FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

MEATS FOR THE BELLY: THE GOOD, THE BAD, THE UGLY

By

PROFESSOR ELISHA ZHIRI JIYA

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1.0 INTRODUCTION

It is with deep humility that I give gratitude to the Almighty God for the privilege accorded me to present this inaugural lecture.

Mr Vice-Chancellor, Sir, distinguished ladies and gentlemen, the summary of my life is that **"I waited patiently for the Lord; He turned to me and heard my cry. He lifted me out of the slimy pit, out of the mud and mire; He set my feet on the rock and gave me a firm place to stand. He put a new song in my mouth, a hymn of praise to our God. Many will see and fear the Lord and put their trust in Him. Blessed is the one who trust in the Lord, who does not look to the proud, to those who turn aside to false gods. Many, Lord my God, are the wonders You have done, the things You planned for us. None can compare with You; were I to speak and tell of Your deeds, they will be too many to declare" (Psalm 40:1-5 *NIV*)**. So much troubles in the journey of life, but I am what I am through Christ Jesus.

My interest in Animal Production is linked to my father whose first pre-occupation in life was tending his guardian's sheep. At early age in life, I was introduced to harvesting fresh grasses and or edible plants for goats which I still practice today, as my darling wife still keep some goats. Food without meat, no matter how small, is like a king without a crown.

The choice of today's inaugural lecture titled "Meats for the Belly: The Good, the Bad, the Ugly" is by no means to elucidate my significant involvement in the teaching and research in the area of Animal Production with emphasis on meat products development for almost two decades.

Back in the early days the scripture recorded that: **"And Abraham ran unto the herd, and fetch a calf tender and good, and gave it to a young man; and he hasted to dress it" (Genesis 18:7 *KJV*).** The key words in this verse are herd, calf, tender, good and dress. For quality meat production, the animal environment, state and processing/handling are very important. The quantity and quality of meat produced is increasingly becoming important. This situation arose from the increased consciousness and demand of consumers who desired meat characterized by special dietetic and health properties (Brunso *et al*., 2005). Meat quality is a generic term used to describe properties and perception of meat which includes attributes such as carcass composition and configuration, eating property of meat, health issues associated with meat, as well as animal welfare and environmental impact (Maltin *et al*., 2003). The flesh of wild animals like cattle, sheep, goat, pigs, poultry and the micro livestock such as rabbits, snails and grass cutters have been consumed. Human beings consumed meat throughout the ages because of its sustaining qualities and its important source of essential amino acids (proteins), irons, B vitamins as well as other nutrients and minerals. History has it that human beings hunted animals for meat and non-meat products. Today, domesticated animals are used for food. The animals are slaughtered under strict guidelines from various government agencies. These organs of government ensure that the animals are slaughtered in a humane manner and also ensure the animals are free of disease at the point of slaughter and the carcasses are kept clean throughout the dressing process to avoid unwholesome products for consumption. The cut parts of the animal tissues consumed as food are collectively referred to as meat.

The definition of meat varies based on application, while Merriam Webster (2017) described meat as animal tissue especially as food, the American Meat Science Association (AMSA) went a step further to define meat as the skeletal muscle and its associated tissues derived from mammalian, avian, reptilian, amphibian and aquatic species commonly harvested for human consumption. Edible offal consisting of organs and non-skeletal muscle tissues are also considered as meat. Aduku and Olukosi (2000) defined meat as edible and acceptable with different interpretations based on the common practice and aesthetic beliefs of the country, religion or groups concerned, and includes organs, such as liver, heart, tongue, head, feet, tripe, small and large intestines, hide and skin in Nigeria. Meat is not only obtained from domestic animals but game and aquatic animals. The largest category of red meat from domestic animals comes from beef, lamb, veal, goat, pork. Meat is also obtained from less popular source of domestic animals in some communities, for example, horse, camel, eland, water buffalo, donkey, dogs and cats. Poultry which supply the white meat is commonly from the domestic birds which include chickens, turkeys, geese, duck, quail, pigeons, guinea fowl and rabbits. Game animals include grass cutter, antelope (that is now being domesticated), deer, wild buffalo, hare, monitor lizard and rodents. The concern of this lecture "Meats for the Belly: The Good, the Bad, the Ugly" is not just about the types of meats, but the factors (nutrition, genetics, environment, transportation and processing) affecting the production of quality meat. The plural form of meat "meats" appearing on the title of the lecture connotes the fact that the lecture is concerned with the different categorical sources of meat mentioned above.

1.1 Meat composition (Skeletal muscle)

At the time of death when the animal is slaughtered, a lot of biochemical reactions take place as the carcass attempts to maintain homeostasis. Homeostasis is the ability to maintain good state of health physiologically. However, exsanguination (removal of blood) which is the ultimate cause of death prevents the carcass from achieving homeostasis, as a result lactate (which is a by-product of anaerobic metabolism) is accumulated in the muscle and begins the process of muscle to meat conversion. Lactate is converted from glycogen which is a carbohydrate stored in the muscle. Thus, the skeletal muscle is composed of 1% carbohydrate stored in form of glycogen. When the animal is alive, respiration is possible and the animal is capable of aerobic metabolism. However, after exsanguination, aerobic respiration stops and anaerobic metabolism continue for a period of time during which glycogen is converted to lactate. Since blood flow has now stopped, there is no means for removing the waste and thus, lactate accumulates in the muscle. The accumulation of lactate in the muscle results in a decrease in pH leading to the conversion of muscle to meat. Since muscle is now converted to edible meat, the ability of the tissues to hold water is altered as a result of the decrease in pH. The water content of meat is approximately 75% (Aberle *et al*., 2012). Water is said to be held in the muscle in three forms: bound, immobilized, and free water with about 95% in free or immobilized form. This is important because immobilized and free water are held by moderate to weak forces and associated with proteins in the meat and can be removed by mechanical or physical forces such as freezing and thermal processing (cooking). It is noteworthy that water loss during these processes negatively influences the eating qualities such as juiciness and tenderness.

Fat is the most variable among all the meat compositions. Fat can be identified based on its location anatomically. In lean meat, intramuscular fat also known as marbling fat is mostly identified with regards to eating quality characteristics. The deposition of marbling fat in a living animal varies according to species and maturity in terms of percentage of total fat (Gerard and Grant, 2003). Even very lean meat is also said to contain a nominal amount of fat referred to as phospholipids which differs from marbling and may be invisible.

1.2 Nutritional value of meat

Eating of meat is associated with three reasons. First people consume meat because of its taste and desirable flavour. Second, meat is often associated with social status or is enjoyed during celebrations or special occasions, and last it has desirable nutritional benefits and supports human health (Gerber *et al*., 2015). From a nutritional standpoint, meat is associated with zinc, iron and protein, hence the acronym, ZIP. Fresh uncooked meat contains 20% protein (USDA, 2017). Meat has high quality protein and provides essential amino acids, which can only be accessed from a food source rather than being synthesized endogenously. It also has high biological value. Most products (meat, milk and egg) derived from animals are considered to have high biological value (Lawrie and Edward, 2006). Meat, apart from providing nutritional protein, also provides vitamins and minerals in complete diet. The most essential is iron. Iron is associated with the non-protein portion of myoglobin. The differences in iron content of meat derived from different species are likely related to myoglobin content. Chicken has the least myoglobin with beef having the most. The authors (Gerber *et al*., 2015) corroborated that iron contents of animal origin are more easily absorbed than iron derived from plant origin. Apart from iron, meat is also a good source of zinc.

2.0 TYPES OF MEAT

Meat types are categorized by their animal sources and how they are prepared and include:

2.1 Red and white meat

Red meat comes from mammals and contains more of the iron-rich protein myoglobin in its tissues. It includes beef (cattle), mutton (lamb), pork (pigs), chevron (goat), veal and game animals, such as; deer, antelope and wild buffalo. White meat is generally lighter in colour than red meat and come from birds and small games including chicken, turkey, chick, goose, wild birds such as; quail pheasant and rabbits. Red meat has high myoglobin and fat content than white meat. It is naturally red in its raw state. High intake of red meat raises negative health concerns. There is the observational link between red meat consumption and cancer as well as cardiovascular disease especially among the aged (Aberle *et al*., 2012). My advice is that the elderly people reduce red meat intake.

2.2 Processed meat

Processed meat has been modified through salting, curing, smoking, drying or other processes to preserve it or enhance the flavour. Examples include sausage, bacon, jerky and luncheon meats such as bologna and pastrami.

2.3 Carcass vs. non-carcass meat

When animals are slaughtered, the products are separated into carcass and non-carcass components. The carcass components consist of post-mortem muscles, fat, and bone. These are cut into smaller sizes to meet the consumers demand. Steaks, chops, roasts, sausages, and cured meats are derived from the carcass components. Carcass components are referred to as meat. The non-carcass component can further be classified into edible and non-edible parts. These are referred to as offal. The edible offal includes organs such as hearts, liver, kidneys and other organs which are wholesome, and sold as food for human consumption. The acceptability of offal is determined by the consumer, cultural practices, regulatory requirements, hygiene and religion. The inedible portion of the non-carcass part of an animal are nails, horns and manure and in some cases the contentious hide and skin popularly referred to as *ponmo*.

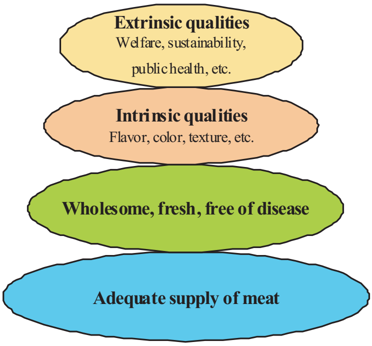
2.4 Laboratory produced (*invitro*) meat

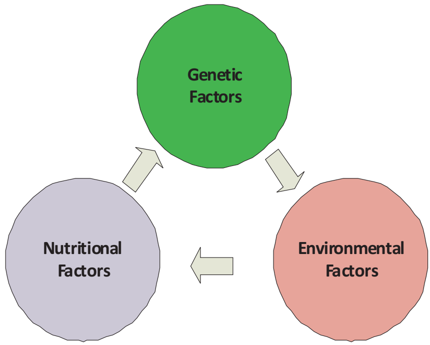
Of recent, the clamour for other meat sources due to the rapid increase in human population growth vis a vis demand for meat has now led to the laboratory produced meat. The conventional meat production requires input such as water, land and feed. Issues that have to do with the current farmers-herders clashes, environmental impact, sustainability, animal welfare associated with conventional meat production (slaughtering) have led to the exploration of alternative meat production. Cultured meat is produced using many of the same tissue engineering techniques traditionally used in regenerative medicine. The objective of cultured meat is to recreate the complex of livestock muscles with a few cells. The process is not without pros and cons. It is difficult to imagine that cultured meat producers will in the near future offer consumers a wide range of meats, reflecting the diversity of animal muscles or coats.

Eating quality depends on a lot of factors ranging from species (pork, poultry, beef, mutton, chevron, etc.), breeds, genders, animal types (young bulls, heifers and steers), farming conditions (depending on location) and depending on muscle anatomy. This complex process still needs to be controlled if in vitro meat is going to be made attractive to consumers. However, the arguments in favour of the cultured meat are that of health and safety, comparison of environmental impact with conventional farming, and comparison of welfare issues with conventional farming. The danger is that if livestock are removed and replaced with cultured meat, a number of livestock services will be lost. Aside the production of meat, livestock farming performs numerous functions which include income to the rural populace. Livestock also provides wool, fibre and leather.

