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THE BAOBAB AND ITS HEALTH BENEFIT

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ABSTRACT

Baobab is the most wide spread of Adansonia specie and is native to African continent. The generic name honors Michael Adason, the French naturalist and explorer who describe Adansonia digitata. All baobab trees are deciduous, losing their leaves in the dry season and remain leafless for nine months of the years. They can grow to between 5-25m (16-82 ft) in height. They are in fact known both for their height and trunk's girth. The trunk tends to be bottle-shaped and can reach a diameter of 10-14m(33-46ft). The Adansonia digitata (baobab) was bought from Sokoto state central market. The fruit (seed and pulp) were analyzed for proximate and mineral composition using AOAC (2003) method. The moisture content of baobab seed and pulp were found to be 8.0 ± 0.52 and 14.0 ± 0.52, the ash content 6.5 ± 0.52 for the seed and 5.5 ± 0.52 for the pulp, the % lipid; pulp contains 1.5 and seed was found to contain 8.5. The fiber in pulp was found to be trace and 1.5 in seed. The nitrogen free in pulp was found to be0.294 and in seed found to be 1.624. the % crude proteins in pulp was also found to be 1.84 and in seed was found to be 10.15. the % carbohydrate (CHO) in pulp was found to be 77.16 and that of sees found to be 65.35 respectively. For the minerals analysis, sodium (Na) in pulp was found to be 72.5mg/kg and in seed 87.5mg/kg, potassium in baobab pulp found to be 5500mg/kg and in seed found to be 3500mg/kg. calcium content was found to be 0.45mg/kg in pulp and 0.55mg/kg in seed, magnesium content was found to be 1.30mg/kg in baobab pulp and 1.90mg/kg in seed and finally phosphorus content in baobab pulp was found to be 5.26mg/kg and that of baobab seed found to be 8.11mg/kg respectively. The plant has many health benefits which include; anti-inflammatory, anti-diarrhea, antioxidant, antiviral, control of blood sugar, absorption of iron, anti-fever among other.

INTRODUCTION

In view of the increasing demand for proteins and energy to support the growing world population, researchers have directed their effort at exploring new and new and conventional sources of food that grow in the arid and semiarid land region of the world (Osman,2016). Originally, the most extensive information about the composition of food was based on a system analysis described as the proximate analysis of food, which was devised over 100 years ago by two German scientist Hennerberg and Stohmann. Recently techniques have been introduced and the information about food composition is rapidly expanding. However, the system of proximate analysis still forms the basis for the statutory declaration of the composition of food in Europe (Dublecz,2011). In recent years the proximate analysis procedure has been severely criticized by many nutritionists as being archaic and imprecise, and in the majority of the laboratories it has been partially replaced by other analytical procedures. Most criticism has been focused on the crude fibre, ash and nitrogen-free extractives fractions. The newer method have been developed to characterize foods inters of the methods have been developed to characterized foods in terms of the method used to express nutrient requirements (Dublecz,2011). In this way, an attempt is made to the analytical method are developed that described the supply of nutrient for the rumen microbes and the host digestive enzymes system (Dublecz,2011).

Baobab is the common name for each of the nine species of the tree in the genus *Adansonia*. The generic name honors Michael Adason, the French naturalist and explorer who describe Adansonia digitata (genus; Adansonia L,2008). Of the nine species, six are native to Madagascar, two are native to mainland Africa and the Arabian peninsula and one is

native to Australia. It was introduced in ancient times to south Asia and during the colonial era to the Caribbean and it is also present in the island nation Cape Verde (Wickens and Lowe, 2008). The nine species were described in 2012 and is found upland population of southern and eastern Africa (Pettigrew *et al*,2012). Baobab reach height of 5-30m (16 to 98 ft) and have trunk diameter of 7-11m (23 to 36 ft). the glencoe baobab a specimen of *Adansonia digitata* in limpopo province, south Africa was considered to be the largest living individual, with a maximum of 47m (154 ft) and a diameter of about 15.9m (52ft) (Patrut *etal.*,2010). The tree has since split into two parts, so the widest individual trunk may now be that of the sun land baobab or plat land tree, also in south Africa. The diameter of this tree is 9.3m (31 ft) and its circumference at breast height is 34m (112ft) (Patrut *et al.*,2010). *Adansonia* trees produce faint growth rings, probably annually but they are not reliable for aging specimens because they are difficult to count and may fade away as the wood age. Radiocarbon dating has provided data on few individuals. A specimen of *Adansonia digitata* known as Groot boon was dated and found to be at least 1275 years old, making it one of the oldest known angiosperm trees (Adansonia digitata,2012 and Patrus *et al.,2010*).

