Lead City University
5th Inaugural Lecture

Topic:

"That We May Enjoy An Extended Life Expectancy: The Roles of Free Radicals, Reactive Oxygen Species (ROS) and Antioxidants in Aging"

by

Professor Omole, J.O.
Department of Biochemistry
Lead City University, Ibadan

8th October, 2015

The Chancellor, Prof. Gabriel Ogunmola,
The Pro-Chancellor and Chairman Governing Council
Professor Jide Owoeye
The Vice-Chancellor, Prof Femi Onabajo
The Registrar Dr. (Mrs.) Oyebola Ayeni,
Prof. Emeritus Johnson Aladekomo (Pioneer, Vice Chancellor Lead City University, Ibadan).
The University Librarian, Mr. Lanre Osaniyi, other Principal Officers.
The Dean of Postgraduate School,
Deans of Faculties,
Heads of Departments,
Eminent Invited Guests,
My dear colleagues and other staff,
Great Lead City University students,
Our Friends from the media,
Distinguished Ladies and Gentlemen.

In all humility and thanks to the almighty God, I stand before you this afternoon to present the 5th Inaugural Lecture of Lead City University, Ibadan. First, I wish to acknowledge this privilege and opportunity given me to deliver the inaugural lecture on behalf of the Faculty of Science. It is on record that this is the 2nd inaugural lecture in the faculty of Science and the second in the department of Biochemistry. I also wish to note that in the entire Lead City University system, I have four predecessors in this noble academic tradition in the persons of Femi Onabajo the current Vice Chancellor; Shadrach Agunbiade of the Department of Biochemistry; Chibuzo Nwoke of the Department of Politics and International Relations; and Felix Onabajo of the Department of Management and Accounting. As a mark of respect, I doff my cap to them.

Mr. Vice chancellor, Sir, I consider this noble academic tradition as a unique and rare opportunity for me to contribute to the current issues of life, and to review my research activities in my chosen field, that is to say, the journey so far, the relevance or otherwise, in uplifting the socio-economic

well-being of our people. It is on this premise that I will anchor my presentation.

Introduction

Mr. Vice chancellor, Sir, as a nutritional biochemist and a food scientist I feel deeply concerned and worried by the reduced life expectancy currently being experienced in this generation of ours due to some degenerative diseases like, cancer, atherosclerosis, coronary artery diseases, arthritis, just to mention a few.

In addition, some of us are aging and we need to slow down the aging process so that we can enjoy an extended life expectancy.

Afterwards, it is the plan of God for all to enjoy our life to the fullest as contained in the book of life that "Beloved, I wish above all things that thou mayest prosper and be in health even as thy soul prospereth" (3rd John 2). It is on record that our predecessors enjoyed an extended life expectancy. For example, Abraham lived for 175 years, Isaac lived for 145 years, Jacob lived for 147 years.

Something must be wrong somewhere, if we are not having an extended life expectancy as our forefathers and predecessors. God said in Genesis 1:29, "Behold, I have given you every herb bearing seed, which is upon the face of all the earth, and every tree, in which is the fruit of a tree yielding seed, to you it shall be for meat.

Mr. Vice chancellor, Sir, there must be a missing part in God's package for our health towards an extended life expectancy, it is therefore to this end that I have considered it appropriate as my choice of topic for this inaugural lecture – "That we may enjoy an extended life expectancy – The Roles of Free Radicals, Reactive Oxygen Species (ROS) and Antioxidants in aging".

Life expectancy can be defined as a statistical measure of how long a person or organism may live based on the year of birth, current age and other demographic factors.

Life span refers to the maximum number of years a human can live. The longest human life documented to date is 122 years for a woman and 144 years for a man. The genes play a key role in determining longevity but

environment is also important. Currently, life expectancy in North America is about 74 years for men and about 80 years for women. (Wardlaw and Smith, 2008)

Worldwide, the highest average life expectancy is in Japan, 82 years for women and 74 years for men, especially on the island of Okinawa. Researchers here suggested that the traditional Okinawa diet based on rice, fish, vegetable protein sources, fruits, vegetables, tea, herbs for seasoning and small amounts of meat, as well as a generally low calorie intake (BMI of 21), minimal intake of alcohol and salt contribute to this longevity [Wardlaw and Smith, 2008].

Presently, in Nigeria life expectancy data from the National Bureau of Statistics reveal that life expectancy for men is 51 years and 53 years for women.

What Actually is Aging?

Aging can be described as a process of slow cell death beginning soon after fertilization. When we are young, aging is not apparent because the major metabolic activities are geared towards growth and maturation. We produce plenty of active cells to meet physiological needs. During late adolescence and adulthood the body's major task is to maintain cells. Inevitably, cells age and die. Eventually, as more cells die, the body can adjust to meet all physiological demands, and body functioning begins to decrease. Such decline in physiological function with age include: Maximum breathing capacity; Nerve velocity conduction; Work Rate, Basal metabolic Rate, Cardiac output.

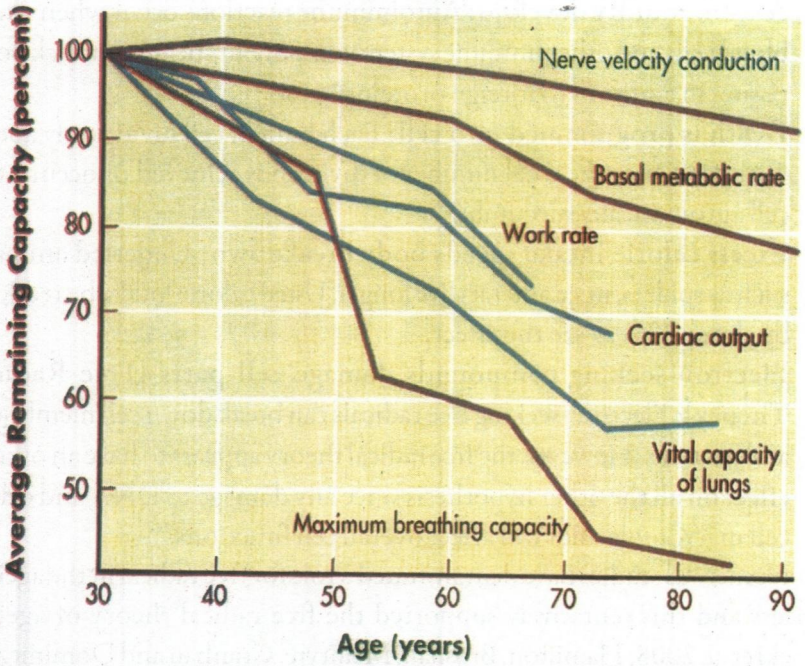

Fig. 1: Effect of aging on metabolic activities
Source: (Wardlaw and Smith, 2008).

Many hypothesis have been proposed for the cause of aging, these include:

1. **Errors occurring in copying the genetic blue print (DNA):** Once sufficient errors in DNA copying accumulate, a cell can no longer synthesize the major proteins needed to function and it therefore dies.
2. **Connective tissues stiffen:** Parallel protein strands found mostly in connective tissue, cross-link to each other. This decreases flexibility in key body components.
3. **Hormone function changes:** The blood concentration of many hormones, such as testosterone in men falls during the aging process.
4. **Glycosylation of protein:** Blood glucose when chronically elevated, attaches to various blood and body protein. This decreases protein function and can encourage immune system attack on such altered protein.

5. **Autoimmunity develops:** Autoimmune reactions occur when white blood cells and other immune system components begin to attack body tissues in addition to foreign proteins.
6. **Death is programmed into cell:** Each human cell divide only about 50times. Once the total number of division is achieved or occurs, the cell automatically succumbs.
7. **Excess calorie intake speeds body breakdown:** Underfed animals, such as spiders, mice and rats live longer. Usual calorie intake be reduced by about 30% to see the effect.
8. **Electron-seeking compounds damage cell parts [Free Radical Theory]:** Electron-seeking free radicals can break down cell membrane and proteins. However, the free radical theory appears to have an overall effect on all the other hypothesis since any damage to DNA and other cell macromolecules will affect overall cell functions.

Numerous studies have demonstrated a role for free radical in the ageing process and this tentatively supported the free radical theory of ageing [Saseki et al, 2008; Hamilton, Brosnan, McIntyre, Granhan and Dominiczak 2001; Chen et al., 2001; Saweda and Carlson, 1987; Jackson, Yam, Gao, Rinco A–Skinner, River and Edwards, 2007]. Miyazawa, Ishii, Yasuda, Noda, Onouchi and Hartman, 2009].

The Free Radical Theory of Aging

This is a theory based on free radicals and radiation chemistry [Harman, 1956]. The Free Radical theory of aging states that organisms age because cells accumulate free radical damage over time. A free radical is any atom or molecule that has a single unpaired electron in an outer shell [Harman, 1956; Hekimi, Laponik and Wen, 2011].

Free radicals are highly reactive and unstable: strictly speaking, the free radical theory is only concerned with free radicals such as superoxide anion ($O^{\cdot}_2$) which is produced by univalent reduction of molecular oxygen in cells and tissues during tissue respiration.

The free radical theory of ageing was proposed by Harman in the 1950s. Two things inspired Harman in proposing this theory;

(i) The rate of living theory which states that life span is an inverse function of metabolic rate, which in turn is directly proportional to oxygen consumption.

(ii) Rebecca Gershman's observations that hyperbaric oxygen toxicity and radiation toxicity could be explained by the same underlying phenomenon of free radicals [Harman, 1956]

Role of Mitochondria in Reactive Oxygen Species (Ros) Production

The mitochondrial electron transport chain (ETC) represents the major source of cellular ROS production.

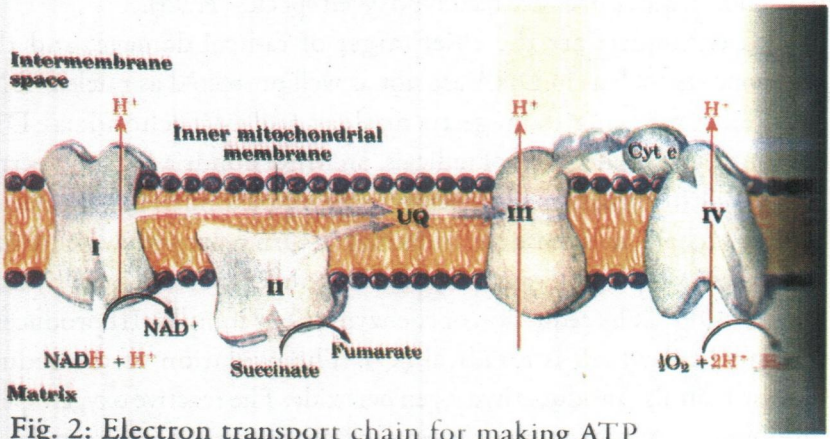

Fig. 2: Electron transport chain for making ATP
Source: Macgilvery, R.W. and Gearald MD (1979)

The superoxide anion is non-enzymatically formed by the Electron transport chain semiubiquinone compound and then enzymatically converted into hydrogen peroxide [H_2O_2] by Superoxide Dismutase (SOD). Superoxide anion $(O^{\cdot}_2)^{-}$ can also be non-enzymatically converted into hydrogen peroxide [H_2O_2] and singlet oxygen. Hydrogen peroxide can be converted into the highly reactive hydroxyl radical ($^{\cdot}OH$) in the presence of reduced transition metals. Alternatively, hydrogen peroxide

may enzymatically converted into water by enzymes catalase or Glutathione peroxidase.

SOD – catelysed dismutation of superoxide

$M^{(n+1)+}$ - SOD + o^-_2 M^{n+} SOD + o_2 →

M^{n+} - SOD + o^-_2 + 2 H^+ $M^{(n+1)+}$ - SOD + H_2O_2 →

Where M= Cu (n=1) Mn(n=2) Fe(n=2) N_1 (n=2).

In this reaction, the oxidation state of the metal caution oscillatas between n and n+1

Mitochondria Theory of Aging

In 1972, Harman modified his original theory of ageing to mitochondria theory of ageing since there is a known chemical mechanism by which mitochondria can produce reactive oxygen species (ROS).

Mitochondria are the chief target of radical damage, and their components such as in DNA are not as well protected as nuclear DNA. Studies comparing damage to nuclear and Mitochondrial DNA demonstrated higher level of radicals, on Mitochondria DNA. Electrons may escape from metabolic processes in the mitochondria like the electron transport chain, and these electrons may in turn react with water to form ROS such as superoxide radical or via an indirect route, to form hydroxyl radical (·OH). The reduction of coenzyme Q in complex III produces an intermediate which is a radical (Q). The oxidation of the reduced flavoprotein also produces hydrogen peroxide. The reactive oxygen species produced in mitochondria causes damages to certain macromolecules including lipids, protein and most importantly mitochondria DNA [Harman, 1972].

Antioxidants

Antioxidants are often reducing agents which are being oxidized themselves. They limit oxidative damage by passivating biological structure from free radical [Halliwell, 2012]. Examples include thiols, polyphenols, antioxidant vitamins C, E, carotene, Glutathoine peroxidase, Glutathoine transferase, reduced glutathione.

Animals maintain complex systems of multiple types of antioxidants which are present in the body fluids at varying levels. These include: ascorbic acid, glutathione, enzymes, catalase superoxide dismutase (SOD) various peroxidases, ubiqunone which is present within the cells, uric acid which is also present within the cells and evenly distributed. The various antioxidants may have synergistic effects on the other, and the action of one antioxidant may depend on the other.

In plants, the antioxidant vitamins A, C, E are particularly important. The flavonoids that are found in cocoa, green tea also possess antioxidant properties. Ascorbic acid is to protect Glutathione peroxidase acid and vitamin E. The following minerals which include zinc and selenium are reported to possess antioxidant property.

Mammals like man do not contain ascorbic acid as one of the enzymes needed for the synthesis has been lost by mutation during human evolution [Wardlaw and Smith, 2008].

There are 3 types of Superoxide Dismutase (SOD):

i. SOD_1 – which is located in mitochondria
ii. SOD_2 – which is located in cytoplasm
iii. SOD_3 – which is located in extracellular fluid

Superoxide Dismutase plays a protective role on endothelial function drug aging [Lund, Chu, Miller and Heistad, 2009].

There are some who believe that a simple linkage of oxidantive stress to aging and lifespan should not hold [Speakman and Selmah, 2011], whereas there are research evidences in support of the fact that oxidative damage shortens life span. These evidences include:

1. In some model organisms such as yeast and Drosophila reducing oxidative damage can extend life span [Fontana, Partridge and Longo, 2012].
2. In mice, interventions that enhance oxidative damage generally shortens life span [Jang and Remmen, 2009].
3. However, in round worms, blocking the production of the naturally occurring antioxidant Superoxide Dismutase increases life span [Fields and Johnson, 2005].

Whether reducing oxidative damage below normal level is sufficient to extend lifespan remains an open and controversial question.

The free radical theory of aging has been criticized because it ignores that ROS are specific signaling molecules necessary for maintaining normal cell function and this has led to another theory which is the metabolic stability theory of aging.

