UNIVERSITY OF ILORIN

THE TWO HUNDRED AND ELEVENTH (211TH)
INAUGURAL LECTURE

"THE BALM IN YOUR BACKYARD: USE IT FOR YOUR HEALTH BENEFIT"

BY

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Courtesies
The Vice-Chancellor Sir,
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All Members of the Academic Staff
All members of Administrative and Technical Staff
Esteemed Invited Guests,
Gentlemen of the Fourth Estate of the Realm,
My Lord, Spiritual and Temporal,
Friends and Relations,
Greatest Unilorites,
Distinguished Ladies and Gentlemen.

Preamble

It is with a heart full of gratitude to God, my creator, life-giver, and sustainer that I present this inaugural lecture. I am humbled and elated that a day like this has come to reality for me in my life and academic sojourn. To my Lord and Saviour, Jesus Christ, be all the glory, honour and adoration forever and ever, amen. I am grateful to you, Mr. Vice Chancellor, and the University for giving me the privilege to present some of my academic and professional achievements to this audience. Today's presentation is the 211thinaugural lecture of the University of Ilorin. The Department of Physiology was initially conjoined with Biochemistry. From these marriage of inconvenience, this inaugural lecture is the 3rd but since

physiology became a full-fledged department in 2006, this is the second. Professor Clement Olatunbosun Bewaji presented the 64th inaugural lecture on the 27th of February, 2003, titled, The Sickle Cell Membrane: Tip of The Iceberg' while Professor Ayodele Olufemi Soladoye presented the 104th inaugural lecture on the 12th of April, 2012 titled, Physiology of the Human Heart and Blood Pressure: The Survival Game. In addition, this inaugural lecture is the first to be presented from the Physiology Department by an alumnus of this University.

Mr. Vice-Chancellor Sir, no one is born solely for one purpose. In my early secondary school days, I was fond of science, I added liquid substances such as water and detergent to bones that I could not crack believing that this will cause some reactions in the bones and soften them. I considered this as one of my amateur scientific experiments. I have now built on my passion and today I am a physiologist and neuroscientist. I was fortunate to be born by a teacher (mother) and healthcare giver (father) who knows the values of education. My father was particularly keen on the education of his children and relatives, he was prepared to spend his last dime to see that we have quality and affordable education. I have also been fortunate to meet caring teachers right from my Primary School days. These teachers saw far ahead of me and were kind and considerate to extend their loving arms to me.

I was introduced to Physiology by one of my mentors (Professor Boaz A. Adegboro) even when many people do not understand what the course stands for. I needed further explanation from another mentor and supervisor (Prof. Ayodele Olufemi Soladoye) before I finally settled down to apply for the programme which was newly floated by the University. I was eventually admitted to the programme and this started my sojourn in this relatively unknown path. As I journeyed through physiology, I derive joy in the quotations in one of Nobel Laureate Roberts Edwards book:

> *'…Two roads diverged in a wood, and I— I took the one less traveled by, And that has made all the difference.'*

which was originally extracted from a poem written by Robert Frost in 1916 (Frost *et al*, 1991). It is little me but the bigger holy spirit, that resides in me.

Introduction

Physiology in simple language is the study of normal body functions. However, professionally, **Physiology is the science of life. It is the branch of biology that aims to understand the mechanisms of living things, from the basis of cell function at the ionic and molecular level to the integrated behaviour of the whole body and the influence of the external environment (TPS, 2020).** The word physiology was derived from the Greek words '*physis*' (nature), and '*logos*' (study) i.e. the study of biological functions. Breaking this down, it can be said that physiology is the study of how living organisms work.

Physiology can be divided into cellular physiology, plant physiology, animal physiology, comparative physiology, and Medical or human physiology (Hall, 2011). Human physiology is the study of how the human body functions, with emphasis on specific cause-and-effect mechanisms. The discipline involves the study of individual molecules as well as complex processes that depend on the interplay of many widely separated organs in the body. We seek an explanation of why, and how we perform our basic functions as humans. We also investigate and provide information about where biological activities take place in our bodies and what is the drive for the activities.

Historical perspectives on Physiology

Mr. Vice Chancellor Sir, Human physiology has been traditionally studied within the medical discipline. This has provided tremendous assistance to the understanding of human functions, and ultimately the treatment of ailments which in most instances are perturbations in the dynamic constancy of the nature of man and animals. The maintenance of this dynamic constancy is basically referred to as ‘homeostasis’ while the

medium regulated is the internal environment (interior milieu). The contributions of Hippocrates, Galen, Bernard, and Cannon laid the solid foundation for the emergence of physiology as an experimental discipline and lead to the evolution of the modern-day Physiology which is now more in-depth, reaching cellular and molecular levels (West, 2014; Ranhel and Mesquita, 2016).

The importance of physiology to medicine can not be overemphasized, it has been described as the ground floor and foundation seal for the practice of medicine (Figure 1). No wonder, Alfred Nobel in 1895 named the highest prize in the fields of life sciences and medicine as a Prize in 'Medicine or Physiology'

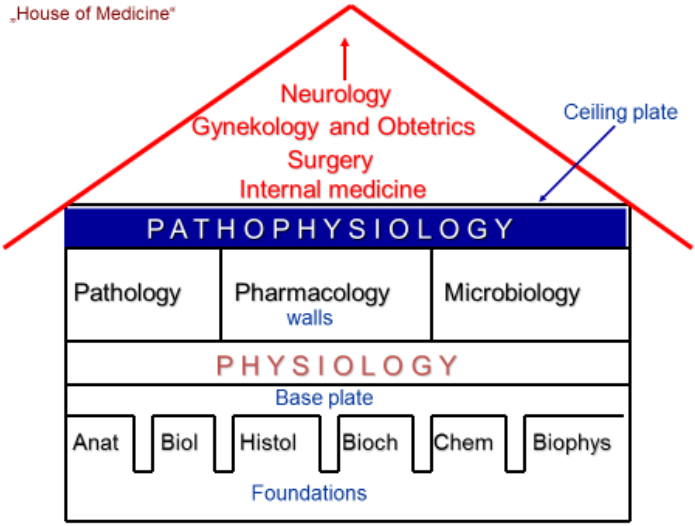


Figure 1. The importance of various disciplines (especially physiology) to medical practice, (Hanacek, 2012)

Most of the advances in medical practice worldwide and here in Nigeria are based on a continuous day to day investigations and results coming out of the laboratories of physiologists and other basic scientists especially now that physiology knows no border. There are relentless collaborations

among several groups of researchers to advance our knowledge of what keeps us normal, whether we are on Everest, the deepest of the Oceans, anywhere on Earth, in the Moon, and hopefully in the Mars.

Physiology could be subdivided into several sub-disciplines. However, the major sub-disciplines are:
Altitude Physiology;
Cellular Physiology;
Blood Physiology;
Endocrine Physiology;
Exercise Physiology;
Deep-sea Physiology;
Respiratory Physiology;
Cardiovascular Physiology;
Renal Physiology;
Reproductive Physiology;
Gastrointestinal Physiology; and
Neurophysiology among others

Neurophysiology is the path that I have chosen. Neurophysiology is a branch of physiology that studies the brain, nerves, and their functions. It is generally situated within another large discipline now called Neuroscience. Neuroscience embodies all disciplines studying the nervous system in health and illness. It pulls memberships from departments across several disciplines such as Medicine, Science, Engineering, and even Arts.

Neuroscience illuminates us about the functions of the nervous system, the mechanisms underlying neurological diseases, the steps to take to prevent these disorders. It also advocates through several means including outreaches for awareness of brain health and the need to invest heavily in researches based on Neuroscience. The study of neuroscience can be subdivided into many parts such as Behavioural, Cognitive, Motor, Sensory, Developmental, Molecular and

Cellular, Neurophysiology, and Clinical Neuroscience. Within the sensory system, Pain is a key component.

What is Pain? According to the International Society for the Study of Pain (IASP), Pain is an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (IASP, 2020). Pain is the single most important experience that drives patients to their healthcare provider (Bonica, 1959, Oniyide and Owoyele*et al*, 2018). About 99% of people would have experienced pain in their lives. Mild pain serves as a protective mechanism for the body to respond to the presence of noxious agents within the body. It thus serves as a warning system of the body, this it does together with inflammation and fever. Inflammation could be the sole cause of pain. These three are related to each other especially through the established cardinal signs of inflammation which were established largely by Aulus Cornelius Celsus. The cardinal signs of inflammation are *rubor* (redness), *calor* (increased heat), *tumor* (swelling), *dolor* (pain), and *functio laesa* (loss of function), known as vital signs of inflammation (Punchard *et al*, 2004).

Mr. Vice Chancellor Sir, the designer of the human body and generally, mammals ensured that the warning systems are in place but religiously, it is believed that pain (and suffering) started from sin against God. However, when pain and its treatment is discussed, the focus is usually on the scientific aspect. Individuals without pain sensors (nociceptors) tend to suffer many undetected injuries and their qualities of life may suffer for it.

Physiology of Pain

Causes of pain include; mechanical (e.g. sharp cuts), electrical (e.g. electric shocks), chemicals (e.g. acids), and thermal (e.g. heat) stimuli. Diseases such as cancers, digestive problems, inflammatory problems cause pain by one or combinations of these stimuli. Suffice to say that natural parturition (birthing process) comes with its own measure of

strong pain yet this is a normal physiological process. There are instances in which the pains are just unexplainable, hence, the insertion of 'described in such terms" within the standard definition of pain. The IASP has proposed a new definition of pain with an explanatory note to say, 'person's report of an experience as pain should be accepted as such and respected. Every effort must be made to alleviate every reported pain. The choice of treatment might even be a placebo or counseling.

Pain is transmitted by sensory receptors which convert algogenic (pain generating) stimulus into action potentials and impulse transmission in small-diameter fibres known as A-delta and C-fibres. With the transmission in these fibres the pain to be felt is already being selectively processed. This is because fast pain is conveyed by A-delta fibre while slow pain is conveyed by C-multimodal fibre. These fibres relay pain from the body to the spinal cord and from spinal cord second-order neurons relay the impulses to the thalamus where another set of neurons relay the information to the cerebral cortex (somatosensory cortex). Pain from internal organs follow slightly different pathways in peripheral but ultimately are transmitted by the same set of fibres within the spinal cord conveying pain from somatic parts of the body (Figure 2.).

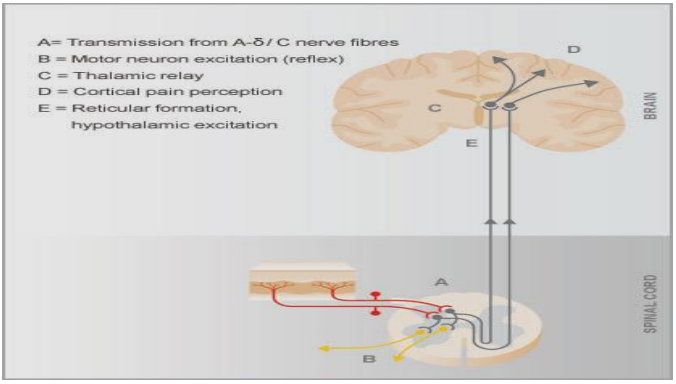


Figure 2: Pain transmission from the peripheral parts of the body to the brain (Grünenthal, 2020)

Inflammation

Inflammation is the reaction of blood vessels leading to the accumulation of fluid in extravascular tissues (Kumar *et al*, 2005, Owoyele, 2007). It gradually starts with the activation of specialized cells. Once the presence of foreign agents such as bacterial, and strange molecules are detected the body's defense mechanism which includes the anti-inflammatory processes are activated. Several chemical mediators of inflammation are released (e.g. Cytokines, Histamine, Nitric Oxide, Serotonin, and prostaglandins) (Galvão *et al*, 2018) and the cellular components move into action in order to destroy the foreign agents and resolve the inflammation created.

Inflammation could be acute or systemic. It may also be localized to the central nervous system (Neuroinflammation). Many of the organs of the body could be selectively affected and for this reason, inflammation in one organ may ultimately affect the other.

