PROXIMATEAND AMINO ACID ANALYSES OF SEEDS OF GOLD MOHUR [*Delonixregia*], TAMARIND [*Tamarindusindica*] AND CAMEL FOOT [*Piliostigmathonningii*] FRUITS.

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CERTIFICATION

This is to certify that this project was carried out and submitted by OYENIYI MICHAEL SEMILORE with matric no. CHE/11/0309 to Industrial Chemistry Department, Federal University Oye-Ekiti, Ekiti state. In partial fulfilment of the conditions for the award of a Bachelor Degree [B.sc] Industrial Chemistry.

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DEDICATION

This project is dedicated to God almighty the custodian of knowledge and the keeper of my soul. And to my parents for their ever available support before, during and after this project research work.

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I want to acknowledge God almighty for His grace that has been more than sufficient for me.

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ABSTRACT

Gold mohur –***Delonixregia***, Tamarind – ***Tamarindusindica***and Camel foot – **Pilostigmathonningii** are tropical seeds reported to be native to Madasgasca, now they grow in every frost free nation across the world.. Based on the compositional analysis, the three seeds are rich in nutritional components especially proteins, oil and dietary fiber. The three seeds are rich in Glutamine, Aspartate, Leucine , Lysine, Arginine and valine.This result support the main aim of this research project, which is providing an alternate and cheap nutrient source to all income class.Hence this seeds can be recommended as Food supplement, to reduce malnutrition rate in Nigeria.

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CHAPTER ONE

1.0 INTRODUCTION

Recent research has shown that one of the challenges confronting under-developed countries is malnutrition. Malnutrition causes a great deal of human suffering and is associated with more than half of all deaths of children worldwide. Malnutrition severely impacts the socio economic development of a nation because a work force that is stunted both mentally and physically may have a reduce work capacity. The consequence of poverty, poor health and poor nutrition has a multiplier effect on the general welfare of the population and also contributes significantly towards keeping a population in a downward trend of poverty and nutritional insecurity (Lowell, 2006).

According to the latest UNICEF report, Nigeria is at the top of the list, with the world's highest number of malnourished children. Out of 146 million children all over the world, Africa alone houses nearly houses 73% of them, which also include Nigeria. Precisely, Nigeria has about 6 million malnourished children. (UNICEF, 2008).

Recent trends in the results of major examination in the country have indicated that there is a decline in academic performance of students at all levels (Ighodalo, 2004). This decline has been attributed to some major factors like poor academic background, another cause of poor academic performance of students could be linked to the worsening socio- economic condition of the country (Ighodalo, 2004). Malnutrition is becoming a plague in both developed and developing countries and deficiencies in nutrients have been reported to cause diseases which could lead to impaired cognitive development (Simeon and McGregor, 1989). Other studies have related lifestyle of students, particularly breakfast consumption, to their cognitive abilities as reflected in their academic performance (Pollit, 1982, 1997).

Nutritional status is the combination of an individual's health as influenced by intake and utilization of nutrients and determined from information obtained by physical, biochemical and dietary studies (Durning and Fidanza, 1985). This study is therefore intended to evaluate the nutritional value of Gold mohur *[Delonix regia]*, Tamarind [*Tamarindus indica*] and Camel foot [*Pilostigma thonningii]* seed samples selected for this study.

Although several attempts have been made in the past to break the strong hold this malnutrition has over Nigerians and Africans at large. (Muller and Krawinkel, 2005). The general poor economic situation, which has persisted in Nigeria for several years, has led to an increase in the incidence and level of poverty, thereby adversely affecting the nutritional status of large numbers of Nigerians. Wages and incomes of workers could not keep pace with rising price levels, leading to food insecurity in most households. The 1993 World Bank report on Nigeria stated that although Nigeria had vast natural and human resources, poor child nutrition meant that it was neglecting the health of future generations.

Argument have been made that inadequate management of severe [PEM] Protein –Energy malnutrition is the cause of an unacceptable high case-fatality rate in Nigeria today, and insufficient skilled manpower and poorly equipped health facilities to deal with life-threatening emergencies can be blamed for this. (Nahar *et al,* 2010). Unarguably, infections too, including HIV, also contribute to the development of severe malnutrition, but traditional risk factors such as poor nutrition, parental disadvantage and illness, poverty, and social inequity remain the important contributors to the prevalence of severe malnutrition. While it is important to strengthen the management of admitted cases of PEM seen in Nigeria, especially during the acute phase, the researcher posit that it will be more cost effective and beneficial if strategies that could help prevent PEM are put in place. This becomes critical as various studies have consistently demonstrated that PEM is primarily a socioeconomic problem that results in a medical problem. (Faruque *et al*, 2008)

JUSTIFICATION

Research has shown that malnutrition is one of the major challenges Developing countries is facing, Hence this project aims at providing alternate and cheap nutrients source to all income class, by subjecting the selected tropical seeds: Gold mohur – *Delonix regia,* Tamarind – *Tamarindus indica* and Camel foot – *Piliostigma thonningii* fruits to proximate and Amino acid analysis. On Assertion of the nutrients content in the fruits samples, they could be recommended as food supplement as none of the fruit seeds selected is consumed as a vegetable in most part of Africa.

1.2 AIM

1. To obtain a dietary supplement source through the determination of the nutritional value of the selected fruit seeds samples through proximate and amino acid analysis.
2. Solving the problem of malnutrition by obtaining an alternate, cheap and readily available nutrient source for all income class.

DEFINITION OF TERMS

1.3 DIETARY SUPPLEMENT

A dietary supplement also known as food supplements or nutritional supplements is a preparation intended to supplement the diet and provide nutrients, such as Vitamins, minerals, fibres, fatty acids or amino acids that may be missing or may not be consumed in sufficient quantities in a person's diets. Some may define dietary supplement as foods while in others they are defined as drugs or natural health products. (Audipudi and Chakicherla, 2010).

1.4 PROXIMATE ANALYSIS

Proximate composition is the term usually used in the field of feed/food and means the 6 components of moisture, crude protein, ether extract, crude fibre, crude ash and nitrogen free extracts, which are expressed as the content (%) in the feed, respectively.

The measured values of these 6 components in feed are important factors to understand the nature and the properties of the subject feed.(Lockett *et al*, 2000). The 6 components in the feed and substances contained in them are listed in the table shown below:

Table 1

PROXIMATE COMPOSITION SUBSTANCES IN RESPECTIVE COMPOSITION

Moisture		Water, volatile substances
Dry matter		
	Organic matter	1. Crude protein Pure protein, amino acids, non-protein compounds
		2. Crude fat (Ether extract) Fat, complex lipid, sterols, fatty acids, fat- soluble dyes
		3. Crude fibre Cellulose, hemicellulose, lignin
		4. Nitrogen free extracts Soluble carbohydrate, hemicellulose, lignin, pectin, organic acids, tannin, water-soluble dyes
	Inorganic matter	Crude ash Pure ash, organic residue and soil.

Proximate are used in the analysis of biological materials as a decomposition of a human-consumable good into its major constituents. They are a good approximation of the contents

of packaged comestible goods and serve as a cheap and easy verification of nutritional panels i.e. testing can be used to verify lots, but cannot be used to validate a food processor or food processing facility: a nutritional assay must be conducted on the product to qualify said producers (Alabi, Akinsulire and Sanyaolu, 2005).

Analytically, four of the five constituents are obtained via chemical reactions and experiments. The fifth constituent, carbohydrates, is a calculation based on the determination of the four others. Proximate should nearly always add up to 100%, any deviation from 100% displays the resolution of the chemical test i.e. small variations in the way each test is performed chemist to chemist will accumulate or overlap the composition make-up. Although proximate do not give the entire nutritional assay, they are an inexpensive way to track deviations from the quality of foods.

There are additional ingredients that may fall under the category of one of the five constituents. Carbohydrates for example include but are not limited to: Dietary Fibers Sugars, Sugar Alcohol Whereas Ash includes but is not limited to: Dietary Minerals (Sodium, Potassium, Iron, and Calcium) Vitamins (β-Carotene, Retinol, Vitamin D_3 Vitamin D_2, B Vitamins).

Although proximates do not give the entire nutritional assay, they are an inexpensive way to track deviations from the quality of foods.

1.5 AMINO ACID ANALYSIS

Amino acid analysis is the precise determination of protein quantities and can be used to determine relative amino acid content of a material. Amino acid analysis is the suitable tool for precise determination of protein quantities, but also provides detailed information regarding the amino acid composition and free amino acid. (Okolo, *et al* 2012).

The relative amino acid composition gives a characteristic profile for protein.

This Procedure include:

1. Hydrolysis
2. Separation, Detection and Quantification

Apparatus: High power liquid chromatography [HPLC]

CHAPTER TWO

2.0 LITERATURE REVIEW

Fruits according to (Adeola and Aworh, 2010a). , are the ripened ovaries of a flower containing fully developed ovules, called the seeds. In common language usage, "fruit" normally means the fleshy seed-associated structures of a plant that are sweet or sour and edible in the raw state, such as apples, oranges, grapes, strawberry, bananas, and lemons. On the other hand, the botanical sense of "fruit" includes many structures that are not commonly called "fruits", such as bean pods, corn kernels, wheat grains, and tomatoes.

Botanical survey showed that more than 600 edible fruits are grown in the tropical, subtropical and temperate region of the world, examples of which are avocado, banana, citrus fruits, pineapple, pawpaw, pear, passion fruit and mango to mention but few (Glew *et al,* 1997).

Fruits play an important role in the diet as they contain virtually all the classes of nutrients namely; carbohydrate, protein, lipids, vitamins, fibre and water. They are good source of vitamins and minerals, which helps, in the osmotic balance of the body. Also, due to their high fibre content, they act as a mild laxative. Furthermore, the appealing taste adds desirable aroma of fruits have increased their acceptability in the diet (Adeola and Aworh, 2010a)..

2.1 CLASSES OF FRUITS

Fruits are classified into two major groups based on their respiratory pattern.

(1.) **CLIMATERIC FRUITS:** These are fruits, which show rapid rate in respiration thereby undergoing ripening rapidly.

(2.) **NON CLIMATERIC FRUITS:** These are fruits which does not show rapid rate in respiration thereby undergoing less ripening.

2.2 SIGNIFICANCE OF FRUITS IN DIETS

Fruits play an important role in the diets as they contain virtually all the classes of nutrients-carbohydrate, protein, lipids, vitamins, minerals, water and fibre. The deficiency of these nutrients will leads to the following:

(1.) The deficiency of carbohydrate will result to insufficient energy in the body, hence poor utilization of other nutrients.

(2.) The deficiency of vitamins and minerals will leads to poor biological reaction within the body.

(3.) Improper digestion will result from the deficiency of fibre.

(4.) Low energy will result from inadequate uptake of lipids, hence insufficient energy required by the body.

(5.) The deficiency of protein will lead to poor growth of tissues. (Adeola and Aworh, 2010a).

2.2.1 CARBOHYDRATE

Carbohydrate is the principal constituent of almost all normal diets and of all food components. It contributes to the structure and function of all insect tissue and can be found in the nucleus, cytoplasm and membranes of all cells as well as in the extra cellular hemolymph and supporting tissues (Lockett *et al,* 2000). Carbohydrate is a naturally occurring organic compound containing carbon, hydrogen and oxygen only. The term carbohydrate is derived from the general formula CnH_2nOn or $Cn(H_2O)n$ where n is greater than 3.