Metabolic Stability Theory of Aging

The metabolic stability theory of aging suggests it is the cells ability to maintain stable concentration of ROS which is the primary determinant of life span. This theory is supported by Epigenetic oxidative redox shift and age-related transcriptional changes in gene expressions in different organs of mice [Brink et al, 2009; Brewer, 2010]. The metabolic stability theory of aging criticizes the free radical theory because it ignores that ROS are specific signaling molecules which are necessary for maintaining normal cell functions [Afanasev, 2010; Droge, 2002]. In order to maintain a state of homeostasis living organisms are striving to keep these highly reactive molecules under tight control with the help of an intricate system of antioxidants [Haynes and Ron, 2010].

It is now recognized that ROS exert a multitude of biological effects ranging from physiological regulatory functions to damaging alterations participating in the pathogenesis of increasing number of diseases.

Reactive Oxygen Species (Ros) in Health

The physiological regulatory functions performed by the free radicals and reactive oxygen species include:

(i) Normal Vascular Diameter Regulation

Mitochondrial ROS specifically superoxide anion ($\cdot O^-_2$) and hydrogen peroxide ($H_2 O_2$) were demonstrated to play a role in normal vascular physiology, in response to such factors as shear stress in the vascular system [Droge, 2002]; Liu, Zhao, LI, Kalyanaraman Nicolosi and Gutterman, 2003]. The mitochondrial origin of ROS was confirmed using electro-biophysical methods that assessed the ROS generation and the response of

vessel diameter to the presence of inhibitors of mitochondrial complexes and antioxidants [Liu et al, 2003; Droge, 2002].

In a model described by Go et al, it provides explanation for the protective antioxidant role of small molecular weight mitochondrial protein such as thioredoxin 2 (T r x2) [Chen, Cai and Jones, 2006], [Chen, Cai, Murphy and Jones, 2002], [Zhang, Liu, Zhang et al, 2007], [Go et al, 2011].

(ii) Roles of ROS in Oxygen Sensing

Oxygen sensing is so critical to cellular health as it allows cells to initiate adaptive response that will increase the likelihood of survival in anticipation for limited oxygen availability (hypoxia).

Gruzy and Schumaker [2006] have proposed that the electron transport chain acts as an oxygen sensor by releasing reactive oxygen species in response to hypoxia. The hypoxia-induced released ROS act as signaling molecules that trigger diverse functional responses, among which is the increased production and stabilization of the hypoxia – inducible factor - 1 (HIF). This has been demonstrated at least in normal cells [Semenza, 2008], [Guzy and Schumacker, 2006].

(iii) The Role of ROS in skeletal muscle physiology

The skeletal muscle is a target for oxidative stress and oxidative regulation since it requires a large supply of energy to ensure efficient contraction. Consequently, it is liable to be exposed to excessive mitochondrial ROS.

The skeletal production of ROS is promoted by multiple stimuli including muscular contraction, insulin and hypoxia. Although, under normal physiological conditions antioxidant systems control the level of ROS in skeletal muscle.

Oxidative stress can take place if ROS level exceeds the muscular antioxidant capabilities and this can have damaging functional effects [Droge, 2012; Harman, 1972]. Recent research have suggested that ROS can act as signaling intermediates in the regulation of skeletal muscle glucose uptake during contraction [Bruton et al 2006], [Merry and McConell, 2012], and [Sandstrom, Zhang, Bruton et al 2006].

Reactive Oxygen Species (ROS) in Diseases

There have been evidences to suggest that free radicals and some reactive oxygen species trigger and increase cell death mechanisms within the body [Chartterjee et al 2001]. Free radical damage within cells has been linked to a range of disorders and diseases including cancer, arthritis, atherosclerosis, diabetes, hypertension [Patti and Corvera, 2010; Robertson, 2004; Houstis, Rosen, Lander, 2006; Rudich, and Bashan, 1998]. Oxidation of LDL's has been reported to trigger the process of atherogenesis which leads to atherosclerosis and finally cardiovascular diseases [Bamin, Tsemakhovich and Shaklai, 2003]

Mitochondrial dysfunction has also been reported as an initiating event in atherogenesis [Puddu et al, 2005].

Reactive oxygen species (ROS) have been reported to play a role in the progression of type 2 diabetes and atherosclerosis [Kaneto, Katakami, Matsuhisa and Matsuoka, 2010].

ROS have a casual role to play in multiple forms of insulin resistance [Houstis, Rosen and Lander, 2006].

Antioxidant Therapy

The antioxidants found in many foods are frequently cited as one of the basis of claims for the benefits of a high intake of fruits and vegetables [Baffeta, Couto, Wichmann et al 2010]. A recent study tracing the eating habits of 478,000 Europeans suggests that consuming lots of fruits and vegetables has little if any effect on preventing cancer [Baffeta et al 2010]. Several natural antioxidants have been investigated in vitro or in model animals to assess their potential therapeutic effect in conditions linked to oxidative stress. [Heart protection study collaborative Group, 2002; The Alpha – Tocopherol, Beta carotene cancer prevention study Group, 1994].

Studies have shown that memory loss associated with brain mitochondrial decay and RNA/DNA Oxidation in old rats can be partially revised by feeding acetyl –L- lipoic carnitine. [Lui et al, 2001]. Vitamin E has been reported not only to block the elevation of intercellular ionic calcium but also prevents the loss of protein thiols from the cellular

membrane. This shows that vitamin E conserves the integrity of cell membrane and might be important for the maintenance of calcium homeostasis [Tsai et al, 2010]. Some recent studies tend to show that antioxidant therapy have no effect and can even increase death when antioxidants are bad. [Perera and Bardeesy, 2011]

Nonetheless, not all antioxidants are identical and moreover many different substances operate synergistically in antioxidant defence [Calabresse et al, 2010]. Its complicated process may require more sophisticated approach to determine if antioxidant therapy may benefit the ageing process.

Melatonin is a powerful antioxidant that can easily cross cell membrane and the blood-brain barrier. Unlike the other antioxidants, melatonin does not undergo redox cycling, which is reduction –oxidation. Redox cycling allows antioxidants (e.g Vitamin C) to act as a pro-oxidant, and promotes free radical. The brain is vulnerable to oxidative injury due to its high metabolic rate. Consequently, antioxidants are commonly used as medications to treat various forms of brain damage.

Expression of mitochondrial thioxedoxin has been reported to improve endothelial cell function and reduced atherosclerotic lesions [Zhang, Luo, zhang et al, 2007]. The antioxidant function of a p.53 tunor suppressor has been reported [Sablina et al, 2005]. Although, the use of antioxidants seems disappointing at the moment in preventing the progression of the ROS-related diseases, current research findings have proposed novel targets that might prove to be more appropriate antioxidants.

Effects of Calorie Restriction on Life Expectancy

Studies have demonstrated that calorie restriction displayed positive effect on the life span of organisms even though it is accompanied by increase in oxidative stress. Many studies suggest this may be due to oxidative stress suppression which occurs in calorie restrictions [Fontana et al 2010]. Calorie restrictions influenced numerous signal pathways through the reduction of insulin-like Growth factor-1 (IGF -1). Additionally, Fontana et al

suggested that antioxidant SOD and catalase are involved in the inhibition of this nutrient signaling pathways.

The increase in life expectancy observed during some calorie restriction studies which can occur with lack of decreases or even increases in O_2 consumption is often inferred as opposing the mitochondrial free radical theory of ageing.

However, Barja (2007) showed significant decreases in mitochondrial oxygen radical production (per unit of O_2 consumed) which occur in dietary restriction.

Free Radicals, Antioxidant and the Immune System

Antioxidants are important in both natural and acquired immunity. Neutrophil and macrophage phagocytes stimulate various cellular processes including the 'respiratory burst', whereby increased cellular oxygen uptake results in the production of potent oxidant, bactericidal agents, hypochlorous acid and hydroxyl radical.

In addition, nitric oxide, a gaseous radical produced by macrophages, reacts with superoxide to form peroxynitrite ($OONO^-$), also a potent bactericidal agent. [Patel, Cornwell and Darley-Usmar, 1999].

Conversely, oxidative stress may be detrimental in acquired immunity by activation of nuclear factor Kappa B, which governs gene expression involving various cytokines, chemokines and cell adhesion molecules among others. However, antioxidant supplementation essentially reverses several age-associated immune deficiencies resulting in increased levels of interleukin – z elevated numbers of total lymphocytes and T-cell subsets, increased killer cell activity, augmented antibody response to antigen stimulation, decreased lipid peroxidation and decreased prostaglandin synthesis.

My Contribution

Mr. Vice Chancellor, sir, it is of interest to note that my research effort started at the undergraduate studies during my final year project in 1973. I was involved in studies on the effect of different diets on fatty acid production in cattle, sheep and goats. This study revealed that ruminant

animals derive the bulk of their metabolic energy requirement from cellulose by a process referred to as energy gleaning.

Thus, it is now recognized that fibers constitute an important component of diet for humans, that is, when planning a high carbohydrate diet, you need to emphasize on grains, fruits and vegetables that are rich in insoluble carbohydrates (Wardlaw and Smith, 2008). Driven by the passion for research, I proceeded to the U.K in 1976 to pursue a postgraduate work (Ph.D) in Food science at the University of Leeds, Leeds. U.K. My research work centered on studies on antioxidants in foodstuffs. And opened the gateway for the discovery of many natural molecules with antioxidant properties (Omole 1980). Today, many components of food are known to possess antioxidant properties. (Omole, 2002).

On completion of my Ph.D. programme in food science, I returned to Nigeria with my research interest focused on the culture of the people, and to see how this culture can be exploited to improve the living conditions of our people. In one of such areas, I observed people living around the border towns of Nigeria and Republic of Benin rawly consume a particular plant, and I became inquisitive about this plant. This lead to my research interest on the chemical composition of *Caesalpina pulcherina*, a legumineous plant.]

This study revealed that the seeds of this plant is rich in protein, which can be consumed to alleviate shortage of protein which is common among children suffering from kwashiorkor (Omole, 2003). Apart from being a good source of protein, it is also a rich source of potassium, thus it became a source to recome with in the control of high blood pressure, diabetes and cardiovascular discuss in human, (Murray, 2009). This plant with a low concentration of Na^+, and a high concentration of K^+ stands the chance of suppressing high blood pressure.

Table 1: The Proximate Composition of *Caesalpinia pulcherima*

Component	% level
Moisture	3.80 ± 0.50
Crude protein	33.50 ± 1.50
Crude fibre	7.60 ± 0.20
Crude fat	16.80 ± 0.20
Ash	5.50± 0.20
Carbohydrate (soluble)	33.00 ± 0.20

(Omole J.O., 2003)
Values are means of four determinations with standard deviations.

Table 2: Mineral Composition of the Seeds of *Caesalphina pulcherima*

Mineral element	Concentration (mg/100g sample) on dry weight basis
Sodium	59.03 ± 0.08
Potassium	3039.94 ± 56.61
Calcium	79.42 ± 4.90
Magnesium	457.64 ± 6.19
Zinc	22.62 ± 1.96
Iron	50.01 ± 2.54
Phosphorous	3550.0 ± 81.64

(Omole J.O., 2003)
Values are mean of four determinations with Standard deviation.

Antioxidant Activity of Some Local Spices in Nigeria

Mr. Vice Chancellor, Sir, it is worth mentioning that our forefathers have used our local spices as preservatives in food without realizing their real potential as sources of natural antioxidants. My studies on some local spices in Nigeria revealed that the antioxidant potential of these plants is the same as those of the synthetic antioxidants like BHA, BHT [Omole, 2002]. Plants are rich sources of different types of antioxidants which make them highly effective in protecting cell membrane from lipid peroxidiation when consumed.

Thus it is now established that consumption of fruits and vegetables rich in these complex system of antioxidants can extend life expectancy through improved immunity (both innate and acquired).

Table 3: Protective Indices of Substances Subjected to Induced Auto-oxidation

Substance	Calculated protective Index, h		
Pepper extract (sombo) 1.25	0.843	0.75	
Pepper extract (atarado) 1.14	1.22	0.85	
Pepper (tatase)	1.38	0.710	0.85
0.02% BHA	1.36	1.038	1.0

Values are means of 3 determinants [Omole J.O. 2002]
Means in the same column with different superscript differ significantly ($P<0.05$)

Soft Drink Concentrate from Bixa Seeds (*Bixa oreolena*)

Mr. Vice Chancellor, Sir, I have also developed a soft drink from a concentrate based on a natural colourant derived from the seeds of Bixa [Omole, 2003].

This is aimed at arresting the ugly trend of monopoly of franchise by multinational companies operating the soft drink business in Nigeria. Under such franchise agreement, the formula and trade mark belong to the multinational company.

This technology is expected to assist intended individuals willing to produce soft drink from locally available raw materials. This will no doubt reduce foreign exchange spent on importation of concentrate. It is worth mentioning that Anatto extracts have been subjected to evaluation by WHO [World Health Organization] and found to be safe for human consumption using laboratory rats [Van Esch et al, 1959].

Table 4: Comparative Physicochemical Characteristics of the New Soft Drink (Gingetise) and Fanta Ginger

Characteristics	Drink (gingertise)	Fanta Ginger
Active acidity (Ph)	3.4	3.0
Total acidity (as citiric acid) (g/100ml)	0.13g/100ml	0.15g/100ml
Sugar (Brix) %	10.0	9.5
Total Soluble Solids %	8.5	8.5
Specific Gravity	1.038	1.036

Values are means of 3 determinations.

Soft Drink Consumption: Calcium and Phosphorous Intake

Calcium and phosphorous are major constituents of bone and teeth and are required for proper teeth and bone for motion. Deficiencies of these minerals in the body can lead to a disease referred to as osteoporosis, a situation that is characterized by loss of bone density, to the point that the skeleton is unable to sustain ordinary stress and fractures develop [Macgilrery and Gerald, 1979; Armbrecht, 1981].

Phosphorous and calcium concentrations in the blood tend to vary inversely because in an alkali medium, calcium forms an insoluble precipitate of calcium phosphate with phosphate. A rise in either exceeds the solubility product of calcium phosphate, causing increased formation of insoluble complex which passes into feces in the case of the bowel. Thus, excessive intake of phosphorous in the form of phosphorous compounds can lead to loss of calcium in the body through the faeces.

In consequence of this a relationship between high phosphorous: calcium ratio and osteoporosis has been prostulated [Shar et al, 1967]. Thus, excessive intake of soft drinks which are rich in phosphorous in the form of phosphoric acid can lead to loss of calcium through the feaces. Cola and ginger drinks which contain phosphoric acid as acidulants permitted for use in soft drinks are mostly affected [FAO/WHO, 1982].

These new use of phosphate as food acidulant coupled with the frequent consumption of foods extremely rich in phosphorous have resulted in increased intake of phosphorous and consequent lowering of calcium in the blood.

The absorption of these elements in the small intestine is very efficient and is stimulated by 1, 25 Dihydroxy vitamin D, while it is inhibited in the renal tubule by parathormone [Ambrecht, 1979, 1998]. Studies on soft drinks in Nigeria confirm that they contain calcium in negligible amounts [Ebuehi, mokede and osuno, 2002].

This study was undertaken to establish the contribution of soft drinks consumption to ca : phosphorous intake with a view to assessing the products if they satisfy the molar ratio of 1:1 for ca : p.