Within the brain, there could be inflammation when the resident defensive (microglial and astrocytes) cells become activated and have cross-talk with the immune regulating system (cells). These ultimately lead to neuroinflammation. Neuroinflammation underlies the development of several neurodegenerative diseases such as Alzheimer's disease, Amyolateral Sclerosis, Parkinson's disease, and others.

Fever

The American College of Critical Care Medicine, the International Statistical Classification of Diseases and the Infectious Diseases Society of America define fever as a core temperature of 38.3 °C or higher (Walter *et al*, 2016). The temperature elevation may be due to internal or external factors. In this part of the World, the commonest fever experienced malaria fever that is caused by the plasmodium parasite. Fever is mainly caused by pyrogens which are toxic substances produced within (endogenous) and outside (exogenous) the body. In some cases, fever may also result from

non-pyrogenic causes within the body. Pyrogens like lipopolysaccharides and Brewer's yeast which are bacterial products are used for inducing fever in the laboratory. Fever increased the set points of the thermoregulatory mechanism in the hypothalamus of the brain and make it operate at a higher level of temperature. Fever sometimes serves as a warning system for the body to alert the body to the presence of foreign aliens in the body that has hijacked our temperature regulatory mechanism.

Relationship between Pain, Inflammation, and Fever

Pain, Inflammation, and Fever sometimes employ the same pathway to bring about their various effects. The commonest one is through the production of prostaglandins E2 which could sensitize pain endings, mediate inflammation, and trigger febrile responses. They can often be treated with the same drugs. An example is aspirin and other related drugs commonly known as the Non Steroidal Anti-inflammatory Drugs (NSAIDs) Simmons *et al*, (2000). As good as the NSAIDS are in the treatment of inflammatory pain, in particular, they also have side effects. One of their common side effects is the formation of gastrointestinal ulcers.

Gastrointestinal Ulcers

Gastrointestinal ulcers are mucosal excoriations found in the stomach and duodenum. They are produced by imbalances between the gastric defensive and offensive systems. The wall of the digestive system is protected by a thick mucosal wall and mucus. The offensive agents include the acid (hydrochloric acid) and enzymes. In addition, biological factors such as infection with a bacterium (*H. Pylori*) also, cause ulcers. Aspirin and other NSAIDs prevent the formation of cyclooxygenase 2 and therefore, inhibit pain, inflammation as well as fever (Vane and Botting, 1997). But cyclooxygenase 2 is protective in the digestive system. Therefore, the use of these drugs on an empty stomach could lead to ulcer formation. Prolong use of the drugs

can also lead to an ulcer. Ulcer models are used in the laboratory to investigate whether a drug that has shown promise as pain or inflammation and/or fever inhibitor operate like the NSAIDs.
Mr. Vice Chancellor Sir, my work has primarily focused on understanding the different warning systems and how to mitigate the chronic states which are not beneficial but inflicting untold sufferings on people.

The Balm
In the bible, God asked

> ***'Is there no balm in Gilead; is there no physician there? Why then is not the health of my daughters recovered*?'** **Jeremiah 8: 22**

Balm refers to any of various oily, fragrant, resinous substances, often of medicinal value, exuding from certain plants, especially tropical trees of the genus *Commiphora* (Dictionary.com, 2020). Specifically, the bible (Jeremiah, 8:22, 46:11) wrote about the 'balm of Gilead' (*Commiphora gileadensis*) which is a rare perfume that is used medicinally (Figure 3). The balm of Gilead was so named because it was specifically found in a region called Gilead in the old testament era. It is also referred to as the 'Balm of Mecca' being also found in the region of Mecca in Saudi Arabia. According to an old but preserved record (Wildenow, 1799), this balm is an important and widely celebrated medicine in biblical times. No wonder God had to ask His people why their health was not recovered despite the abundance of the balm from Gilead. The Bible also specifically mentioned the use of the plant for treatment of pain (Jeremiah 51:8). Balm was an important object of trade (Ezekiel, 27:7) and a precious gift item in the Bible (Gen. 43: 11). Indeed, balm from Balm of Gilead stands as one of the most important multi-purpose perfume and medicine among the recently classified 45 plant species known as medicinal plants of the Bible (Dafni and Böck, 2019).

Figure 3. *Commiphora gileadensis* leaves and fruits. Photo taken in Ein Gedi's botanical gardens. (Amiel *et al*, 2012)

Although many Bible scholars will agree that the expression in Jeremiah 8: 22 that '**Is there no balm in Gilead; is there no physician there? Why then is not the health of my daughters recovered**' is an indictment of the tribe of Judah on why they have a healing God but would not turn to Him for a cure. God used a plant (Balm of Gilead) with quality medicinal properties to demonstrate His healing ability.

The balm of Gilead does not grow in tropical Africa, as a result, I have not personally carried out any research on the medicinal effects of the plant. However, if God provided this powerful healing herb and others for His Children, is it only in Palestine or Arabia that we have the balmy substances? No, I have made several kinds of research to identify and authenticate the medicinal properties of many of our indigenous balms. Many of which are at our backyards.

My contributions to knowledge

Mr. Vice-Chancellor Sir, in my more than two decades of employment as an academic staff involved in research and training, I have made some modest contributions to knowledge that I will like to share accordingly.

Cardiovascular regulations

My first experience of research was during my undergraduate years at this' better by far' university, it was volunteering as a subject in cardiovascular research being conducted by Prof. Ayodele O. Soladoye. I later became his supervisee at my final year and was assigned the task of investigating some of the cardiovascular regulatory mechanisms. I investigated the effect of stimulating the baroreceptors using the Valsalva maneuver on the blood pressure and heart rate during muscular exercise. We found that stimulating the baroreceptors in young adult male and female subjects led to a decrease in systolic and diastolic blood pressures as well as the heart rate. The fall was noticed at rest and more pronounced during maximal exercise. The magnitude of the responses of the heart rate was higher than those of the blood pressures (Soladoye, Owoyele *et al*, 1999; 2000). The responses (Table 1.) were also observed to be age-dependent with very young adults showing better responses than the older adults (Soladoye, Owoyele *et al*, 2000). In a separate study, we also observed that Baroreceptor sensitivity varies cyclically in line with the phases of the menstrual cycle in female subjects aged between 20 and 30 years (Table 2). This shows that the blood pressure profile and heart rate follow the pattern of the menstrual cycle (Soladoye, Owoyele *et al*, 2002) with the response to baroreceptors stimulation being strongest in the menstrual phase (Table 2).

Table 1. Effects of age on heart rate responses among subjects aged 20-29 and 30-39 years

Age	% Change at Rest		% Change at SME		% Change at ME	
Group	20 – 29 (A)	30 – 39 (B)	20 – 29 (A)	30 – 39 (B)	20 – 29 (A)	30 – 39 (B)
Mean	8.2	6.7	14.5	8.0	18.5	7.7
SD	5.3	1.7	4.8	3.8	7.1	1.8
SE	1.1	0.5	1.3	1.2	1.4	0.5
n	25	11	14	11	25	11
P	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	A Vs B = p > 0.2		A Vs B = p > 0.45		A Vs B = p > 0.01	

SME = Submaximal exercise; ME = Maximal exercise

A vs B = A compared with B;p = Level of statistical significance

Table 2. Blood Pressure and heart rate responses to baroreceptor stimulation during menstrual cycle.

A. Systolic Blood pressure

Days of Cycle	A 1st or 2nd Day	B 14th Day	C 21st Day
Control	109 ± 0.6	115.6 ± 0.7	106.0 ± 0.6
BS	105 ± 0.5	114.5 ± 0.9	107.1 ± 2.1
% Change	3.6 ± 0.2	1.38 ± 0.6	3.08 ± 0.6
P	< 0.001	< 0.05	< 0.001
A Vs B = p < 0.001	B Vs C = p < 0.01	A Vs C = p < 0.2	

BS = Baroreceptor Stimulation; p = Level of statistical significance

B. Diastolic blood pressure

Days of Cycle	A 1st or 2nd Day	B 14th Day	C 21st Day
Control	76.8 ± 0.8	74.4 ± 1.51	71.3 ± 0.6
BS	72.2 ± 0.8	75.9 ± 0.9	71.5 ± 1.5
% Change	4.5 ± 0.5	1.1 ± 1.0	3.2 ± 1.4
P	< 0.001	< 0.2	< 0.05
A Vs C = p > 0.1			

BS = Baroreceptor Stimulation; p = Level of statistical significance

C. Heart rate

Days of Cycle	A 1st or 2nd Day	B 14th Day	C 21st Day
Control	66.1 ± 0.4	71.3 ± 0.6	65.3 ± 1.3
BS	61.3 ± 0.4	70.8 ± 0.8	62.4 ± 0.6
% Change	7.3 ± 0.4	0.5 ± 1.0	5.4 ± 0.5
P	< 0.001	> 0.6	< 0.001
A Vs C = p < 0.05			

BS = Baroreceptor Stimulation; p = Level of statistical significance

Understanding pain variability in the Nigerian population

Pain is one of the primary sensations of the body. However, unlike other sensations, pain serves warning and protective functions. It also becomes a disease when it is chronic and aggravated. The nature of the pain varies based on gender, genetic, ethnicity, and many other factors. I sought to understand how four main ethnic groups in Nigeria perceive pain. I also studied the effects of occupation and pathological conditions on members of the society.

We observed that responses to painful stimuli is dependent on the type of noxious stimuli applied and on the ethnicity. In a model of Ischaemic pain (akin to pain from muscle cramps and injuries), The Fulani group had the highest threshold for, and highest tolerance to pain (that is, they didn't easily feel the pain, and they endured the pain longest) (Table 3a). In the negative heat (cold) induced pain, only the Igbo group had a distinct higher threshold and tolerance while other tribes did not show any difference among each other (Table 3b.). When double stimuli (Ischaemia and Cold) were jointly applied to each subject, there were no significant differences in the thresholds required for eliciting pain in all the four tribes. However, the Igbo group had the highest tolerance to the doubly inflicted pain followed by the Fulani, the Yoruba and Hausa groups (Table 3c.) (Oniyide, Owoyele *et al*, 2018).

In another study looking at how diseases like diabetic neuropathy and osteoarthritis affects the integrity of the pain sensory system, we observed that neuropathic (DBN) and Osteoarthritic (OA) patients easily feels pain and lacks the ability to endure the applied pain compared with healthy people (Akintoye, Owoyele *et al*, 2018; 2019).

In attempts to understand the mechanisms underlying the variabilities observed in various populations, we quantified the serum levels of pain and inflammatory mediators. The results for ethnicity study showed that concentrations of endorphins were highest in Yoruba (82.40±4.82 pg/ml) and lowest in Fulani (48.80±2.22 pg/ml) groups, it decreased in all the groups during the cold and ischaemic pain tests (Oniyide, Owoyele *et al*, 2018), and as well as in shift workers (Owoyele *et al*, 2017). Anti-inflammatory cytokines, interleukins 6 and 10 were significantly elevated in OA patients but only interleukin 6 was elevated in DBN patients (Akintoye, Owoyele *et al*, 2018). Calcitonin gene-related peptide was reduced in DBN patients but the blood level was not significantly altered in OA patients (Akintoye, Owoyele *et al*, 2018; Owoyele *et al*, 2019).

Table 3. Effects of ethnicity on pain threshold and tolerance
A. pain threshold (s) and tolerance (s) during cold-induced pain test

Groups	Fulani	Hausa	Igbo	Yoruba
Threshold	63.31±13.12	53.30±10.08	31.80±0.92^{a,b,c}	37.42±2.01
Tolerance	106.12±12.22	101.01±10.26	86.80±15.55	75.20±12.28

Data are expressed as mean ±S.E.M. n=10. Data were analysed by one-way ANOVA followed by Duncan post hoc test. (a,b,c $p<0.05$ relative to Fulani, Hausa and Yoruba respectively).