When carbohydrates is oxidised in the body; it produces energy. The food substance that is easily oxidized in carbohydrate particularly simple carbohydrate such as glucose ($C_6H_{12}O_6$). The oxidation of glucose can be summarized as follows.

$C_6H_{12}O6 + 6O_2$ ------ $6CO + 6H_2O$ + 2827 KJ (energy)

The carbon dioxide and water formed are the end products but the energy so formed is used by all living cells in the body for their metabolic activities.

The principal free sugars present in fruits are glucose, fructose, and sucrose. While xylose and arabinose have also been detected in smaller quantities during different stages of ripening (Adeola and Aworh, 2010a)..

The other carbohydrates or carbohydrate related substances that make up fruits are cellulose, lignin and pentosans.

2.2.2 PROTEIN

The name 'protein' was introduced by (Jimoh and Oladiji, 2005). Its smallest unit is called the amino acid. The source is as follows. Protein – Peptones – Peptides – Amino acids.

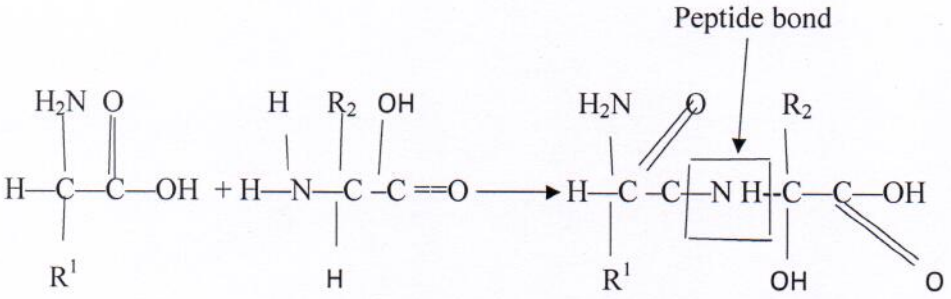
The name protein is taken from the greek proteios, which means first. This name is well chosen. Of all chemical compounds, proteins must almost certainly be ranked first, for they are the substance of life. Protein make up a large part of the animal body, they hold it together, and they run it. They are found in all living cells. They are the principal material of the skin, muscles, tendons, nerves and blood; of enzymes and many hormones. [Only the nucleic acids, which control heredity; can challenge the position of proteins; and the nucleic acid are important because they direct the synthesis of proteins] (Ighodalo, 2004).

Chemically proteins are high polymers. They are polyamides, and the monomers from which they are derived are the α- amino carboxylic acids. A single protein molecule contains hundreds or even thousands of amino acid units; these units can be of twenty-odd different kinds. The number of different combinations, that is, the number of different protein molecules that are possible is almost infinite. It is likely that tens of thousands of different proteins are required to make up and run an animal body; and this set of proteins is not identical with the set required by an animal of a different kind. (Jimoh and Oladiji, 2005)

AN AMINO ACID: $H_2N—CHR—COO^-$

Protein are the chief organic constituent of muscles and tissue. They are important components of enzymes which regulates and carry out metabolism and functional process of living things. Hence the amount of protein adequate I diet must be enough to supply both the total amount of amino acids for the reconstruction of the necessary amount of its own protein which is the necessary amount of its own protein which is the primary nutritional functions of protein.

Protein can be obtained from two sources, animals and plant proteins. Animal protein are food because they are comprise virtually all the essential amino acids needed by the human body. (Oyenuga and Fetuga, 1975) reported that 87% of the total protein consumed in Nigeria comes from plant sources, but only 13% of the protein consumption comes from animal products. The complete hydrolysis (acids, alkaline or enzymic) or protein yields and amino acids of L- configuration. The components of amino acids are joined together by substituted amide bonds, this is done by elimination of water, when the amino group of one amino acid is linked to the carbonyl group of another amino acid.



Protein consist of hundreds of such linkages.

Essential amino acids are those that cannot be synthesized in the body but should be present in the diet while non-essential amino acid are those that can be synthesized in the body provided that there is an available source of nitrogen.

The amino acid are presents in fruits and the major ones include: asparagine, aspartic acid, glutamine, glutamic acid, serine, threonine, alanine valine and cysteine. The protein content of avocado determination by (Atta, 2003) ranged between 1.21-2.26%.

The bulk of nitrogen content of the fruits was contributed by protein nitrogen. Generally, fruits are known to contain essential amino acids but the proportion is not very optimal (Glew *et al*, 1997).

2.2.3 FAT

Fats may be defined as the greasy materials which can be extracted from plants and animal tissue by various non-polar solvent (Mal, 2011). The amount of this varies greatly from one tissue to another. Fats are called oils when they are liquid at room temperature, Fats are used by animals as a source of energy and essentially fatty acids are required for structural lipid membrane tissues such as Brain vasculation. It can also occur in the protoplasm of plants or are specially stored in animal. In cold countries, animals accumulate a layer of fat below the

skin to keep their bodies warm. It helps to regulate body temperature. Deficiency of fat in the body can lead to absorption of vitamin from the body and the formation of scaly skin.

The vast majorities of lipids present in fruit are esters of long chain fatty acids they associated with colour and flavour of fruits during ripening (Nasi, 2011).

2.2.4 ASH

The ash content is the measurement of the total inorganic component in food substances. The remaining part obtained when matter is dried in inorganic content. The ash content is usually determined by burning off the organic matter at a controlled temperature in muffle furnace. Ash content is very important because it consist of or mostly the essential and non-essential minerals and in fact it is good in evaluating and grading the nutritive quality of foods.

Also, the ash content of fruit is relatively high compared to some other food products. Due to this, they are prescribed for the prevention and cure of anaemia (Nasi, 2011). Fruits have been known to aid digestion when consumed due to high fibre content present. For instance, they are now prescribed for correcting intestinal disorders.

2.2.5 MOISTURE CONTENT

Moisture content is also known as the amount of water in food substances. It is of very important factor in storage as a high percentage may activate enzymes that can catalyse the breakdown of such food substances. The drying temperature range varies for different food. For example, proteinous food should be dried at a temperature lower than the temperature at which proteins will be denatured. (Muller, 2005)

Accurate determination of moisture content enables one to know the amount of water to be incorporated during processing. It also predicts the type of preservation technique necessary

for a particular food substance. Drying only evaporates water molecules that are physically bonded on the surface of the food particles, but not those that are chemically bonded. In essence, it is clear that the determination of moisture content involves the amount of water that is physically bonded on the food particles.

2.3 GOLD MOHUR - *Delonix regia.*

The generic name, 'Delonix', is derived from a Greek delos (visible), and onyx (claw), in allusion to the conspicuously clawed petals. The specific name, 'regia', is from the Latin word 'regis' (royal, regal, magnificent). Most of its common names are derived from its large, flame-red flowers. (Ekenem, 1997).

Gold mohur (family: Legminosae, sub family: fabaceae) commonly called as gulmohor in Hindi, *Delonix regia* is the most cosmopolitan of the three species in the genus. A native of Madagascar, it now grows in almost every frost-free country and may be the most recognized flowering ornamental tropical tree in the world (Mbuya *et al,* 1994.).

Gold Mohar, with an impressive range of medicinal and biological properties, has been used in the folk medicine systems of several civilizations for the treatment of constipation, inflammation, arthritis, hemiplagia, leucorrhoea and rheumatism.

Delonix regia is a small to medium-sized tree, typically 7 to 16 m tall and up to 60 cm (Little and Wadsworth, 1964). However, the champion Puerto Rican (D. regia) tree is 32 m tall and 105 cm d.b.h. (Francoise, 1999). This tree is easily recognized with prominent buttresses and a briefly deciduous broad, flat crown when grown in full sun. The species grows well in moist soil derived from limestone, where it is common and reproduces well; but it also tolerates well-drained and somewhat droughty conditions (Francoise, 1999).

2.3.1 LOCAL NAMES

Arabic (goldmore), English (flamboyant flame tree, gold mohur,flame tree,julu tree), German (fammenßaum, Feuerbaum), French (royal,flamboyant,poinciana), Trade name (gold mohar) and Yoruba (sekeseke). (Francoise, 1999)..

2.3.2 BOTANIC DESCRIPTION

Delonix regia is a tree 10-15 (max. 18) m high, attaining a girth of up to 2 m; trunk large, buttressed and angled towards the base; bark smooth, greyish-brown, sometimes slightly cracked and with many dots (lenticels); inner bark light brown; crown umbrella shaped, spreading with the long, nearly horizontal branches forming a diameter that is wider than the tree's height; twigs stout, greenish, finely hairy when young, becoming brown. Roots shallow. (Francoise, 1999).

2.3.3 ECOLOGY

D. regia originates from Madagascar, where it is now almost extinct. It is now widespread in most tropical and subtropical areas of the world. Trees can grow at higher altitudes than recommended, but flowering becomes erratic. The tree demands light and grows weakly and sparsely under shade. It grows in areas with both high and scanty rainfall. D. regia has a superficial root system and competes successfully with the neighbouring shrubs and flowering plants, rendering bare the ground under its canopy. It should therefore be planted away from other plants in the gardens. Trees are deciduous only where the dry season is long and pronounced. (Ighodalo, 2004).

2.3.4 BIOPHYSICAL LIMITS

Altitude: 0-2000 m, Mean annual rainfall: 700-1200 mm, Mean annual temperature: 14-26 deg C

Soil type: The species seems to tolerate many types of soils from clay to sandy, but it prefers sandy soils. PRODUCTS Apiculture: Flowers are reputed to produce bee forage.

2.4 TAMARIND – *Tamarindus indica*

Its common name derives from the Arabic "tamari Hindi" which means "fruit of India." Tamarind or Tamarindus indica L. of the Fabaceae, subfamily Caesalpinioideae, is an important food in the tropics. It is a multipurpose tree of which almost every part finds at least some use (FAO/WHO/UNU. 1985), either nutritional or medicinal. Tamarind is indigenous to tropical Africa but it has been introduced and naturalized worldwide in over 50 countries. The major production areas are in the Asian countries India and Thailand, but also in Bangladesh, Sri Lanka, Thailand and Indonesia. In America, Mexico and Costa Rica are the biggest producers. Africa on the whole does not produce tamarind on a commercial scale, though it is widely used by the local people. Minor producing countries in Africa are Senegal, Gambia, Kenya, Tanzania and Zambia (El-Siddig *et al*., 2006).

2.4.1 LOCAL NAMES

Indian Tamarind, Kilytree, Tamarind.Spanish: Tamarindo, tamarindero, Mandarin, tamarindo de la India. Catalan: Tamarinde, Tamarindi. French: Tamarin, Tamarinier d'Inde. German: Tamarindenbaum. Sanskrit: Amlika.

Scientific name: *Tamarindus indica*

Taxonomic synonym: *Tamarindus officinalis.*

Family: Fabaceae or Leguminosae.

Tamarind (*Tamarindus indica*) is a monotypic species, meaning that there is only one species within the genus Tamarindus.

Habitat: Tropical plant, native to Africa and spread throughout the African continent. It

grows wild in Sudan.It is believed that the tree was introduced in Asia by Arab traders, and their distribution in America is due to the first shipments of slaves from East Africa. Currently it is grown in India, the largest Asian producer of this plant, and in America (Mexico, Costa Rica, Puerto Rico).

Tamarind has adapted to seasonally dry regions of long duration. However, in humid tropical climates, this tree is poorly developed and often fails to bear fruit. It is sensitive to frost and drought resistant. It grows at altitudes up to 1,200 meters.