3.0 FACTORS THAT AFFECT MEAT QUALITY

Meat quality definition changes depending on the consumer. There were four stages (Plate 1) and approach to meat quality over ages. In the early days of 20th century, the major fears of the meat scientists were the provision of enough meat to feed people and the preservation of wholesomeness. The intrinsic factors that affect meat quality including appearance, taste, smell or feel were mostly used to judge meat quality at the point of purchase or consumption after cooking. The focus of the scientists then was to reduce these intrinsic factors by working on genetic selection, animal production, slaughter methods and most especially post-mortem handling of meat. Apart from these intrinsic factors, the consumers were concerned about the extrinsic factors of meat and meat products. They are called extrinsic factors because they cannot immediately be explored by physical or sensory taste of meat, but are linked with the way the meat is produced. The extrinsic factors include animal welfare, nutritional content of the meat and the sustainability of production systems (Grunt, 2006). Now the well-being of the meat animals, the meat consumers and the society as a whole are key parts of the meat production systems and the final products itself. The stacked circles containing meat availability, wholesomeness, intrinsic and extrinsic factors are also dependent on a number of factors which includes the economic state of individuals and in some developing countries, the price and availability of meat are the most important factors for the consumers. Consumers in countries where there is high gross national product are most concerned with issues of animal welfare, human health and ecological sustainability of meat production. Improving meat quality would benefit both consumers and livestock producers; leaner animals produce meat which is more variable in quality, improvement in meat quality will enable consumers to enjoy tenderness and flavour along with enhanced nutrition and health. Improvement in meat quality will influence the demand for meat products. The availability of wholesome meat depends on a number of factors whether intrinsic or extrinsic.





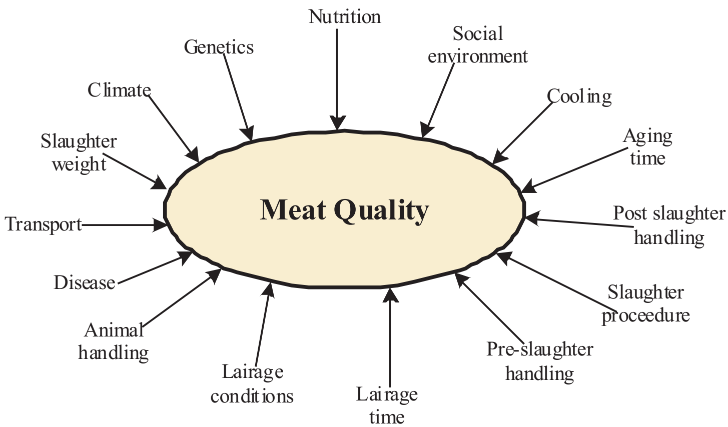


Plate 1: Meat quality factors, adapted from (Grunt, 2006).

3.1 Genetic factors

Genetic factors are known to affect muscle characteristics, for example fibre type, collagen, intra muscular adipose tissue, and proteas activities which in turn affect the sensory properties (tenderness and flavour) of the meat. Tenderness has two major components namely background toughness which results from connective tissues (collagen) and the myofibrillar component. The myofibrillar component is closely related to muscle fibre characteristics that control the tenderization phase which are characterized by post-mortem proteolysis, a major biological process involved in the conversation of muscle into meat (Maltin *et al.*, 2003). The intramuscular fat and its fatty acid composition determine the meat flavour, while the lipid oxidation is responsible for odour which is usually described as rancid. Juiciness is difficult to evaluate but can be influenced by the structure of meat and its water holding capacity (Carmen *et al*., 2018).

3.2 Nutrition

Nutrition is a powerful component of livestock production system that controls many aspects of meat quality. The animal feed generally affects hygienic, sanitary and nutritional characteristics of meat. Meat quality attributes are affected by the amounts and type of nutrient intake; such qualities include dressing yield (meat yield), meat: bone ratio, protein; fat ratio, fatty acid composition, calorie value, colour, physico-chemical and processing properties, shelf life and sensory attributes (Kandepan *et al*., 2009). Consumers' perception has changed overtime and is now more health conscious. They prefer quality meat at affordable cost with bright colour, lean, low fat, tender, free from residues and processed under hygienic conditions. World Trade Organization (WTO) agreements empowered law enforcement agencies to focus on improving quality and safety of meat products through adequate nutrition for the meat consumers (Kandepan *et al*., 2009).

3.3 Environmental factors

Apart from nutrition and genetic factors, the third major factor that affects meat quality are the environmental factors. The genotypic factors depend to a great extent on environmental conditions. Such factors as it affects meat quality include pre-slaughter and post-slaughter conditions.

3.3.1 Pre-slaughter conditions

The pre-slaughter conditions involve all activities and movement of animals from farm to the slaughter house. If the activities carried out on the farm, market and the slaughter house are poorly performed animal welfare will be compromised by causing stressful conditions, thereby resulting in negative changes to the carcass and its quality. How animals respond to stress depends on species, breed, sex and age. Ruminants are said to be more resistant to stress than pigs and poultry. Transportation could have negative effect on animal health, performance and meat quality. Stressful conditions may cause injury, mortality and morbidity. Conditions such as food and water deprivation during transportation period, noise vibrations, diverse climatic conditions, poor holding and even mixing with unfamiliar groups will in turn have effect on the quality of the carcass. The lairage condition at the slaughter house is another critical factor. If quality of meat is to be produced, animals must be rested in the lairage for 24 hours before slaughter. This is done in order to fill glycogen reserves that have been depleted during earlier pre-slaughter activities. Note that lairage conditions if not properly handled could affect meat quality.

3.3.2 Slaughter and post-slaughter conditions

Immediately the animal is slaughtered, it is required to bleed the animal properly to avoid the growth of pathogenic micro-organisms. The carcass(es) of slaughtered animals are to be quickly chilled at 0-4 ^{o}C for 24h to prevent proliferation of micro-organisms, however rapid chilling of goat meat (chevon) results in the production of tough meat (Kannan *et al*., 2014).

3.3.3 Carcass suspension

Carcass suspension restrains muscles from shortening during chilling process tender-stretch effectively stretched the sarcomeres and improved meat tenderness.

3.3.4 Ageing

Ageing improves meat tenderness, and could be critical for the visual appearance of meat. In beef meat ageing is said to have a significant effect on sensory parameters. Tenderness and odour intensity are attributes that are mostly affected by ageing, especially between the first 3 and 7 days of ageing. Generally, tenderness is higher as ageing time increases.

3.3.5 Preservation

Meat storage shelf life is very important for meat industry and consumers. Different packaging techniques (vacuum, modified atmosphere or film) determine the optimum products shelf life. The duration of storage determines the type of packaging system to be used.

3.3.6 Cooking

The quality of meat is strongly affected by method and time of cooking. Differences in the method and cooking time influences texture and the development of meat flavours as evaluated by the consumers. The fact remains that consumers usually prefer meat they are accustomed to and the cooking method with which they are more familiar with. It is therefore important that all agents within the meat chain should be involved so that the meat products in terms of acceptability and durability could be obtained.

4.0 THE NIGERIAN ANIMAL PRODUCT INDUSTRY

Mr. Vice-Chancellor, Sir, it is expected that global meat consumption may double by the year 2050, as a result of increase in the world population and partly due to increase per capita meat consumption mostly in developing nations like Nigeria. The total production of meat in Nigeria increased from 410,526 t in 1970 to 1.48 million t in 2019 and is expected to double by the year 2050 (Sonaiya, 2020). The challenge is that animal product industry takes off from where livestock industry stops. The value addition by the meat production industry is not directly correlated with the livestock resources. The main sources of animal food in Nigeria include poultry meat, goat (chevon), mutton, beef, pork, eggs and milk. Less popular sources include horse, dog and cats. Beef which produces the largest quantity of animal food comes from the northern part of the country. The southern part of the country provides the market. It is estimated that more than two million heads of cattle are slaughtered annually (Sonaiya, 2020). There is poor coordination of slaughtering of animals with significant numbers been slaughtered in small slaughter slabs on a daily basis. That has affected the statics and control of the quality and even the documentation of the quantity of the products is a mirage.

I was privileged to visit Uruguay in 2014. It is amazing that, Uruguay, a small country with nine provinces (states), has only nine but modern abattoirs. The law is such that no one slaughters anything anywhere outside the abattoirs. That has brought about correct data on quantity and quality of meat production in the entire country. In fact there is a synergy between the livestock producers and the meat industry as Uruguayan meat is traceable to the farm from which the animal was raised. As mentioned earlier central slaughtering is limited in Nigeria and not well organized. Today mechanical slaughtering processing is still a mirage except the one privately managed in Lagos central abattoirs, despite the availability of facilities.

Let me reiterate that Minna abattoir was supposed to be a modern abattoir, so also the one in Zaria but all the installed equipment has been vandalized. Mokwa abattoir is said to be the largest in terms of capacity of animals to be slaughtered per day, but it is moribund. Some of this vandalization experienced may be due to the preponderance of traditional/religious methods of slaughtering, which may make it difficult to adapt to mechanical slaughtering. The marketing of meat is such that the marketing system of animal products most especially beef is not organized as it is not based on consumers demand or any grading system and that in turn affects the pricing system. The current traditional way of herding animals thereby causing drudgery and toughening of animal meat as well as the waste of animals on our highways during transportation could be minimized if there is a proper and organized system.

Beef could be the “gold mine” of the northern part of Nigeria if properly processed and packaged before transporting to southern Nigeria. Good quality processing and packaging will attract high premium. Muton (sheep) and chevon (goat) markets are similar to that of cattle. They are less in demand compared to beef, except on festive occasions. Pigs and poultry are usually traded and slaughtered by producers with no central abattoirs for their products. Of course, donkeys, horse and dogs are slaughtered through private arrangements as they do not enjoy wide social acceptance as food. There is little or no grading system for all of these products, thus quality of the products and consequently consumers' satisfaction is not certain. Presently meat handling from the farm to the slaughtering house and to the market is poor (Plate 2-7).

There is the need to review the entire chain with the aim of producing quality products for the teeming consumers and high premium for the producers. Because our abattoirs are not properly organized some of the by-products, particularly hides and skins have been harnessed into human food. These products have no contribution to human nutrition though they are widely consumed. *Ponmo* as it is widely called is killing our leather industry. I want to re-echo the slogan by NIAS “Eating Ponmo is

Plate 2: Lairage

Plate 3: Wheeling a cow for slaughtering

Plate 3: Cow direct from cattle market for slaughter

Plate 4: Meat processing environment

Plate 5: Transportation of meat from the abattoir

Plate 6: Roasting of small ruminants with tyre

Plate 7 Washing roasted beef with unclean water

killing our leather industry", there are better and valuable things to put in the belly than *ponmo*. It is noteworthy, that more processed animal food is now found in the open market and carried along the street of not only cities, but even villages. As at today in most Nigerian villages, not only urban centres, you find *mai suya* and even *kilishi* and *Danbu nama* (meat jerky, and meat floss) on sale. The challenge is that of standards not only in processing of the products, but packaging.

To ameliorate the deficit of protein intake most especially that of animal origin viz a viz the teeming population explosion that has begun already, there is the need for the production of smaller animals with short generation interval, high genetic potential, high prolificacy and low production cost such as the rabbits, quails and other mini livestock. Rabbit meat compared to the earlier sources mentioned is very scarce in the meat shops. These small bodied animals are handy, enough for a family meal. They are tender, lean and rich in protein. They are easy to cook. Above all, some of these animals can be raised at the backyard. Today I want to also advocate backyard animal farming to meet the family protein needs.

5.0 MY CONTRIBUTIONS

I wish to present my contributions under three headings: Animal production, meat processing and product development.

A Animal production

My first experience in research was from a research grant funded by the Board of Research, Federal University of Technology, Minna won by my academic fathers, Professors B.A. Ayanwale and T. Z. Adama. A twelve (12) week feeding trial using 70 weaned rabbits was carried out to investigate the effect of cocoyam (*Colocasia esculentum)* corm and Mango (*Mangifera indica)* on growth performance of rabbits (Table 1). Five concentrated corm-based diets were formulated. The control had 0 % cocoyam corm. A portion of cocoyam corm was cooked and included in the diets at 25, 50 and the uncooked was also included at 25 and 50 % replacing maize as energy source respectively. The significant (P<0.05) low intake is an indication of the high proportion (50 %) of uncooked corm as a replacement for maize in the diets of rabbits. This reduction could be attributed to high content of the needle-shaped calcium oxalate, which has low solubility. This compound is also responsible for the irritation caused by raw cocoyam. The effects could be partly reduced by boiling (Ayanwale *et al*., 2001). However, the rabbits in the treatment compensated for the low concentrate intake by high forage intake (461.70 g). This is particularly true since there was no significance difference in the overall concentrate + forage intake. The study revealed that cocoyam corm supplemented with mango leaves supported growth of rabbits especially when cooked (Ayanwale *et al*., 2001).