B. pain threshold (s) and tolerance (s) during ischemia-induced pain test

Groups	Fulani	Hausa	Igbo	Yoruba
Threshold	28.40±1.03	30.82±2.00	35.90±1.02^{a,b,c}	23.42±2.20
Tolerance	42.10±5.25	43.81±2.80	76.53±8.50^{a,b,c}	39.90±3.18

Data are expressed as mean±S.E.M. n=10. Data were analysed by one-way ANOVA followed by Duncan post hoc test. (a,b,c $p<0.05$ relative to Fulani, Hausa and Yoruba respectively).

C. pain threshold(s) and tolerance(s) during cold+ischemia-induced pain test

Groups	Fulani	Hausa	Igbo	Yoruba
Threshold	40.70±5.12	37.40±4.05	39.31±5.00	31.20±3.82
Tolerance	90.10±6.21	56.30±5.18^{a}	160.53±6.30^{a,b,c}	72.60±3.82^{a,b}

Data are expressed as mean±S.E.M. n=10. Data were analysed by one-way ANOVA followed by Duncan post hoc test. (a,b,c $p<0.05$ relative to Fulani, Hausa and Yoruba respectively).

We investigated the effects of sleep deprivation especially as it affects shift workers on pain perception in Ilorin (Owoyele *et al*, 2017). Our results showed that shift workers easily perceives ischaemia induced pain and could not endure the pain compared with non-shift workers. (Figure 4a). However, the shift workers tolerated the cold-induced pain more than the non-shift workers which is expected because during the night shifts they are exposed to the coldness of the nights and prior

exposure to cold serves as a form of analgesia (Figure 4b). This prior analgesic effect from an ordinary cold exposure may also underlie why the Igbo group had a higher tolerance to cold-induced pain.

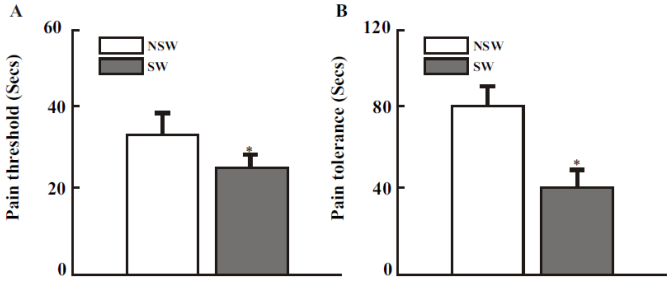


Figure 4a. Effect of sleep deprivation on ischemia-induced pain threshold (a) and tolerance (b).
*P<0.05 vs NSW (Non-shift workers); SW (Shift workers).

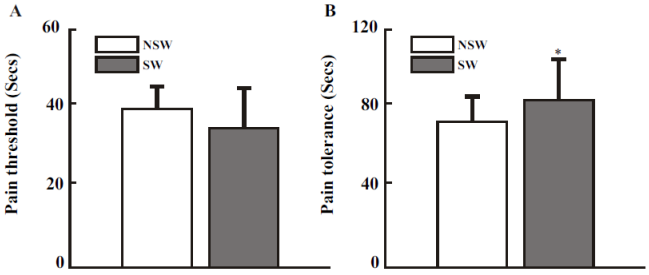


Figure 4b. Effect of sleep deprivation on cold-induced pain threshold (a) and tolerance (b).
. *P<0.05 vs NSW (Non-shift workers); SW (Shift workers).

since sleep deprivation is fast becoming a global problem because of modern-day activities that requires sleeping late and waking early, we further conducted experiments on rodents to understand the effects of sleep-deprivation on experimentally induced-neuropathic pain perception and memory consolidation. We observed that 72 hours of sleep deprivation reduced pain perception by decreasing the production of prostaglandin E_2 as

well as reactive oxygen species, and increasing the levels of antioxidant enzymes (Owoyele and Salaudeen, 2015). This sleep deprivation-induced analgesia is also partly achieved by the facilitation of muscarinic cholinergic pathways as atropine reversed the analgesia (Owoyele and Salaudeen, 2017). We also observed that sleep deprivation impaired memory in Wistar rats. The memory loss was prevented by prior administration of bicuculline- a GABA A receptor antagonist but not by phaclofen (GABA B receptor antagonist) or baclofen (GABA B receptor agonist). In essence, this shows that sleep deprivation produces its memory loss effect by facilitating the GABA A receptors (Owoyele *et al*, 2018). Sleep deprivation increased protein kinase activity but this seems to be in response to the increased in the activity in the type of sleep deprivation-induced which was the rapid eye movement sleep deprivation.

The indigenous natural balms and their derivatives

Most of my research activities have been focused on the investigation of the abundant natural products in our immediate environments. I have investigated the effects of many micronutrients, phytochemicals and other substances on body functions with a view to finding therapeutic windows for pain, inflammation and other neuroinflammatory conditions.

Honey

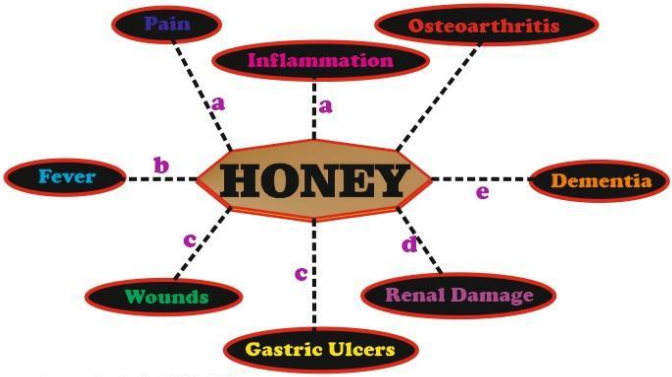
Honey is a natural sweet substance produced by *Apis mellifera* bees from nectars of plants or from secretions of living parts of plants, which the bees collect, transform by combining with specific substances of their own, deposit, dehydrate, store and store and leave in honeycombs to ripen and mature (European Union Directive, 2002; Owoyele *et al*, 2011). Honey has been used from time immemorial as food and treatment for common ailments such as dressing of wounds and ulcers. It has also been shown that the healing effects of honey is dependent on the type of honey. Honey has varying components based on which plant nectar bees make the honey from as well as the geographical origin, climate, environmental conditions and the

beekeeper (Owoyele and Oladeinde, 2014). Therefore, some of the bioactive nutrients in honey are dependent on the influence of these factors in the nectars (Owoyele and Oladeinde, 2014).

Internationally, the highly valuable kinds of honey (in terms of medicinal values) include the Manuka, Clover, Buckwheat, Acacia, Eucalyptus and Alfalfa honey. In Nigeria, it is a bit difficult to find original honey but I was happy about a decade ago when the university set up an apiary for the production of honey. This afforded me the opportunity of using original honey and to promote our locally harvested and processed honey (Unilorin Honey, fig 5a). I must appreciate the efforts of Dr. Tella, who has been doing a good job at the university. I have been using this Unilorin honey to treat rodents after inducing disease models such as dementia, renal damage, gastric ulcers, wounds, fever, pain, and inflammation as well as osteoarthritis. Unilorin honey has the capacity to reduce neurobehavioural deficits in an animal model of dementia (Abdulmajeed…Owoyele, 2016), it also reduces the damages to the nephrons of the kidney and restored filtration function by improving the antioxidant activities within the kidneys (Abdulmajeed, Owoyele *et al*, 2017). Unilorin honey, like other notable kinds of honey, demonstrated analgesic and anti-inflammatory effects by reducing tissue nitric oxide, facilitating adrenergic pathways and working synergistically with adenosine receptor blockers (Owoyele *et al*, 2011, 2014, Owoyele and Oladeinde, 2014). Unilorin honey was also found to improve gastric ulcer healing and open wounds in rodents (Owoyele *et al* (2021), Nafiu and Owoyele *et al*, 2016). It also reduced fever in rats' model of pyrexia (Owoyele and Adeyeye, 2015). These balmy effects of honey and specifically Unilorin honey is due to its rich contents of flavonoids, saponins, many plant pollens, moisture (18.20%), Reducing sugars (74.00%), potassium (29.25 mg/L) calcium (4.13 mg/L), Iron (0.091 mg/L), Copper (0.64 mg/L) and Zinc (2.94 mg/L) (AbdulRahman et al, 2013; Owoyele and Oladeinde, 2014; Owoyele and Adeyeye, 2015).

Fig. 5b show some of our findings on how honey influences pain, inflammation, and neurological diseases. It decreases prostaglandin secretion, serum nitric oxide level. It stimulates adrenergic pathways.

Figure 5a. Unilorin honey



a = Owoyele et al., 2011, 2014
b = Owoyele and Adeyeye, 2015
c = Nafiu....Owoyele, 2016
d = Abdulmajeed.....Owoyele.., 2017
e = Abdulmajeed.....Owoyele, 2016

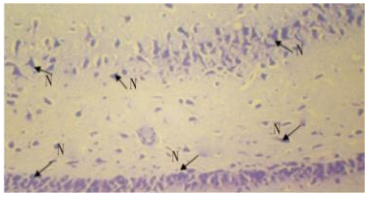
Figure 5b. Therapeutic effects of Unilorin honey

Pawpaw (*Carica papaya* Linn.)

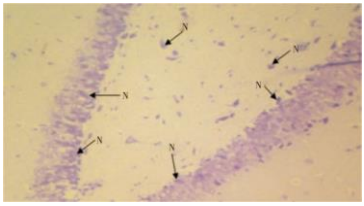
Many parts of the pawpaw plant (figure 6) are employed in the treatment of several ailments. I have investigated the therapeutic effects of the leaves and unripe fruit of this plant in my laboratory and we found that the leaves have pain, inflammation, and fever relieving properties (Owoyele *et al*, 2008; 2010). The mechanism of action resembles that of NSAIDs because the plant produced slight gastric irritation in rats (Owoyele et al, 2008). Furthermore, some of the effects are also achieved by the modulations of dopamine, GABA and serotonin pathways in the nervous system. Likewise, we soaked the unripe fruit (as practiced by traditional medical practitioners) and administered the same to rats induced with gastric ulceration. The results showed that the unripe decoction has both preventive and healing properties on ulcers in the rats (Owoyele *et al*, 2013). We also investigated a common practice of smoking dried leaves of the plant in some parts of the country and found that smoking the leaves for a total of six minutes a day for 21 days has anxiety reliving effects (Oyewole and Owoyele, 2012), it also enhances memory consolidation and retrieval but at high dose, some parts of the hippocampus (area in the brain involved in memory transfer) showed mild neural degeneration as shown in figures 7 (Oyewole and Owoyele 2014). I generally would not encourage anybody to smoke! But who knows? This might unfold like the story of marijuana that is now used medically for the treatment of ailments in some countries like Canada and Germany.

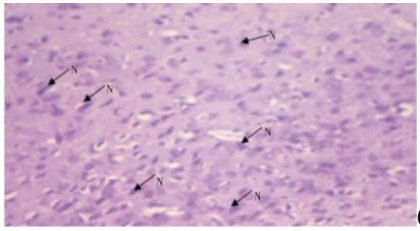
Figure6. Pawpaw in my backyard

A



B





C

Figure 7. Effect of smoking of moderate (B) and high dose (C) *Carica papaya* leaves on hippocampal histology in rats compared with the non-smoking control (A) using cresyl violet stain (X160). Nissl substances were well stained in the control and medium-dose group while there was complete layer disorganization of hippocampus tissue and obvious decrease in neural Neural cells (N).

Siam weed (*Chromolaena odorata)*

*Chromolaena odorata (*Linn) R. M. King and H. Robinson commonly called *Awolowo* or *Akintolataku* plant a highly invasive weed was the plant (Figure 8) of study for my Ph.D. research, I was fascinated with the wound and pain-relieving abilities of the plant since my teenage years when I often get myself wounded on my father's farm. The leaves would be squeezed on the wound and a stinging sensation like that of iodine would be felt followed by drying up of the fresh wound. I was happy when my proposal to investigate the biological activities of this plant was approved by my supervisor (Prof. Ayodele Soladoye). My findings showed that extracts of the leaf of the plant indeed has analgesic, anti-inflammatory effects when administered orally (Owoyele *et al*, 2005; Owoyele and Soladoye, 2007; Owoyele *et al*, 2007b) .