The results of the investigation reveal the cola drinks are higher in phosphorous and lower in calcium than the non-cola drink, hence their low calcium: phosphorous molar ratio of 0.90, 0.90 respectively for the 2 brands of cola drinks under study. These cola drinks are considered inadequate in calcium to prevent osteoporosis. Elderly people are advised to avoid cola drinks to avoid on-set of osteoporosis [Omole and Ighodaro, 2008].

Table 5: Phosphorous Level of Some Brands of Soft Drinks

Brands of soft drinks	Calcium (mg per 100ml)	Phosphorous (mg per 100ml)
Coca cola	$0.053^{a} \pm 0.005$	$16.8^{b} \pm 0.20$
Pepsi Cola	$0.058^{a} \pm 0.005$	$15.38^{b} \pm 0.18$
Fanta	$0.076^{a} \pm 0.007$	$0.10^{c} \pm 0.01$
Mirinda	$0.063^{a} \pm 0.003$	$0.07^{c} \pm 0.01$
7up	$0.066^{a} \pm 0.007$	$0.08^{c} \pm 0.01$

Values are means of 3 determinations with standard deviations
Values with the same superscript are not significantly different (Pd"0.05) [Omole and Ighodaro 2008].

Table 6: Calcium:Phosphorous Ratio and Calcium:Phosphate Molar Ratio of Soft Drinks

Brands of soft drinks	Calcium:phosphorus ratio	Calcium:phosphate molar ratio
Coca cola	1:305	0.90
Pepsi cola	1:265	0.90
Fanta	1:1.31	1.80
Mirinda	1:1.1	1.80
7up	1:1.2	1.96

[Omole and Ighodaro 2008].

Studies on Ascorbic Acid

The roles of ascorbic acid in the prevention of many chronic diseases including certain types of cancer, cardiovascular disease, stroke, atherosclerosis in the body are so important. Hence, several studies have been devoted to this substance. In addition, the body does not synthesize this substances, it has to be obtained from the diet (i.e. exogenously). One of such study is establishing a relationship between p^H and ascorbic acid content of juice, of oranges, grape, lemon and lime which are rich sources of this substance. Thus a rapid method of screening for the ascorbic acid content of juices, from orange, lemon, lime and grape fruit has been established to detect any adaulteration [Omole and Oduse, 2005]. The proposed relationship shows that p^H is inversely proportional to ascorbic acid content and reliable for fresh fruits containing ascorbic acid concentration between 0 and 60mg/ml. [Omole and Oduse 2005].

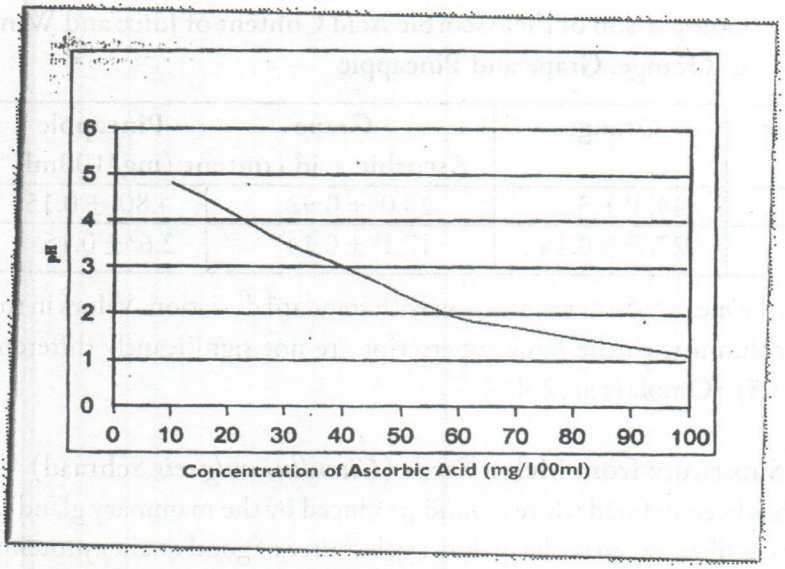

Fig 3: A proposed relationship between p^H and ascorbic acid content of fruit juice

Source: Omole and Ighodaro 2005

Changes in the Ascorbic Acid Content of some Tropical Fruits Fermented to Wine

Tropical fruits including pineapple, orange, and grape waste in large quantities during the peak season of their production and this constitute a huge loss of revenue from Agricultural production. One method of minimizing such losses is to ferment the juice of these fruits to wine which can be consumed at a later day when these fruits are off season in production.

Since these fruits are nutritionally valuable because of their ascorbic acid content, there is therefore need to provide information on the stability of ascorbic acid in the fermented products. This study revealed loses of up to 50% of ascorbic acid during the fermentation of the juices of these fruit to wine, indicating the need to fortify wines from these fruits with additional ascorbic acid: [Omole, 2006].

Table 7: Comparison of the Ascorbic Acid Content of Juice and Wine of Orange, Grape and Pineapple

Sample	Orange	Grape	Pineapple
		Ascorbic acid content (mg/100ml)	
Juice	$44.4^{a} \pm 3.2^{a}$	$28.0^{a} \pm 0.92^{a}$	$4.80^{a} \pm 0.15^{a}$
Wine	$27.7^{b} \pm 0.14^{b}$	$17.1^{b} \pm 0.14^{b}$	$2.6^{b} \pm 0.15^{a}$

Values are means of 3 determination with standard deviation. Values in the same column with the same superscript are not significantly different (pd"0.05). [Omole et al., 2006].

Milk Substitute from Melon Seeds (*Citrullus vulgaris* Schraad)

Milk has been defined white as fluid produced by the mammary gland of mammals like cow, goat, sheep. It is a rich source of good quality proteins, minerals particularly, calcium, phosphorous, zinc, and in small amounts of selenium, fluorine, and iodine. [IDF, 2008].

Imitation milk has been produced from vegetable protein [Norman, 1973]. Imitation milk resembles natural milk but contain neither milk fat nor other important dairy ingredients [Johnson and Snyder, 1978].

There has been a growing demand for milk derived from vegetable protein because of the reported presence of trans fat in natural milk, especially milk obtained from ruminant animals. Trans fat has been implicated in coronary heart diseases [WHO/FAO] and the National Academy of science in U.S.A is quoted as saying that there is no safe level of trans fat in milk derived from cow.

The acute shortage of good quality and affordable protein, especially of animal origin has encouraged research in the production and utilization of some sources of vegetable protein, notably soy protein (Awoh et al 1987). There are other added advantages of the presence of phyto-chemicals in vegetable protein, like the defense of the body against cancer [Wardlaw and Smith, 2008].

This study was therefore undertaken to look into the possibility of producing and utilizing melon seeds as a substitute for milk. Today, we

have succeeded in producing a milk substitute from melon seeds. It is comparable to natural milk in color, p^H and trace mineral composition. Its sensory evaluation reveals that it is comparable to cow's milk in colour, taste and flavor [Omole and Ighodaro, 2012].

The milk substitute from melon seeds can be flavored to an acceptable taste.

Table 8: Proximate Composition of Milk from Melon Seeds

Parameter	%
Moisture	88.20 ± 0.05
Crude protein	1.30 ± 0.00
Crude fat	3.09 ± 0.10
Ash	1.62 ± 0.05
Carbohydrate by difference	5.79 ± 0.50

Values are mean of triplicate determinations. [Omole and Ighodaro 2003].

Protein Quality of Melon Milk

Milk from melon seeds has been produced and reported [Omole and Ighodaro, 2012]. Previous reports also reveal that melon seeds are rich in protein [Oyenuga and Fetuga, 1975]. In order to ascertain that melon milk protein and meet the body's need for growth and maintenance, there is the need to evaluate the quality of protein from melons milk.

There are many methods of evaluating protein quality, these include: the biological value, net protein utilization, the protein efficiency ratio, Amino Acid chemical score and the protein digestibility corrected Amino Acid Score (PDCAAS).

Using the biological value method, the results revealed that both proteins have the same biological value of 101 and sssuggest that both proteins have similar amino acid pattern and support growth and maintenance. [Omole and Ighodaro, 2014].

Table 9: Nitrogen Loss in Rats Fed With Cow's Milk, Melon Milk and Different Ratios of Both Milks

Protein	Ingested Nitrogen (N) mg/week	Urinary Nitrogen mg/week	Faecal nigtrogen mg/week	Total N Loss mg/week	Retained N mg/week	NPU (%)	B.V. (%)
Cow Milk (Control)	424	6.09 ± 4.1	38.96 ± 11[a]	44.96[a]	379.04[a]	89[a]	101[a]
Melon Milk (100%)	424	7.86±1.2[a]	61.5 ± 18.5[a]	69.36[a]	354.64[a]	83[a]	102[a]
Cow Milk: Melon Milk (50:50%)	424	8.16± 2.4[a]	35.5 ± 13.5[a]	43.66[a]	380.34[a] 89[a]	102[a]	
Cow Milk: Melon Milk (75:25%)	424	7.36± 3.3[a]	24.0 ± 0.0[a]	31.36[a]	392.64[a] 92[a]	101[a]	

Values in the same calcium with the same superscript are not significantly different (pd"0.05).
NPU= Net protein utilization; B.V= Biological value; N=Nitrogen. [Omole and Ighodaro 2014].

Studies on Whey from S.W. Nigeria

Mr. Vice Chancellor Sir, as a food scientist and a nutritionist/biochemist have shown great interest in promoting our traditional food industries. In this regard we have looked into the chemical composition of whey which is a by-product of cheese production. It is no gain-saying that this is the first documentation on whey composition in Nigeria. Whey is a green yellow translucent watery portion of milk remaining after milk coagulation and removal of the curd. It is sometimes regarded as a waste and may constitute a major problematic disposal if not processed further [Sienkiew and Reidel, 1990].

The differences in the composition of milk used in cheese manufacture influences the composition of the manufactured cheese and whey. The type of bacteria used in the curdling of the milk also influences the type of cheese and whey produced [Margnus, 1970]. There are 2 types of whey: Swent and acid whey depending on the coagulation method used. In order to determine its use as an ingredient in food processing, it is necessary to evaluate its chemical composition.

This study revealed that whey from Nigeria compares favourably in composition with whey from other nations, except that the protein content is low. [Omole, and Ighodaro, 2012]. Whey is very rich in the essential amino acids and is particularly a good source of the branched-chain amino acids: Leucine, isolencine and valine which are important in body tissue building and weight management regimes. Thus, whey from Nigeria should have a role to play in body tissue building and weight management.

Table 10: Proximate Composition of Whey from Four Different Locations in Ogun State S.W. Nigeria

Source	Protein %	Fat %	Ash %	Lactose %	Moisture %
Ojo Odan	0.40 ± 0.05	0.26 ± 0.00	0.92 ± 0.01	4.01 ± 0.20	92.0 ± 0.00
Oko Yanrin	0.34 ± 0.02	0.26 ± 0.00	0.87 ± 0.03	3.98 ± 0.30	92.0 ± 0.00
Idogo	0.46 ± 0.02	0.26 ± 0.00	0.95 ± 0.02	4.03 ± 0.20	92.0 ± 0.00
Itori	0.38 ± 0.02	0.26 ± 0.00	0.84 ± 0.02	3.88 ± 0.20	92.0 ± 0.00

Values are means of three determinations with standard deviation S.W= Southwest. [Omole and Ighodaro 2012].

Fortification of Ogi With Whey

Mr. Vice Chancellor Sir, as apart of the studies on whey, we have embarked on the use of whey in the processing of maize to our locally fermented beverage referred to as ogi. Maize as a cereal is widely consumed all over the world, and in this region it is very popular in the production of our locally fermented beverage referred to as ogi. Maize is very low in protein and low in the essential amino acid Lysine, Methonine and Tryptophan.

High quality opaque maize has been produced through genetic engineering in order to improve on the protein quality of maize. Further supplementation of maize with fords that can supply the limiting amino acid in maize is encouraged.

To this end, maize has been processed with whey that will supply the limiting amino acids in maize, for the production of a nutritionally balanced diet.

We have succeeded in increasing the protein content of ogi by processing maize with whey resulting in the production of ogi that contains the essential amino acids, in particular, the branch - chain amino acids: Lencine, Isolencine and valine. This product has been subjected to evaluation using laboratory rats. The results of such evaluation reveals that rats fed with whey-processed ogi consume more of this experimental food then those fed on ordinary ogi (control).

In addition such rats exhibited higher sphlachnic protein synthesis than rats fed on ordinary ogi. This demonstrate the superiority of the fortified ogi over the ordinary ogi in terms of protein content and amino acid composition. This product is available for experimentation on humans who would like to use it for weight control and body tissue building for those undertaking exercise [Omole, Ighodaro, Abiola and Durosinlorun, 2015].

Table 11: Effect of Whey Treatment on Body Weight

Group	1st week	2nd week	3rd week
Group A	114.3 ± 10.87g	103.7 ± 9.08g	103.3 ± 8.53g
Group B	107.4 ± 8.46g	103.0 ± 9.39g	98.5 ± 8.15g

Values are expressed as mean ± SEM of 5 rats. The mean values were compared between groups using independent sample t–test and was considered to be significant at $p < 0.05$.

Table 12: Effect of Whey Treatment on Relative Organ Weight

Group	Heart	Liver	spleen	Kidney	kidney
Group A	0.37 ± 0.01g	3.73 ± 0.17g	0.33 ± 0.31g	0.34 ± 0.01g	0.33 ± 0.02g
Group B	0.42 ± 0.03g	4.15 ± 0.37g	0.37 ± 0.33g	0.41 ± 0.02g	0.42 ± 0.03g

Values are expressed as mean ± SEM of 5 rats. The mean values were compared between groups using independent sample t –test and was considered to be significant at $p < 0.05$.

Melon Milk in Cheese-making

Mr. Vice chancellor Sir, we have successfully replaced up to 20% of cow's milk with melon milk in cheese-making using sodom apple leaves as the coagulating agent. [Omole and Ighodaro, 2014].

Cheese is a concentrated form of milk protein and serves as a means of preserving milk protein during the period of excess milk production, especially in summer in temp erate counters.

In Nigeria and other West African countries, soft cheese commonly referred to as warakashi is a major source of animal protein minerals, vitamins and fat. [Awoh and Egunlety, 1985. Awoh and Makais, 1986, Awoh and Adedeji, 1987].

The acute shortage of milk in many part of Africa including Nigeria has lead to the use of vegetable protein as a partial substitute for cow's milk in cheese production. Documented reports of the use of soy milk in cheese production revealed that cheese produced from soy milk lacks good sensory

attributes like colour, flavor and texture. [Awoh, Adedeji and Nwanakezi, 1987, Johnson and Snyder, 1978, Hang & Jackson, 1967].

Brownish discolouration off-flavor productions are some of the poor attributes of cheese made from soy milk as a partial substitute for cow's milk. In order to avoid these shortcomings, it becomes necessary to look inwards for other vegetable protein sources form which cheese could be produced without off-flavour and discolouration.

Cheese yield obtained ranged from 23.6% to 37.6% depending on the level of substitution of coco's milk with melon milk. Sensory attribute ratings of cheese made from melon's milk in terms of colour, flavor and texture was higher when compared with cheese made from 100% cow's milk. [Omole, Ighodaro, 2014].