In 2010, intensifying the search for cheaper feed for rabbit production in order to fill the protein gap for the teaming population, working with my undergraduate students, we investigated growth performance and carcass characteristics of rabbits fed kolanut husk meal (KHM) (Table 2). Thirty-six (36) rabbits were randomly allotted to three dietary treatments containing 0, 10 and 20 % of KHM. The results revealed non-significant difference (P>0.05) in the growth indices. However, the significant (P<0.05) difference observed in the values of loin and rib weight of the rabbits cut, may be due to the processing technique. The differences in heart may be due to a reduction in the heart fat content as a result of high fibre content present in KHM. KHM can be included in the diets of rabbits up to 20% level and energy level of 2505 K/cal metabolizable without any adverse effect.

Table 1: Growth performance and carcass characteristics of rabbits fed cocoyam corm and mango leaves.

Parameters	Diets (%)					SEM
	Control	Cooked cocoyam		Uncooked cocoyam		
	0	25	50	25	50	
Initial body weight (g)	754.50	784.00	762.00	756.00	735.00	5.01NS
Final body weight (g)	1538.00	1553.00	1653.00	1550.00	1437.00	5.01NS
Mean concentrate intake (g)	2419.55^{a}	2442.20^{a}	2414.20^{ab}	2421.86^{a}	2319.03^{b}	26.95*
Mean forage intake (g)	445.33^{a}	500.78^{ab}	410.55^{ab}	411.21^{ab}	461.70^{b}	7.01*
Forage + Concentrate intake (g)	2860.09	2968.78	2822.82	2801.48	2780.68	24.04
Feed conversion ratio	4.39	4.99	4.50	4.36	4.33	2.54NS
Live shrunk weight (g)	1438.12	1455.32	1543.10	1449.10	1396.13	2,34NS
Dressed weight	878.97	830.70	889.31	751.75	760.03	0.15NS
Dressed % live weight	57.15	53.49	53.80	48.50	52.89	2.92NS
External offal (%)	18.70	20.31	18.36	20.07	18.63	1.86NS
Fore limb (%)	9.84	10.62	9.28	8.16	8.83	0.70NS
Hind limb (%)	14.52	14.14	12.82	11.95	12.95	1.23NS
Rack (%)	24.98	25.44	23.30	22.52	24.52	1.58NS
Full gut (%)	10.47	10.46	10.72	11.08	13.29	1.41NS
Empty gut (%)	3.62	4.20	4.57	3.86	4.89	0.50NS
Gut length (cm)	21.24	25.03	19.10	25.95	27.60	1.66NS
Liver (%)	2.37	2.31	2.35	2.31	2.32	0.24NS
Lungs (%)	0.65	0.67	0.41	0.63	0.67	0.15NS
Kidney (%)	0.52	0.54	0.55	0.55	0.60	0.05NS
Heart (%)	0.26	0.22	0.22	0.23	0.21	0.02NS
Abdominal fat (%)	3.55	4.86	6.48	2.11	2.44	1.81NS

Source: Ayanwale, Adama and Jiya (2001).

Table 2: Performance and meat quality characteristics of rabbits fed kolanut (Cola acuminata) husk meal.

KHM Levels Parameters	0	10	20	SEM
Initial body weight (g)	541	550	550	4.55NS
Final body weight (g)	1206	1191	1147	20.02NS
Feed intake/day (g)	25.71	24.07	26.23	0.54NS
Feed conversion ratio	17.16	16.10	20.30	0.87NS
Live shrunk weight (g)	1193	1180	1136	17.02NS
Dressed weight	678.50	599.91	569.26	0.24NS
Dressed % live weight	56.26[a]	50.37[b]	49.63[c]	1.21*
Pelt (%)	21.41	19.60	20.84	0.41NS
Shoulder (%)	10.80	9.96	9.91	0.37NS
Hind limb (%)	18.08	16.33	17.01	6.24NS
Loin (%)	4.50[a]	2.80[c]	4.12[b]	0.31*
Rib (%)	2.56[a]	1.82[c]	1.88[b]	0.13*
Empty gut (%)	11.55[b]	9.34[c]	12.60[a]	0.54*
Liver (%)	3.34	3.01	3.03	0.15NS
Kidney (%)	0.82	0.68	0.78	0.05NS
Heart (%)	1.34[a]	0.88[c]	1.16[b]	0.08*
Abdominal fat (%)	1.34	1.99	1.35	0.31NS
Water holding capacity (%)	30.00	24.47	28.33	1.21NS
Cooking yield (%)	64.43	64.43	62.77	0.96NS
Cooking loss (%)	35.57	34.47	36.10	1.17NS

KHM= Kolanut husk meal. Source: **Jiya,** Ayanwale, Aboyeji and Olorunleke (2012).

In 2001 as we will see in the course of this presentation, the then Dr. B. A. Ayanwale, now a professor, shined a light in a path that looked virgin as not many people trod the path of meat science. He carried me on his shoulders and supervised my M.Tech thesis. Thus began my study of meat science. I joined the University in November, 2005 on lecturer II cadre. In 2008 the University gave me fellowship to pursue my doctoral studies. Again, Professor Ayanwale linked me with Professor A. O. Olorunsanya, a meat science expert from Ibrahim Badamasi University, Lapai, Niger State, to supervise my work with Professor, Abdulmojeed T. Ijaiya as the main supervisor. The arrangement was approved by the University Senate. Thus, the journey to pursue the study of meat science began in earnest. With zeal looking for quality meat product using non-conventional feed resource, as a village boy, we used to go hunting giants' rats. One of my brothers, Mr Silas

Ndakolo Jiya, and others usually went digging giant rat burrows. I remembered that we used to see a lot of shells of tallow (*Detarium microcarpum*) seeds in the burrows, so I felt that will be a good ingredient to feed rabbits, ameliorating the scarce and highly competed conventional feed stuff, most especially maize and ground nut cake. I thus proposed a research work titled: "Performance and organoleptic qualities of rabbits (*Oryctolagus cuniculus*) fed diets containing graded levels of processed tallow (*Detarium microcarpum*) seed meal."

It was the beginning of the struggle to place rabbit meat on the shelf among many other livestock products species. Eighty-one (81) weaned rabbits of mixed breeds and sexes (male and female) were randomly allotted to nine treatment groups with nine rabbits per treatment. Each treatment had three replicates with three rabbits per replicate. Processed tallow was included in the diets as a source of protein which was set as 16 % CP. The control diet had 100 % palm kernel cake (PKC) meal and 0 % tallow seed meal (TSM) groups 1 – 4 contained cooked tallow seed meal (CTSM) diets and included as 75 % PKC: 25 % CTSM, 50 % PKC: 50% CTSM, 25% PKC:75 % CTSM and 0 % PKC: 100 % CTSM, while groups 5 – 8 had fermented tallow seed meal diets (FTSM) and included at the same levels as observed in the cooked diets. The proximate composition of meat from hind leg, shoulder, rib and loin of rabbits fed diets containing graded levels of processed tallow seed meal (TSM) (Table 3), were examined (Jiya *et al*., 2014). The processing method had no significant (P>0.05) effect on the moisture content of the hind legs, shoulder MC, CP and EE and the loin MC and EE of rabbits. However, the processing methods were found to have influenced the hind leg (CP, EE), rib MC, CP, EE) and loin (CP) significantly (P<0.05) by the levels of inclusions of tallow in the diets. The hind leg MC was higher at 0 % although similar to those fed at 25% and 100 % levels, but differed (P<0.05) from the rabbits fed at 50 % inclusion level. The highest CP was at 75 % level, while the least was observed at 100 % inclusion level. The shoulder MC was higher at 25 % level although similar to 50 % level. Shoulder EE was lower. The rib moisture content was also in line with the reported values by Pla *et al*. (2004) although the ether extracts were lower than the (12.80 %) reported by the same authors. The loin values were not appreciably influenced by the diets except the per cent crude protein which were slightly different. The values were slightly higher than the 22.10 % reported by Pla *et al*. (2004). The contents of the lipids in this present study were within the range of 0.60-14.40 as reported by Dalle-Zotte (2000). It was concluded that processing methods improved the nutritional content of meat from rabbit's cut-up parts. The CP contents were higher at 75 % levels in all the cut-up parts measured except in the loins. EE were also within the normal ranges. Therefore, meat from rabbits fed tallow seed meal-based diets had high nutritional quality.

Interaction effect between processing methods and level of inclusion of tallow seed meal (TSM) diets on percentage cooking yield, cooking loss, pH and sensory properties of the meat of rabbits was also studied (Table 4). There was interaction between processing methods and level of inclusion of tallow in the diets of the rabbits in all the parameters measured except for the WHC. The results revealed that cooking yield was higher in meat of rabbits fed 75% CTSM although similar to those fed 100 % CTSM, 25 and 50 % FTSM respectively. Cooking loss was higher in the meat of rabbits fed the control (0 % TSM) diets, which is similar to those fed 25, 50 % CTSM and 100 % FTSM. The pH value of the meat from rabbits was higher in those fed 75 % FTSM diets. Water-holding capacity of meat is defined as the ability of the post-mortem muscle (meat) to retain water even though external pressures (e.g. gravity, heating) are applied to it. Numerous factors can affect both the rate and the amount of drip or purge that is obtained from the product. Also, of extreme

importance is the metabolic state of the live animal at the time of harvest. This can be influenced by the genetic make-up of the animal and by the way the animal was handled. The water holding capacity (WHC) by the rabbits fed processed tallow seed meal-based diets was not affected by the processing methods, however, the levels differ significantly (P<0.05) from one another. The difference observed in the levels of inclusion might be as a result of the factors stated above and not the feeding regime. The cooking yield and loss from the meats of rabbits fed processed tallow seed meal-based diets were significantly (P<0.05) affected by the levels of inclusion. These differences might be driven by the extent of rigour and protein denaturation. This was the case, when Omojola and Adesehinwa (2006) studied the meat characteristics of scalded, singed and conventionally dressed rabbit carcasses.
The rabbits fed FTSM based diets had higher pH; this might depend on the balance of muscle energy and represents a key role in the maintenance of the meat quality during storage. A higher pH of 6.14 was recorded in rabbits fed processed tallow seed meal-based diets at 75 % levels and agrees with the reports of Dalle-Zotte et al. (2005). The interaction effect showed that low cooking yield was recorded from the meat of rabbits fed 100 % FTSM (36.90) diets which is inversely proportional to the cooking loss. The low value reported in this study is higher than value (27.69 %) reported by Omojola and Adesehinwa (2006). The properties of meat, the colour parameters in particular, are strictly related to pH. Also, at high pH levels oxymyoglobin is rapidly turned into reduced myoglobin with dark red colour; it is also related with oxidative energy metabolism (Dall-Zotte, 2002). The mean sensory scores showed that colour, tenderness, juiciness, flavour and overall acceptability were all affected by the processing methods. Rabbits fed at 100 % FTSM had the best meat colour, juiciness and overall acceptability by the panellists.

Table 3: Proximate composition of meat from hind leg, shoulder, rib and loin of rabbits fed diets containing graded levels of processed tallow seed meal.