However, when administered on an empty stomach, it could cause gastric erosion (Ulcer) which showed that the mechanisms of its actions on pain, inflammation and fever is like that of NSAIDs (e.g. Aspirin) which also produces ulcers (Ayinla and Owoyele *et al*, 2015). The main class of active ingredients responsible for these actions is flavonoids some of which have been isolated and characterized (e.g. Flavonoids, Eupatilin, Kaemferol, naringenin, essential oils and others) (Owoyele et al, 2008; Zahara *et al*, 2019). Suffice to say, products (such as the essential oils) from the leaf of this plant are now commercially marketed in many parts of the world especially for the treatment of wounds

Fig 8. Photograph of Siam weed

Onions (*Allium ascalonicum*)

In the year 2002, I approached Dr. AI'R Abioye of the Department of Anatomy of this 'Better by Far' University for information on local medicinal plants commonly employed in the treatment of inflammation and pain. He obliged and went to Ire, Osun State (his home town) where he obtained information that a mixture of shallots (*alubosa elewe)* and *ewe afasan (Bulbostylis coletricha)* would be good for the research (Figure 9). In a collaborative manner, we started looking at the effects of these two plants and found that the *alubosa elewe* that we eat could reduce swelling (inflammation) induced in the laboratory as well as provide relief to the induced pain in the rodents (Owoyele *et al*, 2006). Likewise the *B.Coletricha* plant has similar actions (Owoyele *et al*, 2015). This is part of the native heritage and my laboratory confirmed the primary medicinal uses of these two plants. In addition, we reported that the extract of shallots has detrimental effects on Red Blood Cells but it improved the production of White Blood Cells. It also improved the blood levels of the beneficial blood lipids such as high-density lipoprotein (Owoyele *et al*, 2004).

Figure 9. Pictures of onions and *B.Colectricha*

Copperleaf (*Acalypha wilkesiana)*

My real fascination with this plant (Figure 10) started in 2003 when my son was born and he had boils few days after, the elderly women helping us to take care of him told us we must collect the leaves of this 'flower' (called '*Aworoso*'in Yoruba) and boil in water after which we should bath the boy with it. I was initially skeptical but I yielded to the suggestions and found the decoction to be quite effective. This ignited my interest in conducting research on the plant. We found that the plant extract reduced pain, swellings, and fever (Owoyele *et al*, 2011). Likewise, an extract of the plant was administered to rats with experimentally induced nerve damage from untreated diabetes (diabetic neuropathy) and the pain was reduced (Owoyele *et al*, 2016). This shows that in addition to its ability to reduce blood sugar levels in diabetic rats (Ikewuchi *et al*, 2011), it also reduced the damaging effects of diabetes on the small-diameter nerves that convey pain, itch and fine touch.

Figure 10. Picture of Copperleaf (*Acalypha wilkesiana)*

Mexican sun flower (*Tithonia diversifolia*(Hemsl). A. Gray)

I picked interest in this plant (Figure 11) when one of my students mentioned that the juice from the leaves of the plant is used for the treatment of painful menstrual period. We therefore administered alcohol extract of the plant to rats and found that it has pain and inflammation relieving

effects (Owoyele *et al*, 2004). The extract also demonstrated blood-boosting properties (Owoyele *et al*, 2006). Many other studies outside Nigeria have confirmed these findings and in addition many of the active principles (e.g. sesqueterpenes and flavonoids) in this plant have been reported (Kuroda, 2007; Zhao *et al*, 2012).

Fig. 11. *Arial part of Sun flower*

Maize (*Zea mays*)

In 2009, the secretary of our department told me that her elderly mother had chronic arthritis. This is an inflammatory condition that affects the joints leading to pain and stiffness of the joints especially in the elderly. She told me that her mother usually consumes a mixture of maize husk (Figure 12) and lime to alleviate her arthritis. I was impressed and decided to investigate further in the laboratory. We prepared a water extract of the maize husk and administered it to rats which have been made arthritic in the laboratory. The findings (Table.4) from this study showed that the extract of maize husk has remarkable analgesic and anti-inflammatory effects. A high, but nontoxic dose of 200 mg/kg body weight of the extract was more effective than indomethacin (indocid) a standard anti-inflammatory drug

(Owoyele *et al*, 2010). In a follow-up study (Owoyele *et al*, 2018), the anti-arthritic effect of the combination of maize husk and lime was carried out and the results showed that concurrent administration of maize husk extract and lime juice for 10 days led to significant reductions in induced arthritis in rats. The mixture was also more effective than indomethacin and this was achieved partly through the inhibition C-Reactive protein which is an inflammatory marker (Owoyele *et al*, 2018).

Figure12. Maizehusk and fruit

Table 4. Effect of aqueous extract of *Zea mays* husk on formalin-induced paw licking(A), and carrageenan-induced paw oedema (B)in male Wistar rats

A

Group	Dose (mg/kg body weight) Orally	Licking time (sec) [a]	
		Early phase (1 – 5 min)	Late phase (20 – 30 min)
Control (saline)	-	90.03 ± 2.37	82.04 ± 3.64
Zea mays husk	25	71.74±2.95^{*a,b,c,d}	40.09±2.38^{*b,c}
Zea mays husk	50	58.0 ± 2.71^{*b,c}	37.30± 2.62^{*b,c}
Zea mays husk	100	32.77 ± 1.16^{*a,b}	12.02 ± 0.12^{*a,b}
Zea mays husk	200	27.70 ± 1.10^{*a}	10.58 ± 0.42^{*a}
Indomethacin	5	63.30 ± 1.36*	40.26 ± 3.85*

B.

Groups	Dose (mg/kg body weight) Orally	Increase in Paw size (oedema) (mm)		Inhibition (%)	
		3 h	5 h	3 h	5h
Control (saline)	-	7.0 ± 0.41	6.40 ± 0.40		
Zea mays husk	25	6.80 ± 0.50^{a,b,c}	2.0 ± 0.0^{*a,b,c}	02.86	68.75
Zea mays husk	50	5.60 ± 0.42^{*a}	2.20 ± 0.20^{*a,b}	20.0	65.63
Zea mays husk	100	4.50± 0.91^{*a}	1.40± 0.69*	35.71	78.13
Zea mays husk	200	4.80±0.38^{*a}	1.40±0.31*	31.43	78.13
Indomethacin	5	2.40± 0.22*	1.20± 0.19*	65.71	81.25

Each value represents the mean ± S.E.M. (n = 5);* $P < 0.05$ significantly different from control; $^{a}P < 0.05$ significantly different from indomethacin treated rats; $^{b}P < 0.05$ significantly different from 200 mg/Kg body weight group; $^{c}P < 0.05$ significantly different from 100 mg/Kg body weight treated animals.

Blue pussy leaf (*Nelsonia canescens* (Lam). Spreng.) (Ewe ebe)

In 2003, I was hurrying to attend a church service and we found parts of the church surroundings to be quite bushy with a thriving herbaceous weed that had green leaves and flowers. As we started discussing about how the weed had become a nuisance, a fellow congregant informed me that the weed has medicinal values. She also added that the weed is usually prepared boiled and used for bathing children with high fever (*igbona*) and when it is cooled the children would be given portions to drink. I therefore decided to test the claims in the laboratory. The plant (Figure 13) was found to be highly effective in the reduction of pain (Owoyele *et al*, 2005) and especially fever (Owoyele *et al*, 2007a). We performed further experiments on the pain relieving effects of the plant when I visited the laboratory of Prof, Anna maria Aloisi and the results also showed that the plant reduced many pain-related behaviours in rats (Owoyele *et al*, 2015). The plant also protects against experimentally induced ulcers in rats mainly through reductions in acid production (Owoyele *et al*, 2007b). This implies that the mechanism of action of the leaf extract is not by inhibition of cyclooxygenase or of prostaglandins. Therefore, the plant looks more beneficial than the traditional NSAIDs (e.g. aspirin) because of the absence of this gastrointestinal side effects.

Figure13. Arial part of *Nelsonia canescens*

Bitter Kola (*Garcinia kola* (orogbo))

We evaluated the pain relieving and anti-inflammatory effects of seeds of this plant (Figure 14) and found that it reduced inflammation and pain in rats (Olaleye and Owoyele *et al*, 2000). In a separate study in 2014, we found that recruited 6o healthy human volunteers who consented to participate in the study and gave them 100 mg/kg body weight of the seed acutely reduced the level of C-Reactive protein in the blood and therefore, confirming its putative effect on inflammation (Owoyele *et al*, 2014). Likewise, a biflavonoid constituent (Kolaviron) of the seed was found to protect the brain (Hippocampus part) of rats from brain damage called multiple sclerosis. It also prevented weight loss, memory decline and oxidative stress in the rats (Omotoso and Owoyele*et al*, 2019). Generally, it looks like most of the colas are useful medicinally, in a study that I co-authored with one of my former Ph.D. Student, another Kola, *Cola nitida* restored the function of a major brain transport protein (Na^+/K^+-ATPase) and spatial memory in rats that had been made diabetic (Imam-Fulani and Owoyele *et al*, 2018).

Figure 14. Bitter kola fruits

Caffeine

I was also quite keen on working on pure substances and this made me investigate the effects of substances like caffeine, taurine, lecithin, Carnosine and vitamin D on rodents' performance. Thus in 2004, I investigated the effect of the administration of caffeine on pain perception in rodent models of acute pain. The results showed dose dependent pain relieving effects (Owoyele *et al*, 2004). Caffeine is now used as adjuvants in combination with primary analgesic agents to enhance pain relief e.g. aspirin+caffeine, caffeine +acetaminophen (Sawynok, 2011; Owoyele and Oladeinde, 2014) Together with my students, we investigated the effects of caffeine singly and in combination with either taurine and lecithin and the results (Figure 15) show that caffeine improves memory and bodyweights, (Imam-Fulani and Owoyele *et al*, 2019), reduced neuropathic pain (Abdulmajeed and Owoyele, 2015a; Owoyele *et al*, 2017c) improves spatial memory associated with neuropathic pain (Abdulmajeed and Owoyele, 2015b), plasma C-reactive protein and calcium concentration (Owoyele *et al*, 2015a), enhance Brain Sodium-Potassium ATPase activity in diabetic rats (Imam-Fulani,.Owoyele *et al*, 2016), elicits anxiety effects (Owoyele *et al*, 2016), and manipulates autonomic receptors to achieve its pain-relieving effects (Abdulmajeed and Owoyele, 2015b). In all, Caffeine, and with different combinations listed previously were found to enhance all the parameters for which it was investigated.

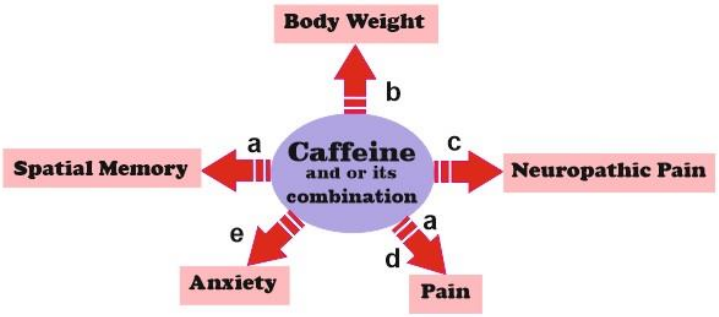


Figure 15: Effects of caffeine, and its various combinations on some brain parameters and other parts of the body

Jute mallow(*Corchorus olitorius)*

Jute '*ewedu*' is a plant used for soup making. However, one of my students reliably informed me that *'ewedu'* consumption could ameliorate gastric ulcer. The leaves were purchased from Oja-Oba, here in Ilorin, processed in our laboratory and administered to rats. The results showed that *ewedu* protected the stomachs of the rats from the damaging effects of the ulcer-causing agents by enhancing mucous production, inhibiting the enzyme, and acid production in the stomach (Owoyele *et al*, 2015b). This study was reported in a health section of one of the national dailies (Oguntola, 2018). In a follow up study, we found that the root extracts reduced swelling induced by inflammatory substances as well as body (Owoyele *et al*, 2015c).