The trees usually grow as solitary individuals and are large and distinctive element of savannah or scrubland vegetation. Some large individual live to well over a thousand years of age (Varmah and Vaid 1978). All baobab trees are deciduous, losing their leaves in the dry season and remain leafless for nine months of the years (Osman,2014). They can grow to between 5-25m (16-82 ft) in height. They are in fact known both for their height and trunk's girth. The trunk tends to be

bottle-shaped and can reach a diameter of 10-14m(33-46ft) (Wikipedia,2017).

The Health Benefit of Adansonia *digitata* (Baobab)

In traditional African Medicine, Baobab Fruit Pulp, leaves, bark, roots, seeds and oil are commonly used to treat a wide variety of ailments. Although natural medicine is a growing sector in the health care industry, many botanical remedies are not very well proven, or approved by regulatory agencies, leading to consumer skepticism. Certainly, there is also a good amount of snake oil on the market as well! Baobab as a food product is relatively new to the market, and its medicinal uses are virtually unknown outside of Africa. I happened upon a peer-reviewed scholarly document in the African Journal of Food Science, written by scientists from Burkina Faso and Denmark, that has a fascinating section about Baobab's medicinal value (David, G.,2012) Baobab powder is a rich source of vitamin c which contributed to normal energy release, immune function and healthy glowing skin. It is also almost 50% fiber half insoluble and health soluble, making it a powerful prebiotic and contains more antioxidants than any other whole fruits (Carlsen M.H.,2010). As it is a natural source of these nutrients, it is more bioavailable than manufactured vitamin supplements, meaning our bodies can absorb the nutrient found in *Adansonia digitata* powder more easily (Akbari *et al.*,2016).

1. Immune System

The human body cannot make or store its own vitamin c (unlike other animals), so we need to make sure we get a good supply from food we eat every day. A single serving spoon of baobab powder 10g or 2-3 teaspoons, provides 33% of your daily vitamin (NRV) one of the key

benefits of vitamin c that is helps to keep our immune system strong, supporting our body's defense against infections, diseases and other illness. (Jakemanl and Mazwel, 1993).

2. Slow Energy Release

Vitamin C contributes to normal energy release this slow and steady release sustains us for a longer period of time and prevents us from feeling tired all of a sudden. Therefore, it helps the reduction of tiredness and fatigue as well as supporting a normal energy yielding metabolism which is "needed for all functions and activities of the body including physical activities and exercise"(EFSA,2012).

3. Blood Sugar Control

Aduna baobab powder contains almost 25% soluble fibre, this helps to slow down the release of sugar into the blood stream, reducing energy spikes. Soluble fibre can also help to control blood glucose levels, improve blood cholesterol and reduce visceral fat (body fat that is stored around the organ in the abdomen). The functional food centre of oxford Brookes university conducted a trial using Aduna baobab powder and found that human participant who consumed a milk containing baobab had a lower blood glucose response than those who had a control drink with no baobab. Later study by oxford Brookes university also showed that baobab significantly reduced the rate at which sugar was release into the blood after digestion. As such baobab is considered ideal for thesis with type 2 diabetes and people following a low Glucose intake diet. Furthermore, Baobab Fruit Pulp is very rich in Vitamin C. Lab tests on Atacora Essential's product indicate that it contains 460 mg per 100 g. Studies cited in the document indicate that Baobab's Integral Antioxidant Capacity is 37 times than that of oranges! Antioxidants can

help to eliminate free radicals that can contribute to cancer, aging, inflammation and cardio-vascular disease. Vitamin C is a powerful antioxidant. It has been linked to lowering blood pressure, bolstering immunity, and less incidence of cataracts and coronary disease. A single serving of Atacora Baobab Fruit Pulp provides as much as 80% of daily value of this essential nutrient. (David 2012).