Methods	Hind leg			Shoulder			Rib			Loin		
	MC	CP	EE	MC	CP	EE	MC	CP	EE	MC	CP	EE
Cooked	65.25	24.21^{a}	6.83^{b}	64.71	25.15	5.13	66.01^{a}	20.58^{b}	9.76^{b}	66.06	23.12^{b}	6.61
Fermented	65.20	23.15^{b}	8.72^{a}	64.72	25.15	5.12	65.022^{b}	22.12^{a}	10.48^{a}	65.90	23.33^{a}	6.74
SE±	0.07	0.04	0.14	0.05	0.07	0.01	0.18	0.32	0.07	0.10	0.04	0.05
LOS	NS	*	*	NS	NS	NS	*	*	*	NS	*	NS
Levels												
0	65.68^{a}	24.23^{a}	6.81^{c}	64.36^{c}	25.24	5.08^{b}	65.88^{a}	19.80^{c}	9.77^{c}	66.09	23.14^{b}	6.50
25	65.34^{ab}	24.24^{a}	6.87^{c}	64.99^{a}	25.22	5.14^{a}	65.68^{a}	21.53^{ab}	9.85^{c}	65.67	23.35^{a}	6.72
50	64.65^{c}	23.86^{b}	8.22^{b}	64.80^{ab}	25.22	5.13^{a}	65.63^{ab}	21.61^{ab}	10.03^{bc}	66.15	23.60^{a}	6.77
75	65.07^{b}	25.83^{a}	7.43^{c}	64.69^{b}	25.03	5.13^{a}	64.79^{b}	22.77^{a}	10.60^{a}	66.06	23.16^{b}	6.66
100	65.39^{ab}	22.24^{c}	9.54^{a}	64.71^{b}	25.03	5.13^{a}	65.59^{ab}	21.06^{bc}	10.35^{ab}	65.95	23.12^{b}	6.73
SE±	1.18	0.06	0.22	0.09	0.11	0.01	0.28	0.50	0.35	0.16	0.06	0.09
LOS	*	*	*	*	NS	*	*	*	*	NS	*	NS
M×L	*	*	*	NS	NS	*	NS	*	*	NS	*	NS

[abc]Means with different superscripts in the same column are significantly ($P<0.05$) different. SE: Standard error, LOS: level of significance, NS: Not significant, *: Significant, MC= Moisture content CP= Crude protein EE= ether extract, M x L: Interaction between method and level. Source **Jiya** et al. (2014).

Table 4: Interaction effect between processing methods and level of inclusion of tallow seed meal (TSM) diets on percentage cooking yield, cooking loss, pH and sensory properties of the meat of rabbits.

Parameters	Cooking Yield (%)	Cooking Loss (%)	pH	Colour	Tenderness	Juiciness	Flavour	Overall Acceptability
Cooked								
0	56.19^{c}	43.81^{a}	5.86^{cd}	5.70^{bc}	6.35^{b}	6.30^{b}	7.00^{cd}	7.00^{cd}
25	59.32^{bcd}	40.68^{abc}	6.28^{ab}	5.45^{c}	5.40^{b}	6.15^{b}	6.30^{bc}	6.65^{d}
50	60.68^{bcd}	39.33^{abc}	5.57^{cd}	5.90^{bc}	6.15^{b}	6.25^{b}	6.20^{c}	6.85^{cd}
75	66.72^{a}	33.28^{d}	5.77^{cd}	6.30^{bc}	6.65^{ab}	6.90^{ab}	7.20^{a}	7.50^{bc}
100	65.74^{a}	34.27^{d}	6.19^{b}	6.50^{b}	6.25^{b}	6.25^{b}	6.75^{abc}	7.35^{bcd}
Fermented								
25	63.76^{ab}	36.24^{cd}	5.87^{c}	6.30^{bc}	6.90^{ab}	6.85^{ab}	7.35^{a}	7.80^{ab}
50	66.63^{a}	33.37^{d}	6.38^{ab}	6.25^{bc}	6.75^{ab}	7.00^{ab}	7.15^{ab}	7.55^{bc}
75	61.04^{bc}	38.96^{bc}	6.51^{a}	6.10^{bc}	9.25^{a}	6.25^{b}	7.05^{abc}	7.20^{bcd}
100	36.90^{d}	42.10^{ab}	5.65^{cd}	7.55^{a}	7.85^{ab}	7.55^{a}	7.30^{a}	8.35^{a}
SE±	0.46*	0.48*	0.03*	0.25	0.73	0.23	0.24	0.20
LOS				*	*	*	*	*

^{abc}Means with different superscripts in the same column are significantly ($P<0.05$) different.
SE: Standard error, LOS: level of significance, NS: Not significant, *: Significant, MC= Moisture content
CP= Crude protein EE= ether extract, M x L: Interaction between method and level. Source Jiya et al. (2014).

Meat from rabbits fed 75 % was tenderer (although not statistically different from meat from rabbits fed 100 % CTSM, 25, 50, 75, and100 % FTSM diets respectively). Flavour was better in meat from rabbits fed 75 % CTSM based diets although statistically, there was no difference between it and meat from rabbits fed diets 100 % CTSM, 25 % FTSM, 50 % FTSM, 75 and 100 % FTSM based diets. The better rating for colour, juiciness flavour and overall acceptability by the panellist on the meat of rabbit's fed100 % FTSM might have been influenced by the muscle type which is said to affect juiciness (Omojola et al., 2003). Juiciness according to the authors is also related to the water holding capacity of meat.

The better tenderness score in meat from rabbits fed 75 % FTSM might be as a result of rigour shortening especially during the first 24 hours post-mortem which is temperature dependent (Omojola and Adesehinwa, 2006). Meat tenderness is dependent on a number of factors such as species, age, sex, ante-mortem stress and slaughter conditions. The least tender meat of rabbits fed 50 % CTSM although similar to other meat samples from the other treatments except the meat from rabbits fed 100 % FTSM might be hinged on sex, ante-mortem stress, slaughter conditions and nutritional regimes of the rabbits and this is in line with the findings of Jiya et al. (2002) who observed the same in the meat of broiler chickens. Another quality characteristic investigated was the fat proportions of rabbits (per cent of dressed weights) (Table 5). The mean per cent fat deposits were not significantly (P>0.05) influenced by the methods of processing. The scapular per cent had higher (P<0.05) fat deposits in rabbits fed FTSM diets than those fed cooked diets. The level of inclusion of tallow however significantly (P<0.05) affected the per cent inguinal fat. Higher (P<0.05) value was recorded in rabbits fed at 100 % levels. The values obtained for 75, 25 and 50 % were not statistically (P<0.05) different from each other. The per cent abdominal fat was greatest at 75 % TSM level though similar statistically to the value at 100 % TSM inclusion which was similar to the control, 25 % and 50 % TSM levels in the diets. There were no interaction effect of processing methods and level of inclusion on fat deposits. The highest inguinal fat per cent observed in rabbits fed at 100 % levels and abdominal fat per cent of rabbits fed 75 % levels irrespective of the processing method might be due to low energy value of PKC in the diets. The higher inguinal fat per cent of rabbits fed diet (75 % FTSM) might be as a result of fermentation of the diets leading to possible ether extract reduction of PKC in the diet. The result agrees with the reports of Ari (2006) who reported a reduction in fat deposition of broilers fed fermented products although no pattern was formed in this study.

The amino acid content of the meat from rabbits revealed that there was an interaction between processing methods and levels of inclusion of tallow seed meal (TSM) on the meat of rabbits (Figure 1). The result revealed significant (P<0.05) differences. Meat from rabbits fed 100 % CTSM diets were observed to have higher values for the amino acids considered except for alanine which was observed to be higher in meat obtained from rabbits fed 25 % FTSM diets. The findings of this study indicate that the meat of the rabbits is highly nutritious due to the high amino acid contents of the meat from the rabbits fed processed tallow seed meal diets irrespective of the processing method or the level of inclusion of TSM in the diets.

MUFA (Mono unsaturated fatty acid), SFA (Saturated fatty acid), PUFA (Poly unsaturated fatty acid) presented in Figure 2. The interaction effect of processing methods and levels of inclusion of TSM on the fatty acid contents of the hind leg of rabbits fed processed tallow seed meal diets revealed that SFA was significantly (P<0.05) higher in meat obtained from rabbits fed control (0 % TSM) diets. MUFA was higher in the meat of rabbits fed 25 % FTSM diets than the least in the meat of those fed 50 % CTSM diets. PUFA was higher in the meat of rabbits fed 75 5 FTSM diets and least in the meat of rabbits fed 0 % TSM diets. SFA / PUFA ratio was least in meat obtained from rabbits fed control (0 % TSM) diets and highest in meat from rabbits fed 75 % FTSM diets.

Table 5: Fat proportions of rabbits (percentage of dressed weights) fed diets containing graded levels of processed tallow (TSM) seed meal diets (% DW).

Methods	Inguinal	Scapular	Abdominal
Cooked	0.43	0.48[b]	1.43
Fermented	0.40	0.60[a]	1.55
SE±	0.02	0.03	0.06
LOS	NS	*	NS
Levels			
0	0.31[c]	0.44	1.37[b]
25	0.38[bc]	0.54	1.42[b]
50	0.36[bc]	0.53	1.44[b]
75	0.45[b]	0.60	1.75[a]
100	0.57[a]	0.61	1.49[ab]
SE±	0.03	0.05	0.09
LOS	*	NS	*
M×L	NS	NS	NS

[abc] Means with different superscripts in the same column are significantly (P<0.05) different, SE: Standard error, LOS: level of significance, NS: Not significant, *: Significant, M x L: Interaction between method and level. Source **Jiya *et al.*** (2014).

The results of interaction effect of processing methods and levels of inclusion of TSM on the mineral content of rabbits (Figure 3) were found to be significantly (P<0.05) different. Potassium was higher in rabbits fed 50 % CTSM diets which was similar to those fed 50 % FTSM but differ (P<0.05) from the least in those fed 25 % FTSM diets, sodium content was higher in

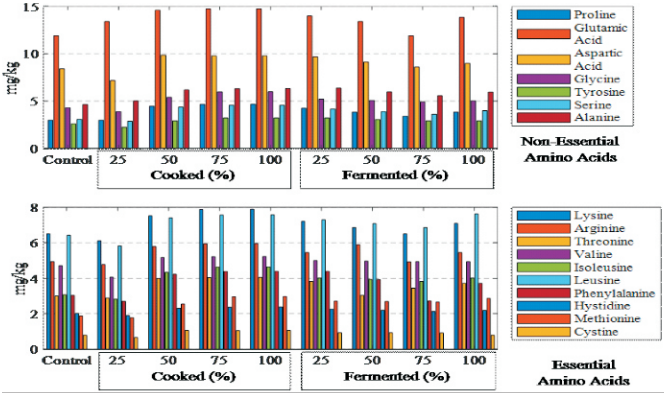


Fig 1: Interaction effect of processing methods and levels of inclusion of tallow seed meal (TSM) on amino acid content of the meat of rabbit. Source **Jiya** *et al*. (2014).

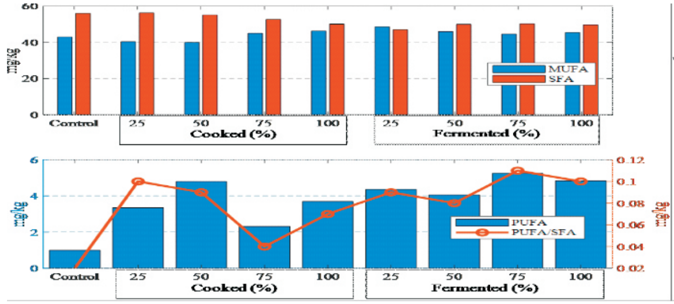


Fig 2: Interaction effect of processing methods and levels of inclusion of tallow seed meal (TSM) MUFA (Mono-unsaturated fatty acid), SFA (Saturated FA), PUFA (Poly unsaturated FA). Source Jiya et al. (2014).