Other studies

Mr Vice-Chancellor sir, I have investigated the healing power of other plants such as *Zingiber officinale, Adansonia digitata*, *Nothospondias staudthi*, *Landolphia owariensis,* and so

on, and found them to be potent as phytotherapeutic agents. (Table .5). This is in line with the philosophy of Hippocrates, the father of Medicine who declared that, '…Let thy food be your first medicine…. (Witkamp and van Norren, 2018). This is also in line with the doctrine signatures

Table 5. List of other plants that I have investigated for their biological activities

S/No	Plant names	Parts used	Findings	Conclusion	References
1	Ginger (*Zingiber officinalis*), Yoruba: *Ata-ile.*	Rhizome	Regulation of blood pressure and heart rate	Has antihypertensive effect	Ojulari and Owoyele *et al*, (2014)
2	*Baobab (Adansonia digitate)*, Yoruba: Ose	Stem bark	Treatment of acute and neuropathic pain	Has pain relieving effect	Bakare and Owoyele, (2018), Bakare, Owoyele… (2019)
3	*(Nothospondias staudthi)*	Leaves	Pain and inflammation	Relieves pain and inflammation	Owoyele *et al*, (2004)
4	Vine rubber *(Landolphia owariensis)*, Yoruba: *Ibo alaitipa*	Leaves	Pain and inflammation, Ulcer	Relieves pain and inflammation but it could cause gastric ulcer if consumed on empty stomach	Owoyele *et al*, (2001), Olaleye and Owoyele, (2008)
5	Mistle toe (*Tapinanthus dodoneifolius*) Yoruba: Afomo	Leaf	Antinociceptive and antipyretic	Relieves pain and fever	Imam-Fulani and Owoyele *et al*, (2015)
6	Bitter leaf (*Vernonia amygdalina*), Yoruba: Ewuro	Leaf	Wound healing when extract of the leaf are applied on the wound	Can be used to improve the healing of wounds	Nafiu and Owoyele *et al*, (2016)
7	(*Phyllanthus amarus*), Yoruba: *Iyin olobe*	Leaf	Reduces chemically and thermally induced pain	Relieves pain	Iranloye and Owoyele *et al*, (2011)

8	Wonderful kola *(Buchholzia coriacea)*, Yoruba*: Uworo*	seeds	Increases in pain threshold reductions in paw volume.	Relieves pain and inflammation	Olaleye and Owoyele *et al*, (2012)
9	Bullock (*Parquetina* nigrescens), *Ewe ogbo*	Leaves, roots	Analgesic, anti-inflammatory, antipyretic, erythropeitic, anti-oxidant and aphrodisiac	Relieves pain, inflammation and fever. The roots increases red blood production, removes damaging molecules from the body and enhance male sexual acivities	Owoyele *et al*, 2009, 2011; Oyelowo, Owoyele…(2012)
10	physics nut *(Jathropha carcass)*, Yoruba: Lapalapa	Leaves	Neuropathic pain	Relieves pain	Mustapha and Owoyele, (2013)
11	(Senna fistula), Yoruba: *Aidantoro*	leaves	Anti-diabetic, amelioration of haematological alterations anti-oxidants, antibacterial	Reduces blood glucose in diabetics, improve the number of blood cells, and kill bacteria	Ayinla and Owoyele *et al*, (2014, 2015, 2019);
12	Clove basil (*Ocimum gratissimum*), Yoruba: *Efirin*	Leaves	Anti-diabetic	Reduces blood glucose	Owoyele *et al*, (2005)
13	Guava (*Psidium guajava*), Yoruba: guafa	leaves	Analgesic, antipyretic	Relieves pain and fever	Owoyele *et al*, (2006)
14	African yellow wood (*Enantia chlorantha*), Yoruba: *Awopa*	Stem bark	Antipyretic	Relieves fever	Adesokan, Owoyele….(2008)
15	Glory of the	Leaves	Anti-diabetic	Reduces	Adebayo,

	garden (*Bougaivillea glabra*)			blood glucose	Owoyele *et al*,.(2009)
16	Avocado Pear (*Persea americana*), Yoruba: *Pia*	Leaves	Reduction in ulcer scores	Reduces ulcer formation	Owoyele *et al*, (2010)
17	Cashew (*Anacardium occidentale*), Yoruba: Kasu	Leaves	Anti-inflammatory and anti-asthmatic	Reduces inflammation and the severity of asthma	Awakan, Owoyele *et al*, (2018)
18	Coco nut (*Cocos nucifera*), Yoruba: *Agbon*	Oil	Prevention of retinal degeneration	Protects against damaging effects of bright light on the eyes	Owoyele and Ayilara, (2019)

Other neurological diseases

Mr. Vice-Chancellor sir, apart from my main research looking at the effects of medicinal plants on pain, inflammation and fever, I have recently widened the scope to include neuroinflammatory diseases. Thus, in 2016, I led a team that won a prestigious multi-million naira grant from TETFund/NRF (TETF/DESS/NRF/STI/11/Vol.1) to investigate the effects of administration of vitamin D for the treatment of Parkinson's disease. This work is 70% completed and the results have been presented at conferences within and outside Nigeria (Owoyele *et al*, 2019, Bayo-Olugbami and Owoyele*et al*, 2019) with a full publication in standard neuroscience journal (Bayo-Olugbami and Owoyele *et al*, 2020). We also extended the research to one of the trace element in our diet (selenium) and found that selenium mitigated pain and neuroinflammation in Parkinson's disease in mice (Bayo-Olugbami and Owoyele *et al*,2019). We are now focusing on other small molecules and amino acids to see if they could offer therapeutic benefits in any of the neuroinflammatory diseases.

Your food in your garden as your medicine

My research has shown that our food apart from providing the basic energy needed for the day to day activities, are very vital for making us healthy because they protect against diseases. Foods that I have investigated for their medicinal properties include Pawpaw *(Ibepe)*, *Guava (guafa)*, Maize *(agbado)*, Coco nut *(Agbon)*, Cashew, Bitter cola, Plantain, Pear, Pineapple, honey and others (Table 5 These foods are readily available in our farms and gardens. Some of the medicinal plants investigated were ornamental plants. In a published survey (Oyelowo and Owoyele*et al*, 2016), we sought the views of about a thousand people across the South-west of Nigeria on the usage of medicinal herbs. The results showed that 61.3% of those surveyed have uses one form of traditional medicine or the other. Furthermore, 80% of the people are actively using orthodox medicine singly or in combination with traditional medicine while 20% of the people report that they will never voluntarily use orthodox medicine (Oyelowo and Owoyele*et al*, 2016). **It is clear that we can not do away completely with healing herbs, plants, and other forms of traditional medicine provided to us to complement our existence here on earth**. I do not advocate that we eat and die, but let us choose our food carefully. Then good health and longevity of lives will be ours.

Contributions to the community

Brain Awareness Outreaches

I have been involved in brain awareness programmes/outreaches since 2013 as the President of the Ilorin Neuroscience Group (ING). These outreaches are aimed at educating the society about brain health, helpful practices, and causes of brain diseases. We also advocate that the private/governmental organizations could be involved in stemming brain related illnesses including promotion of mental health.

International Brain Research (IBRO) Schools and Workshops

I have won singly or in combination four appreciable grants to organize IBRO Schools and workshops here at The University of Ilorin and at the University of Lagos, Nigeria. The IBRO Schools and workshops have impacted generations of students within and outside Nigeria.

Service to National and International Organizations

I have been actively involved in the promotion of neuroscience research and development in Nigeria as well as the study of pain. This has led to my playing key roles in many national societies in the country. Thus I am currently the President of the Nigerian Society for Experimental Biology (NISEB), Neuroscience Society of Nigeria (NSN) and the first Vice President of the Society for the Study of Pain Nigeria (SSPN).

I am a member of two important committees of the International Association for the Study of Pain (IASP), its Developing Countries Working Group (DCWG), and the Executive Committee of the Non-Human Pain (NHP) Special Interest Group (SIG). The DCWG promotes pain and pain-related education in the developing countries of the World, while the Board of the NHP provides governance for the SIG.

I am one of the two representatives of The Physiological Society (UK) here at the university of Ilorin. I promote the activities of the Society and recommend the best graduating students for the Undergraduate prize. I have successfully recommended and secure the award for four of our graduates. I feel highly fulfilled doing this.

Training and supervision of students

I have had the privilege of teaching physiology to many sets of students within and outside this university. These included Physiology major, Anatomy, MB;BS, Medical Laboratory Science, and Performing Arts at the undergraduate

level. I have supervised up to 250 undergraduate projects, 24 masters dissertations and 7 Ph.D. Thesis (Dr. Maryam. T. Ayinla, Dr Aminat. O. Imamfulani-Hassan, Dr. A. L. Oyewole, Dr. Adedamola. Bayo-Olugbami, Dr. Anthonia Agboola, Dr. A. O. Bakare and Dr. M. A. Akinlade) . Other Ph.D students are in various stages of completion of their programmes. They are Mr. Folajimi Olaseinde, Mrs Mosunmola Oyeleke, , Mr. G. O. Ayilara, Mr P. O. Abolarin, Mr. G. O. Owolabi and Dr. Rashidat A. Tajudeen). It has been worthwhile supervising all of them.

Contribution to manpower development at the Department of Physiology

The main goal of establishing physiology programme as a first degree by the then Faculty of Health Sciences was to mitigate the shortage of manpower in the Department of Physiology of this University, and by extension in the Colleges of Health Sciences in Nigeria. I am a product of the lofty programme, and I have in turn made my own modest effort in the human capacity building in my Department as well as other relevant sectors of the society. I have been involved in the training of up to 80% of the academic staff of the Department by way of being one of their lecturers at postgraduate levels. I supervised four of them at the Master level (Dr Hidaayah Jimoh-Abdulgaffar, Mr. A. Amin, Mr. A. Abdulmajeed, Dr. A. L. Oyewole). I supervised the Ph.D. thesis of three members of staff (Dr. Maryam T. Ayinla (Co-supervised with Prof. M. T. Yakubu), Dr. Aminat O. Imamfulani-Hassan, and Dr. A. L. Oyewole).

Future plans

Mr. Vice-Chancellor Sir, I received the news of my elevation to the professorship position just a few minutes before boarding my flight to Massachusetts General Hospital and Harvard Medical School, Boston, USA, for a postdoctoral Fellowship. Naturally, I should have turned back home to enjoy my new status, but for the love of knowledge, I proceeded to

spend the next 6 months like a junior research fellow in the laboratory in USA, in order to get the necessary exposure and I am happy for doing that. But this got me agitated, with questions, like, now that I am a professor, what is next? I found a burden lifted off me, that of 'publish or perish'. All these have left me with a feeling that I must do more intensive research, make more translational findings, and mentor more students and staff. I will be focusing on pineapple extract (bromelain), phytonutrients, and more refined molecules to find their translational relevance in the treatment of pain and neuroinflammatory diseases. I intend to apply for more grants and to promote the worth of this great university within my professional associations by taking more leadership roles. These aims are now quite achievable, all thanks to the new professorial laboratory which was allocated to me in March 2018. Grants from TETFund /NRF and personal income has helped to kick start the laboratory. This laboratory will produce many Ph.D. graduates with groundbreaking discoveries. I also hope to intensify efforts with Physiology/Neuroscience advocacy activities together with our research group named Ilorin Neuroscience Group, reach out to more secondary schools with neuroscience debates, and career talks.