4. Absorption of Iron

Over 30% of the world's Population are deficient in iron making it the most common nutritional disorder (WHO, 2017). Many turn to various iron supplements to increase their intake (we like to use Moringa Powder as a natural alternative). A less known fact is that vitamin C is needed to help the body absorb iron so pairing iron with vitamin C actually increases absorption. Our bodies require two types of iron; heme iron (found in fish, poultry and red meat) and nonheme iron (present in plant foods, eggs, milk and meat). Compared to the former, nonheme iron is not easily absorbed by the body. One of the ways in which absorption of both types of iron can be increased is by combining the consumption of iron with vitamin C. As baobab is a rich natural source of vitamin C, it is easily accessible to the body and is better absorbed than artificial supplements. Sprinkle some baobab onto your iron-rich foods for a lemony zing or shake it into your water when taking your iron supplements (Schwalfenberg ,2012).

5. Digestive Health

Approximately 40% of people have at least one digestive symptom at any one time (NHS, 2016). Despite the growing awareness of the role of fibre in improving our digestive health, 80% of people in the UK don't eat enough of it. Aduna Baobab Powder is almost 50% fibre. There are two

types of fibre that our body needs: soluble and insoluble - and baobab contains equal quantities of both. Soluble fibre dissolves in the water found in your digestive system and can help to reduce the level of cholesterol in your blood. Insoluble fibre doesn't dissolve it passes through your gut and enables other foods to move through your digestive system easily. It also helps to keep your bowels healthy and prevents digestive problems.

6. Prebiotic

Most people are familiar with probiotics – good bacteria found in foods such as yoghurt, kefir and kimchi which have beneficial effects to your health, particularly your digestive system. However, very few are familiar with prebiotics which play an equally important role in gut health. Prebiotics are indigestable dietary fibres, also known as soluble fibres, made up of non-living organic matter. The soluble fibers of baobab fruit pulp are prebiotics: non-digestible food components that beneficially affect the host by selectively stimulating the growth and activity of beneficial microflora (Schwalfenberg ,2012). It's these prebiotic qualities that could explain how baobab might just be the secret to having the world's healthiest gut. Studies of the Hadza Tribe in Tanzania, some of the planet's last remaining hunter gatherers, found they have 40% more diverse gut microbiomes than the average Westerner! "According to scientists, the Hadza have the most diverse gut bacteria of anyone anywhere in the world". The benefits of including prebiotics in your diet don't stop there, a study by the University of Colorado Boulder suggested that prebiotics can improve sleep after a stressful event, suggesting that adding baobab into your diet can also help support a good night's sleep. For best results, it is recommended you take prebiotics with probiotics – we like to mix our baobab with

yoghurt to keep our gut health in check, or do like the Hadza's do and stir it into a traditional milky beverage. The soluble fiber in Baobab Fruit Pulp stimulates the growth of beneficial probiotic bacteria including lactobacilli and bifidobacteria in the digestive tract. This can foster a SYN-BIOTIC digestive effect. (David, 2012).

7. Radiant Skin

Baobab has the highest antioxidant content of any fruit. Baobab powder has twice the antioxidants gram per gram of goji berries and more than blueberries and pomegranates combined. Baobab is packed with antioxidants and vitamin C which supports collagen formation - helping to give you radiant, glowing skin as well as preventing wrinkles. In fact, baobab's skin benefits are so impressive that Aduna Baobab was the first ever food item to be sold in the beauty halls of prestigious London department store Liberty where it is listed as "must-have" thanks to its exceptional beauty from within properties. A decoction of Baobab roots is often used to bathe children in Africa to promote smooth skin. Baobab Seed Oilcontains antioxidant Vitamins A, D & E as well as Omega 3, 6 & 9 essential fatty acids and is a soothing, rejuvenating skin care serum. (David, 2012).

8. Pregnancy

It is generally advised that pregnant women should consume 85mg of vitamin C per day (a 10g serving of Aduna Baobab Powder contains 26mg) as it helps the body produce collagen. Collagen is a structural protein that is needed for your baby's normal growth during pregnancy. It plays a vital role in structuring a baby's body and supporting their developing organs. Vitamin C, also known as ascorbic acid, helps your body fight infections and protects cells from damage helping to keep you

healthy. Another key role that vitamin C plays during pregnancy is its ability to increase the absorption of iron a vitamin that most pregnant women are deficient in. Iron is needed to help our bodies produce red blood cells which carry oxygen around the body and to the baby (Schwalfenberg , 2012).