2.4.2 BOTANIC DESCRIPTION

Tamarind (Tamarindus indica L.) is found in majority of the Tropics where it grows wild in backyards, roadsides or wastelands (Gunasena and Hughes, 2000). It is mostly found in the savannah region of Nigeria. The indigenous people utilise various parts of the plant as medicine and food. Tamarind, though has a great wide range of domestic and industrial uses, is still underexploited (Gunasena and Hughes, 2000).

The most valuable and commonly used part of tamarind tree is the fruit, which is reputed to have one of the highest levels of protein and carbohydrate when compared with other of types of fruits (Gunasena and Hughes, 2000). Tamarind fruits could therefore serve as a reasonable source of protein and thereby help to alleviate the perennial problem of malnutrition in many developing nations.

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perennial problem of malnutrition in many developing nations.

Seeds are gaining importance as an alternative source of proteins, and are besides rich in some essential minerals. Seed pectin can form gels over a wide pH range. Leaves and flowers can be eaten as vegetables, and are prepared in a variety of dishes. They are used to make curries, salads, stews and soups. Tamarind leaves are a fair source of vitamin C and α-carotene; mineral content is high, particularly Phosphorus [P], Potassium [K], Calcium [Ca] and Magnessium [Mg]. Anti-oxidant, anti-inflammatory, anti-microbial and anti-fungal activity has been documented from several plant parts. Tamarind is also extensively used in traditional medicine.

Nutritional composition of tamarind fruit varies considerably (Morton, 1987; Chapman (1984) and Persueglove (1982) both cited in El-Siddig *et al.*, 1999). However, a typical fruit contains 40% pulp (El-Siddig et al., 1999). According to other authors, the fruit contains about 55% pulp, 34% seeds, and 11% shell (pod) and fibres (Rao & Srivastava (1974) cited in (Ishola *et al* (1990).). In the past, and even today, seeds have been wasted (El-Siddig *et al.*, 2006) even though they could be ground to make a palatable livestock feed cited in El-Siddig *et al.*, 2006).

2.4.3 AMINO ACID PROFILE

The fruit pulp is relatively poor in protein though the fruit is rich in several amino acids (Ishola *et al.,* 1990). Glew and co-workers reported the amino acid composition of tamarind fruit pulp. essential amino acids of tamarind fruit pulp exceed those of the 'ideal' protein standard established by the World Health Organization, except for tryptophan (82%).

Although tamarind fruit contains potentially useful amounts of protein, they have been shown to be poorly digested and utilized by rats, as compared with proteins in coconut meat that are

extensively digested and efficiently utilized by mammals (Grant *et al.* (1995) and Mepba *et al.* (2003) both cited in Glew *et al.*, 2005).

2.5 CAMEL FOOT – *Piliostigma thonningii*

2.5.1 LOCAL NAMES

Arabic (tambareib,khuf aj jamal,kharub,abu khameira); English (wild bauhinia, Rhodesian bauhinia, monkey bread, camel's foot); Luganda (kigali); Ndebele (ihabahaba); Shona (mutukutu); Swahili (mchikichi, mchekeche). Locally called Kalgo (Hausa), Abefe in the Yoruba land (Nigeria).

Native: Botswana, Kenya, Namibia, Senegal, South Africa, Sudan, Tanzania, Uganda, Zambia and Nigeria. (Ighodalo, 2004).

2.5.2 BOTANIC DESCRIPTION

Piliostigma thonningii is a tree 4-15 m in height with a rounded crown and a short but often crooked bole. Twigs rusty-hairy. The bark is rough and longitudinally fissured, being creamy-brown when fresh and grey-brown later. P. thonningii grows in open woodland and savannah regions that are moist and wooded grassland in low to medium altitudes. It is widely distributed in Africa and Asia. It is found growing abundantly as a wild uncultivated tree in many parts of Nigeria such as Zaria, Bauchi, Ilorin, Plateau, Lagos and Abeokuta (Djuma, 2003). The seeds of P. thonningii fruits have been reported to be eaten by African antelope and elephant while farmers in the lower Savanna region grind up the seed as fodder for cattle during winter months (Djuma, 2003).

2.5.3 GERMPLASM MANAGEMENT

Seed collection should be done immediately the pods turn brown to prevent insect attack. Seed drying is recommended. The different seed pre-treatments include washing, soaking for 24-48 hours, hot water treatment and different degrees of removal of the seed coat of Piliostigma sp. which gives more than 80% germination. There are 7, 300 seeds per kg. The seeds are difficult to extract because of the tough/ woody pod covering.

2.5.4 ECOLOGY

P. thonningii is common in open woodland and wooded grasslands of sub-humid Africa at medium to low altitudes. It is found throughout tropical Africa except in Somalia. It is usually associated with Annona senegalensis, Grewia mollis and Combretum spp.

2.5.5 BIOPHYSICAL LIMITS

Altitude: 0-1 850 m Mean annual temperature: 20 deg. C Mean annual rainfall: 700-1 400 mm Soil type: Heavy clayey soils or medium loamy soils are preferred by this plant. It tolerates acid soils and prefers deep fluvisols or ferrasols soils.

Since the selected samples for study are fruits, even though are not consumed vegetatively by any tribe in Nigeria from the literature gathered they must possess several nutrients which is general to most fruits. The researcher found that Goat, sheep and monkeys find the 3 tropical fruit seeds: Gold mohur – *Delonix regia,* Tamarind – Tamarindus indica and Camel foot – *Pilostigma thongi.* consumable when they fall off trees and during the sun-drying process. (Djuma, 2003).

Delonix regia is reported to contain rich content of β-sitoserol, tannins, saponins, flavonoids, steroids, alkaloids and carotene hydrocarbons. The carotenoids and perhaps non-nutrients like dietary fibers and other phenolic components (falvonoids, tannins and terpenoids) can

influence the enzyme involved in the activation and detoxification of xenobiotics including carcinogens.(Swaminathan and Jain 1973).

Nutritional evaluation of varying levels of cooked flamboyant seed meal *(Delonix regia)* on the growth performance and body composition of Nile tilapia (Oreochromis niloticus) fingerlings. *Delonix regia* lead to an increase in carcass lipid content and a decrease in the moisture content of the fish fed experimental diet. The results indicate 10-15% inclusion of *Delonix regia* seed meal improved growth performance and nutrient utilization of Nile tilapia fingerlings. (Gabriel, Elizabeth, Suleiman and Eku, 2014).

Shabir, and Anwar, *et al*, 2011. Reports, the antioxidant and antimicrobial activities and phenolic components of different solvent (absolute methanol, absolute ethanol, absolute acetone, 80% methanol, 80% ethanol, 80% acetone and deionized water) extracts of leaves, flowers and bark of Gold Mohar. The extract yields from leaves, flowers and bark ranged from 10.19 to 36.24, 12.97 to 48.47 and 4.22 to 8.48 g/100 g dry weight (DW), respectively. Overall, 80% methanol extract produced from the leaves exhibited significantly ($P < 0.05$) higher antioxidant activity, with high phenolic contents (3.63 g GAE/100 g DW), total flavonoid contents (1.19 g CE/100 g DW), inhibition of peroxidation (85.54%), DPPH scavenging capacity (IC50 value 8.89 µg/mL) and reducing power (1.87). Similarly, this 80% methanol leaves extract also showed superior antimicrobial activity. HPLC analysis of the 80% methanol extracts for individual phenolics revealed the presence of gallic, protocatechuic and salicylic acid in leaves; gallic, protocatechuic, salicylic, trans-cinnamic and chlorogenic acid in flowers, and gallic acid in bark as the main (amount > 1.50 mg/100 g DW) phenolic acids. Besides, small amounts (<1.50 mg/100 g DW) of some other phenolic acids such as sorbic, sinapic, p-coumaric, mcoumaric, ferulic, caffeic, 3-hydroxybenzoic, 4-hydroxycinnamic and 4-hydroxybenzoic acids were also detected. The extracts of the tested

parts of Gold Mohar, especially, the leaves, might be valuable for functional food and therapeutic applications.

Adeola, (2013) reported the Amino Acid Composition of Tamarind Fruit Growing Wild in Oyo Town. The amino acid composition of tamarind pulp was determined using amino acid analyser. Tamarind pulp was found to contain both essential and non-essential amino acids. Tamarind pulp could supply 53.8 %, 52.8 %, and 87.6 % of total essential, total sulphur and total aromatic amino acids respectively (FAO/WHO/UNU 2013).

A feeding trial was conducted to evaluate the effect of inclusion level of cooked Delonix regia seed meal (CDRM) in the practical diet of Oreochromis niloticus fingerlings through their growth performance and nutrient utilization for 56 days. Proximate composition result revealed that increase in the inclusion level of cooked Delonix regia lead to an increase in carcass lipid content and a decrease in the moisture content of the fish fed experimental diet. The results indicate 10-15% inclusion of Delonix regia seed meal improved growth performance and nutrient utilization of Nile tilapia fingerlings. (Gabriel and Suleiman, *et al* 2014).

Ukwuani *et al*, 2012. Showed the Acute Oral Toxicity and Antiulcer Activity of Piliostigma thonningii Leaf Fraction in Albino rats. The present study provides preliminary data on the antiulcer potential of Camel foot - *Piliostigma thonningii* leaf and support the traditional uses of the plant for the treatment of gastric ulcer.

A. Kwaji1and P. U. Bassi *et al*, 2010. Worked on the Preliminary studies on Piliostigma thonningii Schum leaf extract: Phytochemical screening and in vitro antimalarial activity the crude leaf extracts obtained were tested for in vitro antimalarial activity using chloroquine resistant strain of P. Falciparum clone (W2 – Indochina isolates). The 50% inhibitory concentrations (IC50) were evaluated after 48 - 72 h contacts between the extracts and the

parasite culture. The 50% inhibitory concentration values for both the crude amide ethanolic extract and the partially purified methanolic extract ranged between 6.20 - 15.06 µg/ml. While that of chloroquine was 0.316 µg/ml. This study suggested that P. thonningii leaf extract possess a significant level of antimalarial activity.

From several works done on the selected seeds it is no gain saying to say these seeds are rich in essential and non-essential nutrients even though they are not consumed as vegetable and are usually left not fully tapped in most parts of Africa, making the seeds quite suitable for the research.

2.6 NUTRITIONAL COMPOSTION OF FRUITS SEEDS

2.6.1 PROTEINS AND AMINO ACIDS

Protein are formed by amino acids linked by peptide bonds. All amino acids have the same basic structure groups; a hydrogen atom, and amine group (NH_2), and acid group (COOH) and a distinctive side group. The side groups, which vary from a single hydrogen atom to a complex ringed structure, distinguish the 21 different amino acids. Generally, dietary protein sources are divided into two categories (1) Animal protein, such as meat, poultry, fish, eggs, milk and milk product; (ii) Plants protein, such as legumes (Peanuts, Peas, Beans and Lentils), cereals, vegetables and fruits. (Mbuya *et al*, 1994).