Conclusion

Physiology allows us to understand our body and this form one of the bedrock of medical practice. Without a sound knowledge of physiology, all medical and allied disciplines will not be able to function effectively. It often happens that we have ailments **either** due to in-born errors, infections, or deficiencies of essential nutrients in our body. When this occurs we need to seek for solutions among which are what I term 'balms'. the balms which are common foods, naturally occurring medicinal plants and nutraceuticals that can be found at our backyards, farms, and even in the fresh waters and oceans. Let us always remember that our food is our first medicine. Eat well so that

you will not have to spend your money on expensive medical care.

Recommendations

1. Irrespective of whatever divide we find ourselves, we should not blatantly condemn what nature has given as remedy for sound health. The alternative medicine is still relevant, it should be refined and carefully regulated for us in Nigeria so that we can benefit maximally from it as it is in Asian countries (e.g. China, India, Japan).
2. There is a need to make the provision of individualized research spaces a priority for all cadres of academic staff, this will enhance productivity and innovation. In addition, these laboratories need to be well equipped. While academic staff needs to source for funds, there should be basic facilities that would be provided for each research laboratories by the University.
3. Incentives for publications: Academic staff should be encouraged to publish their works in high impact journals and books by making available to them incentives like paying page charges and rewarding the laboratories financially. The reward should not end with considering these publications for promotions only. In addition, the University should subscribe to high impact journals.
4. Highlighting important findings in the News bulletin: one way of promoting our research and the University in general is to highlight the important publications by staff in the weekly Unilorin bulletin. This will also encourage productivity among researchers as well as allow the important stakeholders the opportunity to be informed about what opportunities are available in the University. This could be done in a similar fashion to the way 'Unilorin in the news' is captured in the bulletin.
5. Strengthen our ICT**:** Our ICT needs to be strengthened for the operators to be innovative about how to capture our diversity and strength as a 'Better by far' University. This would

involve among other things, seeking additional information or using algorithms to generate what successes are being recorded by students, staff, and alumni of the University.

6. Improving Town and Gown Interaction: There should be a conscious attempt to impact our surrounding communities by encouraging not only public lectures but creating open days for members of the community including primary and secondary school pupils, industrialists, and other important sections of the society. The open days maybe for laboratory visits or for other critical engagements. This would make us more of a community-oriented University. It would further endear the university to these communities.

7. Reworking the curriculum: Globally there are efforts to create discipline from the traditional ones, and to facilitate easy dilution of knowledge. We should allow new and emerging disciplines to start in the university and relax the rigid admission requirements in terms of subject combinations. This sort of innovations have benefitted medicine tremendously over the years in advance countries as people from different backgrounds (Agriculture, Physics, Music and so on) have found ways to either enroll in medically related disciplines or collaborated with biomedical scientists to make groundbreaking discoveries.

Acknowledgment

My first acknowledgment goes to my Creator, the creator of the heavens and the earth whose name is Jesus Christ. I am grateful for being alive not only to get promoted to this noble rank of a professor but being able to be present here before you today to present this inaugural lecture (Balm at your backyard: Use it for your health benefit). To God be all the glory!

I appreciate every one of you who have honoured me with your presence today. Thank you for being here.

I had a cradle, so I want to thank profoundly all my teachers right from my Primary School (ECWA YELGEA, Isanlu), and Secondary School (St Kizito's College, Isanlu) for

the knowledge impacted and specifically for those who saw in me the potential of what I could be and encouraged me. I specifically thank Mr. Igunnu (Primary 5 teacher), these selected teachers at my Secondary School (Mrs. Silas, Mr. Elesho, Dr. Agbabiaka (Now of Microbiology Department of this University)

I thank my teachers, supervisors, and mentors at the undergraduate and postgraduate levels. First of all, My deep appreciation goes to my Teacher and Supervisor at the B.Sc and Ph.D. Levels (Prof. Ayodele O. Soladoye), I am grateful for the tutelage and the work ethics that I gained from him. I appreciate my supervisor and co-supervisor at the M.Sc, level, Late Prof. R.A. Elegbe, and Prof Samuel B. Olaleye, for their tutelage. They introduced me to neuroscience and the importance of the 'balms' in the treatment of pain and inflammation. Their kindness has influenced me forever. I have also enjoyed mentorship from Prof. Elizabeth A. Balogun, Prof. C. O. Bewaji, Prof. F. B. O. Mojiminiyi (Usmanu Danfodiyo University, Sokoto), Prof. Anna Maria Aloisi (University of Siena, Italy), Dr Anne Louise Oaklander (Massachusetts General Hospital, and Harvard Medical School, USA).

I appreciate my late mother, she was a mother indeed, she died while I was still finding my footing in the academic world but she had already made her mark on me. She was a primary school teacher and endeared teaching to me. So I had no problem taking up a lecturing job as I had longed for it. May her soul continue to rest in peace. My daddy has been a beacon of support, kind and affectionate, caring, and considerate. I thank him for training me in the university and being my pillar when in need. He prioritized the education of his children and siblings. I am forever grateful!

I also use this moment to appreciate my siblings and their spouses (Prophet Timothy Aina and Mrs. Ranti Aina (nee Owoyele), Mr. Taiye Arungbemi, and Mrs. Gladys B. Arungbemi (nee Owoyele), Mr. Femi Owoyele, Dr. Gbenga. Adebayo and Mrs. Atinukemi Adebayo (nee Owoyele), Mr.

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I extend my sincere gratitude to my employer (the University of Ilorin), for the privilege I have to work in this citadel of academic excellence. Working here was facilitated by my Ph.D. supervisor, Prof Ayodele.O. Soladoye. It was made smooth by the decision of one of the former Vice-Chancellor, Prof Oba Abdulraheem who facilitated my ability to start my Master degree programme by instructing the then HOD (Prof Soladoye) and Dean (late Prof M. A. Araoye) to seek for a special placement for my colleagues and I (five of us) at the University of Ibadan and the University of Lagos. We were just employed as graduate assistants and during the regularization of my appointment interview Prof. Oba Abdulraheem (and the panel) saw the potentials in us, and he was keen that we should be mentored and further our studies. I am grateful, that young man is now a professor today.

I appreciate all the members of my department. They are Prof. L. A. Olatunji, Prof. L. A. Olayaki, Dr. T. M. Salman, Dr. Maryam T. Ayinla, Dr. T.O. Ayinde, Dr. L. S. Ojulari, Dr. F.. A. Niyi-Odumosu, Dr. H. O. Jimoh-Abdulgaffaar, Dr. A. L. Oyewole, Dr. Aminat. O. Imamfulani-Hassan, Mr. E. D. Areola, Mrs. R Oluyemi (former secretary), Mrs. M. O. Oladosu (former secretary), Mrs. K. Alayande, Mrs. R. O. Balogun, Mrs. H. O. Omofe, Mrs. E.F. Olawale-Bello, Mr. R. Garba, Mrs. R. O. Ayinmode. I also appreciate the support of Mrs. F. O. Oni of the Department of Pharmacology and Therapeutics.

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I appreciate the love and support from the executives and memberships of my professional bodies. They are; International Association for the Study of Pain (IASP), IBRO-ARC, Physiological Society, UK, Society of Experimental Biology of Nigeria (SONA), Physiological Society of Nigeria, Neuroscience Society of Nigeria, Society for Experimental Biology of Nigeria (NISEB), Society for the Study of Pain Nigeria (SSPN).

I also appreciate all my in-laws for being good in-laws to me. They are Pa (Late). and Mrs. M. A. Awotunde, and Mr. and Mrs. J.B. Oyewopo. I appreciate all my brother and sisters-in-law and their families.Pa Awotunde went to be with the lord about five months ago. May his soul rest in peace.

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I appreciate and remember fondly the contributions of my late wife, Funke Elizabeth Owoyele (nee Awotunde) whom death snatched away from me six years ago. She was caring and very understanding. She loved me and my children with all that was in her; I wish she is here physically today. Her death was a

rude shock to me but I am happy that she is resting at the bosom of our Lord and Saviour Jesus Christ.

To my young, loving, energetic and dynamic wife, Grace Temitope Owoyele (nee Oyewopo) whose other real name is Comfort (Itunu). Itunu indeed she is, thank you for stepping in to what you considered a very big shoe by then. I have found vitality by marrying you, I am grateful that the family continued to thrive and for your love.

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References

Abdulmajeed, W. I. and **Owoyele, B. V.** (2015): Ameliorative effects of taurine and caffeine on spatial memory deficit associated with neuropathic pain in sciatic nerve ligated rats. *Nigerian Journal of Neuroscience* 7(1): 30-35.

Abdulmajeed, W. I., Sulieman, H. B., Zubayr, M. O., Imam, A., Amin, A., Biliaminu, S. A., ... & **Owoyele, B. V.** (2016). Honey prevents neurobehavioural deficit and oxidative stress induced by lead acetate exposure in male wistar rats-a preliminary study. *Metabolic brain disease*, *31*(1), 37-44.

Abdulmajeed, W. I., Sulieman, H. B., Zubayr, M. O., Imam, A., Amin, A., Sulyman, A. O., &**Owoyele, B. V.** (2017). Honey Prevents Lead Induced Renal Dysfunction By Improving Antioxidant Activities in Male Wistar Rats. *Tropical Journal of Health Sciences*, *24*(2).

Abdulmajeed, W., &**Owoyele, B. V.** (2015). Anti-nociceptive effects of taurine and caffeine in sciatic nerve ligated wistar rats: involvement of autonomic receptors. *Journal of African Association of Physiological Sciences*, *3*(1), 41-48.

Abdulrahaman, A. A., Solomon, O. R., Adeyemi, S. B., Liadi, M. T., Ahmed, R. N., Belewu, M. A., & Oladele, F. A. (2013). Melisopalynological analysis of honey samples from Jatropha Plantation and Unilorin Apiary Farm. *International Journal of Phytofuels and Allied Sciences*, *2*(1), 81-92.

Adebayo, G. I., Alabi, O. T., **Owoyele, B. V.,**& Soladoye, A. O. (2009). Anti-diabetic properties of the aqueous leaf extract of Bougainvillea glabra (Glory of the Garden) on alloxan-induced diabetic rats. *Records of Natural Products*, *3*(4), 187.

Adesokan, A. A., Yakubu, M. T., **Owoyele, B. V.,** Akanji, M. A., Soladoye, A. O., & Lawal, O. K. (2008). Effect of administration of aqueous and ethanolic extracts of Enantia chlorantha stem bark on brewer's yeast-induced

pyresis in rats. *African Journal of Biochemistry Research, 2*(7), 165-169.

Akintoye, O. O., Oniyide, A. A., &**Owoyele, B. V**. (2018). A study of pain threshold, interleukins and NLR in diabetic polyneuropathy in a selected Nigerian population. *Nigerian Journal of Physiological Sciences*, *33*(2), 151-157.

Amiel, E., Ofir, R., Dudai, N., Soloway, E., Rabinsky, T., & Rachmilevitch, S. (2012). β-Caryophyllene, a compound isolated from the biblical balm of gilead (Commiphora gileadensis), is a selective apoptosis inducer for tumor cell lines. *Evidence-based complementary and alternative medicine*, *2012*.

Awakan, O. J., Malomo, S. O., Adejare, A. A., Igunnu, A., Atolani, O., Adebayo, A. H., &**Owoyele, B. V.** (2018). Anti-inflammatory and bronchodilatory constituents of leaf extracts of Anacardium occidentale L. in animal models. *Journal of integrative medicine*, *16*(1), 62-70.

Ayinla, M. T., Adeyemi, S. B., **Owoyele, B. V**., & Krishnamurthy, R. (2019). Secondary Metabolites Constituents and Antibacterial Screening of Methanolic Leaves Extracts of Senna fistula and Ocimum gratissimum. *Tropical Journal of Health Sciences*, *26*(1).

Ayinla, M. T., **Owoyele, B. V.,**& Yakubu, M. T. (2014). Antidiabetic activity of aqueous extract of Senna fistula leaves in streptozotocin-induced diabetic rats. *Nigerian Journal of Biochemistry and Molecular Biology*, *29*(2), 93-106.