9. ALKALINE

Baobab is considered to be one if the highest alkaline foods available as it has a PRAL (Potential Renal Acid Load) rating of -52. Eating highly alkaline foods helps to balance our body's pH levels. Alkaline foods can also help defend our bodies from chronic diseases and ailments (such as hypertension, arthritis and deficiency in vitamin D) (Schwalfenberg ,2012)

10. Anti-inflammatory

A dose of 800 mg/kg of aqueous extract of Baobab Fruit Pulp has a very similar anti-inflammatory effect as 15 mg/kg of phenylbutazone. (David, 2012).

11. Antipyretic (Anti-Fever)

Fever in Africa is most often associated with malaria, but, of course can arise from other conditions as well. In the Atacora region of Benin, where Baobabs are plentiful, Baobab Fruit Pulp, seeds and bark are used for people with malaria to help reduce fever. It is used as a substitute for quinine as a prophylactic and to reduce malaria-related fever in parts of Africa. The reference article indicates an effect comparable to asprin (D avid, 2012).

12. Analgesic

Again, aqueous extract of Baobab Fruit Pulp is shown to have an analgesic (pain releiving) effect comparable to asprin, likely due to the presence of sterols, saponins and triterpenes in the pulp (David, 2012).

13. Anti-microbial

The addition of Baobab Fruit Pulp to the fermented soy product, Tempeh, inhibited the growth of pathogenic bacteria such as Salmonella, Baccilus and Streptococcus in the food product. It aided the growth of Lactic Acid bacteria, which are beneficial, and serve to preserve many fermented foods. They also indicated that the Fruit Pulp showed anti-microbial activity against E. coli. (David, 2012).

14. Anti-viral

Baobab leaves, fruit pulp and seeds have been shown to act against influenza, herpes simplex and respiratory syncytial viruses. This is likely due to several bioactive compounds found occurring naturally in the plant (David, 2012).

15 Anti Trypanosoma

Sleeping sickness in humans and nagana in animals are caused by trypanosoma protozoa. Infection is caused by the bite of tsetse flies. An extract of Baobab roots seriously reduces or eliminate the microbes' motility within one hour (David, 2012).

16. Anti-diarrhoea

Perhaps the most common medicinal use of Baobab Fruit Pulp in traditional African medicine is to treat diarrhoea. The fruit pulp is about 50% fiber, with nearly equal proportions of insoluble (cellulose) and

soluble (mucilage) fiber. It also contains astringent tannins and citric acid, all of which may contribute to its efficacy against diarrhoea. When compared to the World Health Organization's recommended oral rehydration solution for its effects, Baobab solution performed statistically as well. Baobab has the added advantages of a significant nutrient content, easy access and affordability in Africa (David,2012).

17. Antidote to Poison

It appears that Baobab bark, fruit pulp and seeds are used to neutralize the effects of Strophanthus-derived poisons commonly used on arrows in Africa (David,2012)

MATERIALS AND METHOD

Sample of baobab fruit (seed and pulp) were bought from Sokoto state central market. The sample was identified as *Adansonia digitata Baobab* (kwame/Kuka in Hausa) at Department of Biological Science Botany unit Usmanu Danfodiyo University, sokoto.

Table 3.1: list of Apparatus used

Name	Model	Manufacturer
Micro-kjeldahl digestion-distillation	MFr2127601	Swaziland
Micro-kjeldahl Flask 500ml and 750ml	Pyrex	England
Measuring cylinder	Pyrex	England
Beakers	Pyrex	England
Weighing balance	Bs4	Swaziland
Test tube	Glass	England
Muffle furnace	LMF-3550	Universal surgical equipment
Flame photometer	SLE-S-935	Spectro lab equipment New Delhi
Crucible	CCBYSA-3.0	England
Spatula		