Animal product foods are generally higher in protein than plant products and the proportion of amino acid in the protein of animal origin comes closer to meet the human needs than in most plant sources. Plants protein is potentially important in undeveloped and developing countries. Several countries in south Asia such as Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka, the most regular foods come from plant sources where rice and wheat are the main samples; Wheat, legumes and edible oil are the main foods. Although

a variety of animal foods are used by economically privileged people, for a large section of the population animal foods do not constitute part of their diet due to economic reasons (Jimoh and Oladiji, 2005). Similarly, human populations of the western Sahel regions of Africa normally depend upon a number of edible wild plants to satisfy a substantial part of their nutritional requirements. The dependency on wild plant foods is heightened during times of drought that lead to poor cereal harvests. Thus, the wild plants foods of the western sahel play an essential role in the survival and health of human populations who utilize the (UNICEF, 2000). Bean proteins are found to be relatively high in essential amino acids, in particular lysine, threonine, Isoleucine, leucine, phenylalanine and valine. But, they are deficient in sulphur – containing amino acids, in particular methionine and cysteine (Katende *et al.* 1995.). Methionine is the first limiting essential amino acid in legumes because the major storage proteins, globulin, is low in this amino acid (FAO/WHO/UNU. (1985).

Amino acids can be divided into essential and non-essential amino acid. The non essentail are those that can be synthesized by the body. In adults, 12 of the amino acid can be synthesized and nine are essential. Early in infancy, several of amino acids that are non-essentail later in life are conditionally essential, namely cystenine and arginine (UNICEF, 2000). Protein is an essential component of the diet needed for the survival of living beings. The basic function of protein in nutrition is to supply adequate amounts of needed amino acids.

2.6.2 OTHER COMPONENT

Carbohydrates supply the greatest percentage of calories and bulk in an average diet, yet they make up less than 1% of total body weight. The main function of dietary carbohydrate is to supply energy (UNICEF, 2000). The Carbohydrates content of the 3 tropical seeds Gold mohur- *Delonix regia*, Tamarin –*Tamarindus indica* and Camel foot – Pilostigma thonningii have been understudied. Nevertheless, (Khalil and Manan, 1990.) found that the seeds have a high content total carbohydrate content ranging from 36-38%.

CHAPTER THREE

3.0 MATERIALS AND METHODS

The raw materials used were obtained from the northern part of Nigeria, Sokoto state precisely. The seeds were screened, distilled, grinded and preserved in polyethene bag before use.

3.1 PREPARATION OF RAW MATERIALS

The fresh raw materials i.e. Gold mohur [***Delonix regia]***, Tamarind [***Tamarindus indica]*** and Camel foot [***Pilostigma thonningii***] were sun-dried for 6 weeks and were separated from their coat or fleshy outer layer carefully.

The seed were grounded, sieved and packed into a polythene bag until used.

3.2 APPARATUS USED

For amino acid composition analysis, the following apparatus were used during the analysis: condenser, circulator, water bath, Gas chromatography, weighing balance, soxhlet extraction apparatus, filter paper, etc.

3.2.1 PROXIMATE COMPOSITION

3.2.1.1 Moisture content using oven method

Apparatus: Petri dishes, Analytical weighing balance, Drying oven, Desiccator.

Reagent: sample, distilled water.

Procedure: The Petri dishes were washed with distilled water and kept in the oven at a temperature of 105°C for some minute to condition them for use. The Petri dishes were then transferred into the desiccator to cool. The empty Petri dishes were weighed using the analytical weighing balance and recorded as W_1 and about 5g of the samples were weighed into the Petri dishes and recorded as W_2 and they were transferred into the oven for drying for about 3hours @110°C. The Petri dishes containing the sample were then transferred to the

desiccator for cooling and were weighed and recorded as W_3. Drying and weighing was repeated until constant weight was achieved. The analysis was done in duplicate.

Fig 2.1a: Drying oven

Source: Central laboratory, FUTA

3.2.1.2 Determination of percentage ash content in food samples using dry digestion method

The dried samples were macerated into finer particles. The crucible was washed with distilled water and then put in the furnace for about 15 minutes to condition it, after which it was cooled in the desiccator. The crucible was weighed and recorded as W_1 and then about 1g of the sample was weighed into the crucible. It was placed on a plugged hot plate in a fume cupboard to char for about 30 minutes till the organic components are burnt off.

NB: ***Charring*** (Decarbonation) is the process of breaking down the bonds since it contains water to prevent explosion in the furnace and also to lose volatile components in the sample i.e. incombustible combustion of organic material. For fat containing sample, we first pass to the water bath to reduce the water content before charring

It was transferred into a preheated muffle furnace @550°C and allowed to stay for 2hours. Normally, the charred sample ought to stay for about 1hour in the furnace but over time it was realized that the time was insufficient for complete combustion of organic material Ashing is completed when white or gray ash results. After ashing was completed, the crucible was brought out from the furnace using a thong and place in the desiccator to cool.

NB: If the residue was black in color, moisten with a little quantity of water to dissolve the salts, dry in an oven and repeat ashing procedure.

The sample was weighed and returned into the furnace until a constant weight was obtained. It was then cooled in a desiccator and reweighed.

Calculation:

$$\% \text{ Ash content} = \frac{W3 - W1}{W2 - W1} \times 100$$

Where W_1 = Weight of empty crucible

W_2 = Weight of crucible + sample before drying

W_3 = Weight of crucible + ash

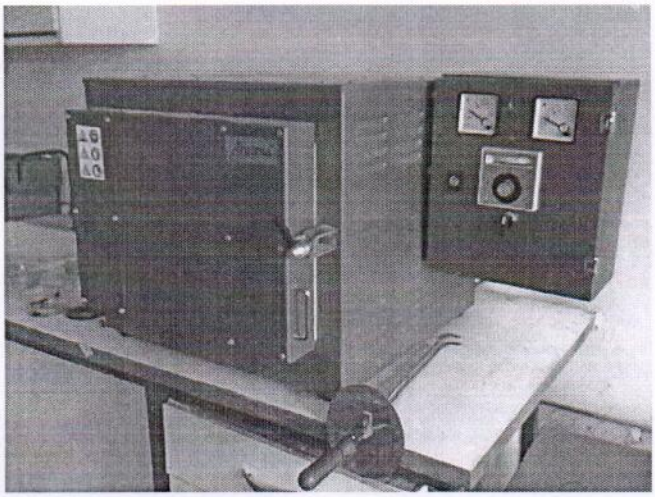


Fig 2.2: The muffle furnace

Source: Central laboratory, FUTA.

3.2.1.3 Determination of percentage crude protein in food samples using kjeldahl method

Kjeldahl apparatus, digesters and rack, analytical weighing balance, kjeldahl catalyst, digester, burette, pipette, conical flasks, spatula, measuring cylinder

Reagents: Sample, sulphuric acid (0.1 N H_2SO_4), boric acid indicator, sodium hydroxide (NaOH), kjeldahl catalyst

Procedure: The kjeldahl method of analysis of protein in food samples is divided into four stages:

1. Sample preparation
2. Digestion
3. Distillation
4. Titration

3.2.1.3.1 Sample preparation

1g of the solid food sample was weighed using the digital analytical weigh balance and transferred into a digesting tube (kjeldahl flask).

3.2.1.3.2 Digestion

The sample was heated with 10ml of concentrated Sulphuric acid, H_2SO_4, which served as the oxidizing agent that decomposes the organic substances by oxidation to liberate the reduced nitrogen as ammonium sulfate. One tablet of kjeldahl catalyst ($CuSO_4.5H2O$) was added to increase the boiling point, hence, speeding up the rate of the reaction. The digester was then transferred into the digestion block of the kjeldahl apparatus.

The temperature controller was turned on, which has been programmed to 430°C for 2hours. As digestion took place, the nitrogen in the food (other than that which is in the form of nitrates or nitrites) was converted to ammonium sulfate while carbon dioxide (CO_2), sulphur (iv) oxide (SO_2) and water vapor were released in form of fumes and trapped in the scrubber unit (which contained 150g sodium bicarbonate in 600ml of distilled water) and the remaining fumes were finally condensed in the vacuum air space condenser (which contained 10g of Na_2CO_3 in 12litres of water)

Degradation: Sample + H_2SO_4 $\longrightarrow$ $(NH_4)_2SO_4$ (aq) + CO_2 (g) + SO_2 (g) + H_2O (g)

After cooling, it was transferred to the distillation apparatus

3.2.1.3.3 Distillation

- 50ml of prepared boric acid (40g Boric acid + 0.02g Methyl red + 0.06g Bromocresol green) was pipetted into a conical flask.
- 40% of Sodium hydroxide was prepared and put in the NaOH tank and the water reservoir tank was filled with water in the distillation apparatus.
- A constant flow of water was ensured to be connected to the distillation apparatus.
- The distillation apparatus was allowed to warm up.
- The digested sample was fixed into the apparatus after the addition of 20ml distilled water to digest any crystal still present after digestion and the conical flask containing boric acid was also fixed accordingly.
- From the apparatus, the STEAM button was clicked once to dispense 25ml of steam and the NaOH button was clicked thrice to dispense 75ml of NaOH. i.e. each click dispenses 25ml

$$(NH4)_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + H_20 + 2NH_3$$

The ammonia generated was collected in an excess of boric acid.

$$2NH_3 + 2H_3BO_3 \longrightarrow 2NH_4H_2BO_3$$

3.2.1.3.4 Titration

Using direct titration method, the solution was then titrated with 0.1N H_2SO_4 until its **original pink colour** was restored. . The nitrogen content is then estimated by titration of the ammonium borate formed with standard sulfuric or hydrochloric acid, using a suitable indicator to determine the end-point of the reaction.

$$2NH_4H_2BO_3 + H_2SO_4 \longrightarrow (NH_4)_2SO_4 + H_2BO_3$$

Determination of percentage crude fibre in food samples

Procedure

(1.) The crucible was washed to get rid of all impurities and then dried in the oven. It was placed in the desiccator to cool.

(2.) 0.5g of Celite was weighed into the crucible and placed in the muffle furnace at 550^0C for about 15 – 20 minutes to condition the crucible. Celite aids filtration, making it easy for the reagent to be washed out of the crucible.

(3.)1g of the sample was weighed accurately into the crucible containing the Celite and recorded as W_0. The food sample was mounted in the Fibertec.

(4.) 150ml of 1.25% sulphuric acid was preheated for 10 minutes.

The preheated acid was added to the food sample and boiled for 30 minutes. Then the reagent was drained and washed with deionized water to remove traces of the acid.

(5.)150ml of 1.25% sodium hydroxide was preheated for 10 minutes.

The preheated base was added to the food sample and boiled for 30 minutes. The base was drained and washed with deionized water to remove the traces of the base left.

(6.) The sample was removed from the Fibertec and placed in the cold extraction unit.

10ml of acetone was added to the digested food sample and left for 5 minutes to remove the fat residue from the food sample. The acetone was drained and removed the sample from the cold extraction unit.

(7.)The sample was placed in the oven for 1 hour at 105^0C after which it was placed in the desiccator to cool. The weight was recorded as W_1.

(8.)The sample was placed in the muffle furnace for ashing for 3 hours at 550^0C. It was then allowed to cool, and then the weight was taken and recorded as W_2.

Calculation:

Weight of sample = W_0

Weight of oven dried sample = W_1

Weight of ash sample = W_2

$$\% \text{ Crude Fiber} = \frac{W1 - W2}{W0} \times 100$$

3.2.1.4 Determination of Fat Content in selected samples

Gold mohur – *Delonix regia,* Tamarind – Tamarindus indica and Camel foot – *Pilostigma thongi.*

Procedure

2g of the sample was weighed and recorded as W_1. The round bottom flask was washed and dried in the oven @105°C for 30 minutes. The flask was placed in a desiccator to cool and its weight was taken and recorded as W_2. The sample was wrapped in a filer paper and put inside the thimble which was loaded into the main chamber of the soxhlet extractor. About 150ml of the extraction solvent (petroleum ether) to be used was poured into the quick-fit flask and the apparatus was set-up. The soxhlet was then connected to the condenser.