Ayinla, M. T., Yahaya, D. A., **Owoyele, B. V**., and Odumosu, F. A (2015). *Chromolaenaodorata* leaves: Ulcerative effects of its dichloromethane fraction in Wistar Rats. *Nigerian Journal of Biochemistry and Molecular Biology* 30(2): 86-92.

Bakare, A. O., Oyewole, A. L., &**Owoyele, B. V.** (2019). Prostaglandin E 2 and oxidative defense system contributed to anti-nociception action of aqueous

Adansonia digitata bark extract in induced neuropathic pain in Wistar rats. *Oriental Pharmacy and Experimental Medicine*, *19*(3), 287-298.

Bayo-Olugbami, A., Nafiu, A. B., Amin, A., Ogundele, O. M., Lee, C. C., &**Owoyele, B. V.** (2020). Vitamin D attenuated 6-OHDA-induced behavioural deficits, dopamine dysmetabolism, oxidative stress, and neuro-inflammation in mice. *Nutritional Neuroscience*, 1-12.

Bayo-Olugbami, A., Oyewole, A. L., Nafiu, A. B., Amin, A., Ogundele, O. M., **Owoyele, B. V.,**& Lee, C. C. (2019). Dopaminergic modulatory effects of vitamin-d3 in 6-hydroxydopamine-induced nigrostriatal-lesioned mice. *IBRO Reports*, *7*, 18-19.

Bayo-Olugbami, A., Oyewole, A., Nafiu, A., Amin, A., Ogundele, B., **Owoyele, B.,**& Lee, C. (2019, October). Cholecalciferol (VD3) attenuated motor deficits and dyskinesia in Hemi-Parkinsonian mice: behavioural, biochemical & electrophysiological implications. In *movement Disorders* (Vol. 34, pp. S320-S320). 111 River St, Hoboken 07030-5774, NJ USA: Wiley.

Bonica J. J. (1959). Control of pain; the most common complaint which prompts patients to seek medical aid. *The Journal of the Kansas Medical Society*, *60*(1), 10-18.

Dafni, A., & Böck, B. (2019). Medicinal plants of the Bible—revisited. *Journal of ethnobiology and ethnomedicine*, *15*(1), 1-14.

European Union Directive, (EU) (2002). European Union Directive, 2001/110/EC relating to honey.

Frost, R. (2002). *The road not taken: A selection of Robert Frost's poems*. Macmillan.

Galvão, I., Sugimoto, M. A., Vago, J. P., Machado, M. G., & Sousa, L. P. (2018). Mediators of inflammation. In *Immunopharmacology and Inflammation* (pp. 3-32). Springer, Cham.

Grünenthal (2020). The way of the pain signal – from the periphery to the cns. eLearning Module.

http://www.changepain-emodules.com/index?modulesId=2&languagesId=1. Accessed on 28/01/2020

Hall, J.E and Guyton A.C. (2011). Guyton and Hall textbook of medical physiology. *Philadelphia, PA: Saunders Elsevier*, *107*, 1146.

Hanacek J. Introduction to pathophysiology. www.jfmed.uniba.sk Accessed on 06/03/2020

Ikewuchi, J. C., Onyeike, E. N., Uwakwe, A. A., & Ikewuchi, C. C. (2011). Effect of aqueous extract of the leaves of Acalypha wilkesiana 'Godseffiana'Muell Arg (Euphorbiaceae) on the hematology, plasma biochemistry and ocular indices of oxidative stress in alloxan induced diabetic rats. *Journal of ethnopharmacology*, *137*(3), 1415-1424.

Imam-Fulani A.O., Atta A.O. &**OwoyeleB. V.** (2019). Effects of Caffeine Administration on Body Weight and Memory in Healthy and Streptozotocine-Induced Diabetic Female Wistar Rats. *Tropical Journal of Health Sciences* 26(1): 44 -51.

Imam-Fulani, A. O., Baba, M. A., &**Owoyele, B. V**. (2015). Antinociceptive And Antipyretic Properties Of Tapinanthus Dodoneifolius Leaf Extract In Albino Rats. *Tropical Journal of Health Sciences*, *22*(2), 12-15.

Imam-Fulani, A. O., Bamikole, O. K., &**Owoyele, B. V.** (2016). Effects of Caffeine Administration on Brain Sodium-Potassium ATPase Activity in Healthy and Streptozotocin-Induced Diabetic Female Wistar Rats. *Journal of Caffeine Research*, *6*(3), 117-125.

Imam-Fulani, A. O., Sanusi, K. O., &**Owoyele, B. V.** (2018). Effects of acetone extract of Cola nitida on brain sodium-potassium adenosine triphosphatase activity and spatial memory in healthy and streptozotocin-induced diabetic female Wistar rats. *Journal of Basic and Clinical Physiology and Pharmacology*, *29*(4), 411-416.

International Association for the Study of Pain (2020). IASP Terminology. https://www.iasp-pain.org/Education/Content.aspx?ItemNumber=1698#Pain accessed on 28/01/2020

Iranloye, B. O., **Owoyele, V. B**., Kelani, O. R., & Olaleye, S. B. (2011). Analgesic activity of aqueous leaf extract of Phyllanthus amarus. *African journal of medicine and medical sciences*, *40*(1), 47-50.

Kuroda, M., Yokosuka, A., Kobayashi, R., Jitsuno, M., Kando, H., Nosaka, K., ... & Mimaki, Y. (2007). Sesquiterpenoids and flavonoids from the aerial parts of Tithonia diversifolia and their cytotoxic activity. *Chemical and Pharmaceutical Bulletin*, *55*(8), 1240-1244.

Maryam, A. T., **Owoyele, B. V.**& Yakubu M. T. (2015). Effect of ethanolic leaf extract of Senna fistula on some haematological parameters, lipid profile and oxidative stress in alloxan-induced diabetic rats. *Nigerian Journal of Physiological Sciences*, *30*(1-2), 87-93.

Mustapha, A.A. and **Owoyele, B. V.** (2013). Effects of methanol extract of *Jatropha curcas* leaves on partial sciatic nerve ligation-induced neuropathic pain in Wistar rats. *International Journal of Phytofuels and Allied Sciences* 2(1): 64-71.

Nafiu, A. B., Akinwale, O. C., Akinfe, O. A., **Owoyele, B. V**., Abioye, A. I. R., Abdulazeez, F. I., & Rahman, M. T. (2016). Histomorphological Evaluation of Wound Healing-Comparison between Use of Honey and Vernonia Amygdalina Leaf Juice. *Nigeria. Trop. J. Health Sci*, *23*(3), 10-11.

Oguntola S. (2018): How Ewedu Eases Heartburn The nigerian Tribune, https://tribuneonlineng.com/ewedu-eases-heartburn/ accessed 05/09/2021

Ojulari, L. S., Olatubosun, O. T., Okesina, K. B., &**Owoyele, B. V**. (2014). The effect of Zingiber officinale (ginger)

extract on blood pressure and heart rate in healthy humans. *IOSR J Dent Med Sci*, *10*, 76-8.

Olaleye, S. B., Farombi, E. O., Adewoye, E. A., **Owoyele, B. V**., Onasanwo, S. A., & Elegbe, R. A. (2000). Analgesic and anti-inflammatory effects of kaviiron (a Garcinia kola seed extract). *African journal of biomedical research*, *3*(3), 171-174.

Olaleye, S. B., Ige, A. O., Michael, O. S., &**Owoyele, B. V.** (2012). Analgesic and anti-inflammatory effects of ethanol extracts of Buchholzia coriacea seeds in male rats. *African Journal of Biomedical Research*, *15*(3), 171-176.

Olaleye, S., **Owoyele, B. V.,**& Odukanmi, A. O. (2008). Antiulcer and gastric antisecretory effects of Landolphia owariensis extracts in rats. *Nigerian Journal of Physiological Sciences*, *23*(1-2).

Omotoso, G. O., Olajide, O. J., Gbadamosi, I. T., Adebayo, J. O., Enaibe, B. U., Akinola, O. B., &**Owoyele, B. V.** (2019). Cuprizone toxicity and Garcinia kola biflavonoid complex activity on hippocampal morphology and neurobehaviour. *Heliyon*, *5*(7), e02102.

Oniyide, A. A., Olaniyi, K. S., Olasehinde, O. F., Yusuf, F. A., &**Owoyele, B. V.** (2018). Effect of ethnicity on pain perception among healthy nigerians. *PACIFIC JOURNAL OF MEDICAL SCIENCES*, 27.

Owoyele B.V. (2007). Analgesic, Anti-inflammatory and Antipyretic effects of extracts of *Chromolaena odorata* and mechanism of action in laboratory animals. *Ph.D. Thesis, University of Ilorin*

Owoyele B.V. and Salaudeen A. D. (2017). Rapid eye movement (REM) sleep deprivation reduces pain perception in sciatic nerve-ligated Wistar rats; involvement of muscarinic autonomic receptor. *Indian Journal of Physiology and Pharmacology* 61(1) : 3–6.

Owoyele B.V., Ayinla, M.T., Esan A.A. and Bayo-Olugbami A. (2021) Gastro-protective Effects of Honey in Male Wistar Rats. *Nig. J. Nat. Appl. Sci.* (Accepted).

Owoyele B.V., Toluhi, A.M., Oyewole, A.L., ImamFulani A.O. and Yakubu M.T. (2016). Combined Caffeine and Lecithin Induces Anxiogenic-Like Behaviours via Oxidative Stress. Annals of Depression and Anxiety. *Ann Depress Anxiety* 3(2): 01-06

Owoyele, B. V and Salaudeen A. D.(2015). Sleep deprivation alters prostaglandin and anti-oxidant enzymes in rats induced with neuropathic pain. *Archives of Basic and Applied Medicine, 3*(3), 123-127.

Akintoye O.O., Oniyide A.A. and **Owoyele B.V.** (2019). Amplified pain perception in patients with diabetic neuropathy is associated with altered serum calcitonin gene related peptide (CGRP). *African Journal of Medicine and Medical Sciences*, *48*(1), 47-53.

Owoyele, B. V., & Ayilara, O. G. (2019). Coconut oil protects against light-induced retina degeneration in male Wistar rats. *Pathophysiology*, *26*(1), 89-95.

Owoyele, B. V., & Bakare, A. O. (2018). Analgesic properties of aqueous bark extract of Adansonia digitata in Wistar rats. *Biomedicine & Pharmacotherapy*, *97*, 209-212.

Owoyele, B. V., Abdulmajeed, W., Adisa, B. M., Owolabi, O. O., & Oyeleke, S. A. (2015). Anti-Ulcerogenic and Gastric Antisecretory Effects of Corchorus olitorius Extract in Male Albino Rats. *Journal of Herbs, Spices & Medicinal Plants*, *21*(1), 1-8.

Owoyele, B. V., Abioye, A. I. R., Afinowi, N. O., Jimoh, A., & Soladoye, A. O. (2006). Analgesic and anti-inflammatory effects of Allium Ascalonicum. *Tropical Journal of Health Sciences*, *13*(1), 28-32.

Owoyele, B. V., Abioye, A. I. R., Oyewole, A. L., Ameen, M. O., Owemidu, I. O., & Adewusi, M. O. (2015). Effects of the Ethanolic Extract of Bulbostylis coleotricha

(Hochst. Exa. Rich.) on Inflammation in Adult Wistar Rats. *Group*, *1*(30.2), 2-4.

Owoyele, B. V., Adebayo, I. K., & Soladoye, A. O. (2015). Anti-ulcer effects of aqueous extract of Persea americana Mill (Avocado) leaves in rats. *Comp. Bio. Nat. Pro*, *3*, 179-184.

Owoyele, B. V., Adebukola, O. M., Funmilayo, A. A., & Soladoye, A. O. (2008). Anti-inflammatory activities of ethanolic extract of Carica papaya leaves. *Inflammopharmacology*, *16*(4), 168-173.

Owoyele, B. V., Adenekan, O. T., & Soladoye, A. O. (2011). Effects of honey on inflammation and nitric oxide production in Wistar rats. *Zhong xi yi jie he xue bao= Journal of Chinese integrative medicine*, *9*(4), 447-452.