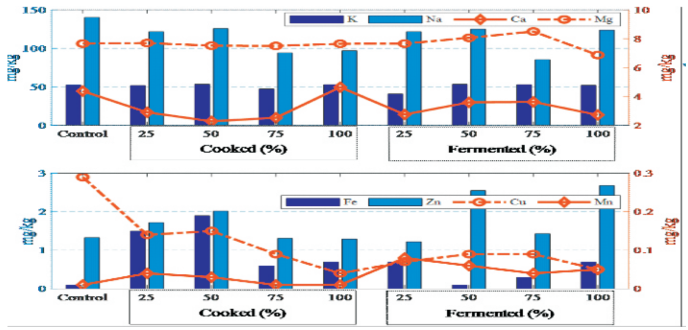


Fig 3: Interaction effect of processing methods and level of inclusion of tallow seed meal (TSM) on the mineral content of rabbits K= Potassium, Na = Sodium, Ca = Calcium, Mg = Magnesium, Cu = Copper, Mn = Manganese. Source Jiya et al. (2014).

rabbits fed control (0 % TSM) diets. Calcium was higher in rabbits fed 100 % CTSM diets and least in those fed diet 50 % CTSM diets. Magnesium was higher in rabbits fed 75 % FTSM diets compared to the lowest in rabbits fed 100 % FTSM diets, copper was higher in rabbits fed 0 % TSM diets with those 25 % FTSM diets being the least. Iron content was higher in rabbits fed 50 % CTSM diets, while zinc was higher in rabbits fed 100 % FTSM diets compared to the least in those fed 25 % diets. The significant ($P<0.05$) differences observed in the values of the mineral contents of rabbit meat could be attributed to the effect of the diets. The moderate potassium and sodium concentration observed in this study confirmed rabbit meat as a good diet Juiciness according to the authors is also related to the water holding capacity of meat. for coronary heart patients (Hermida *et al*., 2006).

In a bid to provide the good meats for the belly we investigated meat quality and sensory properties of weaner rabbits administered different concentrations of probiotic (*Saccharomyces boulardii*) (Jiya *et al*., 2018). A total of 36 mixed breeds of rabbits were randomly allotted to four treatments with three replicates and three rabbits per replicate. The weaner rabbits were fed the same diet. Treatments T_1, T_2, T_3 and T_4 had zero (0) concentration of probiotic, 1ml each of 160 x10^6 cfu/ml concentration of probiotic, 1 ml each of 80 x10^6cfu/ml concentration of probiotic and 1 ml each of 40 x 10^6cfu/ml concentration of probiotic, respectively. The administration of the probiotic was done once every 14 days (*Table 6)*. It was concluded from the study that oral administration of probiotic (*Saccharomyces boulardii)* at 80 x 10^6cfu/ml concentration improved meat qualities and overall acceptability of rabbit meat. As earlier said in order to provide quality meat for the belly and to avoid the bad and the ugly Professors B. A. Ayanwale and T. Z. Adama in 2001 won a research grant that gave me the opportunity to manage 270-day old broilers to evaluate meat cuts, organ weights and sensory characteristics of broiler chickens fed trona treated rice bran (Table 7). Rice bran is a by-product of rice mill industry consisting largely of the husks and bran. Rice bran is very high in fibre and low in crude protein and can be fed to livestock up to 25 % (Ogundipe, 1991). The fluctuation in the cost of feed supply which is a limitation to the availability of quality and quantity of protein supply especially protein of animal origin forms the basis of this studies. A total of 270-day old chicks purchased from Zatecch farms, Ibadan were used. The rice bran used as replacement for maize bran was treated with trona (*Sodium sesquicarbonate*) otherwise known as Kaun'. The rice bran was divided into three groups. Group one was not treated (0 treated), two was treated with trona at 1 % and three at 3 % solutions for 24 h. the treated rice bran was air dried and used to formulate nine iso-nitrogenous and iso-caloric diets. The untreated was included in the diets of broilers at 0, 10 and 20 % respectively. While those treated at 1, and 3 % were included in the diets at 5, 10 and 20 % respectively. Though the results were not statistically significant among the treatment means, I am happy to inform this august gathering that at six weeks of age the birds attained table size average. By eight weeks most of the broiler chickens weighed an average of 3 kg with abdominal fat range of 1.09- 4.78 % which is quite low. Sir for feed millers this is a great mile stone. Though the research was conducted over two decades ago the feed composition is ever new and waiting to be exploited.

Another research conducted by Jiya *et al.* (2019) was to evaluate the “Performance and carcass composition and meat quality characteristics of broiler chickens fed diets containing varying levels of shea butter cake fermented with *Aspergillus niger*” (Table 8). One hundred and eighty (180) day-old broiler chicks were assigned to five experimental diets. The control diet (T_1) contained 0 % fermented shea butter cake while T_2, T_3, T_4 and T_5 contained 5 %, 10 %, 15 % and 20 % fermented shea butter cake respectively. Each treatment had 36 birds with 3 replicates of 12

Table 6: Meat Quality Characteristics of Rabbits Orally Administered Probiotic (*Saccharomyces boulardii).*

Parameter	T1	T2	T3	T4	SEM
pH	6.79^{a}	6.63^{d}	6.75^{a}	6.72^{ab}	0.02*
Thermal shortening (%)	5.42^{d}	2.15^{c}	1.70^{b}	2.77^{a}	2.48*
Cooking yield (%)	71.70	73.93	72.57	74.13	0.98NS
Cooking loss (%)	28.30	26.07	27.42	25.87	0.98NS
Water holding capacity (%)	25.49	25.45	21.84	23.84	0.78NS
Moisture content	67.00	67.49	65.1	66.49	0.48NS
Crude protein	28.30	27.85	30.80	28.00	0.58NS
Ether extract	6.31^{c}	7.05^{bc}	9.51^{a}	8.49^{ab}	0.42*
Colour	5.75^{b}	6.25^{b}	7.10^{a}	5.90^{b}	0.13*
Tenderness	6.00^{b}	6.05^{b}	7.60^{a}	6.15^{b}	0.13*
Juiciness	6.10^{b}	6.21^{b}	7.80^{a}	6.20^{b}	0.15*
Flavour	6.25^{b}	6.30^{b}	7.80^{a}	6.20^{b}	0.13*
Overall acceptability	6.25^{b}	6.60^{b}	8.10^{a}	6.65^{b}	0.14*

a,b,c: Mean denoted by different superscript are significantly differing (P < 0.05)
T_1 = 0 ml of probiotic *Saccharomyces boulardii*
T2 = 1ml of 160 x 10^6 cfu/ml of probiotic *Saccharomyces boulardii administered orally*
T3 = 1ml of 80 x 10^6 cfu/ml of probiotic *Saccharomyces boulardii administered orally*
T4 = 1ml of 40 x 10^6 cfu/ml of probiotic *Saccharomyces boulardii administered orally*
Source: **Jiya**, Chinma and Ahmad (2018).

birds in a completely randomized design. The results of growth performance at the finisher phase revealed significant (p<0.05) differences in final weight, total body weight gain, daily weight gain, total feed intake, daily feed intake and feed conversion ratio but no significant (p>0.05) difference in percentage mortality. Results of carcass and internal organs characteristics revealed no significant (p>0.05) differences in live weight, slaughter weight, dressed weight and weights of breast, thigh, back, drumsticks, shanks, wings, liver, lungs, gizzard, intestines and abdominal fat. However, there were significant (p<0.05) differences in dressing percentage and heart weight. Results of

carcass composition revealed significant ($p<0.05$) differences in moisture content, ether extract and ash. There was no significant ($p>0.05$) difference in crude protein. Results of meat quality characteristics revealed significant ($p<0.05$) differences in water holding capacity, cooking yield and cooking loss but no significant ($p>0.05$) difference in pH. Based on the findings from the study, it can be concluded that up to 20 % inclusion of shea butter cake fermented with Aspergillus niger had no adverse effects on carcass and internal organs characteristics.
Another study was carried out to ascertain the growth response, meat yield and carcass characteristics of broiler chickens fed beni seed and drumstick leaves as sources of lysine (Jiya *et al*., 2014). One hundred and thirty-five-day old chicks of abor acre breed with an average weight of 40.00g. The birds were distributed into three groups with three replicates of fifteen birds each. Group one had 0.2% lysine, two had 6% beni seed and three had 15% drumstick leaves. The amount of 6% beni seed and 15% drumstick leaves included were calculated to be equal to the 0.2% industrial lysine which was the control. Most of the parameters measured were not significantly ($P>0.05$) different except live weight (2066.70g, 2050g and 1750g), breast (16.51, 17.85, and 19.35 %), back (11.12, 11.54 and 10.11 %) and wing (7.19, 7.66 and 8.06 %). All cut parts were expressed as per cent of dressed weight. Chicken breast is of high premium to consumers and that's why of all processed poultry products imports into Nigeria only breast is missing. Both beni seed and drumstick leaves can substitute 0.20% industrial lysine in broilers diets without any deleterious effect.

Table 7: Meat (cuts) organ weights and sensory characteristics from meat of broiler chickens fed trona treated rice bran.

Trona treatment levels	0 %			1 %			3 %			
	Rice bran inclusion levels (%)									
Parameter	0	10	20	5	10	20	5	10	20	SEM
Live weight (g)	2405.18	2227.94	2429.20	2462.27	2290.91	3032.43	2966.51	2484.53	2235.53	0.142NS
Dressed weight (g)	1700.48	1512.55	1690.72	1755.60	1610.28	2113.60	2075.07	1723.02	1582.98	0,12NS
Dressed %	70.95	67.89	69.60	71.30	70.29	69.70	69.95	69.35	70.81	1.26NS
Meat (boneless) %	58.24	53.53	55.64	56.68	53.47	59.14	61.79	59.20	57.78	2.47NS
Bone %	10.67	12.26	10.67	12.42	12.50	8.17	11.07	7.98	10.40	1.06NS
Drumstick %	10.33	10.41	10.52	9.51	8.88	9.19	9.14	9.00	8.84	0.41NS
Thigh %	11.95	12.05	11.67	12.42	11.42	11.39	11.34	11.53	11.48	0.38NS
Breast %	20.81	19.39	21.21	26.62	19.77	20.40	20.54	20.05	21.56	0.61NS
Back %	12.30	10.83	11.35	11.54	11.21	12.05	12.27	11.93	11.99	0.49NS
Wing %	8.26	8.35	7.83	8.17	8.38	7.99	8.70	8.20	8.31	0.27NS
Abdominal fat %	1.68	1.09	1.18	2.79	2.73	2.68	2.92	3.08	4.78	0.80NS
Lungs %	0.60	0.59	0.57	0.61	0.75	0.16	0.06	0.57	0.65	0.09NS
Liver %	2.12	1.21	2.18	2.24	2.18	1.94	2.19	2.07	1.66	0.21NS
Kidney %	0.66	0.57	0.59	0.61	0.62	0.59	0.58	0.65	0.61	0.06NS
Heart %	0.47	0.48	0.37	0.32	0.41	0.36	0.34	0.30	0.41	0,05NS
pH	6.34	6.15	6.12	6.32	5.89	6.11	6.28	6.50	6.25	0.12NS
Colour	5.60	5.80	6.00	5.90	5.80	6.20	5.80	6.30	6.00	0.25NS
Texture	5.60	6.00	5.90	6.10	6.20	5.90	5.80	6.00	5.60	0.23NS
Juiciness	6.00	6.30	5.90	6.20	6.00	6.30	6.10	6.10	5.90	0.11NS
Flavour	5.60	5.50	5.70	6.00	5.40	5.80	5.60	5.90	5.60	0,17NS
Tenderness	5.80	5.90	5.80	6.50	6.20	5.50	6.00	6.00	5.90	0.22NS
General acceptability	6.00	6.20	6.20	6.40	6.30	6.50	6.30	6.30	5.90	0.16NS

P>0.05 Source: **Jiya** et *al*. (2001).

B Meat processing

Meat quality is very important for consumers when it comes to making purchasing decisions. Many factors (both pre and post-mortem) can affect carcass quality from producer to consumer. Paramount among the post-mortem activities that affect nutritional and eating qualities of meat are processing methods. We conducted a research using twenty-four red Sokoto bucks to evaluate effect of scalding methods on the carcass quality and sensory properties of meat from the bucks (Table 10). The buck carcasses were randomly allocated to four scalding methods of hot water, firewood, rubber tyre and kerosene singeing after slaughter. Scalding methods significantly ($P<0.05$) affected the crude protein and fat contents of the meat samples with crude protein significantly ($P<0.05$) higher in rubber tyre (31.53%) singed carcasses. While the fat contents were significantly ($P<0.05$) higher in hot water (5.80%) singed carcasses. The mineral contents differ significantly ($P<0.05$) among singeing methods. The pH and thermal shortening were significantly ($P<0.05$) higher in buck carcasses scalded with kerosene (6.75 and 35.35 respectively). Methods of scalding had significant effect on the carcass quality and sensory properties of meat samples. It was therefore concluded that hot water be used to remove hairs in slaughtered goat carcasses, as this will reduce to practicable level cross contamination of meat during processing. The use of firewood, tyre and kerosene should be total discouraged in meat processing and the public should be educated about the health implication of consuming animal carcasses singed with these methods.