Desiccators	Glass	United Kingdom
Condenser-soxhlet extraction unit	64825	England
Hot air dry oven		
Dry porous thimble	Whatman 1.5mm	Whatman cellular extraction, England
Water bath	N/S	N/S

Table 3.2: List of Reagents used

Reagent	Chemical Formula	Manufacturer
Sulphuric acid	H_2SO_4	BHD chemical U.K
Ammonium sulphate	$(NH_4)_2SO_4$	BHD chemical U.K
Boric acid	H_3BO_3	BHD chemical U.K
Hydrochloric acid	HCl	BHD chemical U.K
Potassium Sulphate`	K_2SO_4	BHD chemical U.K
Cupper(II)Sulphate	$CuSO_4$	BHD chemical U.K
Sodium Hydoxide	NaOH	BHD chemical U.K
Ammonium hydroxide	NH_4OH	BHD chemical U.K
Potassium hydroxide	KOH	BHD chemical U.K
Nitric acid	HNO_3	BHD chemical U.K
Perchloric acid	$HClO_4$	BHD chemical U.K

PREPARATION OF REAGENTS

Preparation of 0.1N HCl Solution

This solution was prepared by measuring 8.70ml of concentrated HCl by means of measuring cylinder and transferred to $1dm^3$ volumetric flask via funnel. The measuring cylinder were rinsed with distilled water and filled the flask to the mark.

Preparation of 4% Boric Acid Solution

This was prepared by weighing 4.0g of boric acid by means of weighing balance, transferred into beaker, 50ml of distilled water were added to

dilute the reagent, the beaker was rinsed and added up to 100ml volumetric flask.

Preparation of 0.5N Sodium hydroxide (NaOH) Solution

This was prepared by weighing 20g of sodium hydroxide (NaOH) crystals by means of weighing balance and transferred into a beaker, 50ml of distilled water were added, then transferred into $1dm^3$ volumetric flask. The beaker were rinsed and pour in to the flask up to mark.

Preparation of 0.128M H_2SO_4 solution

This solution was prepared by measuring 7.10ml of concentrated sulphuric acid by means of measuring cylinder and transferred into $1dm^3$ volumetric flask. The measuring cylinder were rinsed with distilled and filled the flask up to the mark.

Preparation of 0.223M Potassium Hydroxide (KOH) solution

This was prepared by weighing 12.5g of potassium hydroxide crystal and transferred into a beaker, 50ml of distilled water were added and transferred into 1dm3 volumetric flask. The beaker were rinsed with distilled water and pour into the flask up to the mark.

PROXIMATE COMPOSITION

After bringing the samples to uniform size, they were analyzed for moisture, protein, fats, ash, fiber and nitrogen free extract using (AOAC,2003) method.

Determination of Moisture

Moisture was determined by oven drying method. 2g of well-mixed sample was accurately weighed in clean, dried crucible (W_1). Then crucible was allowed in an oven at 100-105^{0}C for 6-12 hours until a constant weight was obtained. Then the crucible was placed in the desiccators for 30 min to cool. After cooling it weighed again (W_2). The percentage moisture was calculated by the following formula:

$$\%\ moiture = \frac{W1 - W2}{Wt\ of\ sample} X100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where

W_1= initial weight of crucible + sample

W_2= final weight of crucible + sample

Determination of Ash

In the determination of ash, clean empty crucible was placed in a muffle furnace and heated to 600^{0}C for 1 hour, then it was cooled in a desiccator and then weight of empty crucible was noted (W_1). One gram of sample was taken in crucible (W_2). The sample was ignited over a burner with the help of blowpipe, until it is charged. Then the crucible was placed in muffle furnace at 550c for 2-4 hours. The appearance of grey white ash indicates complete oxidation of all organic matter in the sample. The crucible was cooled and weighed (W_3). Percentage ash was calculated by following equation

$$\%\ ash = \frac{difference\ in\ wt.\ of Ash\ \times 100}{Wt.\ of\ Sample} X100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

Determination of Crude Protein

Principle: Protein in the sample was determined by kjeldahl method. The sample was digested by heating with concentrated sulphuric acid

(H_2SO_4) in the presence of digestion mixture. The mixture was then made alkaline. Ammonium sulphate thus formed, released ammonia which was collected in 2% boric acid solution and titrated against standard HCl. Total protein was calculated by multiplying the amount of nitrogen with appropriate factor (6.25) and the amount of protein was calculated.