The solvent was heated to reflux such that the solvent vapour traveled up through distillation arm and condensed back into the liquid state. The petroleum ether flows into the soxhlet extractor housing the thimble. The fat gets dissolved in the warm solvent until the soxhlet extractor is almost filled with the warm petroleum ether. The soxhlet extractor was automatically emptied through its siphon side arm with the solvent returning back to the boiling quick-fit flask. The cycle was repeated continuously for 2-3 hours. After many cycles, the desired organic compound which is fat was concentrated in the quick-fit flask. The thimble was removed with care and the petroleum ether in the soxhlet extractor was collected and drained into a container for re-use.

The flask was removed when it was almost free of petroleum ether and dried in the oven @105°C for 1hour. The flask was transferred from the oven into a desiccator to cool and was then weighed and recorded as W_3.

Calculation:

$$\% \text{ Crude Fat} = \frac{\text{weight of fat}}{\text{weight of sample}} \times 100$$

$$\% \text{ Crude Fat} = \frac{W_3 - W_2}{W_1} \times 100$$

Where W_1 = Sample weight (g)

W_2 = Extraction cup weight (g)

W_3 = Extraction cup + residue weight (g)

Summarily:

Moisture content was determined by heating 2.0 g of each fresh sample to a constant weight in a crucible placed in an oven maintained at 105^{0}C. The ash content was determined by the incineration of 1.5 g samples placed in a muffle furnace maintained at 550 ^{0}C. for 5 -8 hrs. The crude fibre was obtained by digesting 2 g of the samples with H_2SO_4 and NaOH and incinerating the residue in a muffle furnace maintained at 550 ^{0}C. for 5 -8 hrs. The crude protein (% total nitrogen X 6.25) was determined by Kjeldahl method, using 2 g of the samples. The crude lipid content was obtained by exhaustively extracting 10 g of each sample in a Soxhlet apparatus using N-Hexane as the extractant. Each analysis was carried out in triplicates. The carbohydrate content was determined by the difference i.e. deducing the sum of the percentage (moisture, ash, fibre, fat, and protein) from 100.

3.2.2 AMINO ACID COMPOSITION

For amino acid composition analysis, the following apparatus were used during the analysis; condenser, circulator, water bath, Gas chromatography, Weighing balance, soxhlet extraction apparatus, filter paper, e.t.c

3.2.2.1 REAGENT USED

The reagent used include normal hexane, distilled water, ice block e.t.c

3.2.2.2 METHODS OF ANALYSIS

The amino acid analysis was carried on Gold mohur – *Delonix regia,* Tamarind – Tamarindus indica and Camel foot – *Pilostigma thonningii.* Using the following

3.2.2.3 GC CONDITIONS FOR AMINO ACID

GC:	HP 6890 powered with HP chemstation
	Rev. A 09.01 (1206) software
Injection Temperature:	Split Injection
Split Ratio:	20:1
Carrier Gas:	Hydrogen
Inlet Temperature:	250°C
Column Dimensions:	30m x 0.25mm x 0.25µm
Oven Program:	Initial Temperature at 60 °C
	First Ramping at 8 °C / min for 20 mins, Maintained for 2min.
	Second Ramping at 12 °C / min for 6mm. Maintained for 2 min.
Detector:	PFPD
Detector Temperature:	320 °C
Hydrogen Pressure:	20psi
Compressed Air:	35psi

3.2.2.4 METHODOLOGY

3.2.2.4.1 AMINO ACID EXTRACTION

Modified AOAC method, (2006) was followed in the extraction of the sample for the amino acid analysis. The dried and pulverized sample was made to be free of water by ensuring constant weight for a period of time in the laboratory. The sample of 10.0g was weighed into the 250ml conical flask capacity. The sample was defatted by extracting the fat content of the sample with 30ml of the petroleum spirit three times with soxhlet that was equipped with thimble. The sample was hydrolysed three times for complete hydrolysis to be achieved. The amino acid content of the sample was recovered by extracting with 30ml of the dichloromethane three times before concentrating 1.0ml for HPLC gas chromatography analysis.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULT OF PROXIMATE COMPOSITION

Below are the obtained result from proximate composition (g/100g crude protein) of Gold mohur – (***Delonix regia)***, Tamarind – (***Tamarindus indica) and*** Camel foot – (***Pilostigma thonningii)***.

Table 2

PROXIMATE COMPOSITION OF SELECTED SEEDS

S/N	% Moisture Content	%Ash	%Crude protein	% Fat	% Fiber	% CHO
Gold mohur	9.08 ± 0.01	3.60 ± 0.02	49.12 ± 0.04	21.57 ± 0.02	2.35 ± 0.03	14.24 ± 0.49
Tamarind	10.59 ± 0.49	3.85 ± 0.04	20.34 ± 0.02	4.61 ± 0.02	10.17 ± 0.01	50.37 ± 0.49
Camel foot	10.84 ± 0.01	8.01 ± 0.01	11.71 ± 0.04	2.84 ± 0.04	12.00 ± 0.02	54.56 ± 0.02

Means ± standard deviation of repeated determinations.

The proximate and elemental composition of Gold mohur – (***Delonix regia),*** Tamarind – (***Tamarindus indica) and*** Camel foot – (***Pilostigma thonningii).*** Repetted analysis shows that they are very rich in nutrients namely, protein 49.12% in Gold mohur, 20.34% in Tamarind and 11.71% in Camel foot and fat, 14.24% in Gold mohur, 50.37% in Tamarind and 54.56% in Camel foot.

The Gold mohur's value compares favourably with those obtained from [Shumaila and Safdar , 2009]. Proximate Composition Parameters: Moisture 8.30±0.29, Ash 9.01±0.01, Fat 21.47±0.29, Fibre 2.45±0.22 Protein 37.51±0.15 Carbohydrate 19.02±0.30.

Proximate composition on Tamarind – ***Tamarindus indica's*** *value* compares favourably to that obtained from Comparative Proximate Studies Okolo, Simon *et al.* Moisture 7.51±0.00, Ash 4.01±0.09, Fat 3.19±0.14, Fiber 18.02±0.55, Protein 31.01±0.57 and Carbohydrate 36.10±0.26.

Proximate composition of Pilostigma thonningii also compares favourably to values obtained by Jimoh and Oladiji, 2005. Component Value (% composition) Moisture content 6.71 ± 0.04 Ash 3.50 ± 0.04 Crude protein 30.33 ± 0.31 Crude fibre 35.03 ±0.11 Lipid 1.42 ± 0.03 CHO 23.00 ± 0.24.

4.2 RESULT OF AMINO ACID COMPOSITION ANALYSIS

Below are the obtained result from the amino acid composition (g/100g crude protein) of Gold mohur – ***(Delonix regia),*** Tamarind – ***(Tamarindus indica) and*** Camel foot – ***(Pilostigma thonningii).***

Table 3.

AMINO ACID COMPOSITION ANALYSIS OF ABOVE NAMED SEEDS.

AMINO ACID	GOLD MOHUR[g/100g]	TAMARIND[g/100g]	CAMEL FOOT[g/100g]
Glycine	3.60	4.63	3.37
Alanine	5.73	4.15	6.15
Serine	4.36	4.52	2.95
Proline	4.23	5.30	3.45

Valine	4.42	5.49	3.47
Threonine	3.46	4.56	2.47
Isoleucine	3.04	4.22	2.86
Leucine	7.41	7.70	6.90
Aspartate	8.84	9.35	8.34
Lysine	4.80	6.12	3.48
Methionine	1.28	2.13	1.78
Glutamine	12.74	14.74	14.20
Phenylalanine	3.56	4.26	5.99
Histidine	2.35	1.95	2.28
Arginine	6.45	6.50	6.18
Tyrosine	2.82	3.18	3.22
Cystine	1.41	3.47	1.43

TOTAL AMINO ACID - TAMARIND ***[Tamarindus indica]***	92.34961
TOTAL AMINO ACID – GOLD MOHUR ***[Delonix regia]***	90.29549
TOTAL AMINO ACID - CAMEL FOOT ***[Pilostigma thonningii]***	78.61056

Table 4

Analysis of Amino Acid date (g/100g Crude Protein) on Gold mohur – (***Delonix regia),*** Tamarind – **(*Tamarindus indica) and*** Camel foot – **(*Pilostigma thonningii).***

Amino Acid description	Gold mohur	Tamarind	Camel foot
Total Amino acid	90.3	92.3	78.6
Total Non-essential amino	43.73	49.34	43.11
% (TNEAA)	48.42	53.43	54.84
Total essential amino acid With histidine	36.7	42.93	35.41
Essential amino acid without Histidine	34.35	40.98	33.13
Essential aliphatic amino acid	67.54	77.58	63.58
Essential Aromatic Amino acid	12.96	14.69	14.94
Total neutral Amino acid	41.8	40.3	42.4
% TNAA	42.9	55.4	56.3
Total acidic Amino acid	21.58	24.09	22.54
% TAAA	23.89	26.09	31.16
Total basic amino acid	17.1	11.6	15.9
% Basic amino acid	17.5	15.9	18.3
Total suphur Amino acid	3.7	4.08	4.06

4.3 DISCUSSSION

From the result in 4.1, the following facts can be related concerning each of the different content. The proximate and elemental composition of Gold mohur – (***Delonix regia),*** Tamarind – (***Tamarindus indica) and*** Camel foot – (***Pilostigma thonningii).*** Repetted analysis shows that they are very rich in nutrients namely, protein 49.12 ± 0.04% in Gold mohur, 20.34 ± 0.02% in Tamarind and 11.71 ± 0.04% in Camel foot and fat, 21.57 ± 0.02% in Gold mohur, 4.61 ± 0.02 % in Tamarind and 2.84 ± 0.04% in Camel foot. The seeds also possess reasonable amount of ash content which may be a source of minerals in foods. i.e % Ash 3.60 ± 0.02 in Gold mohur, 3.85± 0.04 in Tamarind and 8.01 ± 0.01 in Camel foot.

It is also evident that the seeds are also rich in Amino acids i.e containing several essential and non- essential amino acid, acidic and basic amino acid e.t.c from the result obtained from Amino acid composition % Total Non-essential amino acid Gold mohur 48.42, Tamarind 53.43 and Camel foot 54.84. And Total essential amino acid with Gold mohur 36.7 Tamarind 42.93 and Camel foot 35.41With histidine.

Result obtained from both the proximate composition and Amino acid composition analysis compares favourably with theory obtained on the selected seeds i.e The Gold mohur's proximate value compares favourably with those obtained from [Shumaila and Safdar , 2009]. Proximate Composition Parameters: Moisture 8.30±0.29, Ash 9.01±0.01, Fat 21.47±0.29, Fibre 2.45±0.22 Protein 37.51±0.15 Carbohydrate 19.02±0.30.

Proximate composition on Tamarind – ***Tamarindus indica's*** *value* compares favourably to that obtained from Comparative Proximate Studies Okolo, Simon *et al.* Moisture 7.51±0.00, Ash 4.01±0.09, Fat 3.19±0.14, Fiber 18.02±0.55, Protein 31.01±0.57 and Carbohydrate 36.10±0.26.