The traditional animal husbandry system is characterized by moving the animals from one place to another, as such a major cause of meat toughness (Jiya, 2001). Due to this toughness, meat would need long cooking or processing time before it can be tendered or palatable for consumption. Furthermore, the time it takes consumers to tenderize a piece of tough meat is of high economic concern to the processor. Children, people with tooth

Table 8: Performance and carcass composition and meat quality characteristics of broiler chickens fed diets containing varying levels of shea butter cake fermented with *Aspergillus niger.*

Parameters	0 (control)	5	10	15	20	SEM
Live weight (g)	1750.00	1500.00	1700.00	1550.00	1550.00	45.83NS
Daily weight gain (g)	33.13[a]	29.71[ab]	27.56[bc]	26.25[bc]	24.31[c]	0.91
Daily feed intake (g)	59.00[c]	60.00[bc]	61.33[ab]	63.33[a]	61.00b[c]	0.46
Feed conversion ratio	1.79[c]	2.03b[c]	2.25[ab]	2.44[a]	2.54[a]	0.08
Mortality (%)	0.80	0.12	0.00	0.00	0.78	0.19
Slaughter weight (g)	1680.00	1415.00	1550.00	1465.00	1465.00	51.02NS
Dressed weight (g)	1350.00	1100.00	1250.00	1150.00	1150.00	39.44NS
Dressing (%)	77.13[a]	73.33[b]	73.50[b]	74.16[b]	74.17[b]	0.51*
Back (%)	8.40	7.36	8.12	6.96	7.20	0.53NS
Breast (%)	10.51	9.68	10.07	10.38	11.86	0.70NS
Thigh (%)	8.55	8.73	8.25	8.50	7.98	0.66NS
Drum stick (%)	6.26	7.18	6.86	6.87	6.33	0.58NS
Wings (%)	8.56	7.14	6.14	7.76	7.46	0.47NS
Heart	0.18[c]	0.29[a]	0.24[c]	0.19[c]	0.26[b]	0.02*
Liver	1.00	0.67	0.73	0.61	0.65	0.06NS
Lungs	0.46	0.47	0.23	0.26	0.29	0.04NS
Gizzard	1.13	1.47	0.84	0.94	1.17	0.12NS
Intestine	3.13	3.00	3.18	3.19	2.82	0.20NS
Abdominal fat	0.75	0.84	0.56	0.78	0.82	0.09NS
pH	6.45	6.43	6.44	6.53	6.50	0.04NS
WHC	51.59[b]	34.93[d]	34.17[e]	52.37[a]	39.92[c]	5.65*
Cooking yield	83.35[c]	84.34[b]	78.37[e]	89.33[a]	81.36[d]	1.21*
Cooking loss	16.85[c]	15.91[d]	21.86[a]	10.94[e]	18.88[b]	1.20*
Moisture content	65.75[d]	75.47[a]	65.63[d]	70.10[b]	68.97[c]	1.20*
Crude protein	18.75	18.75	18.75	18.75	18.52	0.04NS
Fat content	1.24[b]	2.00[a]	1.36[b]	1.84[a]	1.00[b]	0.13*
Ash content	4.55[b]	3.44[d]	4.76[a]	3.85[c]	4.35[b]	0.16*

Means on the same row with different superscripts are significantly ($p<0.05$) different, SEM: Standard Error of Mean.
Source: **Jiya,** Ewa and Tiamiyu (2019).

problems and the aged find eating such meat a very big challenge, if not softened or tenderized. This made us to investigate the effects of papain enzyme concentration and cooking time on beef tenderness from the chuck meat of spent cow (Table 11). The papain enzyme was obtained from precipitate that settled out from a two-carbon organic co-solvent system which comprised

77 % equal volume of ethanol and acetone and 23% pawpaw fruit liquid extract (crude protein solution). Uniformed beef cuts from the chuck portion of spent cow were marinated with different concentrations of papain extract (0 ml, 10 ml, 15 ml), aged in the freezer and cooked at 75°C for 30 and 60 minutes in a water bath. Cooking time and levels of inclusion of papain enzyme significantly ($P<0.05$) affected the meat quality characteristics measured. There were interactions between cooking time and levels of enzyme inclusion in the results of the physical, proximate and sensory properties of the meat samples. The result showed that the papain extracts derived from the two-carbon organic co-solvent extraction of pawpaw fruit could be used to tenderize the chuck of spent cow cooked for 30 minutes with up to 15mls level of inclusion.

Table 9: Growth performance and carcass characteristics of cut-up parts visceral organs of broilers fed beni seed and drumstick leaves as sources of lysine.

Parameter	Ti	T2	T3	SEM	LS
Body weight gain (g/b/d)	21.31	19.17	19.49	0.66	NS
Feed intake (g/b/d)	96.15	96.00	91.86	5.25	NS
FCR	4.54	5.05	4.66	0.26	NS
Live wt (g)	2066.70^{a}	2050.00^{a}	1750.00^{b}	57.40	*
Dressed wt (%)	89.49	90.28	89.43	0.73	NS
Breast (%)	16.51^{c}	17.85^{b}	19.35^{a}	O.44	*
Back (%)	11.12^{ab}	11.54^{a}	10.11^{b}	1.27	*
Thigh (%)	12.94	12.01	11.33	0.36	NS
Wing (%)	7.19^{b}	7.66^{b}	8.06^{a}	0.94	*
Drumstick (%)	9.80	9.33	10.09	0.19	NS
Intestinal wt	4.95	4.79	5.00	0.14	NS
Kidney	0,07	0.11	0,11	0.01	NS
Lungs	0.49	0.46	0.45	0.04	NS
Liver	1.91	1.96	1.93	0.06	NS
Gizzard	3.40	3.41	3.13	0.20	NS
Heart	0.56	0.52	0.56	0.03	NS
Abdominal fat	0.73	2.19	0.58	0.42	NS

abc = Means with the same superscript in the same row are not significantly different ($P>0.05$). Source: **E.Z. Jiya**, Ayanwale, Ibrahim and Ahmed (2014).

Table 10: Meat quality characteristics of meat samples from red Sokoto buck scalded using different Methods.

Parameters	HW	FW	TYR	KERO	SEM
pH	6.08^{b}	7.01^{a}	6.87^{a}	6.75^{a}	0.125*
WHC (%)	90.82	90.02	88.77	88.22	1.350NS
Thermal-shortening (%)	31.10^{ab}	24.13^{b}	25.04^{b}	35.35^{a}	1.803*
Thawing Loss (%)	9.70	11.43	11.37	11.43	0.65NS
Cooking yield (%)	61.26	72.01	66.76	64.21	1.90NS
Cooking loss (%)	38.55	27.99	33.24	35.79	1.86NS
Moisture (%)	24.50	23.29	24.68	23.96	0.67NS
Crude protein (%)	27.70^{b}	29.33^{ab}	31.53^{a}	30.21^{ab}	0.50*
Fat (%)	5.80^{a}	2.67^{b}	2.87^{b}	2.30^{b}	0.54*
Ash (%)	3.53	2.16	2.43	1.80	0.32NS
Calcium (mg/100g)	12.31^{c}	12.79^{ab}	12.89^{a}	12.55^{bc}	0.08*
Magnesium (mg/100g)	19.10^{c}	19.56^{b}	19.86^{a}	19.33^{bc}	0.09NS
Potassium (mg/100g)	292.59^{b}	292.92^{b}	296.13^{a}	291.55^{b}	0.58*
Sodium (mg/100g)	68.76^{a}	61.63^{d}	67.10^{b}	64.65^{c}	0.82*
Phosphorus (mg/100g)	176.48^{a}	153.61^{d}	155.44^{c}	162.05^{b}	2.71*
Colour	6.95^{c}	6.10^{d}	8.00^{b}	9.00^{a}	0.17*
Tenderness	5.80^{b}	6.80^{ab}	6.50^{b}	7.55^{a}	0.18*
Juiciness	5.85	5.80	6.45	6.65	0.18NS
Flavour	5.5^{c}	5.65^{bc}	6.50^{ab}	6.90^{a}	0.182*
Overall acceptability	6.40^{b}	6.70^{b}	7.40^{a}	7.75^{a}	0.15*

a, b Means in the same row not followed by the same superscript are significantly different (P<0.05). HW = Hot water, FW = Firewood, TYR = Rubber tyre, KERO = Kerosene, NFE = Nitrogen Free Extract, LS= Level of significant, *= significantly different at (P<0.05), NS = Non- significantly different.
Source: Ugochuckwu, **Jiya** and Ocheme (2018).

Jiya and Ilori investigated the effect of different wood type on the nutritive value of roasted beef (*tsire*) from fore and hind limbs stored for 7 days (Table 12). Raw beef from fore and hind limbs were collected from a two-year old White Fulani cattle and roasted with mahogany (*Khaya senegalensis*), shea butter (*Vitellaria paradoxa*) and locust bean (*Parkia biglobosa***)** woods.

Table 11: Effect of cooking time, papain enzyme inclusion levels and their interaction on quality characteristics of chuck meat.

	Cooking time (mins)			Enzyme (mls)					TxE
Treatment	30	60	SE±	0	5	10	15	SE±	
WHC (%)	0.31^{b}	0.41^{a}	0	0.49^{a}	0.39^{b}	0.29^{c}	0.27^{d}	0.00	P<0.001
CY (%)	43.61^{b}	44.02^{a}	0.66	49.51^{a}	40.90^{b}	41.64^{b}	43.20^{b}	0.94	P>0.6989
CL (%)	8.85^{b}	9.23^{a}	0.13	6.79^{d}	8.09^{c}	9.84^{b}	11.44^{a}	0.18	P>0.2898
pH	5.41^{b}	5.61^{a}	0.01	5.84^{a}	5.32^{d}	5.39^{c}	5.48^{b}	0.01	P<0.001
MC (%)	59.83	60.54	0.53	60.12^{b}	63.05^{a}	54.78^{c}	62.78^{b}	0.74	P<0.001
CP (%)	54.69^{b}	59.06^{a}	0.22	48.41^{d}	54.88^{c}	58.99^{b}	65.23^{a}	0.32	P<0.001
Fat (%)	9.43^{a}	6.77^{b}	0.42	9.43^{a}	8.74^{a}	7.39^{ab}	6.83^{ab}	0.59	P<0.0322
SP (%)	0.72^{a}	0.63^{b}	0.01	0.61^{c}	0.64^{c}	0.65^{b}	0.80^{a}	0.01	P<0.001
Colour	4.48^{a}	4.41^{a}	0.11	4.38^{a}	4.43^{a}	4.58^{a}	4.40^{a}	0.16	P<0.94
Tenderness	4.69^{b}	6.24^{a}	0.09	3.00^{d}	5.08^{c}	6.33^{b}	7.45^{a}	0.13	P<0.0003
Juiciness	5.43^{b}	6.15^{a}	0.15	4.93^{b}	5.83^{a}	6.10^{a}	6.30^{a}	0.21	P<0.961
Flavour	5.55^{b}	6.26^{a}	0.15	5.03^{b}	5.93^{a}	6.23^{a}	6.45^{a}	0.21	P<0.827
O/Acceptability	4.85^{b}	6.38^{a}	0.09	3.43^{d}	5.45^{c}	6.35^{b}	7.23^{a}	0.13	P<0.386

^{abcd}Means with different superscripts in the same column are significantly (P<0.05) different.
WHC: Water Holding Capacity, CY: Cooking Yield, CL: Cooking Loss, MC: Moisture Content, CP: Crude Protein, SP: Soluble Protein. TxE = Interaction between Time and enzyme inclusion.
Source: **Jiya,** *et al*. (2016).