Table 13: Effect of Substituting Cow's Milk With Melon Milk on Cheese Yeild

Cow's milk (ml)	Melon milk (ml)	% Cheese yield
100	0	30.6
95	5	29.5
90	10	23.6
85	15	37.6
80	20	35.0

Omole and Ighodaro 2015.

Table 14: Hedonic Differences Scores of Cheese Samples Subjected to Sensory Evaluation

Cheese samples	Colour	Flavor	Texture
A	5.6	5.9	6.7
B	5.7	5.2	5.7
C	5.2	5.2	3.5
D	5.3	3.1	4.5
E	4.6	3.5	3.3

A = Cheese from 100% Cow milk, B = Cheese from 95% Cow milk, C = Cheese from 90% Cow milk, D = Cheese from 85% Cow milk, E = Cheese from 80% Cow milk.

Omole and Ighodaro 2015.

Submerged Fermentation of Melon Seeds: Low-fat Content Ogiri

The seeds of the melon plant (citrullos vulgaris schrad), a member of the family cucurbitacae, when ground can be used in thickening and emulsifying soups. It can also be fermented traditionally to produce ogiri. [Odunfa, 1983]. Ogiri has made significant contribution to the diet of the average Nigerian considering its richness in protein and oil (Oyenuga and Fetuga, 1975). However this fermented product is fattening considering its chemical composition a situation that can lead to obesity.(Oyenuga and Fetuga, 1975).

Submerged fermentation of ground melon seed with *Bacillus subtilis* centure revealed that it is possible to produce ogiri with low-fat content due to the ability of the micro-organism to utilize some of the fatty acids in melon oil as source of carbon and energy during the fermentation [Omole, 2010]. A comparison of the oil content of the unfermented cake with that of the fermented cake shows that there was a loss of 32%. The oil content of the unfermented cake being 47.1% while that of the fermented cake is 33.0%. submerged fermentation of melon seeds has resulted in reduction of lipid content. Individuals who desire low-fat fermented melon (ogiri), in order to cut down on their weight are likely to prefer this products.

Dehydrated Okra

Okro (*Hibiscus esculentus*) is a widely cultivated crop in the tropics where it is consumed as a vegetable in the boiled form. In soup making, okro is liked because of its smoothness effect that facilitates swallowing of rough-textured food, [Owoye, caurie Alligheny and Oyenzill, 1990). During warm weather, the shelf-life of okro is considerably reduced due to the high respiratory rate of the crop, which promotes breakdown and senescence [Woodroof and Shellur, 1958]. Hence, it is necessary to process okro into canned okro or dehydrated okro as soon as it is harvested to avoid losses through rapid determination. Mr. Vice Chancellor, Sir, we have succeeded in producing dehydrated okro of the same viscosity and colour as that of fresh okro in aqueous suspension (fig. 2) [Omole and Ogunbamise 2009].

Table 15: Effect of Different Drying Temperatures on the Viscosity of Dried Okra Dispersed in Water at 850°c, and on Colour

Drying temperature of Dehydrated okra (°C)	Viscosity (Degrees Overswing)	Colour of dehydrated okra
Fresh Okra (Control)	$240^{0} \pm 0$	Green
50°C	$241^{e} \pm 2.10^{c}$	Green
60°C	$252^{e} \pm 4.61^{c}$	Green
70°C	$270^{e} \pm 0.0^{b}$	Dark brown
80°C	$305^{e} \pm 0.50^{a}$	Dark brown
90°C	$311^{e} \pm 1.15^{a}$	Dark brown
100°C	$314^{e} \pm 0.73^{a}$	Dark brown
110°C	$320^{e} \pm 3.12^{a}$	Dark brown
120°C	$326^{e} \pm 1.13^{a}$	Dark brown

Values are means of 3 determinations with s.d.

Values in the same column with different superscript differ significantly ($P < 0.05$).

Source: Omole and Ogunbamise 2009.

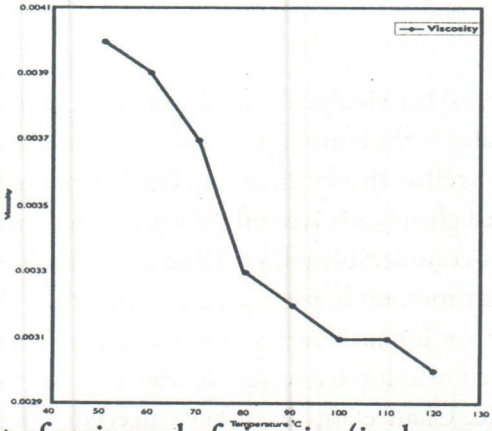

Fig 4: Plot of reciprocal of viscosity (in degrees overwsing) against drying temperature of dehydrated okra.

Source: Omole and Ogunbamise 2009.

Studies on Fermentation of Cassava Mash to Garri Using Whine Yeast

Fermentation is described as any process for the production of any product by mass culture of a micro-organism. Fermentation is an old tradition that dates back to several countries and occurs in brewing, production of organic solvents.

In a broader sense of the word, fermentation includes aerobic processes [Stanberry and Whitaker 1989]. Gari is a staple food in many African countries, Asia, Latin America. The fermentation of cassava mash to Gari has been described as partial anaerobic conversion of sugar to methanol by a group of micro-organisms [Akirele, cooker and Holgate, 1962]. The fermentation consists of storage of peeled, grated and mashed cassava roots in a tank for a period of 3-4 days.

The popularity of cassava is due largely to its usage in the production of a wide variety of forms of food including gari, fufu. Cassava root is rich in stored starch (25%-30%) but poor in other nutrients like protein, vitamin and minerals.

The traditional fermentation of cassava mash to garri is believed to be partial aerobic since the mash is enclosed in sacks and allowed to ferment in open air. The present study aimed at comparing the quality of gari produced by the traditional method with the anaerobic laboratory method using a culture was investigated.

The results of the chemical analysis of garri samples obtained by traditional aerobic and laboratory anaerobic fermentation showed that the method of fermentation has no significant effect on the nutrient composition of the garri samples from either method. However, the protein content of the gari from anaerobic fermentation using yeast culture is higher than that of gari from the traditional aerobic fermentation even though it is not significant [Pd"0.05].

In terms of the Lactic acid content, both methods of fermentation produced the same level of Lactic acid in the gari obtained. Lactic acid content being an important index of taste in gari, suggests that both methods of fermentation produced gari of the same taste [Omole and Ighodaro, 2010].

Table 16: The Effect of Method of Cassava Mash Fermentation on The Nutrient Composition of Garri Samples.

Samples of garri	Crude protein (%)	Crude fibre (%)	Moisture content (%)	TTA (lactic	Ca (Mg/ acid) (%)	P (mg/ 100g)	Fe (ppm) 100g)	pH
Traditional aerobic	0.84 ± 0.01	0.45± 0.01	13.1 ± 0.5	0.069	24.0	4.0	12.56± 0.50	4.4
Laboratory anaerobic	0.92± 0.02	0.55± 0.01	12.8± 0.06	0.069	24.0	4.0	17.60±0.5	5.0

Values are means of triplicate determination with S.D. Values with same superscript do not differ significantly (p=0.05). [Omole, Ighodaro and Makanjuola 2010].

Toxic Trace Elements in Cassava Products: Lead and Cadmium

Toxic trace element including lead and cadmium are always a source of worry when consumed with food considering their harmful effects in the body [Adeloju and Bond, 1984; Stephen et al, 1982]. Regular monitoring of these elements in biological and processed foods is therefore necessary in order to avoid any catastrophic effects which include vomiting.

The unpackaged nature of some product, the location of the markets along motor highways and reports that cassava crop might accumulate these contaminates from soil where they are grown have lead to speculations that the product may not be completely safe for human consumption (Odoemena and Akpa bio 1997. Satzgar et al, 1982)

This study was undertaken to establish the levels of cadmium and lead in unpackaged tapioca exposed for sale along motor highways in selected markets in Lagos State S.W. Nigeria.

Another stripping voltammetry technique which is considered accurate, precise and sensitive was used. The results showed a range of 1.6 to 2.7 ug/g of cadmium and 5.2 to 7.0 ug/g of lead in all the samples subjected to analysis. The data obtained were compared with those obtained by WHO 1973 in a similar study on human milk from 5 different countries, and found that the level of lead in tapioca compares favourably with those found in human milk in Philippines and Hungary. A comparison of the cadmium level found in tapioca in this study with that found in human milk for four different countries in another study by WHO, (1973) show that cadmium level in tapioca was higher than the value found in human milk in four different countries (Guatemala, Hungary, Sweden and Zaire).

This study provides reliable information on the possible danger arising from the consumption of unpackaged foods like tapioca, exposed to contaminants on high traffic motorways in Lagos State Nigeria.

Table 17: Mean Concentration of Cadmium and Lead (Ug/G) in Tapioca from Five Selected Markets in Lagos, Southwest Nigeria

Sample sources	Cd level (pg/g)	Pb level (ug/g)
Agee	1.6 ± 0.11^{b}	7.6 ± 0.16^{a}
Mushin	2.7 ± 0.12^{a}	7.5 ± 0.16^{a}
Oke-Odo	2.6 ± 0.12^{a}	7.4 ± 0.22^{a}
Orile-Agege	1.7 ± 0.11^{b}	5.2 ± 0.099^{b}
Oyingbo	1.9 ± 0.12^{b}	5.3 ± 0.26^{b}

Date are means of 4 determinations; and values in the same column with the same superscript are not significantly different (pd"0.05). [Omole 2010].

Table 18: A Comparison of the Levels of Heavy Metals in Human Milk from Different Countries (ug/g)

Elements	Countries				
	Guatemala	Hungary	Sweden	Philippines	Zaire
Lead 1.8	10.0	1.3	11.0	2.3	
Cadmium	0.6	0.70	0.8	1.7	0.5

(WHO, No. 532 1973) and (WHO/LAEA, 1989) [Omole 2010].

Aluminum – Induced Liver and Testicular Damage in Rats: Effect of *Piliostigma thonningii* Methanol Extract

The impact of aluminum on human health has been increasingly alarming and damaging in recent years.

Most recently is the Hungary aluminum sludge toxicity which claimed may valuable lives and left over 120 injured. Aluminum is believed to be non-toxic and easily eliminated from the body, a belief that encourages its use in daily life. Previous studies have reported a strong correlation between high aluminum contents in human testes, lay dig cells, spermatozoa, seminal plasma, blood and urine with impaired sperm quality and viability.

Suppressed testosterone production and sexual behavior were also observed in animals exposed to aluminum (Guo, Lu and Hsu, 2005: Yousef,

2004: El-Dermerdash, 2004). In addition, the presence of aluminum (III) chloride suppressive effect on the fertility of male rats (Bataineh, Al-Hamood and Elbetieha 1998).

More than ever before, humans are continually exposed to this element through cooking utensils (Sharma, Mishra, 2006), food product and drinking water and through medicines such as antacids, phosphate binders, buffered aspiring, vaccines and injectable allergens [Lione, 1985: Kowalcyzk, Kedzioral, Blasczky, Et al 2004] Environmental pollution from a variety of aluminum-containing waste, industrial waste water increases human exposure beyond normal level [Kloppel, Fliender and Kordel 1997].

Studies have established that $AICI_3$ mediated toxicity in animals or man is mainly due to its ability to generate reactive oxygen species (ROS) or free radicals when metabolized [Yousef, Kamel and El-Guendi 2007] and inhibit antioxidant enzymes and other components of antioxidant system in a variety of organs including the Liver, testes, kidney, lungs and brain.

On the contrary, *Piliostigma thonningii* is reported to be rich in different antioxidant molecules [Aderogba Et al, 2004: Akindahunsi, 2005: Ighadaro, Agunbiade, Omole Et al 2012]. The protective potential of *Piliostigma thonningii* methanol leaf extract on aluminum – induced hepatotoxicity and testicular damage in Wister rats at a dosage of 250mg/kg body weight has been studied. Result from the study showed that *Piliostigma thonningii* methanol extract at a dose of 250mg/kg body weight was effective in protecting rats from liver damage induced by the toxicant [Ighodaro and Omole, 2012].

Aqueous Leaf Extract of Ocimum Gratissimum can Reverse Ethanol-induced Hepatoxicity in Wister Rats

It is worth mentioning that the etiology of some oxidative stress-based pathological conditions in the liver has implicated excessive ethanol consumption.

More than ever before, there is an upsurge in alcohol abuse and as a result, alcohol disorders are becoming increasingly important causes of mobidity and mortality globally [Rulkkumani et al, 2004].

Many research reports have linked chronic alcohol consumption and a variety of pathological conditions varying from simple intoxication to severe life-threatening pathological states [Tsulkamoto and Lu, 2001; McDonough, 2003; Tuma, 2002; Lieber 2003]. The liver is particularly susceptible to alcohol-related injury such as fatty liver, hepatitis and Cirrtrosis because it is the primary site of alcohol metabolism. Alcohol-induced hepatotoxicity has been observed to develop mainly through excessive generation of free radicals and reactive oxygen species, as well as impaired antioxidant defence mechanisms, condition which result in oxidative stress, with attendant health problems [Wu and Cederbrum, 2003]. This situation has a negative effect on the nutritional status of the alcoholics, interfering with the digestion, absorption and utilization of essential nutrients such as vitamins, minerals and protein [Gruchow et al, 1985; Lieber; 2003]. *Ocimum gratissimum* leaves which are widely used in folklore medicine in Nigeria and some parts of the world has been evaluated and found to reverse ethanol-induced hepatotoxicity in male wister rats.

The plant is rich in polyphenolic compounds with antioxidant properties, thus it possess the ability to scavage free radicals and reactive oxygen species. These facts were established by measuring serum levels of liver enzymes markers: Alanine amino transferase (ALT) and Aspartate amino transferase (AST), Gamina Glutaryl transferase (GGT) and Alkaline phosphates (ALP) in the liver and blood serum of control and experimental rats [Ighodaro and Omole, 2012].

Evaluation of the Leaves of Piliostigma Thonningii for Nutritional Antimicrobial and Antioxidant – Vitamin Profile

Mr. Vice chancellor, sir, *Piliostigma thonningii* leaves (Nigeria species) have been evaluated for its nutritional, antimicrobial and antioxidant – vitamin profile as part of the search for herbal extracts that can be of benefit in unorthoelox medicine.

This study reveals that the ethanol extract of the leaves possess antimicrobial properties, and rich in antioxidant vitamins A, C, E which are important in protecting the body from oxidative damage and subsequent degenerative diseases like cancer, Arthritis, atherosclerose etc.

A dosage of 250mg/kg body weight/day can reverse liver damage in rats induced by a toxicant.