Proximate composition of Pilostigma thonningii also compares favourably to values obtained by Jimoh and Oladiji, 2005. Component Value (% composition) Moisture content 6.71 ± 0.04 Ash 3.50 ± 0.04 Crude protein 30.33 ± 0.31 Crude fibre 35.03 ±0.11 Lipid 1.42 ± 0.03 CHO 23.00 ± 0.24.

Amino acid composition analysis carried out on selected seeds also compares to those obtained from Adeola and Aworh 1995. which asserts the contents of Tamarind seed as follows: Alanine 3.11±0.01, Arginine 4.01±0.01, Aspartic acid 5.30 ± 0.10, Cystine 0.62 ±0.01, Glutamic acid 6.58 ± 0.06, Glycine 1.75 ± 0.15, Histidine 1.61 ± 0.01, Isoleucine 2.30 ± 0.16, Leucine 6.71 ± 0.20, Methionine 0.71 ± 0.01, Phenylalanine 3.50 ±0.40, Proline 1.80± 0.10, Serine 2.36 ± 0.04, Threonine 1.70 ± 0.02, Tyrosine 2.05 ± 0.01 and Valine 2.26 ± 0.02.

Comparing the result obtained from proximate composition and the Amino acid composition it was observed that Gold mohur is richest amongst the three sample with protein content 92.349 total amino acid present, followed by Tamarind which contains 90.295 total amino acid present and Camel foot containing 78.61056 amino acid content. This reveals that the seeds are highly rich in beneficial nutrient, even though they are under-exploited.

Hence, the researcher recommends that the seeds be processed as food supplement and included in some diets to balance malnutrition in all income class earners especially the low income Nigerian's Diet.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

Having carried out the proximate and amino acid composition analysis, for Gold mohur – (***Delonix regia),*** Tamarind – (***Tamarindus indica) and*** Camel foot – (***Pilostigma thonningii).*** It was concluded that the amino acid composition and other useful nutrients i.e crude protein and CHO Carbohydrate for the seeds are excellent i.e for 100g of fresh Gold mohur flours 90.29% protein is present, for every 100g of fresh Tamarind flours it contains 92.34% protein and for every 100g of Camel foot there is 78.61% protein present. From the result, tamarind – ***Tamarindus indica*** *is* richest in protein content compared to the other two selected seeds, followed by Gold mohur – ***Delonix regia*** and Camel foot – ***Pilostigma thonningii*** which is also rich in protein but not as rich as the other two.

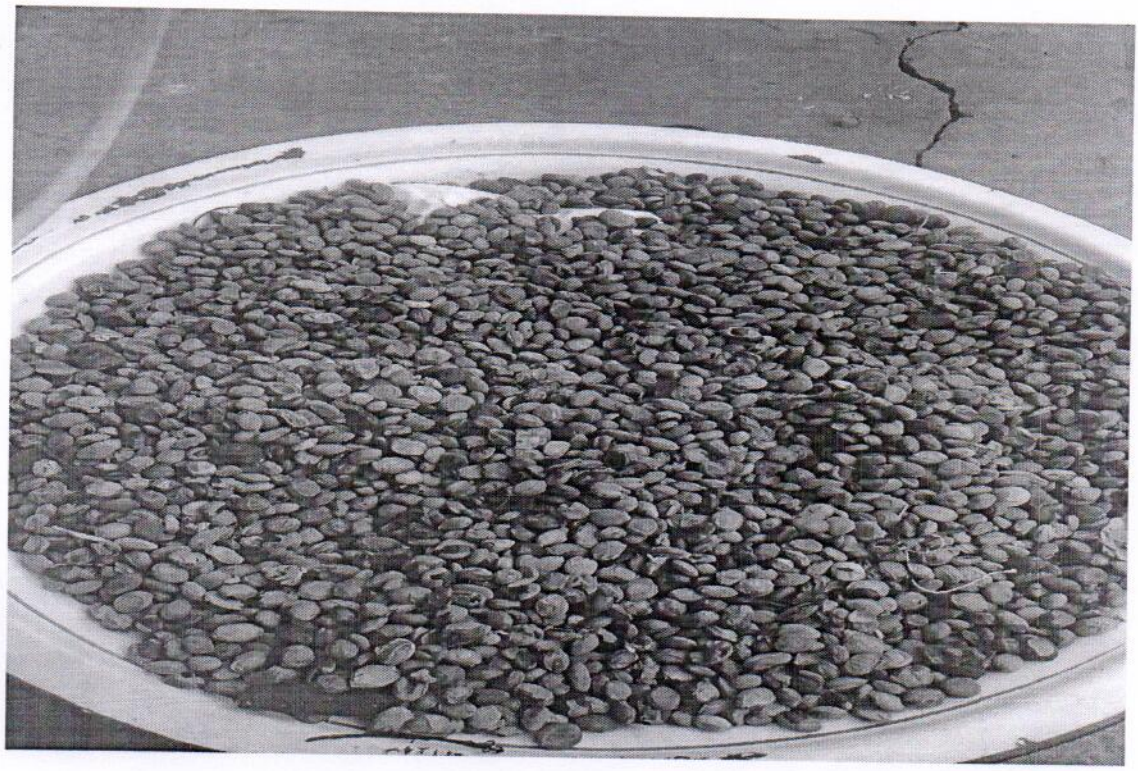
5.2 RECOMMENDATION

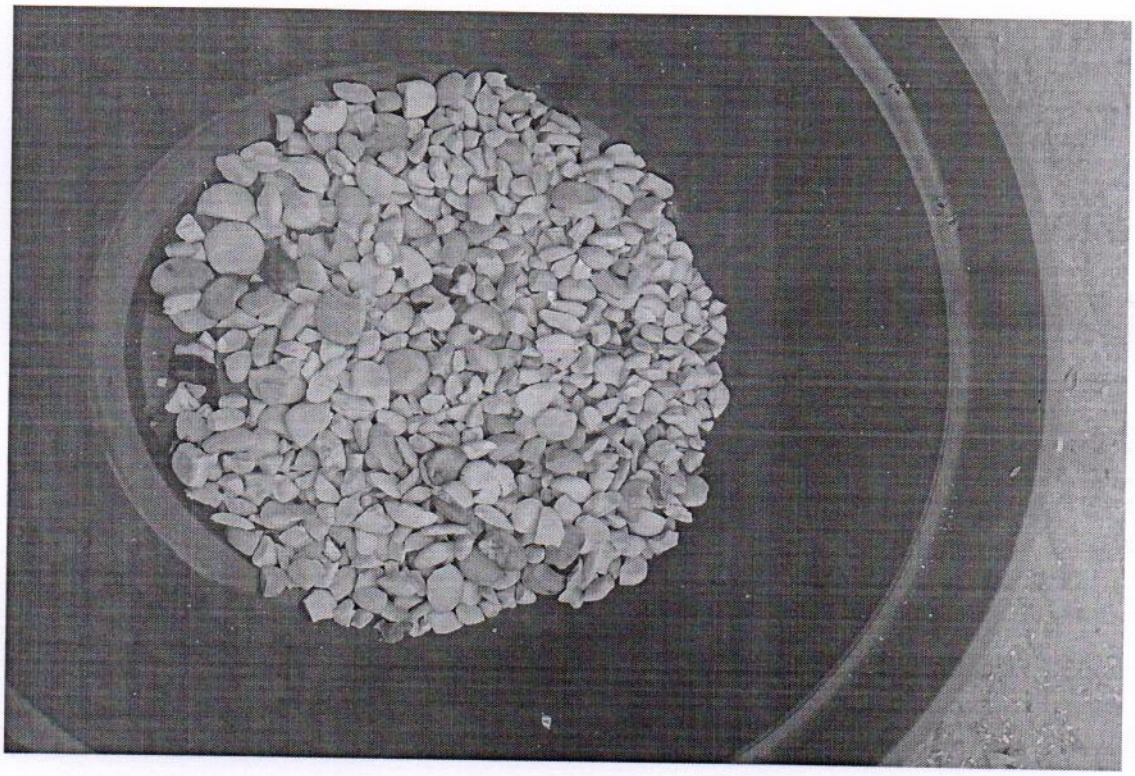
Based on the theoretical framework, the three seeds have been used in the treatment of several diseases such as control of antimicrobial activity Aqil, Khan, Owais, 2005. The study also provides preliminary data on the antiulcer potential of Camel foot - *Piliostigma thonningii* leaf and support the traditional uses of the plant for the treatment of gastric ulcer.

Research also showed that Delonix regia contains a high percentage of β- sitoserol, tannins, saponnins, flavonoids e.t.c which can influence the enzyme involved in the activation and detoxification of xenobiotics including chemical and occupational changes. (Aqil, Khan and Owais, 2005).

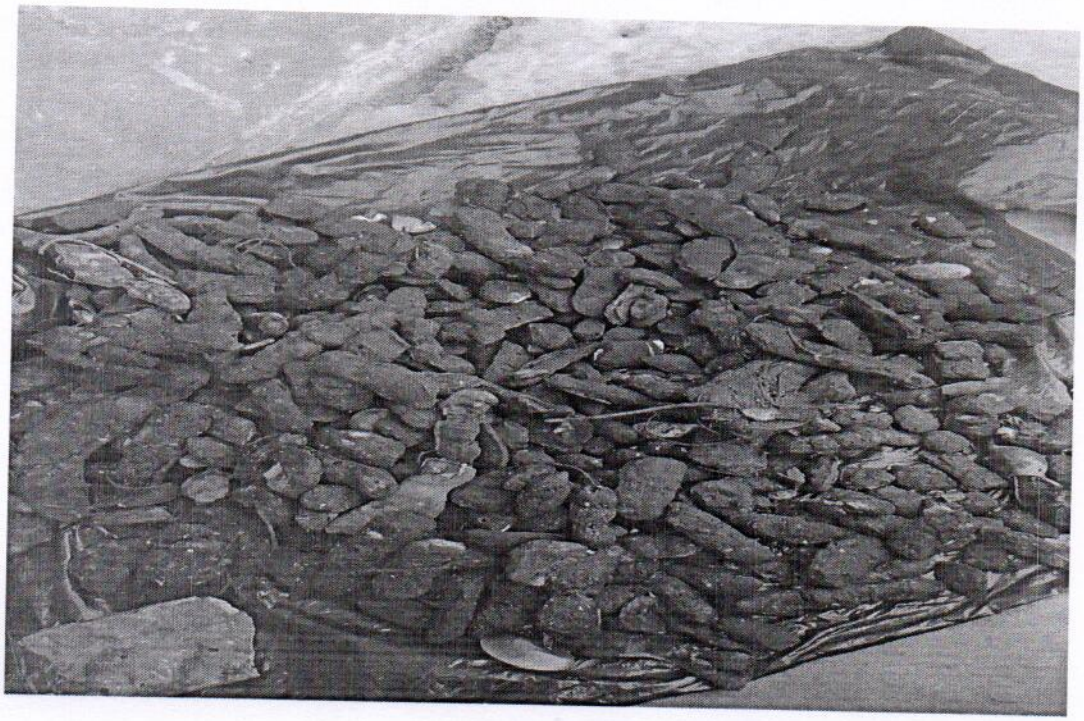
From the values obtained from the proximate composition and Amino acid composition of the selected seeds Gold mohur – ***Delonix regia,*** Tamarind – ***Tamarindus indica*** and Camel foot – ***Pilostigma thonningi.*** It is discovered that they are rich in several useful nutrients to humans, Therefore it is recommended that the seeds can be processed as food supplements which could to be included in food before they are sold and distributed. Thereby tackling malnutrition in Nigeria, which is the main aim of this research work.