Ninety sticks of *tsire* samples were prepared, thirty sticks of beef were roasted with each of the wood type as fifteen sticks comprised of each part. A 4 (storage) x 3 (wood types) x 2 (meat parts) factorial arrangement in a completely randomized design was used for the study. Data were collected on proximate composition, organoleptic properties, water holding capacity, pH and shelf life parameters (microbial counts and lipid oxidation) of the meat product. The results of the study showed that the chemical composition, organoleptic, water holding capacity, pH and shelf life were significantly ($p < 0.05$) affected by the number of days in storage, wood types and meat parts used. The chemical composition showed a dry matter 56.75 to 67.05 %, crude protein value ranged from 38.31 to 50.53 %, ether extract 4.24 to 13.43 % and the ash content ranged from 1.42 to 10.53 % as affected by storability, wood types and meat parts. Organoleptic properties scored on a nine-point hedonic scale were rated lowest (4.60) in the *tsire* samples roasted with locust bean wood while highest (7.32) with mahogany wood. The pH values from day 1 to 5 were within the acceptable limit (5.5-6.5) in the *tsire* samples roasted with mahogany wood. Per cent water holding capacity was highest (30.02 and 30.08 %) in *tsire* roasted with mahogany wood and on day 1 respectively. Total bacteria and fungi counts were all within satisfactory limits (< ½ million/g) within the first 3 days. Meanwhile, the lipid oxidation (free fatty acid, peroxide value and thiobarbituric acid) were also significantly ($P > 0.05$) affected by the number of days in storage and wood types but not with meat part. In conclusion, the score for overall acceptability indicated that the consumers preferred *tsire roasted with mahogany and shea butter tree* which were significantly ($P < 0.05$) different.

Table 12: Effect of Processing Methods on the Heavy Metal Content (Mg/Kg) and Poly Aromatic Hydrocarbons (PAHs) Presence in Cowhide Samples.

Parameters	HW	FW	RT	KE	SEM
Metals (mg/kg)					
Arsenic	0.01^{d}	0.03^{c}	0.06^{a}	0.05^{b}	0.0005*
Lead	0.16^{a}	0.05^{d}	0.085^{c}	0.15^{b}	0.0024*
Cadmium	0.007^{d}	0.018^{a}	0.016^{b}	0.013^{c}	0.0001*
Manganese	90.56^{c}	121.71^{b}	139.61^{a}	125.72^{b}	0.54*
Mercury	0.003^{c}	0.01^{a}	0.004^{b}	0.003^{c}	0.00012*
Hydrocarbons (µg/kg)					
Naphthalene	0.0095^{a}	0.0029^{b}	0.0039^{b}	0.0018^{c}	0.00*
Acenaphthylene	0.0012^{d}	0.0049^{a}	0.0013^{c}	0.0032^{b}	0.00*
Acenaphthene	0.0032	0.0044	0.0051	0.0047	0.10NS
Fluorene	0.0091^{a}	0.0035^{c}	0.0035^{c}	0.0063^{b}	0.00*
Phenanthrene	0.0023^{d}	0.0056^{c}	3.62^{a}	3.33^{b}	12.06*
Anthracene	0.0024^{b}	0.0052^{b}	4.24^{a}	4.52^{a}	19.18*
Fluoranthene	1.44^{d}	2.18^{c}	6.28^{a}	4.51^{b}	14.70*
Pyrene	0.051^{c}	0.0073^{c}	4.74^{a}	4.22^{b}	20.14*
Benzo(a) anthracene	0.021	0.0037	0.0032	0.0022	0.4000NS
Chrysene	0.054	0.051	0.034	0.072	0.10NS
Benzo(b) fluoranthene	0.0018^{c}	0.026^{ab}	0.051^{a}	0.024^{b}	0.000*
Benzo(k) fluoranthene	0.0086^{a}	0.0030^{d}	0.0037^{c}	0.074^{b}	0.000*
Benzo Benzo (a) pyrene	0.0061	0.075	0.026	0.0015	0.000NS
Indeno (1, 2, 3-cd) pyrene	0.0027^{d}	0.0039^{c}	0.0076^{a}	0.0054^{b}	0.004*
Dibenz(a,h) anthracene	0.0031^{b}	0.0016^{c}	0.071^{a}	0.076^{a}	0.000*
Benzo(g,h,i) perylene	0.0053	0.0015	0.0020	0.0053	0.000NS

Means in the same row not followed by the same superscript are significantly different (P<0.05). hw= hot water, fw= firewood, rt= rubber tyre, ke= kerosene. LS= Level of significant, *= significantly different at (P<0.05), NS = Non-significantly different, SEM = Standard error mean. Source: Etuk ***et al.*** (2018).

The Nigerian Institute of Animal Science slogan "Eating ponmo is killing our leather industry" stirred our interest to come up with facts and to save our bellies from bad and the ugly. We thus conducted a research in 2018 to investigate the effect of processing methods on the heavy metal content (Mg/Kg) and

Table 13: Proximate, WHC, pH, microbial counts and lipid oxidation of roasted beef (tsire) from fore and hind limbs roasted with different wood types.

Parameter		%								Meq/kg/fat		µmole^{-1}
		DM	CP	EE	Ash	WHC	pH	FC	BC	FFA	PV	TBA
Day	1	67.05^{a}	38.31^{d}	13.43^{a}	10.53^{a}	30.08^{a}	6.53^{a}	1.72^{a}x10^{1}	2.24^{a}x10^{1}	0.49^{a}	1.72^{a}	0.38^{a}
	3	63.99^{b}	42.13^{c}	8.77^{b}	7.36^{b}	27.99^{b}	6.09^{b}	2.83^{a}x10^{3}	3.21^{b}x10^{3}	0.59^{ab}	2.83^{b}	0.44^{b}
	5	60.87^{c}	46.62^{b}	6.41^{c}	4.21^{c}	25.80^{c}	5.68^{c}	5.68^{b}x10^{3}	4.99^{c}x10^{3}	0.67^{b}	5.68^{c}	0.52^{bc}
	7	56.75^{d}	50.63^{a}	4.24^{d}	1.42^{d}	23.68^{d}	4.77^{d}	7.65^{b}x10^{3}	7.62^{d}x10^{3}	1.00^{c}	7.68^{d}	0.65^{c}
	SEM	0.31	0.20	0.11	0.10	0.24	0.14	0.15	0.26	0.62	0.43	0.21
Wood type	Mahogany	62.86^{a}	43.83^{c}	8.87^{a}	6.21^{a}	30.02^{a}	5.20^{c}	3.63x10^{3}	3.61^{a}x10^{3}	0.56^{a}	3.63^{a}	0.28^{a}
	Shea butter	61.96^{b}	44.37^{b}	7.83^{b}	5.65+c	22.99^{c}	5.86^{b}	3.43 x10^{3}	4.80^{b}x10^{3}	0.78^{b}	4.35^{b}	0.62^{b}
	Locust bean	61.67^{c}	45.07^{a}	7.94^{c}	5.78^{b}	27.65^{b}	6.25^{a}	5.44 x10^{3}	5.14^{c}x10^{3}	0.71^{b}	5.46^{c}	0.59^{b}
	SEM	0.34	0.25	0.12	0.10	0.18	0.21	0.19	0.98	0.17	0.15	0.31
Meat part	Hind limb	62.11^{b}	44.65^{a}	8.31^{a}	5.96^{a}	28.47^{a}	5.71^{b}	4.18	4.43^{a}x10^{3}	0.1	4.78	0.48
	Fore limb	62.22^{a}	44.20^{b}	8.11^{b}	5.81^{b}	25.30^{b}	5.83^{a}	4.77	4.59^{b}x10^{3}	0.66	4.18	0.51
	SEM	0.29	0.25	0.14	0.10	0.33	0.08	0.32	0.12	0.10	0.11	0.14
Interaction	DxM	0.0001	0.0001	0.0054	0.0002	0.9080	0.0250	0.7569	0.0003	0.9596	0.0001	0.9330
	DxW	0.0001	0.0001	0.0001	0.0387	0.7742	0.0001	0.9187	0.0001	0.2776	0.0001	0.6125
	Mx W	0.0001	0.0007	0.0001	0.0043	0.0001	0.0001	0.9085	0.7586	0.8302	0.0001	0.1226
	DxMxW	0.0001	0.0001	0.0001	0.0005	0.4698	0.0003	0.8439	0.0001	0.7240	0.0001	0.8183

DM= Dry matter, CP= Crude protein, EE= Ether extract, WHC= Water holding capacity, FC= Fungal count, BC=Bacterial count, FFA= Free fatty acid, PV= Peroxide value, TBA= Thiobarbutric acid. Source: Ilori *et al*. (2017).

poly aromatic hydrocarbons (PAHs) presence in cowhide samples. A total weight of 20kg of cowhide (*ponmo*) was collected from an abattoir. The samples were divided into four equal portions of equal weight for the four treatments with 5kg assigned to each. The results showed that heavy metals ranges from (0.014 – 0.061, 0.007 – 0.018, 90.55 – 139.61 and 0.03 – 0.12mg/kg) respectively in arsenic, lead, cadmium, manganese. Carcinogenic polyaromatic hydrocarbon (PAHs) ranges from (0.0021 – 0.0206, 0.0330 – 0.0719, 0.001530 – 0.0751, 0.00182 – 0.0504µg/kg) in benzo (a) anthracene, chrysene, benzo (a) pyrene and benzo (b) fluoranthene. This study, therefore established that the heat generated from firewood, rubber tyre, and kerosene may introduce some substances to the cowhide which are detrimental to health. Wang *et al*. (2007) reported that open tyre fire emissions include substance such as particulates, carbon monoxide (CO), sulfur oxides (SOx), oxides of nitrogen (NOx), and volatile organic compounds (VOCs), polynuclear aromatic hydrocarbons (PAHs), dioxins, furans, hydrogen chloride, benzene, polychlorinated biphenyls (PCBs), thiophenes, carbazoles and non-metals.

Consumption of cowhide should be discouraged because of its low nutritional value as it does not meet up with amino acid requirements since it is made up of predominantly non-essential amino acid (glycine, alanine, and proline). It is therefore recommended that the use of firewood, rubber tyre, kerosene in processing as well as processing cowhide with contaminated hot water as corroborated by Yisa. (2021) who reported that most water bodies in Minna contained organic pollutants. Processing of cowhide with these substances pose health risk because of its bio-accumulate in human tissues.

C Product development

We conducted a research to determine the effect of duration on free range system on broiler chicken's meat in relation to meat floss (*Dambu nama*). Two hundred (200) unsexed Arbor broiler chicks were randomly assigned to 4 treatments. The birds were transferred to the free-range paddock, at 2 (Wk2), 4 (Wk4) and 6(Wk6) weeks, some of the birds were reared indoors throughout the rearing period to serve as the control (Wk0). After reaching 8weeks of age, the broiler chickens were slaughtered *to produce dambu-nama. The total bacterial count of the product was taken at intervals of 28 days for period of 112days. The products were assessed by 32 semi-trained taste panelists in terms of sensory property. Proximate compositions of the product were also determined. Meat floss from Wk0 broiler chickens* had higher (p>0.05) sensory ratings for colour, aroma, flavour, tenderness and juiciness. Overall acceptability revealed meat floss (*dambun-nama*) from Wk0, Wk2, Wk4 and Wk6 scored above intermediate (7.2, 7.0, 6.75 respectively), which indicated that all the products irrespective of the rearing system were accepted to the panelists. High ash and crude protein were observed in meat floss (*dambun-nama*) from Wk2. No significant (p>0.05) differences were observed in moisture and % fat contents in the treatments. Microbial results after 112 days of storage showed that bacterial and mould plate counts were within passable limit of 10 million. Wk0=Log7.886 cfu/g, Wk2=log7.813cfu/g, Wk4=Log7.863cfu/g and Wk6=log7.929. Mould counts Wk0= 7.778cfu/g, Wk2= 7.041cfu/g, Wk4= 6.954cfu/g, Wk6= 7.114cfu/g. It was evident that meat floss (*dambun-nama*) from broiler chickens in Wk0 were more preferred by the panelists than the other treatments, though with higher bacterial count.

