My appreciation also goes to my colleagues in the

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