Table 19: Activities of Enzyme Markers of Liver Function in Treated and Non Treated Rats

Group	ALT IU/mg protein		AST IU/mg protein		ALP (U/L)		GGT IU/mg protein	
	Serum	Hepatic	Serum	Hepatic	Serum	Hepatic	Serum	Hepatic
A(Control)	14.01 ± 1.01	131.19± 6.70	23.51 ± 1.28	152.22 ± 4.02	18.66 ± 3.12	405.87 ± 24.19	28.05 ±1.72	162.13 ±5.89
B (Og)	13.76 ± 0.32	142.0 ± 5.02	22.85 ± 1.64	167.44 ± 8.38	18.27 ± 1.35	418.21 ± 20.09	27.12 ± 1.25	173.71 ±9.35
C (ET)	26.32 ± 0.19*	83.60 ± 1.03*	48.39 ± 1.20*	79.56 ± 0.91*	33.28 ± 1.15*	263.11 ±1.34*	51.12 ± 1.01*	95.09 ±0.88*
D (ET & Og)	19.23 ±1.45**	117.98±4. 03**	31.43 ± 0.21	119.34±5 .67**	27.56 ± 0.46	335.67 ±8.33**	39.44 ±1.87**	134.35 ±2.67**
E (ET,Og &Og)	14.68 ± 0.67	132.31 ± 3.06 a*	24.66 ±0.87	149.55 ± 2.08 a*	21.98 ± 0.09	402.51 ± 12.87 a*	30.97 ± 1.32 a*	165.07 ±2.11 a*

P<0.05 = Significance. *=compared to control. **= compared to ET. a*= compared to ET & Og

[Ighodaro and Omole, 2012].

Table 20: Levels of Oxidative Damage Related Parameters in Treated and Non Treated Rats

Group/Treatment	MDA (µmol/g tissue)	GSH(µg/g tissue)	GST (µg/ min/mg protein)
A (control)	51.36 ± 0.09	12.38 ± 0.83	3.1 3± 0.43
B (Og only)	33.87± 6.43	16.57 ± 2.31	3.09 ± 0.82
C (ET only)	107. 39 ± 12.11*	4.12 ± 0.31*	6.36 ± 0.19*
D (Og & ET)	52.12 ± 3.44**	8.56 ± 2.45**	3.59 ± 0,11**
E(Og.Og & Et)	43.31± 5.27 a*	13.09± 2.22 a*	3.21± 0.20 a*

mean ± S.D for ten animals per group

P<0.05 = Significance. *=compared to control. **= compared to ET. a*=compared to cET & Og

Papain Reduces Cooking Time of Cowpea Seeds

Mr. Vice chancellor, Sir, because of my believe that research is meant to improve the standard of living of our people through the provision of answers to their existing challenges, I embarked on research into how the cooking time of cowpea seeds can be reduced to save energy. Cowpea seeds which contribute significantly to the protein requirement of most people in lie sub-Sahel Africa including Nigeria, are commonly consumed where access to animal protein is limited.

Cowpeas are rich in protein, minerals, vitamins and second to cereals in terms of the amino acid composition of the protein, and fibre content. Cooking of the beans requires a supply of large quantity of fuel energy to complete its cooking because of the hardness of the beans. [Dovlo, 1976].

To minimize the energy required, a protease, papain has been discovered to reduce the cooking time of beans boil at atmospheric pressure. The optimal cooking time required to attain the standard texture of well cooked beans in the control is 50minutes as determined by penetrometer reading and subjective testing, whereas this is 35 minutes for beans cooked in papain solutions.

The cooking times to give the same yield forces as that produced by cooking the control for 50minutes i.e. 0.42kg/m have been estimated in Table 21. Cooking time is halved by about 250 ppm of papain. This is due to the proteolytic activity of papain. [Omole, 2003].

This is very important in a country like Nigeria where firewood constitutes the main fuel used in rural areas. This reduction will minimize the depletion of forest resources. It is worth noting that papain occurs naturally in unripe pawpaw fruits and leaves.

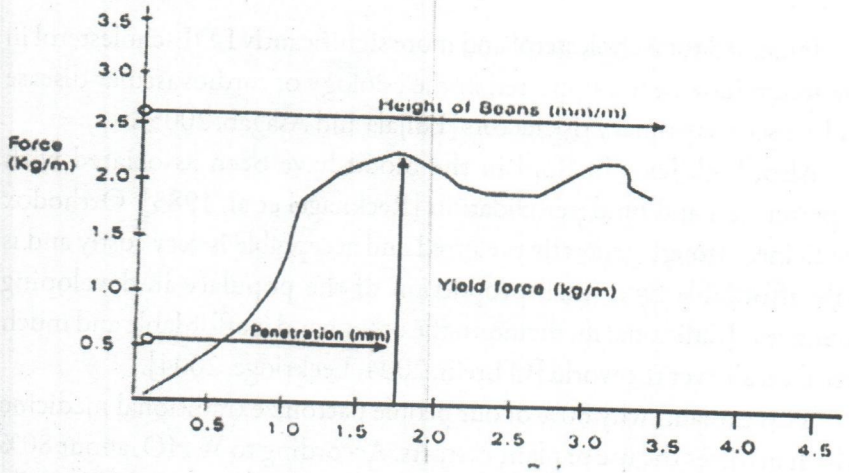

Fig. 5: Typical force deformation curve during penetrometer test of cooked cowpea beans. (This is to show how the data for the penetrometer test were derived).

Table 21: Effect of Papain on Optional Cooking Time of Cowpea

Cooking papain, ppm	Cooking time minute	Organoleptic quality	Water absorption, %	Yield Force kg/m	Initial P^H	Final P^H
0	0.5	LBS	180.69	0.42	6.7	6.9
100	35	BS	154.40	0.31	6.5	6.7
200	35	BS	147.88	0.33	6.7	6.9
300	35	BS	154.13	0.21	6.4	6.5
400	35	BSM	454.64	0.51	63	6.7

LBS: Light brown and soft; BSM: Brown soft and mustly; Values are means of 4 determinants; 6.3 ± 0.12. [Omole, 2003].

***Piliostigma Thonningii* Leaves contain Antilipidaemic and Anticholesterolaemic Substances.**

Mr. Vice Chancellor, Sir, cardiovascular diseases and related disorders are a major cause of mortality both in man and woman all over the world [Smith, 2004]. They are commonly characterized by high levels of total cholesterol, triglycerides and low-density lipoprotein cholesterol in the serum.

Increased total cholesterol and more significantly LDL-cholesterol in the serum have been implicated in the etiology of cardiovascular disease and are seen as primary risk factors [Edijala and Asagab, 2005].

Also, high level of lipid in the blood have been associated with hypertension and lipid peroxidation [Recknagel et al, 1983]. Orthodox medicine, through generally preferred and acceptable is very costly and is only affordable by a small proportion of the populace in developing countries. Traditional medicine on the other hand is affordable and much relied on all over the world [O'brein, 2004; Leckridge, 2004].

This explains why 80% of our people patronize traditional medicine which involves the use of plant extracts. According to WHO, about 80% of folks in developing countries depend mainly on traditional medicine for their primary health care and about 80% of such traditional extracts [Farnsworth, 1988].

Some commonly consumed herbs have been reported to promote reduction in blood lipid [Perez, Canal and Campillo, 1999; Gignarella, Nastasi and Cavalli, 1996; Adebayo, Aliyu and Gatsing, 2006]. *P. thonnigii* which is an under-exploited leguminous plant that belongs to the family leguminosae caesalpiniodae, a family that comprises of trees, shrubs. The tree is perennial in nature and its petals are white to pinkish in colour, produced between November and April [Jimmoh and Oladiji, 2005]. Its various organs: root, bark, seed and fruit have been used for various traditional medicine.

In this study, the concentrated aqueous extract of the leaves of piliostigma thonningii was used and administered to the treated rats at the rate of 0.2g/kg body weight and 0.4g/kg respectively body weight for 140g while the control rats received normal salic daily for 14days. The result obtained in this study suggests that piliostigma thonningii leaves may protect against accumulation of cholesterol and triglycerides in the blood [Ighodaro and Omole, 2011].

This may be useful in the treatment or management of atherosclerosis and coronary heart disorders. However, it is strongly recommended that the use of plant extract should be within the limits that are non-toxic to body cells and tissues preferably between 200 and 250 mg/kg of body weight.

Hepatotoxicity Level of *Cajanus cajan*

The toxicology of medicinal plants and extract their products is an important and integral part of the early and late phase of drug development [Gamaniel, 2000]. Documented information on toxicity and side effects associated with most plants used in ethno medicine abound. *Cajanus cajan*, popularly referred to as pigeon pea (English) and otile (Yoruba) in Nigeria belongs to the botanic family Fabaceae and grows in the forest and savannah regions of the world. The different part of the plant is widely used to treat various kinds of diseases, either alone or in combination with other herbs in many African countries.

Some of the medicinal uses of *Cajanus cajan* include treatment of cough, coronary heart, diseases, intestinal disorders, jaundice and bronchitig [Morton, 1976; Duke, 1981]. It is also used as antihelmintic sedative and in child delivery. Aqueous leaf extract of *cajanus cajan* when consumed by pregnant women especially in southwest, Nigeria aids easy delivery. Cajanus *cajan leaf* extract has also been reported to induce uterine contraction in rats [Olatunji-Bello et al, 2002].

Its hypoglyceamic, anti sickling and antiplasmodial properties are well documented [Giri et al, 1987; Ogoda et al, 2002; Duker-Eshun et al, 2004]. The furtherance of information on the biochemical and toxicological components of this important medicinal plant necessitated this study on the effects of *Cajanus cajan* aqueous leaf extracts on serum amino transferase, alkaline phosphatase and electrolytes concentration of rats. The result of this study showed that the aqueous leaf extract of *Cajanus cajan* at 0.5g/kg and 1.0g/kg body weight doses caused a significant increase in ALP concentration when compared with the control.

Significant increases were also noticed in the serum concentrations of AT when compared with the control. However, the mean concentrations of Potassium, sodium, bicarbonate and chloride was remained within the normal physiological range. The present study showed that the aqueous leaf extract of *Cajaus cajan* has the potential to be hepatotoxic when consumed at a daily dose of 0.5g/kg of body weight or more for 14 days. On this basis, it is strongly recommended that lower dosage be considered in the local use of the plant leaf extract for treatment of ailment.

Antidiabetic Effect of *Parinari polyandra* Seed Extract

Diabetes Mellitus (DM) is a chronic metabolic disease which either results from deficiency in insulin production by the pancreas or inability of the insulin produced to bind effectively to its receptor on the cell surface. Either of these conditions leads to accumulation of glucose in the blood (hyperglycemia) and often imparts negatively on a number of organs in the body, especially in blood vessels.

Micro-vascular and macro-vascular complications are readily seen in diabetics [Brownlee, 2001; virella-Lopes and virella, 2003;]. The complications associated with diabetes are not likely unconnected to oxidative stress induced by hyperglycemia which overcomes the body natural antioxidant system. In the later stage of diabetes, lipid metabolism is affected and seen as hyperlipidemia and hypercholesterdemia which are risk factors in atherosclerosis [Ross, 1999: Schwarts, 2006].

There is also the probability of liver damage due to increased gluconeo genesis and ketogenesis [Felig and Ohman Chau, 1970]. The increase of diabetes is still on the rise and is estimated to be over 150 million cases worldwide [Wild, Roglie, Green, Sicree and King, 2004]. There is yet no effective cure for diabetes and the available drugs and insulin currently used in management of the disease are associated with several undesirable side effects [WHO, 2002]. Besides, they are not affordable by low-income earners. All these facts have led to research into plants with hypoglycaemic properties, which can be employed in the management of diabetes.

Several species of medicinal plants used in traditional treatment and management of diabetes worldwide have been evaluated and generally plants rich in alkaloids and flaronoids have been observed to possess hypoglycaemic properties [Brai, Odetola, and Agomo, 2007].

Phytochemical screening of *Parinarri polyandra* seed extract reveals the presence of flavonoids, tannins, saponin and glycosides [Vonglau et al, 2004]. In light of traditional anti-diabetic claim on this plant, therapeutic effect of coconut water extract of *Parinarri polyandra* seeds on fasting blood sugar level and serum biochemical indices on alloxan-induced diabetic rats was investigated. The results revealed that rats treated with parinarri

polyandra seed extracts expressed significant (pd" 0.05) decrease in the level of ALT, AST, TAG, Total cholesterol, LDL with slight increase in HDL as compared with diabetic control rats.

The data obtained from the current study indicate coconut water extract of p.polyandra has anti-diabetic, anti-lipidemia and anticholesterolemia potentials. Hence, its local use in the management of diabetes should be encouraged.[Ighodaro, Omole and Odunaiya].

Table 22: Blood Glucose Levels of Normal Alloxan-induced (150mg/ Kg I.p.) Daibetis Albino Rats (Treated and Untreated) on the 3rd and 7th Day of the Experiment.

Group Treatment	Pre-Treatment Day 0	Blood Glucose (mmol/L) Post Treatment		
		Day 3	Day7	% Δ
Normal control (2ml saline)	3.82±0.18	3.80±0.21	3.81±0.12	-0.26
Diabetic control (untreated)	29.46±1.03	33.21±1.1	38.11±1.3	+29.4*
Coconut water extract of P.polyandra seed (2ml)	30.3±0.81	32.09±0.56	21.32±0.76	-29.6**
Coconut water only (2ml)	29.11±0.43	29.24±0.12	28.62±0.27	-2.1*
Glibenclamide ($5mgkg^{-1}$)	32.06±0.89	22.06±0.54	18.35±0.31	-42.7*

alues are expressed as mean ± SD (Unit: mmol/L). n = 5, *P<0.05 nst normal control.

ercentage change in blood glucose level (Normal range for the cose: 2.5 to 5.0 mmol/L). + = increase, - = decrease. [Ighodaro, 2010].

Peeling of Carrot Enhances Ascrobic Acid Content, Carrotene Content and Colour of Carrot Wine

Mr. Vice Chancellor Sir, the foods we eat in their natural state contain anti-nutritional substances which must be removed or destroyed in order to make them palatable, digestible and make nutrients available for use in the body. Traditional processing methods like peeling, fermentation and heat treatment have been employed in achieving these objectives.

In the processing of carrots for wine making, peeling of the carrot tubers before juice extraction was found to significantly (Pd" 0.05) increase the ascorbic acid content, carotene content and colour intensity of wine from carrot when compared with wine from the control (unpeeled carrot tubers). Peeling removes peroxidase and catalase which destroy ascorbic acid in carrot tubers. [Omole, 2005].

Table 23: Comparative Physico-chemical Properties of Wine from Peeled Carrot Juice and Wine From Unpeeled Carrot Juice

Analysis	Wine from peeled Carrot juice	Wine from unpeeled Carrot juice
Alcoholic (% by volume)	2.0	2.0
Sugar (g/100ml)	0.0	0.0
Specific gravity	1.003[a]	1.002[a]
Sugar free extract (g/100ml)	2.0[a]	2.5[a]
Total acidity (g/100ml)	0.096[a]	0.144[a]
Volatile acidity (g/100ml)	0.002[a]	
Fixed acid (g/100ml)	0.094[a]	
Titratable acidity (% Lactic acid)	0.115[a]	
PH	5.07[a]	

Ascorbic acid (mg/100ml)	2.60[a]	1.30[a]
Carotene (mg/100ml)	11.0[a]	10.50[a]
Colour intensity (530mm)	0.72[a]	0.69[a]
Ash (g/100ml)	1.5[a]	2.08[a]

Values are means of three determinations

Values in the same row with same superscript do not differ significantly (pd"0.05) [Omole, 2005].