Daramola-Oluwatuyi, Olugbemi and Jiya (2020) assessed the effect of egg storage period on the proximate composition and microbial quality of whole egg powder. Sixty fresh eggs were divided into 4 batches of 15 eggs per batch which were analyzed for proximate composition and microbial quality on weeks 0, 1, 2

Table 14: Proximate Composition of dambu-nama from broiler chickens on free range system.

Parameter	Age exposed to free rage				
	Wk0	Wk2	Wk4	Wk6	SEM
Moisture (%)	6.58	8.61	7.73	7.24	1.66NS
Ash (%)	5.98^{c}	7.69^{a}	6.11^{bc}	6.38^{bc}	0.50*
Crude Protein (%)	52.63^{c}	60.81^{a}	56.56^{b}	55 .98^{b}	1.23*
Fat (%)	7.03	6.58	6.19	6.72	0.58NS

^{abc}Means in the same row with common superscripts are not significantly different ($p > 0.05$). Wk0, Wk2, Wk4, Wk6; birds exposed to free range at 0, 2, 4 and 6 weeks respectively. Source: Ijasini **et al.** (2019).

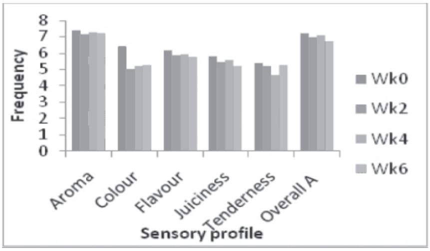


Fig. 4: Sensory profile of freshly processed *dambu-nama*. Source: Ijasini ***et al.*** (2019).

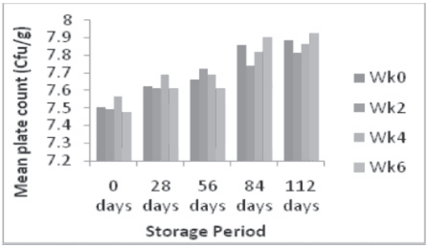


Fig. 5: Microbial mean plate count (Cfu/g) of Dambu-nama. Source: Ijasini et al. (2019).

and 3. The crude protein and ether extract of the whole egg powder declined from 50.96 - 42.91% and 5.01 - 3.87% respectively while ash and nitrogen free extract increased from 1.51 - 3.38% and 42.52 - 49.84% respectively as egg aged from week 0 to 3 weeks. Total bacterial and non-coliform counts were within the permissible limits. Salmonella spp and E. coli were absent (Table 15). This study concluded that poultry egg farmers can sell 3 weeks eggs stored at room temperature to egg powder producers at possibly discounted prices and dry whole egg powder from these eggs may be safely used in the confectionary industry without deleterious effects on the health of product consumers.

We also carried out the organoleptic evaluation results of fried unspiced egg from differently processed whole-egg powders

Table 15: Proximate composition and microbial load of differently processed and commercial whole-egg powders.

Nutrients	FDWEP	DDWEP	CWEP	SEM
Dry matter	92.28[c]	93.93[b]	95.00[a]	0.25
Crude protein	49.92[b]	50.71[b]	52.78[a]	0.50
Ether extract	3.77	3.37	3.02	0.39
Crude fibre	0.00	0.00	0.00	0.00
Ash	1.96	1.92	1.84	0.08
Nitrogen free extract	44.36[a]	44.38[a]	42.37[b]	0.42
Total-coliform count (CFU/ml/g)	0.000	0.000	0.000	0.000
Non-coliform count (CFU/ml/g)	0.042	0.019	0.030	0.540
Total bacteria count (CFU/ml/g)	0.175	0.120	0.136	0.570
Mold count	0.330[b]	0.000[a]	0.000[a]	0.002
Yeast count	-ve	-ve	-ve	
Salmonella spp	-ve	-ve	-ve	
E. coli	-ve	-ve	-ve	

[abc] Means with different superscripts within rows differ significantly, SEM= Standard error of mean, FDWEP= Freeze dried whole egg powder, DDWEP= Dehydrator dried whole egg powder, CWEP= Commercial whole egg powder. Source: Daramola-Oluwatuyi, Olugbemi and **Jiya** (2020).

(Table 16). All determined parameters significantly varied amongst the treatments. The colour of the fried unspiced egg was best (P<0.05) rated among the treatments with a score of 7.70. The flavour of the raw egg though possessing the highest score of 5.47 did not differ significantly (P>0.05) from DDWEP and CWEP. Texture and taste ratings followed a similar trend with the fried egg from raw, CWEP and FDWEP not differing significantly (P<0.05). Acceptability results were significantly higher in raw eggs and CWEP (7.30, 5.63) however, the egg powder treatments were not significantly different (P<0.05) from one another implying that the “home made” powders compared favourably with the commercial. The preference of the fried raw egg colour could be attributed to the lighter colour of the product after frying as there was a rapid change in the yellow colour of egg slurry immediately after.

Table 16: Organoleptic evaluation of fried un-spiced egg and product development from differently processed and commercial whole-egg powders and raw eggs.

Parameters	FDWEP	DDWEP	CWEP	RAW EGG	SEM
Colour	4.17^{b}	4.70^{b}	4.63^{b}	7.70^{a}	1.01
Flavour	3.00^{b}	4.00^{ab}	3.97^{ab}	5.47^{a}	1.16
Texture	4.80^{ab}	3.97^{b}	5.73^{ab}	6.27^{a}	1.05
Taste	3.43^{ab}	3.33^{b}	5.50^{a}	6.43^{a}	1.04
Acceptability	4.43^{b}	4.97^{b}	5.63^{ab}	7.30^{a}	1.13

^{ab}Means with different superscripts within rows differ significantly($P<0.05$), SEM= Standard error of mean, FDWEP= Freeze dried whole egg powder, DDWEP= Dehydrated dried whole egg powder, CWEP= Commercial whole egg powder. Source: Daramola-Oluwatuyi, Olugbemi and **Jiya** (2020).

6.0 CONCLUSION AND RECOMMENDATIONS

Mr. Vice-Chancellor Sir, to avoid the bad and the ugly and to produce not just meats for the belly but good meats, efforts must be geared towards producing meat and meat products that are of high quality with basic emphasis on good nutrition, environment, welfare of the meat animal as well as processing and preservation procedures as highlighted by this lecture. My contributions demonstrated the use of non-conventional feed ingredients in producing quality meats using poultry and rabbits which are early maturing with quick turnover.

The present boom in the meat industry requires close care by the industry players in order to save the consumers from the bad and the ugly. The following recommendations are made:

i. The government at all levels should establish modern abattoirs and initiate private sector collaboration in order to have modern abattoir facilities with a view to ensuring proper slaughtering of animals in an hygienic and wholesome manner.

ii. Government should ensure that meat vans with cold rooms are available and used for transportation and storage of meat products.

iii. An integrated link should be established to facilitate the exchange of knowledge between researchers, producers, abattoir processors and the consumers. The need for meats with traceability to abattoirs and livestock producers should be established to curtail sharp practices in the industry as practiced in a developing nation like Uruguay.
iv. A re-awakening of sanitary or meat inspectors is advocated in order to enforce strict healthy standards that comply with hazard analysis of critical control points (HACCP) especially abattoir meat processors and meat vendors.
v. The present open meat market and hawking of meat and meat products is unacceptable. Packaging of fresh meat and meat products is important and should be domiciled in shops and supermarkets.
vi. The present insecurity cannot guarantee food security especially adequate protein of animal origin. Government should be pragmatic in ensuring security of lives.
vii. Research is key to the development of any nation. Government should invest and also provide enabling atmosphere for private sponsors in research especially in the livestock sub-sector.
viii. There is the need for training and re-training of the players in the meat industry especially abattoir workers.
ix. High penalty through enactment of laws should be paid by those who indulge in bad and ugly practices in the meat industry especially abattoir workers.
x. With the emerging global markets, there is a critical need for improvement on our local breeds that are adapted to our environment and disease resistant with a potential for quality meat production. Meat quality enhancement techniques and development of value-added products are also needed in order to meet up with consumers demand.

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Brief Profile of the Inaugural Lecturer

Professor Elisha Zhiri Jiya was born on the 8th of October, 1964 to the family of Late Mr. Mathias Baba Jiya (popularly known as *Baa Mata*) and Late Mrs. Juliana Nnako Jiya (popularly known as *Yandako*) at Pati-Shabakolo in Lavun Local Government Area of Niger State. He attended Local Education Authority Primary School, Pati-Shabakolo between 1973 and 1979 where he obtained the First School Leaving Certificate. He went further to obtain the Grade II Certificate at the Government Science Teacher's College, Bida, between 1979 and 1984 and Nigerian Certificate of Education (NCE) at the Niger State College of Education, Minna, Niger State, between 1984 and 1988. Prof. Jiya, had university education at the Federal University of Technology, Minna where he obtained the B. Agric. Tech. (Second Class Upper Division, 1996-2000), M. Tech. (2000-2002) all in Animal Production and a PhD (2007-2012) in Animal Production specializing in Meat Science.

Between 1989 and 2005, he was under the employment of Niger State Ministry of Education, first under Voluntary Teaching Scheme (VTS, 1989-1990) and as an Agricultural Science Teacher (1990-2005). He transferred his services to the Federal University of Technology, Minna as Lecturer II in 2005 and has risen through the ranks to become a Professor of Animal Production in October, 2018. Prof. Jiya has served in several capacities in FUT Minna, such as 500 Level Adviser (2005-2008), Assistant Postgraduate Coordinator (2007-2008), Postgraduate Coordinator (2008-2011), 100 Level Adviser (2011-2015; 2017-Date), Chairman, School of Agriculture and Agricultural Technology (SAAT) Welfare Committee (2012-2017), acting Head of Department of Animal Production in 2013, Member, University Examination Misconduct Committee (2015-Date) and a member of the University Senate. He also served as Head of Rabbit Unit (2014-2019), member of the committee responsible to prepare the SAAT student handbook in 2013; member, committee responsible to investigate a case of examination racketeering at CPES in 2014; Chairman, committee that investigated a case of theft at Department of Educational Technology in August 2019.

Prof. Jiya has demonstrated professional and academic excellence as he has been involved in winning research grants worth twenty-five-million two hundred and thirty-two thousand eight hundred and twelve naira (N25, 232, 812. 00) only in 2019. He has over eighty (80) publications in reputable journals and attended conferences both locally and internationally to underscore his research activities. He has also supervised many undergraduates' projects, PGD, MTech and PhD thesis. Among the numerous awards he has received include the SAAT Award of Excellence in recognition of his dedication and hard work during the 2013/2014 academic session.

He has delivered many guest lectures, seminars and workshops at many organizations including Niger State Polytechnic, Zungeru, Bejin Doko Bank and Niger State Agricultural Development Project (NSADP) among many others. He has served as external examiner and assessor to Federal Polytechnic, Mubi; Niger State College of Education, Minna; University of Agriculture, Makurdi; Ahmadu Bello University, Zaria; and Nasarawa State University, Keffi. He is also a reviewer of some journals. He has also served as ad-hoc staff of the Independent National Electoral Commission (INEC) as collation officer at various levels for elections held in Niger State since 2014. He is a member of several professional associations such as Nigerian Society for Animal Production (NSAP), Animal Science Association of Nigeria (ASAN) and American Meat Science Association (AMSA). He is a Registered Animal Scientist (RAS) with Nigerian Institute of animal Science (NIAS) and a Registered Teacher with the Teachers Registration Council of Nigeria (TRCN).

Prof. Jiya is a devout Christian; he has been on the Agricultural Boards of the Doko and Bida dioceses since 2009 and 2011 respectively to date. He is a member of the Fellowship of Christian Students and Nupe Intercessors among many others. He is also committed to the development of Pati-Shabakolo, his '*home*' as he is an active member of the Pati-Shabakolo Development Association (PASDA) where he has served in various committees and capacities such as Assistant Secretary, Secretary and Chairman consecutively between 1998 and 2005. Prof. Jiya is happily married to Mrs. Florence Jiya and the marriage has produced three children: Immanuel, Jemimah and Lydia.