Procedure

Protein in the sample was determine by kjeldahl method. 0.5-1.0g of dried sample was taken in digestion flasks. Add 10-15ml of concentrated H_2SO_4 and 8g of digestion mixture i.e K_2SO_4 $CuSO_4$ (8:1). The flask was swirled in order to mix the contents thoroughly then placed on heater to start digestion till the mixture becomes clear (blue green in colour). It needs 2 hours to complete. The digest was cooled and transferred to 100ml volumetric flask and volume was made up to mark by the addition of distilled water. Distillation apparatus was performed in markam still distillation apparatus (Khalil and Manan,1990). Ten milliliters of digest was introduced in the distillation tube then 10ml of 0.5N NaOH was gradually added through the same way. Distillation was continued for at least 10 min and NH_3 produced was collect as NH_4OH in a conical flask containing 20ml of 4% boric acid solution with few drops of modified methyl red indicator. During distillation yellowish color appears due to NH_4OH. the distillate was then titrated against standard 0.1N HCl solution till the appearance of pink color. A blank was also run through all steps as bove. Percentage crude protein content was calculated by using the formula

$$\%\ crude\ protein = 6.25 \times N(\text{Correction factor}) \quad \text{.....3}$$

$$\%N = \frac{S - B \times N \times 0.14 \times D \times 100}{Wt\ of\ sample} \quad \text{.....4}$$

Where

S = sample titration reading

B = blank titration reading

N = Normality of HCl

D = Dilution of sample after digestion

V= volume taken for distillation

0.014 = Milli equivalent weight of nitrogen

Determination of Crude Fiber

A moisture free and ether extracted sample of crude fiber made of cellulose was first digested with dilute H_2SO_4 and then with dilute KOH solution. The undigested residue collected after digestion was ignited and loss in weight after ignition was registered as crude fiber.

PROCEDURE

About 2g of sample was weighed as (W_0) and transferred to porous crucible. Then placed the crucible into Dosi-fiber unit and kept the valve in "OFF" position. After that 150ml of preheated H_2SO_4 solution was added and some drops of foam-suppresser to each column also was added. The cooling circuit was opened and the heating element was turned on (power at 90%). When it start boiling, the power was reduced at 30% and it was left for 30min. valve were opened for drainage of acid and rinse with distilled water thrice to completely ensure the removal of acid from sample. For alkali digestion, KOH was used instead of H_2SO_4 using similar procedure. The sample was dried in an oven at 150^{0}C for 1 hour. It was allowed to cool in a desicator and weighed as (W_1). The sample crucible was kept in muffle furnace at 55^{0}C for 3-4 hours. It was cooled again in a desiccator and weighed as (W_2). Calculation was done by using the following equation:

$$\% \, crude \, fiber = \frac{W_1 - W_2}{W_0} X100 \, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.5$$

Determination of Crude Lipid

Dry extraction method for fat determination was adopted. It consisted of extracting dry sample with some organic solvent, since all the fat materials e.g. fats, phospholipids, sterols, fatty acids, carotenoids, pigments, chlorophyll etc. are extracted together therefore, the results are frequently referred to as crude fat. Fats were determined by intermittent Soxhlet apparatus. Approximately 1g of moisture free sample was wrapped in filter paper, placed in fat free thimble and the introduced in the extraction tube. Weighed, cleaned and dried the receiving beaker was filled with petroleum ether and fitted into the apparatus, turned on water and heat to start extraction. After 4-6 siphoning, the solvent that is ether was allowed to evaporate. Then the extract was transfer into a clean glass dish. Then, the dish was placed in an oven at 105^0C for 2 hours and cooled in a desiccator. The percentage crude fat was determine using the following equation

$$\% \, Crude \, Fat = \frac{Wt \, of \, ether \, extract \, X \, 100}{Wt \, of \, sample} \, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

Determination of Nitrogen Free Extract

Nitrogen free extract (NFE) was calculated by difference after analysis of all the other items method in the proximate analysis.

$$NFE = (100 - \% \, moisture + \% protein + \% fat + \% crude fiber + \% \, ash)$$

Energy calculation: the percentage calories in selected sample were calculated by multiplyined the percentage crude proteins and

carbohydrate with 4 and crude fat with 9. The values were then converted to calories per 100mg of the sample.