Dietary Fibre and Health: Hypo-cholestrolemic Effect of Soluble Dietary Fibre

Excess consumption of eggs especially the yolk has been implicated in hyperlipidaemia. Conversely, soluble dietary fibres probably due to their ability to bind free lipid molecules in the small intestine before absorption into the blood, appear to play an important role in protecting against hyperlipidaemia [Wardlaw and Smith 2008].

This study was undertaken to evaluate the comparative effects of selected sources of fibres: apple, oats and wheat bran on serum lipid profile in physiologically normal wister rats. The animals were divided into four groups and each group fed with egg yolk, oats, apple and wheat bran.

The result obtained showed that the group fed with oats had the lowest level of total cholesterol, low density lipo protein (LDL) cholesterol, triglycerides, as well as the highest level of high density lipo protein (HDL0 cholesterol. On the contrary, the group fed with egg yolk showed the highest level of total cholesterol, low density Lipoprotein (LDL) cholesterol, triglycerides, as well as the lowest level of HDL cholesterol.

There were no significant differences ($P>0.05$) between oats and apple in their effects on blood lipid profile of wister rats. Wheat bran being an insoluble dietary fibre, had less significant ($p< 0.05$) effect on the blood lipid profile when compared to oats and apple [Omole and Ighodaro, 2013]. Soluble fibres bind to cholesterol in the small intestine and prevent it from being absorbed [Wardlaw and Smith, 2008].

Findings from this study may assist physicians and dieticians in recommending appropriate diet for individuals desiring to normalize their blood lipid profile as a means of preventing cardiovascular diseases.

Table 24: Proximate Analysis of Apple, Oats and Wheat Bran

Diet	Moisture (%)	Protein (%)	Crude Fat (%)	Crude fibre %	Ash(%)	Carbohydrate %
Oats	3.1±0.7	11.3±1.0	1.5±0.6	9.3±2.1	4.3±1.4	70.5±1.8
Apple	4.5±1.2	15.2±1.5	1.3±0.8	7.1±2.7	1.4±0.5	83.1±1.1
Wheat bran	11.2±0.0	15.2±1.5	3.5±1.2	9.9±1.7	5.1±1.4	55.3±2.6

[Omole and Ighodaro, 2013].

Antimicrobial and Antioxidant – Vitamin Profiles of *Piliostigma Thonningii* Leaves (Nigeria Species)

Increased awareness of the significance of medicinal plants and their contribution to nutrition and health of individuals and communities has necessitated the need for knowledge of the food nutrients and phytochemicals present in the various parts of different plants. The phytochemicals contained in plants are largely responsible for the definite physiological action they exert on the human body [Ighodaro et al 2009] and their nutritional value is determined by the food nutrients they contain. *Piliostigma thonningii* leaves have been evaluated through its proximate analysis and found to be rich in antioxidant vitamins C, E and carotenes which are important in protecting the body from oxidative damage and subsequent degenerative diseases like cancer, arthritis, atherosclerosis etc. In addition, the aqueous and ethanol extract possess antimicrobial properties. These findings have lent credence to the use of this plant in folklore medicine.

Table 25: Quantitatives Values of the Phytochemicals Present in *Piliostigma Thonningi* Leaves

Phytochemical	Amount (mg/100g)
Saponins	2.1
Alkaloids	1.2
Flavonoids	1.3
Tannins	0.8

Values are means of triplicate determinants. [Ighodaro et al, 2012].

Table 26: Antioxidant Vitamin Content of *Piliostigma thonningii* Leaves

Parameter	Amount (mg/100g)
Vitamin C	17.80
Vitamin E	3.29
Beta carotene	12.25

Values are means of triplicate determinants [Ighodaro etol, 2012].

Table 27: Diameters (Mm) of Inhibition Zones of Microbial Growth *Piliostigma thonningii* Extract

		Concentration of P.thonningii (mg mL^{-1})				
Organism	-ve control	+ve control	25	12.5	6.25	3.01
Staphylococcus aureus	0	17.50	3.70	2.00	1.00	0.40
Escherichia coli	0	22.40	3.40	2.20	1.20	0.40
Bacillus cereus	0	14.30	2.80	1.4	0.80	0.30
Pseudomonas aeruginosa	0	14.60	2.90	2.10	1.40	0.48
Proteus mirabilis	0	12.60	3.20	1.80	1.10	0.35
Fusarium	0	13.80	1.40	0.60	0.40	0.20
oxysporium Aspergillus niger	0	11.70	1.80	1.20	0.50	0.20
Rhizous nigiricans	0	12.60	1.60	1.08	0.48	0.35

Values are means of triplicate determinants. [Ighodaro et al, 2012].

Modulatary Effects of Chronic Ethanol Ingestion

Drug abuse, in particular that of excessive consumption of alcohol has become a major problem in our society today, and has being responsible for many sudden deaths, breakdown of many homes, separation in marriages, cause of many chronic diseases to mention a few.

Ethanol is the active chemical substance contained in many alcoholic beverages and drinks like beer, wine, gin, brandy, whiskey and liquors. It is a clear and colourless liquid with a characteristics agreeable taste and small. It is present in varying concentration in these products and well known for its intoxicating effect on its consumers. It is primarily metabolized in the liver (Maher, 1997) and absorbed into the blood stream in the gastrointestinal tract (GIT) [Bode and Bode, 1997].

Ethanol breakdown generates potentially dangerous by-products such as acetaldelyde and highly reactive molecules called free radicals and reactive oxygen species (ROS), which are capable of attacking cell membrances and biomolecules like DNA, protein, fats [Lindros, 1995; Balkam et al, 2001].

Studies have shown that Alanine amino transferase (ALT), Asparate amino transferase (AST) gamma glutamyl transferase and alkaline phosphatase (ALP) which are physiological and drug metabolizing enzymes located mainly in the liver are often used as markers of liver functions and soft tissue damage. Our study revealed that there was an increase in the blood plasma levels of these enzymes by 87.8%, 105.82%, 82.24% and 78.34% respectively with a concomitant reduction in their hepatic concentrations: ALT by 36.27%, AST by 47.73%, GGT by 41.34%, ALP by 35.17% in male wister rats administered with ethanol in a dose of 5g/kg body weight [Ighodaro and Omole, 2009].

This respective rise and decrease in the plasma and hepatic levels of these enzymes may be attributed to damaged structural integrity of the liver, which resulted in the leakage of these enzymes from the cytosol into the blood stream [Vermaulen et al, 1992; Uzun et al 2005].

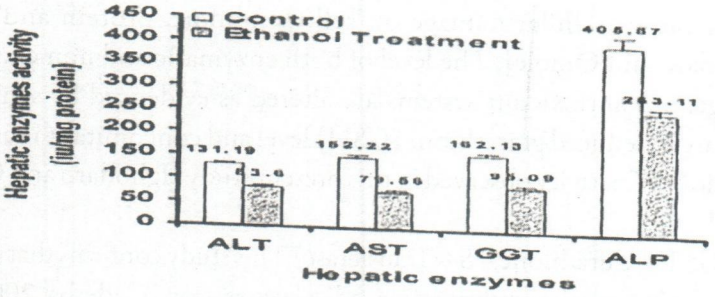

Fig. 6: Effect of ethanol on hepatic activity (iu/mg protein) of liver enzymes

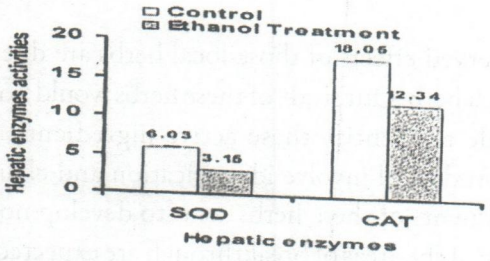

Figure 7: Effects of ethanol on SOD and CAT hepatic activities
Source: Ighodaro and Omole, 2009.

Alcohol Activates Free Radical Generation, Reduces the Level of Endogenous Antioxidant System in the Body and Body Weight Loss

Our studies on chronic ethanol administration to wister rats at a dosage of 5g per kilogram body weight also revealed that there was loss of body weight in rats treated with alcohol when compared with control animals. This was due to poor digestion absorption, storage, utilization and excretion of essential nutrients such as vitamins, minerals and protein [Gruchov et al 1985; Lieber 2003].

Alcohol impairs nutrients absorption by damaging cells lining the stomach and ingestions, and disabling transport of some nutrients into the blood [Freinman, 1998]. Alcohol also inhibit breakdown of nutrients into usable substances, by decreasing the secretion of digestive enzymes from the pancreas [Korsten, 1989].

There was also an increase in the level of Malondialdelyde (MDA) observed in the various target organs due to generation of free radicals which causes cellular damage on cell membrane, protein and lipids. [Ighodaro and Omole]. The level of both enzymatic and non enzymatic endogenous antioxidant systems are altered as evidenced by significant decrease in reduced glutathione (GSH) level and concomitant increase in hepatic GST activity observed in this present study [Ighodaro and Omole, 2009].

(GST – Cutathione – S – Transferase) This study confirms that chronic alcohol consumption activates free radical generation [Cederba, 2001] and reduces the level of endogenous antioxidant system in the body.

Future Plan

Some of the observed effects of those local herbs are due to some active ingredients in each herb. Our study of these herbs would not be complete if no effort is made to identify these active ingredients. To this end, a comprehensive study will involve identification and characterization of the active constituents of these herbs so as to develop novel plant drugs from them. Some of the areas of breakthrough are expected to be patented with a view to encouraging Nigerians to pick up these inventions and thus contributing to national growth and development.

Conclusion

Vice Chancellor Sir, Ladies and Gentlemen, I have in this lecture discussed the role of free radicals and Reactive Oxygen species in the aging process. Many studies have shown that free radicals and Reactive oxygen species have a role to play in the aging process. These highly reactive molecules are byproducts of severed steps in the mitochondrial electron transport chain.

Since the body must continue to use O_2 for life to continue, oxidative damage caused by these byproducts of metabolism will continue. Your body therefore needs plenty of antioxidants to defend itself against the assault of free radicals on healthy cells. The naturally occurring endogenous antioxidants, superoxide Dismutase [SOD] and catalase are responsible for lowering the level of these reactive oxygen species in the cell. However, this system is not 100% effective, hence the body needs the antioxidants vitamins. Vitamin C, E, and carotenoids, Glutathione systems to protect endogenous antioxidants and thus limit oxidative damage in the cells. This demonstrates the dependence of man on plants, and the missing part of God's plan for our healthy living.

Mr. Vice Chancellor, Sir, Distinguished Ladies and Gentlemen, that you may enjoy an extended life expectancy, the following are my recommendations:

i. Eat more of fruits and vegetables because the most effective antioxidants come from the food we eat.
ii. Engage in calorie restriction by eating a low-calorie diet since a low calorie diet extends median and maximum life expectancy.
iii. Take to daily physical exercises as the importance of daily physical exercise in health cannot be over emphasized.
iv. Avoid smoking, exposure to pollutants, fried foods, poison. All these promote and produce free radicals.
v. Avoid exposure to ionizing radiation to prevent radiation toxicity in cells and damage to cell components, especially DNA, proteins. Workers who operate equipment emitting ionizing radiations, should wear protective garments that can absorb the radiation. Instrument that measure the exact quantity of radiation coming in contact with the

body should be used also to determine the minimum amount of radiation which the body is exposed to, in order to ascertain that it is at a safe limit.

Vice Chancellor, Distinguished Ladies and Gentleman, I wish to use this moment to appeal to the Federal Government to have a re-think on her proposed Nuclear energy plants for nuclear energy, considering the huge challenges that are likely to be faced in the management of the nuclear waste. We should learn from the experience of Russia in the Chernobyl nuclear disaster of 1986: the Japanese experience of 2004 when the nuclear wastes and discharges find their way into the food chain of the inhabitants where the nuclear plants were sited.

The victims of Chernobyl nuclear waste disaster are still nursing the cancer, and there is a high probability of the effect being replicated in the genes of future generations. The Question is, can we afford to manage the nuclear waste when our railway systems are ineffective and old?

Acknowledgements

To God be the glory for all he has done for me. It is of the Lord's mercies that I am not consumed because his compassions fail not [Lamentations 3:22].

The road leading to the peak of my career has not been smooth, it has been full of challenges. At last, God has fulfilled my dream to become induced into the professional hall of fame.

Initially my ambition on completion of my Ph.D. programme was to work in the industry considering my interest in industrial processes. However, due to circumstances beyond my control, I find myself in the then Food & Drug Administration, now NAFDAC. However, when I could not cope with the bureaucracy of dealing with the public, I had to resign my appointment.

I am indeed thankful to Dr. Tijani Alawe and Professor Adeyemo for being instrumental to my coming to Lead City University, Ibadan. I also appreciate the mentor-roles of the following in my life:

i. My late uncle, Mr. Akin Ola Obeisun, the former Deputy Director of West African Breweries, Lagos.
ii. Late Professor Afolabi Toye, former V.C. of the University of Ilorin.
iii. My late uncle, Mr. Femi Arojojoye.

I wish to register in proxy, my deep appreciation to the following:

i. Professor D.S. Robinson, my former Head of Department of Food Science, University of Leeds, Leeds UK, for his love and affection for my family while in UK for my Ph.D programme.
ii. Dr M. Kapel, my Ph.D supervisor, for his thoroughness and leadership quality in ensuring an earlier conversion of my M.Phil status to Ph.D. programme.

Mr. Vice Chancellor, Professor Olufemi Onabajo, your administrative style and spiritual intervention in the affairs of this institution has brought hope, joy and inspiration to many of us. Remain blessed.

The immediate past Vice Chancellor, Professor Emeritus, Prof. J.B Aladekomo. I sincerely appreciate you for your words of wisdom and guidance when the need arises.

The Chancellor of this great institution, Professor B.A. Ogunmola, a humble and erudite scholar of international repute, your contribution to the growth of this institution is monumental. You have continued to inspire the youths academically. I pray that the Almighty God will continue to strengthen you to serve humanity.

The Pro-Chancellor and the Chairman, Governing Council of this great institution Professor Jide Owoeye, I wish to specially thank you for allowing God to use you in blessing others, because God has used you to fulfill his purpose for my life. I indeed admire your vision for setting up this institution and I pray that the vision shall be perfected in Jesus name.

I also wish to use this occasion to appreciate the Registrar, Dr. (Mrs.) Oyebola Ayeni, the Director of Academic Planning, Dr. (Mrs.) Adewole, the University Librarian, Mr Lanre Osanyi, the Senate Office in particular, Mr. Fatoki for their support at all times.

I also pay glowing tributes to my late parents Mr. and Mrs. Ilesanmi Omole who, despite their meager financial resources, were committed to my education.

My late immediate junior brother, Engineer David Omole for his advisory role in the family while alive.

My bosom friend, Elder Kehinde Oduntan Managing Director of Oduntan Farms (Nig) Ltd, Sagamu for his love and affection while alive. I cannot but appreciate my old friends in academia, these include: Professor Adetunji, Professor S.O. Awonorin, Professor M.A Idowu, Dr. Akinola A. all of the Federal University of Agriculture, Abeokuta; Mr. A. Ajiwo, Mr. Adepegba, the Makanjuolas, Mr. A. Ajayi all of Federal Polytechnic, Ilaro, Ogun State for their steadfastness and faith in me.