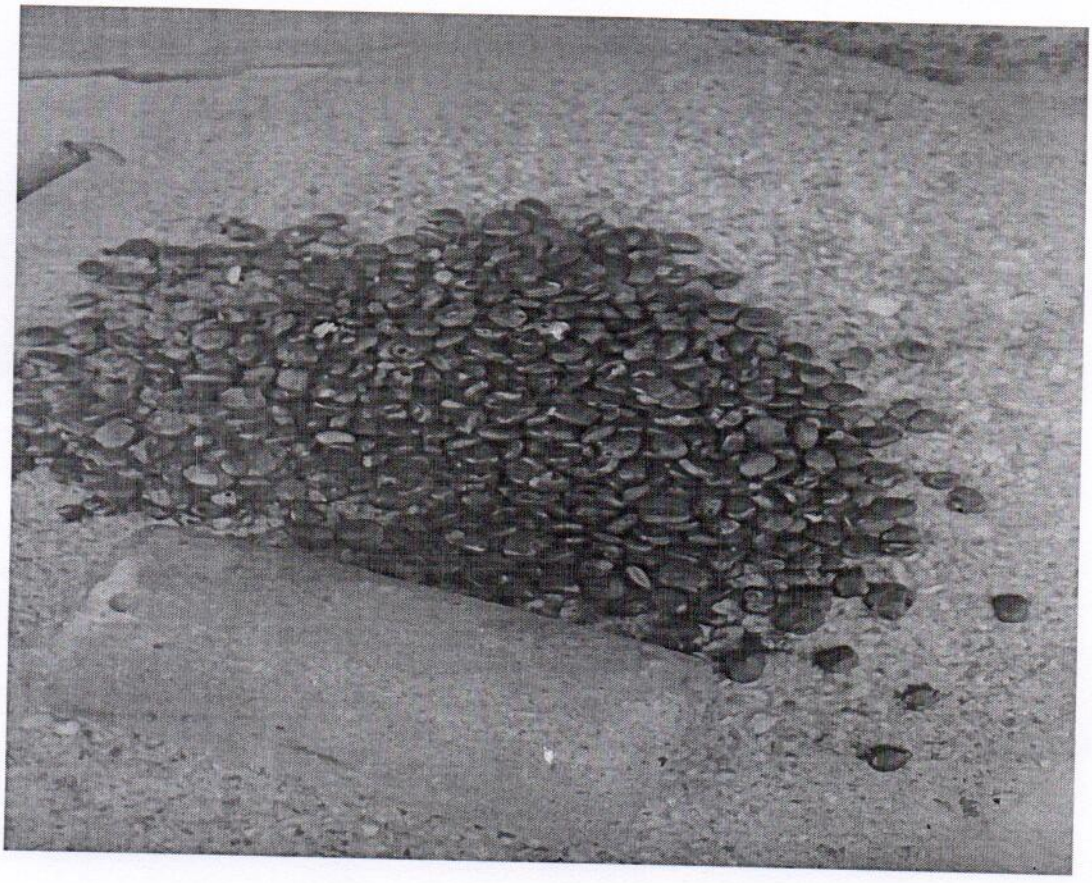
GOLD MOHUR --- ***Delonix regia***



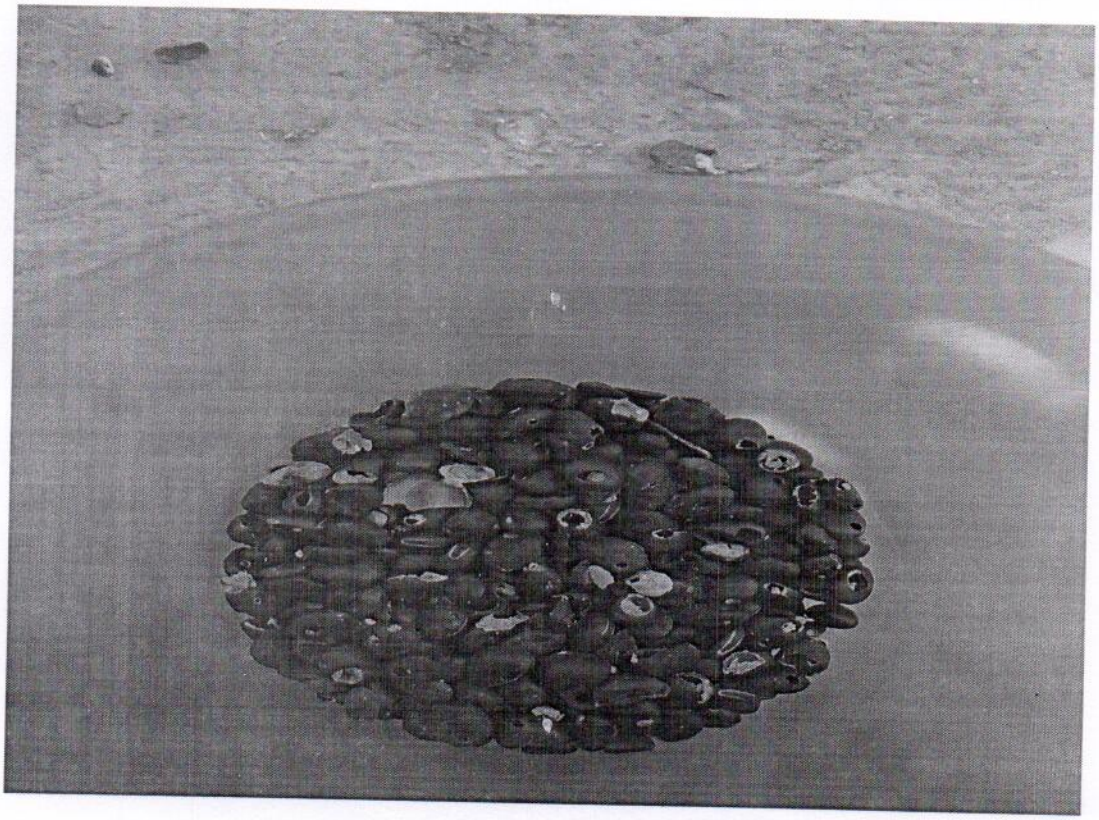


TAMARIND --- ***Tamarindus indica***





CAMEL FOOT ---- ***Pilostigma thonningii***



REFERENCES

ADEOLA, A.A. AND AWORH, O.C. (2010A).

Sugar and dietary fibre components of tamarind (*Tamarindus indica*) Fruits from Nigeria Food Journal 28 (2): 32-40.

ADEOLA, A.A. AND AWORH, O.C. (2010B).

Development and sensory evaluation of an improved beverage from Nigeria's tamarind [*Tamarindus indica*] African Journal of Food, Agriculture, Nutrition andDevelopment 10 (9): 4079-4092.

AFRICAN JOURNAL OF BIOTECHNOLOGY 2005

African Journal of Biotechnology Vol. 4 (12), pp. 1439-1442, December. ISSN 1684–5315 © 2005 Academic Journals.

AFRICAN JOURNAL OF MICROBIOLOGY RESEARCH 2010.

African Journal of Microbiology Research Vol. 4(9), pp. 735-739, 4 May.

Agriculture, Forestry and Fisheries. Vol. 3, No. 4, , pp. 233-239. ISSN: 2328

AJAYI, I.A., ODERINDE, R.A., KAJOGBOLA, D.O., UPONI, J.I. (2006).

Oil content and fatty acid composition of some underutilized legumes from Nigeria. Food chemistry, 99, 115-120

ALABI, D.A., O.R. AKINSULIRE AND M.A. SANYAOLU, 2005.

Shanmukhall, Harshil Patell, Jignesh Patell, Riyazunnisa ISSN : 0974-4290

AL-FATIMI, M., WURSTER, M., SCHRÖDER, G., LINDEQUIST, U. (2007).

Antioxidant, antimicrobial and cytotoxic activities of selected medicinal plants from Yemen. Journal of Ethnopharmacology, 11, 657-666

AQIL, F.; KHAN, M.S.A.; OWAIS, M.; AHMAD, I. 2005.

Effect, of certain bioactive plant extracts on clinical extracts on clinical isolates of β-lactamase producing methicillin resistant Staphylococcus. J. Basic Microbiol, 45, 106-114

ASHRAFUZZAMAN, 2011 in the paper; Molecules, 16, 7302-7319;

ISSN 1420-3049 doi:10.3390/molecules16097302.

ATAWODI, S.E., AMED, D.A., IBRAHIM, S., ANDREW, J.N., NZELIBE, H.C., ONYIKE, E.O., ANIGO, K.M., ABU, E.A., JAMES, D.B., NJOKU, G.C., SALLAU, A.B. (2002).

Indigenous knowledge system for treatment of trypanosomiasis in Kaduna state of Nigeria . journal of Ethnopharmacology, 79,279-282

ATTA MB (2003): Some chgaracteristics of Nigella (Nigella Sativa L)

seed cultivated in Egypt and its lipid profile. Food Chemistry 83, 63- 68.

AUDIPUDI, A.V.; CHAKICHERLA, B.V.S. 2010.

Audipudi, A.V.; Chakicherla, B.V.S. Antioxidative and antimicrobial activity of methanol and chloroform extracts of Gmelina arborea Roxb. Int. J. Biotechnol. Biochem. 2010, 6, 139-144.

AJB ISSN 1684–5315 © 2005

biglobosa (Jacq.) Benth. Afr. Jour. Biotech., 4(8): 812-815.

COLDIN GA, BRANCH LG, LIPNIC RJ, WILLET WC AND ROSNER B. et al. 1985

Common trees of Puerto Rico and the Virgin Islands. Agricultural Handbook. No. 249

consumed during drought. Study of rural Fulani, Northeastern Nigeria.

DJUMA (2003). Djuma Game Reserve Copyright(C)1998-2003.

Durnin JVGA, Fidanza F (1985). Evaluation of Nutritional Status. Biblthca Nutr. Dieta 35: 20-30.

EDWARD F, DENNIS G, WATSON. 2004.

Delonix Regia- Department of Plant Sciences; Aridus. Vol.16, no.1, 4) 10

Delonix Regia- royal Poinciana. Face sheet ST-228, a series of Environmental

Institute of food and Agriculture Sciences, University of Florida. 1993.5

EKENEM OJ (1997). MALARIA IN NIGERIA: A Keynote Address,

National Symposium on Malaria, National Institute of Medical Research, Yaba, Lagos, pp. 4-9.elderly population Am.J. Clin. Nutr; 41:32. 2).

EL-SIDDIG, K., EBERT, G., LÜDDERS, P. (1999). Tamarind – (Tamarindus indicaL).

A Review on a Multipurpose Tree with promising Future in the Sudan. Journal of Applied Botany – Angewandte Botanik 73, 202-205.

EL-SIDDIG, K., GUNASENA, H.P.M., PRASA, B.A., PUSHPAKUMARA, D.K.N.G., RAMANA, K.V.R., VIJAYANAND. P., WILLIAMS, J.T. (2006).

Tamarind – Tamarindus indica L. Fruits for the future 1. Southampton centre for Underutilized Crops, Southhapmton, UK, 188p

FAO/WHO/UNU. (1985). Energy and protein requirements. Report of a Joint

FAO/WHO/UNU Expert Consultation . WHO Tech. Rep. Ser. No. 724. Geneva: WHO

FARUQUE AS, AHMED AM, AHMED T, ISLAM MM, HOSSAIN MI, ROY SK, *et al*. 2008

Nutrition Basis for Healthy Children and Mothers in Bangladesh.J Health popul Nutr; 26:325-39Fat mass percentage, body mass index and mid upper arm circumference

Fisheries. Vol. 3, No. 4, pp. 233-239. Food Chemistry, 99, 115-120.