Owoyele, B. V., Alabi, O. T., Adebayo, J. O., Soladoye, A. O., Abioye, A. I. R., & Jimoh, S. A. (2004). Haematological evaluation of ethanolic extract of Allium ascalonicum in male albino rats. *Fitoterapia*, *75*(3-4), 322-326.

Owoyele, B. V., Alashi, Y., & Oyewole, A. L. (2017). Effect of taurine and caffeine on spatial memory in adult male wistar rats. *Nigerian Journal of Neuroscience Nig. J. Neurosci*, *8*(2), 44-51.

Owoyele, B. V., Ceccarelli I., Pinassi, J., Fiorenzani, P. & Aloisi, A. M. (2015). *Nelsonia canescens* extract: analgesic properties in male rats. *International J Pharmacy and Natural Med*. 3(2): 300-397

Owoyele, B. V., Enaworu, I. I., Bayo-Olugbami, A. A., & Owolabi, G. O. (2018). Rapid eye movement sleep deprivation impairs hippocampus-dependent spatial memory: involvement of GABAergic receptors. *Journal of African Association of Physiological Sciences*, *6*(1), 38-45.

Owoyele, B. V., Gbago, A. F., & Ashaolu, O. S. (2013). Gastroprotective effects of aqueous extract of unripe carica papaya fruit in rats. *Pacific Journal of Medical Sciences*, *11*(2), 3-11.

Owoyele, B. V., Ibiyemi, A. V., & Oyeleke, M. B. (2018). Anti-athritic effects of lime, maize husk extract and its co administration on wistar rats. *Advanced Herbal Medicine*, *4*(4), 59-64.

Owoyele, B. V., Nafiu, A. B., Oyewole, I. A., Oyewole, L. A., & Soladoye, A. O. (2009). Studies on the analgesic, anti-inflammatory and antipyretic effects of Parquetina nigrescens leaf extract. *Journal of Ethnopharmacology*, *122*(1), 86-90.

Owoyele, B. V., Negedu, M. N., Olaniran, S. O., Onasanwo, S. A., Oguntoye, S. O., Sanya, J. O., ... & Soladoye, A. O. (2010). Analgesic and anti-inflammatory effects of aqueous extract of Zea mays husk in male Wistar rats. *Journal of medicinal food*, *13*(2), 343-347.

Owoyele, B. V., Oguntoye, S. O., Dare, K., Ogunbiyi, B. A., Aruboula, E. A., & Soladoye, A. O. (2013). Analgesic, anti-inflammatory and antipyretic activities from flavonoid fractions of **Chromolaena odorata**. *Journal of Medicinal Plants Research*, *2*(9), 219-225.

Owoyele, B. V., Oladejo, R. O., Ajomale, K., Ahmed, R. O., & Mustapha, A. (2014). Analgesic and anti-inflammatory effects of honey: the involvement of autonomic receptors. *Metabolic brain disease*, *29*(1), 167-173.

Owoyele, B. V., Oladimeji, A., David, A. J. & Soladoye A.O. (2007): Antipyretic activities of the leaf extract of *Chromolaena odorata. The Tropical Journal of Health Sciences,* 14 (1); 1-3.

Owoyele, B. V., Olaleye, S. B., Oke, J. M., & Elegbe, R. A. (2001). Anti-inflammatory and analgesic activities of leaf extracts of Landolphia owariensis. *African Journal of Biomedical Research*, *4*(3).

Owoyele, B. V., Olaleye, S. B., Oke, J. M., & Elegbe, R. A. (2004). Anti-inflammatory and analgesic activities of Nothospondias staudtii. *Nigerian Journal of Physiological Sciences*, *19*(1), 102-105.

Owoyele, B. V., Oyelowo, O. T., Biliaminu, S. A., Alaran, O. N., Alimi, S. A., & Saliu, R. S. (2011). Hematological and biochemical studies on Parquetina nigrescens root extract in albino rats. *Journal of Applied Pharmaceutical Science*, *1*(10), 176.

Owoyele, B. V., Oyewole, A. L., Alimi, M. L., Sanni, S. A., & Oyeleke, S. A. (2015). Anti-inflammatory and antipyretic properties of Corchorus olitorius aqueous root extract in Wistar rats. *Journal of basic and clinical physiology and pharmacology*, *26*(4), 363-368.

Owoyele, B. V., Oyewole, A. L., Amuda, O., Abioye A. and Biliaminu, S. A. (2014). Effect of *Garcinia kola* seed on plasma C-reactive protein in human subjects. *Nigerian Journal of Pure and Applied Sciences 26: 2402-2410*

Owoyele, B. V., Soladoye, A. O., & Omopariola, O. A. (2010). Studies on the analgesic and antipyretic activities of ethanolic extract of Carica papaya leaves in rats. *Medicinal plants: phytochemistry, pharmacology and therapeutics, Volume 1*, 378-383.

Owoyele, B. V., Yusuf, F. A., Oniyide, A. A., Olaniyi, S. K. and Olasehinde O.F. (2017). Sleep deprivation in Shift work alters pain perception. *World Journal of Biomedical Research* 4 (2): 6- 13

Owoyele, B., Abolarin, P., Nafiu, A., Amin, A., & Ogundele, O. (2019). Selenium reduces pain perception in acute 1-methyl-4-phenyl-1, 2, 3, 6-tetrahydropyridine (MPTP)-induced mouse model of Parkinson's disease. *IBRO Reports*, *6*, S497.

Owoyele, B.V, Ojo, T.S. & Soladoye, A.O. (2007): Antipyretic activities of *Nelsonia canescens* in rats. *Nigerian Journal of Physiological Sciences,*22(1-2); 145.

Owoyele, B.V. & Adeyeye, E.O. (2015): Antipyretic effect of honey in albino rats. In Utilisation and Management of Medicinal Plants, *Gupta V.K (Eds)* 3, 315-320

Owoyele, B.V., Imam-Fulani, A.O. Joseph, L.A., Arikawe, O.O.& Olayaki L.A. (2016). Methanolic extract of

Acalypha wilkesiana inhibited thermally but not chemically induced pain in diabetic rats. *Centrepoint Journal*. 22(1): 70-78.

Owoyele, B.V., Jegede, T.O., & Soladoye, A.O. (2006). Analgesic and anti pyretic activities of ethanolic extract of *Psidium guajava* in Rats. *Recent Progress in Medicinal Plants*13: 485-492.

Owoyele, B.V., Jimoh, S. A., Ogunrombi, A.O., Balogun E.A & Soladoye, A.O. (2006): Haematological evaluation of aqueous extract of *Tithonia diversifolia* in Wistar rats. *Recent Progress in Medicinal Plants.*13: 411-419

Owoyele, V. B., & Soladoye, A. O. (2007). Anti-inflammatory and analgesic activities of ethanolic extract of *Chromolaena odorata* leaves. *Natural products II*, 397-406.

Owoyele, V. B., Adediji, J. O., & Soladoye, A. O. (2005). Anti-inflammatory activity of aqueous leaf extract of Chromolaena odorata. *Inflammopharmacology*, *13*(5), 479-484.

Owoyele, V. B., Adeyemi, F. M., & Soladoye, A. O. (2005). Effect of aqueous leaves extract of ocimum gratissimum (sweet basil) on alloxan induced diabetic rats. *Pharmacognosy Magazine*, *1*(2), 62.

Owoyele, V. B., Akozor, F. A., & Soladoye, A. O. (2006). Anti-ulcer effect of leaf extracts of Nelsonia canescens in Rats. *RPMP–Chronic and Common Diseases II*, *18*, 345-349.

Owoyele, V. B., Oloriegbe, Y. Y., Balogun, E. A., & Soladoye, A. O. (2005). Analgesic and anti-inflammatory properties of Nelsonia canescens leaf extract. *Journal of ethnopharmacology*, *99*(1), 153-156.

Owoyele, V. B., Wuraola, C. O., Soladoye, A. O., & Olaleye, S. B. (2004). Studies on the anti-inflammatory and analgesic properties of Tithonia diversifolia leaf extract. *Journal of ethnopharmacology*, *90*(2-3), 317-321.

Oyelowo O.T, Adejumo A.O and **Owoyele B.V.** (2016). A Survey of Traditional Medicine Usage in South-Western Nigeria. *Archives of Basic and Applied Medicine*, *4*(1), 25-31.

Oyelowo, O. T., Fabiyi, O. V., Jimoh, O. M., &**Owoyele, B. V**. (2012). Aphrodisiac and male sexual characteristics in albino rats treated with the aqueous extract of Parquetina nigrescens root. *Nigerian Journal of Natural Products and Medicine*, *16*, 18-25.

Oyewole, A. L., &**Owoyele, B. V.** (2012). Neurobehavioural effects of exposure of wistar rats to smoke from traditional Carica papaya (pawpaw) leaves. *CELLMED*, *2*(4), 36-1.

Oyewole, A. L., &**Owoyele, B. V**. (2014). Long–term spatial memory and morphological changes in hippocampus of Wistar rats exposed to smoke from Carica papaya leaves. *Asian Pacific journal of tropical biomedicine*, *4*(3), 213-218.

Owoyele B. V., Oyewole, A.L., Biliaminu A. S. and Alashi, Y. (2015a). Effect of taurine and caffeine on plasma c-reactive protein and calcium in Wistar rats. *African journal of medicine and medical sciences*, *44*(3), 229-236.

Punchard, N. A., Whelan, C. J., & Adcock, I. (2004). The journal of inflammation 1: 1

Ranhel, A. S., & Mesquita, E. T. (2016). The middle ages contributions to cardiovascular medicine. *Brazilian journal of cardiovascular surgery*, *31*, 163-170.

Sawynok, J. (2011). Caffeine and pain. *Pain*, *152*(4), 726-729.

Simmons, D. L., Wagner, D., & Westover, K. (2000). Nonsteroidal anti-inflammatory drugs, acetaminophen, cyclooxygenase 2, and fever. *Clinical infectious diseases*, *31*(Supplement_5), S211-S218.

Soladoye, A. O., **Owoyele, B. V.,**& Olatunji, L. A. (1999). Cardiovascular responses to baroreceptor stimulation

during muscular exercise in young adults. *Res, 2*(2), 63-67.

Soladoye, A.O., **Owoyele, B.V**. and Olatunji L. A. (2000): Cardiovascular responses to baroreflex stimulation at different levels of muscular exercise in different age groups. *Bioscience Research Communication.* 12 (1); 73-77

Soladoye, A.O., **Owoyele, B.V.,** Olatunji, L.A. and Ogunsola O.S. (2002): Menstrual cycle Influences on baroreceptor stimulation in young Adult subjects. *NISEB Journal*(2): 123-126.

The Physiological Society (2020): What is physiology? https://www.physoc.org/explore-physiology/what-is-physiology/ Accessed on 06/03/2020

Vane, J. R., & Botting, R. M. (1997). Mechanism of action of anti-inflammatory drugs. *Recent advances in prostaglandin, thromboxane, and leukotriene research*, 131-138.

Vinay, K., Abbas, A. K., Fauston, N., & Aster, J. C. (2005). Robbins and Cotran pathologic basis of disease. *New Delhi, India*, 628-636.

Walter, E. J., Hanna-Jumma, S., Carraretto, M., & Forni, L. (2016). The pathophysiological basis and consequences of fever. *Critical Care*, *20*(1), 1-10.

West, J. B. (2014). Galen and the beginnings of Western physiology. *American Journal of Physiology-Lung Cellular and Molecular Physiology*, *307*(2), L121-L128.

Zahara, M. (2019, April). Description of Chromolaena odorata LRM King and H. Robinson as medicinal plant: A Review. In *IOP Conference Series: Materials Science and Engineering* (Vol. 506, No. 1, p. 012022). IOP Publishing.

Zhao, G., Li, X., Chen, W., Xi, Z., & Sun, L. (2012). Three new sesquiterpenes from Tithonia diversifolia and their anti-hyperglycemic activity. *Fitoterapia*, *83*(8), 1590-1597.