To all my colleagues in the faculty of science Prof. Femi Lana, Prof. Shola Ladokun, Prof. Taiwo Fashola, Prof. Onilude, Dr. Arojojoye and others. I appreciate your support and cooperation. I love you, all students of the faculty of science.

To my research collaborators, Mr. O.M. Ighodaro a erudite scholar, Dr. Adejuwon, Mr. A. Adeosun, Miss O. Durosinlorun, Mr. A. Aminu. I enjoy working with you, and appreciate your contribution to my academic career. I also appreciate the effort of Victory Computers in the production of these manuscripts.

My acknowledgement will not be complete without appreciating my loving wife Mrs. Yetunde Iyabo Omole and my children for their support and encouragement during the challenging periods of my academic career. I also wish to appreciate the support of all members of Omole, Ayoades family; and my in-laws (the Otubus). The co-operation of the laboratory staff of Biochemistry Department, Lead City University, Ibadan is also appreciated.

Lastly, I wish to appreciate my spiritual fathers: Pastor Deji Alake of Living Proof Parish, Orita, Ibadan; and Bishop David Oyedepo of Living Faith Church (a.k.a Winners Chapel) Otta, Ogun state, for their prayers and grace upon my life.

Mr. Vice Chancellor, Distinguished Ladies and Gentlemen, permit me to end my lecture with this song: I am grateful oh Lord, I am grateful oh Lord for all you have done for me, I am grateful, I am grateful oh Lord.

References

Adeloju S.B., Bond A.M. (1984). Evaluation of some dry ashing methods for anodic stripping voltametric determination of cadmium and lead in biological materials. Analytica Chimicia Acta, 16:303-314

Aderogba, M.A., Okoh E.K., Adelenwa T.A. and Obuotor E.M. (2004). Antioxidant Properties of the Nigerian *Piliostigma* Species. J. Biological Sci., 4; 501-503.

Afans'er I Signalling and Damaging Functions of Freer Radicals in Aging-Free Radical Theory. Aging & Disease 2010 1(2) 75-88

Akindahunsi A.A., Salawu S.O. (2005): Phytochemical screening and nutrient composition of selected tropical green leafy vegetables Afr. J. Biotechnol 6:499.

Akinrele LA, Cooke AS, and Holgate, RA (1962) The manufacture of gari from cassava Proceedings of the First international Congress of Food Technologists, London pp 633-644

Armbercht HJ, Wasserman RH and Bruns (1979). The effect of 1,25 dihydnoxyvitamin D on intestinal calcium absorption in strontium fed rats. Arch Biochem Biophys 192: 466-473

Armbrecht HJ (2010). Gross CJ and Zenester, TV. Effect of Dietary Calcium and phosphorus restriction on calcium and phosphorous balance in young and old rats. Arch Biochem Biophys 2010: 179-185.

Armbrecht HJ, Boltz MA, Christakos S and Bruns ME (1998). Capacity of 1,25 dihydroxy vitamin D to stimulate expression of vitamin D changes with age in the rats. Arch Biochem Biophys 352: 159-164

Awoh O.C and Egunlety, M (1985) Preparation of West African soft Cheese by Chemical treatment. J.Dainy Res. 52, 189.

Awoh O.C and Nakais (1986) Extraction of milk clothing enzyme from Sodom apple (*Calotropis procera*) Journal of Food Science, Vol.51, No. 6, pp 1569-1570

Awoh O.C, Adedeji B.A and Nwanekezi, EC 91987) Effect of partial substitution of cow's milk with soymilk on yield and Quality Attributes of West African Soft Cheese. International Journal of Food Science and Technology. 22, 135-138

Balkan J. et al (2001). Taurine has a protective effect against thio-acetamide – induced liver cirrhosis by decreasing oxidative stress. Human and Experimental toxicology, 20:251-254.

Bamin VV, Tsemakhovich VA, Shaklai N. Oxidation of Low-density lipoprotein by haemoglobin-hemichroine. The International Journal of Biochemistry and Cell Biology. 2003, 35(3) 349-358

Barja, G (2007). Mitochondria oxygen consumption and Reactive Oxygen species production are independently modulated: implications for aging studies. Rejuvenation Research 2007: 10 (2) 215-224.

Bataineh, H., M.H. Al-Hamood and A.M. Elbetieha, (1998). Assessment of aggression, sexual behavior and fertility in adult male rat following long-term ingestion of four industrial metals salts. Hum. Exp. Toxicol., 17:-570-579.

Bode, C and Bode J.C (1997). Alcohols Role in Gastro Intestinal Tract Disorders. Alcohol Health and Research World 21(1): 76-83

Boffetta P, Couto E, Wichmann J et al (2010). "Fruit and Vegetable Intake and overall cancer risk in the European prospective investigation into cancer and Nutrition. (EPIC. J. Natl Cancer Inst 102 (8): 529-537.

Brai, B.I.C., Odetola, A.A and Agomo, P.U (2007). Hypoglycemic and hypo cholesterol potential of per sea Americana leaf.J. Med. Food. 10:356-360.

19. Brownlee, M., (2001). Efficacy, safety, quality control, marketing and regulatory guidelines for herbal medicine (phototherapeutic agents). Braz.J. Med. Biol. Res., 33:179-189.

Castello L; Froio T, Cavallini G, Biasi F, Sapino A, Lionanrduzzi G, Calorie Restriction protects against age-related rat aorta sclerosis. FASEB – Journal: Official Publication of the Federation of America Societies for Experimental Biology 2005; 19(13) 1863-1865

Chatterjee S, Lardinois, O Bhatta charjee, S, Turker, J Corbett, J Deter dung, L oxidative stress induces protein and DNA radical for motion in follicular dendritic cells of the germinal centre and modulates its cells death patterns in late sepsis: Free radical Biology and Medicine, 2011; 50(8) 988-999.

Chen H, Cangello D, Benson S Foliner, J, Zhu H, Trush MA Age-related increase in mitochondria superoxide generation in the testoster – producing cells of Broom Norway rate testes relationship to reduced steroidogenic function? Experimental Geronotolog 2001, 36(8) 1361-1373

Chen, Y, Cai J, Jones DP, Murphy TJ. Mitochondrial thioteduxin in regulation of oxidation – induced cell death: Letters (2006); 580 (28-29) 6596-6602

Chen Y, Cai J, Murphy TJ, Jones DP. Over-expressed human mitochondrial thioredoxin confers resistance to oxidant – induced apoptosis in human osteosrcoma cells. Journal of Biological Chemistry 2002, 277(36); 33242-33248

Cignarella, A. M. Nastasi, E. Cavalli, and L. Puglisi, "Novel lipid-lowering properties of Vaccinium myrtillus L. leaves, a traditional antidiabetics treatment, in several models of rat dsylipidaemia; a comparison with ciprofibrate," *Thrombosis Research,* vol. 84, no. 5, pp. 311-322, 1996.

Dizdaroglu M, Jaruga P, Mechanism of free radical – induced damage to DNA. Free Radical Research. 2012: 46 (4) 382-419

Dizdaroglu, M Jaruga P. Mechanism of free radical-induced change to DNA.

Dovlo EE, Williams CE and Zoaka, L (1976) Cowpea: Home preparation and uses in West Africa. International Research & Development Council.

Droge W Free radicals in the physiological control of cell function. Physiological reviews, 2002: 82 (1) 47-95

Ebuehi O.A, Mekedi, AA and Osuno I.G (2002) Nutritive composition and consumers preference of soft drinks in Nigeria. Nigerian Food Journal. Vol. 20, (2002) pg. 36-40

Edijala, J.K. S.O. Asagba, G. E. Eriyamremu , and U. Atomatofa, "Comparative effects of garden egg fruit, oat and apple on serum lipid profile in rats fed high cholesterol diet," *Pakistan Journal of Nutrition,* vol. 4, pp. 245-249, 2005.

Edijala, JK and Asagba, (2005), Eri yamremu, GE and Atomaroufa (2005) "Comparative Effect of Garden egg, fruit, oat and apple on serum lipid profile in rats fed high cholesterol diet" Pakistan Journal of Nutrition, Vol. 4, 2005 pp 245-249

El-Demerdash, F.M., M.I. Yousef, F.S. Kedwany and H.H. Baghdadi, (2004). Role of á tocopherol and â carotene in ameliorating the fenvalerate induced changes in oxidative stress, hemotobiochemical parameters and semen quality of male rats. J. Environ.Sci.HealthBull., 39:443-459

FAO/WHO Expert Committee on Food Additives (1982) summary of evaluation performed by the Joint FAO/WHO Experts committee on Food Additives FAO/WHO phosphoric acid, FAO Nutrition Report series 38 (1).

Farnsworth, W. R. *Biodiversity,* National Academy Press, Washington, DC, USA, 1998.

Felig P.E, Ohaman, J.L. and Chall. G.F (1970). Plasma amino acid levels in diabetic ketaacidosis. Diabetes, 19:727-734.

Fields, S, Johnson, M (2005) Cell biology: Will model organizes scinces 307 (5717) 1885-1886.

Fontana, L, Partridge, L, Longo, V.D Extending Healthy Life Span – from Yeast to human Science 2010 (328) (5976) 321-326

Gandhipuram, P.S.K., Palanisamy, A., Durairaj, S.K and Sorimuthu, P.S. (2006). Anti diabetic activity of fruits of Terminalia chebula on streptozocin-induced diabetics rats. *J. Health Sci., 52:283-29*

Gruber J, Schaffer S, Hallwell B. The mitochondrial free radical theory of Aging – where do we stand? Frontons in Bioscience: a journal and virtual theory. 2008: 13: 6554-6579.

Grutzy RD, Schumacker PT, Oxygen sensing by mitochondria at complex III: the paradox of increased Reactive oxygen species during hypoxia. Experimental physiology. 2006 91 (5) 807-819

Guchow HN, Soboclaski KA and Barboriak JJ (1985). Alcohol consumption, nutrient intake and relative body weight among us Ame J, Clin. Nutr. 42 (2): 289-295.

Guo, C.H., Y.F. Lu and G.S.W. Hsu, (20050. The influence of aluminum exposure on male reproduction and offspring in mice. Environ. Toxicol. Pharmacol., 20: 135-141.

Guzy RD, Schumaker PT, Oxygen sensing by mitochondrial at complex III: The paradox of increased reactive oxygen species during hypoxia. Experimental physiology. 2006, 91(5): 807-819.

Halliwell, B. "Free Radicals and Antioxidants" updating a personal view Nutrition Reviews. 2012, 70(5) 257-265

Hamilton CA, Brosnan M.J, Mclntye M, Graham D, Dominiczak AF Superoxide excess in hypertension and aging: a common cause of endothelial dysfunction. Hyperten 2001; 37(2 part 2) 529-534

Hamitton C.A, Brosman M.J, Mcintyre M, Graham, D, Dominic Zak AF. "Superoxide excess in hypertension and Aging: A Common cause of endothehal dysfunction" Hypertension 2001: 37 (2 part 2) 529-534.

Hang, Y.D, and Jackson, H (1967). Preparation of Soybean Cheese using Lactistarter organizes General characteristics of the finished cheese Food Technology 21, 1033-1034

Harman, D (1956) "Aging: A theory based on free radical and radiation chemistry". Journal of Gerontology. 11 (3): 298-300.

Harman, D (1972) "A biologic clock: the mitochondria?". Journal of the America Geriatics society. 20 (4): 145-147.

Harman, D (2009). Origin and evolution of the free radical theory of aging: a brief personal history, 1954-2009. Biogerontology. 2009; 10(6) 773-781

Harman, D. Aging: a theory based on free radical and radiation chemistry J. Gerontol. 1956 (3) 298-300.

Heart Protection study collaborative Group (2002) MRC/BHF Heart Protection Study of Antioxidant Vitamin supplementation in 20, 356 high-risk individuals: a randomized place – controlled trial" Lancet 360 (9326), 23-33

Hekimi S, Lapointe, J, Wen, Y Taking a "good" look at free radicals in the aging process. Trends in cell biology 2011, 21(10) 569-576

IDF (2008) International Diary Federation Minerals in milk and milk products 118, 218 Norman NP (1973). Milk substitutes. Food science Third Edition pp. 389. Avi publishing company Inc. Westport, connection.

Ighodaro O.M., Omole J.O., Ebueni, O.A., and Salawu F.H. Aluminum-induced liver and testicular damage: Effects of Piliostigma thonningii Methanolic Leaf Extract Nigerian Quarterly Journal of Hospital Medicine 2012, Vol. 22 (3): 158-163

Ighodaro, M.O. and Omole, J.O. Ethanol-induced hepatoxicity in male Wistar rats: Effects of aqueous leaf extract of ocimun gratissimum. Journal of Medicine and Medical Sciences Vol.3(8) p. 499-505 (2012)

Ighodaro, M.O., Omole, J.O. Adejuwon, A.O., and Odunaiya, A.A. Effects of parineri polyandra seed extract on Blood Glucose Level and Biochemical indices in Wistar Rats. International journal of Diabetes Research 2012, 1(4): 68-72.

Ighodaro, M.O., Omole, J.O. and Fadipe S.O. Effects of piliostigma thoningii Ethyl Acetate Leaf Extract on Aluminum-cum Extract Treated Wistar Rats. Animal Research International (2012). 9(2). (Accepted for publication).

Ighodaro, O.M, Agunbiade, S.O, Omole, J.O and Kuti, A.O (20120. Evaluation of the chemical, nutrition, antimicrobial and antioxidant vitamin profiles of Piliostigma thonningii leaves (Nigerian species). Research Journal of Medicinal Plant .6 (7) 537-543.

Ighodaro, O.M, Mairiga, JP and Adeyi, O.A (2009) Reducing and Anti-proxidant profiles of flavonoids in ocimum gratissimum. Int-J. Chem. Sci. 2: 85-89

Ighodaro, O.M. and Omole, J.O. (2009), Modultaory effects of Chronic Ingestion on Hepatoxicity-Related Parameters in Male Rats. Animal Research International 6(3): 1049-1053

Ighodaro, O.M. and Omole, J.O. Effects of Cajanus Cajan Aqueous Leaf Extract on serum Amino Transferase, Alkaine phosphate and Electrolytes concentration of Normal Wistar Rats. Animal Research International (2010) 7(3) pg 1022-1026.

Ighodaro, O.M., Omole, J.O. and Umaifo, A.O. (2010). Effect of Chronic Ethanol Administration on Body Weight, Reduced Glutathione (GSH) Malondialdehyde (MDA) Levels and Glutathoine 5 Transferase Activity in rats New York Science Journal 3(4) page, 39-47.

Igohdaro, O.M. and Omole, J.O. Effect of Nigerian Piliostigma thoningii speicies Leaf Extract on Lipid profile in Wisfar rat. British Journal of Pharmacology and Toxicology. 1(2): 109-112, 2011.

Jacobson M. Yam C, Gao Q, Rincon-skinner T, Rivera A, Edwards J. Aging enhances pressure – induced arterial superoxide formation. American

Journal of physiology Heart and Circulatory physiology. 2007, 293(3) HI344-H350

Jang, YC, Remmen HV. The mitochondrial theory of Aging: Insight from transgenic and knockout house models Experimental Gerontology: 2009: 44 (4) 256-260

Jimoh F. O. and Oladiji, A. T. "Preliminary studies on Piliostigma thonningii seeds: proximate analysis, mineral composition and phytochemical screening," *African Journal of Biotechnology,* vol. 4, no. 12, 1439-1442, 2005.