Mineral Determination

Mineral content of baobab seed and fruit were determined by atomic absorption spectrometry, flame photometry and spectrophotometry according to the method of AOAC (2003).

Wet Digestion of Sample

In wet digestion of sample, exactly 1(g) of the powdered sample was shaken in digesting glass tube. Twelve milliliters (12ml) of HNO_3 was added to the mixture and was kept for overnight at room temperature. Then 4.0ml perchloric acid ($HClO_4$) was added to this mixture and was kept in fumes block for digestion. The temperature was increased gradually, starting from 50^0C and increases up to $250-300^0C$. the digestion completed in about 70-85 minutes as indicated by the appearance of white fumes. The mixture was left to cool down and the contents of the tubes were transferred to 100ML volumetric flasks and the volumes of the contents were made to 100ml with distilled water. The wet digested solution was transferred to plastic bottles labeled accurately, stored the digest and used it for mineral determination. (AOAC,2003)

Determination of Calcium (Ca) and Magnesium by Atomic Absorption Spectrometry (AAS)

Principle: In this technique the atoms of an element are vaporized and atomized in the flame. The atoms then absorb the light at a characteristic wavelength. The source of the light is hollow cathode lamp, which is made up of the same element, which has to be determined. The lamp

produces radiation of an appropriate wavelength, which while passing through the flame is absorbed by the free atoms of the sample. The absorbed energy is measured by a photo-detector read-out system. The amount of energy absorbed is proportional to the concentration of the element in the sample.

Procedure: The digested sample was analyzed for mineral contents by atomic absorption spectrophotometer at Usmanu danfodiyo University, Sokoto. The absorption measurement of the elements in *Adansonia digitata* was read-out, difference electrode lamps were used for each mineral. The equipment was run for standard solutions of each mineral before and during determination to check that it is working properly. The dilution factor for all minerals with the exception phosphorous and magnesium was 100. For determination of Mg, further dilution of original solution was done by using 0.5ml original solution and enough distilled water was added to it and make the volume up to 100ml. Also for the determination of Ca, 1.0ml of lithium oxide solution was added to the original solution to unmask Ca from Mg. the concentrations of minerals recorded in terms of part permillions (ppm) were converted to milligrams (mg) of the minerals by multiplying the ppm with dilution factor and dividing by 1000,

$$MW = \frac{absorbance\ (ppm)\ X\ dry\ Wt\ \ X\ D}{Wt.of\ sample\ x\ 1000} \ldots\ldots\ldots\ldots\ldots\ldots\ldots.8$$

Note: Dilution factor for phosphorous is 2500, for magnesium 10000, and for other minerals including calcium, iron potassium, sodium manganese and chromium is 100

Determination of Sodium (Na) and Potassium (K) by Flame Photometry

Principle: the flame photometer measures the emission of radiant energy when atoms of an element return to their ground state after excitation

by the high temperature of the flame. The degree of emission is related to the concentration of the element in the solution.

Procedure: Na and K analysis of the sample were done by the method of flame photometry. The sample wet digested sample solution as used in AAS were used for the determination of Na and K. standard solution of 20,40,60 80 and 100 milliequivalent/L were used both for Na and K. the calculations for the total mineral intake involve the same procedure as given in AAS.

Determination of Phosphorous (P) by Spectrophotometry

Phosphorous in the sample was determined by the method of spectrophotometry as follows:

Principle: Calorimetric determination is depended upon the principle that certain elements or compounds on reaction with suitable reagent develop colour. The intensity of the colours measured with colorimeter of spectrophotometer. The inorganic phosphorous reacts with ammonium molybdate to produce ammonium phosphomolybdate which on reaction formed molybdenum blue colouration. The blue colour of the solution was measured and the amount of phosphorous was determined.

Procedure

Sample from final blue solution was taken into a cuvate and introduced to the spectrophotometer. The reading of phosphorous was recorded in ppm. The calculation for the total mineral intake involve the same as procedure given in AAS (AOAC,2003).