FOOK, J.M.S.L.L, MACEDO, L.LP., MOURA, G.E.D.D., TEIXEIRA, F.M., OLIVEIRA, A.S., QUEIROZ, A.F.S., SALES, M.P. (2005).

A serine proteinase inhibitor isolated from Tamarindus indica seeds and its effects on the release of human neutrophil elastase. Life Sciences, 76,2881-2891

FRANCOISE B, ALEX V, MICHELE M, JEAN-MARIE B (1999).

In-vitro antimalarial activity of cochlospermum tinctorum and C.Planchonii leaf Extracts and Essential oils. Plant Med. 65: 378-381.from Yemen. Journal of Ethnopharmacology, 111, 657-666. Fruits from Nigeria. Nigerian Food Journal 28 (2): 32-40.

G. SHABIR, F. ANWAR, B. SULTANA, Z. M. KHALID, MUHAMMAD AFZAL, QAISER M. KHAN AND M. GABRIEL GANA BAKE*, ELIZABETH ITUNU MARTINS, SULEIMAN OMEIZA EKU SADIKU 2014.

Agriculture, Forestry and Fisheries vol.3, No. 4, pp 233-239. ISSN: 2328-563X (Print); 2328 – 5648 (Online).

GABRIEL GANA BAKE, ELIZABETH ITUNU MARTINS, SULEIMAN OMEIZA EKU SADIKU. Nutritional Evaluation of Varying Levels of Cooked Flamboyant Seed Meal (Delonix Regia) on the Growth Performance and Body Composition of Nile Tilapia (Oreochromis Niloticus) Fingerlings. Agriculture, Forestry and Fisheries. Vol. 3, No. 4, 2014, pp. 233-239. doi: 10.11648/j.aff.20140304.14

GLEW, R.H., VANDERJAGT, D.J., LOCKETT, C., GRIVETTI, L.E., SMITH, G.C., PASTUSZYN, A., MILLSON, M. (1997).

Amino Acid, Fatty Acid, and Mineral Composition of 24 Indigenous Plants of Burkina Faso. Journal of Food Composition and Analysis,10 205-217.

HAMILTON AC. 1994. REGIONAL OVERVIEW: AFRICA. In: Davis SD, Heywood VH, Hamilton AC, eds. Centres of plant diversity. A guide and strategy for their conservation, Vol. 1: Europe, Africa, South West Asia and the Middle East. Cambridge: The World Wide Fund for Nature (WWF)/ IUCN

IGHODALO D (2004). Reasons for yearly weakness observed in WAEC candidates. Punch Newspaper p.48. Jones JM, Bennet S, Olmsted MP, Lawson ML, Rodin G (2001)

IKENEBOMEH, M.J., R. KOK AND J.M. INGRAM, 2006.

Processing and fermentation of the african locust bean (Parkia filicoidea Welw.) producing methicillin resistant Staphylococcus aureus. J. Basic Microbiol. 45, 106-114.

ISHOLA, M.M., AGBAJI, E.B., AGBAJI, A.S. (1990). A Chemical Study of Tamarindus indica (Tsamiya) Fruits Grown in Nigeria. Journal of the Science of Food and Agriculture, 51, 141-143.ISSN: 2328-563X (Print); ISSN:2328-5648 (Online) . Agriculture, Forestry and

LOWELL JAMES AND FUGLIE B. THE MORINGA TREE a local solution to malnutrition B. P 5338 Dalear Senegal. 2006, Pg 3. J. Biomed. Pharmaceutic. Sci., 1, 73-82.

JIMOH F.O. AND OLADIJI A.T. 2005.

African Journal of Biotechnology Vol 4 (12),pp. 1439-1442, December.

JYOTHI, M.V.; MANDAYAN, S.N.; KOTAMBALLI, N.C.; BHAGYALAKSHMI, N.

Katende AB et al. 1995. Useful trees and shrubs for Uganda. Identification, Propagation and Management for Agricultural and Pastoral Communities. Regional Soil Conservation Unit (RSCU), Swedish International Development Authority (SIDA).

KHALIL, I.A. AND F. MANAN, 1990. TEXT book of Chemistry I. Bio. Analytical Chemistry 2 Edn. Taj Kutab Khana nd Peshawar.

KOSHIMIZUR K, OHIGASHI H, TOKUDA H, KONDO A, YAMAGUCHI K. 1988

Screening of edible plants against possible antitumor promoting activity. Cancer Lett, 39: 247.11 Jungalwala FB, Charma HR. Carotenoids in Delonix regia (Gulmohor) Flower. Dept of Biochem,IIS Bangalore, Biochem J. 1962;85-93

KWAJI1, P. U. BASSI, M. AOILL1, C. M. NNEJI AND G. ADEMOWO 2010

African Journal of Microbiology Research Vol. 4(9), pp. 735-739, 4 May 2010 Available online http://www.academicjournals.org/ajmr ISSN 1996-0808 © 2010 Academic Journals

LITTLE EL and WADSWORTH FH. 1964. Common trees of Puerto Rico and the virgin islands. Agricultiure Handbook, No 249 US Department of Agriculture. Washington DC.

LOCKETT, C.T., CALVERT C.C and GRIVETTI, L.E. (2000). Energy and micronutrient composition of dietary and medicinal wild plants consumed during drought. Study of rural Fulani, Northeastern Nigeria. International Journal of Food Sciences and Nutrition, 51 195-208

MAL, B., RAO, R., ARORA, R., SAJISE, P AND STHAPIT, B. (2011). Conservation and Sustainable Use of Tropical Fruit Species Diversity: Bioversity's Efforts in Asia, the Pacific and Oceania. Indian Journal of Plant Genetic Resources, 24 (1), 1 – 22.

MBUYA LP ET AL. 1994. Useful trees and shrubs for Tanzania:

Identification, Propagation and Management for Agricultural and Pastoral Communities. Regional Soil Conservation Unit (RSCU), Swedish International Development Authority (SIDA).

MORTON, J. (1987). TAMARIND. In: Fruits of warm climates, Morton, J.F. (ed.).

Miami, USA, p. 115-121.

MULLER O, KRAWINKEL M. 2005 Malnutrition and health in developing countries.

NAHAR B, AHMED T, BROWN KH, HOSSAIN MI. 2010. Risk factors associated

with severe underweight among young children reporting to a diarrhoea treatment facility in Banglash. J Health Popul Nutr; 28476-83

NASI, R. 2011 BEYOND TIMBER: Making multiple use forest management a

reality in Central Africa forests . In: Geldenhuys C.J, Ham C, & Ham H (eds.) Sustainable forest management in Africa: some solutions to natural forest management problems in Africa. Proceedings of the Sustainable forest management in Africa Symposium. Stellenbosch, 3 – 7 November 2008, 33-46. Stellenbosch University, Stellenbosch, South Africa.

NATH, C.D, PELISSIER, R, RAMESH, B.R, GARCIA, C.A. 2011 Promoting

native trees in shade coffee plantations of southern India: Comparison of growth rates with the exotic Grevillea robusta. Agroforestry Systems 83(2): 107-119. DOI: 10.1007/s10457-011-9401-8.

NEW YORK: UNICEF, 2000. 5. Akesode FA, Ajibode HA. Prevalence of obesity

Nutritional Evaluation of Varying Levels of Cooked Flamboyant Seed Meal

Nutritional Status of Women and Children. Participatory Information Collection Study.

Oil content and fatty acid composition of some underutilized legumes from Nigeria.

OKOLO, SIMON. C, OLAJIDE, OLUTAYO. O, IDOWU ,DOYINSOLA I, ADEBIYI ADEDAYO.B, IKOKOH P.P, ORISHADIPE, ABAYOMI 2012 .

T .Annals of Biological Research3, (2):773-779 on the release of human neutrophilelastase. Life Sciences, 76, 2881-2891.

OYENUGA VA, FETUGA BL (1975). Some aspects of the biochemistry and nutritive value of the watermelon seed (Citrullus vulgaris schrad) J. Sci. Food Agric. 26: 843-846p. 48. Jones JM, Bennett S, Olmsted MP, Lawson ML, Rodin G (2001).

POLLIT E, LEWIS NS, GARZA C, SHULMAN R (1983). Fasting and cognitive function J. Psychiatr. Res. 17: 168-174.

POLLIT E, WATKINS WE, HUSAINI MA (1997). Three month nutritional supplementation in Indonesia infants and toddlers, benefit child memory function 8years later. Am. J. Clin. Nutr. 66: 1357-1363. Popul Nutr;26:325-39.

SHUMAILA GUL AND MAHPARA SAFDAR Pakistan Journal of Nutrition 8 (9): 1456- 1460, 2009 ISSN 1680-5194.

SIMEON DT, GRANTHAM–MCGREGOR SM (1990). Nutritional deficiencies and Children's behaviour and mental development. Nutr. Res. Rev. 3: 1-24.Social Sectors Strategy Review. Report No. 11781 - UNI.Sugar and dietary fibre components of tamarind (*Tamarindus indica*)

SWAMINATHAN MS, JAIN HK (1973). Food legumes in India Agric. In: Nutritional improvement of food legumes by breeding. Protein Advisory Group, United Nations. New York. pp. 69-82.

THE WORLD BANK. FEDERAL REPUBLIC OF NIGERIA. 1993.

Tilapia (Oreochromis Niloticus) Fingerlings. Agriculture, Forestry and Fisheries.

to produce dawadawa. J. Sci. Food Agr., 37(3): 273-282.

to a diarrhoea treatment facility in Bangladesh. J Health Popul Nutr;28:476-83.

UCHECHUKWU U. NWODO 1,*, CHRISTIAN U. IROEGBU 2, AUGUSTINE A. NGENE 3, VINCENT N. CHIGOR 1 AND ANTHONY I. OKOH 1 2011

Tamarind – Tamarindus indica L. Fruits for the future 1. Southampton Centre

Tamarind (Tamarindus indica L.): a Review on a Multipurpose Tree with

tamarind *[Tamarindus indica]* African Journal of Food, Agriculture, Nutrition and Development 10 (9): 4079-4092.

UKWUANI AN1, IHEBUNNA O1, SAMUEL RM1 AND PENI I.J. 2012

Env. Pharmacol. Life Sci. Volume 2 [1] December 2012: 41- 45 2012, Academy for environmental and life sciences,India. Website.www.bepls.com.

2007 Antioxidative efficacies of floral petal extracts of Delonix regia Raffin. Int

(Print); ISSN:2328-5648 pg73, 202-205.

UNICEF. THE STATE OF THE WORLD'S CHILDREN 2000.

UNICEF. The State of the World's Children 2000. New York: UNICEF, 2000.

UNICEF 2008, Federal government; Nutritional status of women and children

participatory information collection study Lagos, Nigeria: UNICEF, 2008.

UNICEF/FEDERAL GOVERNMENT OF NIGERIA. 1994

US Department of Agriculture. Washington DC.

Vol. 3, No. 4, , pp. 233-239. doi: 10.11648/j.aff.20140304.14. ISSN: 2328-563X

Vol. 4 (12), pp. 1439-1442, December.

Vol. 4(9), pp. 735-739, 4 May Available online

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