Johnson KW and Snyder HE (1978). Soymilk: Comparison of processing methods on Yield and composition. Journal of Food Science, 43 349-353

Johnson KW and Synder H.E (1978) Soymilk: A comparison of process method on yield and composition of process method on yield and composition. Journal of food and Science 43, 349-353

Kloppel, H., A. Fliender and Kordel, W. (1997): Behvaior and endotoxicology of aluminum in soil and water. Review of the scientific literature. Chemosphere, 35:353-363.

Kowlczyk, E., Kopffl, A., Kedzioral, J., Blaszczyk, J., Kopffl, M., Neidworok, J. and Fijalkowski, P. (2004). Effect of long term aluminum chloride intoxication on selected biochemical parameters and oxidative antioxidative balance in experimental animals, Polish journal of environmental studies, 13(1): 41-43.

Lieber, CS (2003). Relationship between Nutrition, Alcohol use and Liver Disease. Alcohol Health and Research World: 27 (3): 220-231

Lindras, K.O (1995). Alcoholic liver disease: Pathobiological aspect: Journal Hepatology 23:7-15

Lione, A., (1985). Aluminum toxicity and the aluminum containing medication. J. APharmacol. Ther., 29: 255-285. Neuman, M.G. (2003): Cytokines- Central Factors in Alcoholic Liver Diseases. Alcoholic Research $ Health. 27(4) 307-316.

Liu Y, Zhao H, Li H, Kalyanara man B, Nicolosi A C, Gutterman DD. Mitochondrial sources of hydrogen peroxide generation play a key role in flow-mediated dilation in human coronary resistance arteries. Circulation research 2003: 93(6) 573-580.

Liu, J, Head E, Gharib AM Yuan W, Ingersoll RT, Hagen TM Cotman TW, Amos BN: Memory loss associated with brain mitochondrial decay and RNA/DNA Oxidation in old rats can be partially revised by feeding acetyl –L- lipoic carnitine and/or R- alpha acid Proc. Natt Acad. Sci. U.S.A 2001 (99)4 2356-61.

Lund DD, Chu Y, Miller JD, Heistad DD. Protective Effect of extracellular SOD on endothelial function during aging. American Journal of

Physiology. Heart and Circulatory physiology. 2009: 296 (6) HI 920 – H5

Macgilvery, R.W and Gerald MD (1979) Mineral element: Calcium, Phosphorous, Biochemistry, a functional approach pages 798-799. Publisher: W.B. Saunders company, London UK.

Magnus P, (1970). Cheese: Food Science and Technology. 3rd Edition pages 101-102 John murray Ltd, London.

Maher, J.J (1997) Exploiting alcohol effects on liver functions. Alcohol Health and Research World: 21(1): 5-12.

McDonough, KH (2003). Antioxidant nutrients and alcohol. Toxicology, 189: 89-97

Merry TL, McConell GK. Do reactive oxygen species regulate skeletal muscle glucose uptake during contraction? Exercise and sport sciences review 2012, 40 (2): 102-105

Micqurel J, Economics AC, Fleming J Mitochondrial role in cell aging. Exp Gerontol, 15 (1980) pp. 575-591

Miyazawa M, Ishii T, Yasuda K, Noda S, Onouchi H, Hartman Ps. The role of mitochondrial superoxide anion $O_2^{(-}$ on physiological aging in C5 7BL/ 6J Mice Journal of Radiation Research 2009: 50 (1) 73-83

Murray, T.M (2009). Heart Disease and high Blood pressure: American Living Magazine, 64-110 Van Esch et al (1957).

O'brien, K. "Complementary and alternative medicine: the move into mainstream health care," *Clinical and Experimental Optometry,* vol. 87, no. 2, pp. 110-120, 2004.

Odoemena, C.S and Akpabio, KE (1987) Accumulation of lead, cadmium and Sulphur in pasture grass growing along traffic highway and industrial layout in South East Nigeria. Nigerian Journal of Animal production 24(1): 70-73

Odunfa, S.A. (19830. Biochemical changes during production of ogiri, a fermented melon product (Citrullus vulgaris schrad) and plant food. Human Nutrition 32 11-18

Ogunsua, A.O (1980). Changes in some chemical cassava tubers. Food chemistry. 5:249-255.

Omole J.O, Ighodaro, O.M, Abiola Durosinlorun (2015). Fortification and Ogi with Whey: Effect on Body weight and Relative organ weigh in wistar rats (In press)

Omole J.O. (2003). Changes in the Ascorbic Acid Content of Some Tropical Fruits Fermented into Wine. Nigerian Food Journal VOL. 24, November 1 2006 pages 118-122.

Omole J.O. (2005). Effect of Peeling on the Physico-Chemical Property of Wine from Carrot. Nigerian Food Journal. Vol. 23, 2005, pages 261-264.

Omole J.O. and Ighodaro, O.M. (2012). Proximate composition and Quality Attributes of Milk Substitute From Melon Seds (Citrulus vulgaris Schrad) Reports and Opinion 2012, 4 (9) pp 75-78

Omole, J.O, Ighodaro, O.M. and Makunjuola, O.M. (2012). Proximate Composition of whey from South West Nigeria. Advances in Bioresearch Vol. 3, issue 1, pp 14-16

Omole, J.O. (2002). Studies on the Antioxidant Activity of some local spices from Nigeria Journal of Food Science and Technology, Vol. 39, pages 528-529.

Omole, J.O. (2003). Effect of papain on cooking time of cowpeas. Journal of Food Science Technology Vol. 40, pages 357-360.

Omole, J.O. (2003). Production and Evaluation of soft drink concentrate from Bixa seeds. The Nigerian journal of Technical Education (in press).

99. Omole, J.O. (2003). The Chemical Composition of cacsalpinia, pulcheriana, Journal of the Nigerian Society for Animal production, Vol. 30, page 15-19

Omole, J.O. (2010). Cadmuim and Lead Content of Unpacked Tapioca Exposed for Sale in Selected Markets in Lagos, South West, Nigeria. Journal of Natural Science Technology 2010 9(1): 79-83.

Omole, J.O. (2010). Effect of Lipase Activity of Bacillus Substillis on the Fatty Acid Composition of Fremented Melon Seeds (Citrullus vulgaris Schrad). International Journal of Physical Science, Vol. 6, No's 1, page 81-85.

Omole, J.O. and Ighodaro, M.O. Proximate composition and Quality Attributes of Milk substitute from Melon seeds (Citrulus vulgaris Schrad). Report and Opinion 2012, 4; (9) 75-78

Omole, J.O. and Ighodaro, O.M. (2008). Soft Drink Consumption Pattern in South West Nigerian: Calcium and Phosphorous Intake. International Journal of Environmental Sciences. Vol. 3, Nos. 1&2, pages 19-25. 2008

Omole, J.O. and Ighodaro, O.M. Effects of partial substitution of cow's milk with melon milk on yield, sensory attributes and Nutritional Quality of West African soft cheese. Food & Nutrition Science 2014, 2148-2153. Acceptance Notification ID 2700-6001.

Omole, J.O. and Oduse, E.A. a Proposed Relationship Between P^H and ascorbic acid content of fresh fruit juices of orange, grape, lemon and lime. Journal Vol. 23 2005 pages 256-260.

Omole, J.O. and Ogunbamise, O. (2009). Effect of Different Drying Temperatures on Viseosity of Dehydrated Okra (Hibiscus esculentus) Dispersal in water. International Journal of Physical Science, Vol. 4, No. 2 pages 103-106.

Omole, J.O. Ighodaro, O.M. and Makanjuola, O.M. (2011). Comparative Study of Garri Samples produced by Traditional Aerobic and Laboratory

Anaerobic Fermentation of Cassava Mash World Journal of Agricultural Science 6(6) 746-748.

Omole, J.O., and Ighodaro, O.M. Evaluation of the protein Quality of Melon (Citrulus vulgaris) milk. Food & Nutrition Science 488-493. 2014, 5, Acceptance Notification ID. 2700-6051

Omole, Ighodaro, Abiola and Durosinlorun, 2015. (Fortification of Ogi with Whey) (in Press).

Owoeye A.I., Caurie MC, Alligheny NN and Oyenuzii FN 1990. Chemical and physical Parameter affecting the viscosity of mixed okra and tomato homogenate. J. Sci of Food Agric. VOL. 53, 283-286

Oyenuga V.A. and Fetuga BL (1975). Some Aspects of the Biochemistry and Nutrition Value of the water melon seed. (Citrulus vulgaris Schrad). J. Sci Food Agric. 26: 843-846.

Patel RP, Cornwell T. Darley-Usmar VM. (1999). The biochemistry of Nitric oxide ad peroxynitrite: implication for mitochondria function: in parker L, cadenass E understanding the process of Aging: the role of mitochondria, free radicals and antioxidants. New York, N.Y Marcel Dekker pp 39-56.

Perera R.M, Bardessey N. Cancer: when antioxidants are bad. Nature 20: 475 (73540) 43-44

114. Perez, C., Canal, J. R., Campillo, J. E. A. Romero, and M. D. Torres, "Hypotriglyceridaemic activity of Fiscus caarica leaves in experimental Hypertriglycerideamic rats", Phytotherapy Research, vol. 13, pp. 188-191, 1999.

Sandstorm ME, Zhang S-J, Bruton J, et al. Role of Reactive oxygen species in contraction – mediated glucose transport in mouse skeletal muscle. Journal of physiology (2006), 575 (1) 251-262

Sasaki T, Unno K, Tahara S, et al Age –related increase of superoxide generation in the brain of mammals and birds. Aging cell 2008, 7 (4) 159-169.

Satzger, RD, Charles, SC, Evelyn, B and Fred, LF (1982). Determination of background level of lead and cadmium in raw agricultural crops by using different pulse anodic stripping voltammetry. J.Association of Analy Chem., 65(4): 987-990

Sawada, M, Carlson, J.C Changes in superoxide radical and lipid peroxide formation in the brain, heart and liver during the life time of the rat. Mechanisms of Aging and Development (1987): 41(1-2) 125-137.

Shar MH, Baylink DJ, Krisknarao, WG and Drapper HH (1967). The relationship of calcium and phosphorous nutrition during adult life and osteoporosis in aged mice. J. NUTR. 92: 30-42 W.B. Saunders company, London, Phosphorous Recommended Dietary Allowance pg 115

Sharma, P. and Mishra, K. (2006). Amelioration of fumonisin B1 hepatotoxicity in mice by depletion of T cells with anti-Thy-1.2. Reprod. Toxicol., 21: 313-321.

Sienskiew T and Riedel CL (1990) Whey and whey utilization. Mann. Galssen-kirchen-Buer, Germany. Second Ed. P379 Veriag Th.

Smith Sc (2004) Heart Diseases prevention must get more attention. World Health Federation, Circulation, 2004

Smith, S.C, Heart Diseases Prevention Must Get More Attention, World Health Federation, Circulation, 2004.

Speakman, JR, Selinan, C. The free radical change theory: "Accumulating evidence against a simple link of oxidative stress to aging and life span" (2011).

Stanbury, PF and Whitaker, A (1989). An introduction to fermentation processes. Pg 1. Principle of Fermentation Technology pergamon press Oxford, U.K. Fourth Edition.

Stephen, GC, Raymond, JG and Elizabeth M. (1982). Determination of lead and cadmium collaborature study. J.Assoc. Analy. Chem 65(4): 978-985

The Alpha-Tocopherol, Beta-Carotene Cancer Prevention Study Group (1994). "The Effect of Vitamin E and beta carotene on the incidence of lung cancer and other cancers in male smokers" New England Journal of Medicine 330 (15): 1029-1035

Tsukamoto, H and Lu SS (2001). Current concept in the pathogenesis of alcoholic liver injury. The FASEB J. 15: 1335-1349

Tuma DJ, Cassay, CA (2003. Dangerous Bipro duets of alcohol breakdown: focus on addict. Alcohol Health & Research World. 27 (4); 285-290

Tsai J-H, Chen H-W, Chen Y-W, Lui J-Y, Lii C-K, The protection of hepatocyte cells from the effects of oxidative stress by treatment with vitamin E. journal of Biomedicine and Biotechnology. 2010: 7 pages 486267

Ungvari, Z, Parrado–Fernandez C; Csiszar A, de Cabo, R. Mechanisms underlying calorie restriction and lifespan regulation: implications for vascular aging. Circulation Research 2008; 102 (5) 519-528.

Uzun, H et al (2005). Potential effects of L-NAME on alcohol-induced oxidative stress. World Gastroentology 11 (4): 600-604

Vermaulen NPE, Bessems, JG and Van De Straat R. (1992). Molecular Aspects of Paracetamol – induced hepatotoxicity and its mechanism-based prevention. 407 Drug Metabolism Review. 24:367-407

Virella-Lopes, M.F, and Virella, G. (2003). The role of immune and inflammatory processes in the development of macro vascular disease in diabetes. From. Biosci.8:750-768.

Vongtua, H.O., Abbah J., Ngazal, I.E., Kunle, O.F., Chindo, B.A and Otsapa, P.B. (2004). Anti-nociceptive and anti-inflam matory activities of the methanolic extract of *Parinari polyandra stembark in rats and mice. J. Ethnopharmacol.,* 90: 115-121.

Weindruch R- "Calorie Restriction and Aging" Scientific America; 49-52 (1996).

WHO (1973). Technical Report Service No. 532, Elements in Human Nutrition Report of World Health Expert Committee.

WHO, (2002). WHO news: Traditional medicine strategy launched. Bull. World Health Organization, 80: 610-610.

WHO/IAEA (1989). Minor and Trace element in breast milk.

Wild, S.G, Roglic, A..., Green, R., Sicree and King, H (2004). Global prevalence of diabetes: Estimates for the year 2000 and projections for 2030. *Diabetes Care* 27: 1047-1053.

Woodroof, JO and Shellur E (1958). Okra for processing. Georgia Ar. Expt. Station Bull 56 pg 5

Wu, D and Cederbaum AI (2003). Alcohol oxidative stress and free radical damage. Alcohol Res. Health 27(4): 277-284

Wardlaw and Smith, (2007). Forms of Fibres: Contemporary Nutrition. pp. 115, Updated 6th Edition Mc Graw Hill International Edition

Yaryura- Tobias, J.A., Pinto, A. and Neziroghu, F. (2001). Anorexia nervosa, diabetes mellitus, brain atrophy and fatty liver. *Int. J. Eating Disorders,30:350-353.*

Youse, M.I., K.I. Kamel, M.I. El-Guendi and F.M. El-Demerdash, (2007). An in vitro study on reproductive toxicity of aluminum chloride on rabbit sperm: the protective role of some antioxidants Toxicology, 239: 213-223, DOI: 10.1016/j.tox.2007.07.011.

Yousef, M.I., 2004. Aluminum-induced changes in hematobiochemical parameters, lipid peroxidation and enzyme activities of male rabbits: Protective role of ascorbic acid. Toxicology, 199:47-57.