RESULT AND DISCUSSION

Table 4.1 proximate composition of seed and pulp of baobab fruit

Parameters (g/100g)	Pulp	Seed
Moisture content	14.0± 0.4	8.0±0.1
Ash content	5.5± 0.02	6.5± 0.52
Lipid	1.8± 0.01	8.5± 0.12
Crude fiber	Trace	1.5± 0.01
Crude protein	1.84± 0.05	10.1± 0.5
Carbohydrate (CHO)	77.16± 2.70	65.35± 1.50
Calorific value (kj/100g)	332.2± 9.80	378.5± 4.50
Nitrogen Free Extract NFE	0.7686± 0.02	0.6535± 0.01

Table 4.1 Mineral analysis of seed and pulp of baobab fruit

Parameters (mg/kg)	Pulp	Seed
Sodium (Na)	72.5±2.2	87.5± 3.0
Potassium (K)	5500± 30	3500± 10
Calcium (Ca)	0.45± 0.01	0.55± 0.001
Magnesium (Mg)	1.30± 0.01	1.90± 0.02
Phosphorous (P)	5.26± 0.05	8.11± 0.01

DISCUSSION

From the table 4.1 above, the ash content of baobab seed was found to be 6.5 ± 0.52 and that of pulp was found to be 5.5 ± 0.52, this indicates that baobab seed have much % ash content than the pulp. The % moisture of baobab seed were found to be 8.0 ± 0.1, and that of pulp were found to be 14.0 ± 0.4, this indicates that baobab pulp have much % moisture than the seed. The % lipid of baobab seed was found to be 8.5 ± 0.12 and for the pulp 1.8 ± 0.01, this shows that baobab seed have much % lipid than the pulp. The fiber in baobab pulp were found to be trace and that of baobab seed were found to be 1.5 ± 0.01 this indicates that baobab seed have much fiber than baobab pulp. The % crude

proteins of baobab pulp were found to be 1.84 ± 0.05 and that of baobab seed were found to be 10.15 ± 0.50, this indicates that the % crude proteins of seed is much higher than that of baobab pulp. The % carbohydrate (CHO) of baobab pulp was found to be 77.16 ± 2.70 and that of baobab seed were found to be 65.35 ± 1.50, this shows that the pulp have higher % carbohydrate than the seed. The nitrogen free content of baobab pulp was found to be 0.7686 ± 0.002 and that of baobab seed were found to be 0.6535 ± 0.001. This shows that baobab seed have high free nitrogen content that its pulp.

Table 4.2 shows the mineral analysis of baobab seed and pulp in mg/kg are as follows; sodium (Na) in pulp were found to be 72.5 ± 2.2 and that of seed were also found to be 87.5 ± 3.0, this indicates that baobab *Adansonia digitata* seed have higher sodium content than its pulp. The potassium (K) in *Adansonia digitata* pulp were found to be 5500 ± 30 and that of seed 3500± 10 mg/kg, this indicates that *Adansonia digitata* pulp have high potash content than its seed. The calcium (Ca) in *Adansonia digitata* pulp were found to be 0.45 ± 0.01 and that of seed were also found to be 0.55 ± 0.01; this indicates that the Adansonia digitata seed have much calcium content than its pulp. The magnesium (Mg) in *Adansonia digitata* pulp were found to be 1.30 ± 0.01 and in seed were found to be 1.90 ± 0.02 this indicates that *Adansonia digitata* seed have much magnesium content than its pulp. The phosphorous (P) in *Adansonia digitata* pulp were found to be 5.26 ± 0.05 and that of seed were also found to be 8.11 ± 0.01, this shows that the phosphorous content in *Adansonia digitata* seed is high than that of its pulp.

SUMMARY

Adansonia digitata is the most wide spread of the adansonia species. The *Adansonia digitata* (baobab) was bought from Sokoto state central market. The fruit (seed and pulp) was analyzed in accordance with AOAC method.

CONCLUSION

The result of this study has shown that the rich energy, proteins and minerals content of *Adansonia digitata* fruit (pulp and seed) give it potential usefulness as a food protein source in tropical and subtropical region. As beverage ingredient, the fruit pulp may also serve as a calcium supplement because of it high calcium content. Available carbohydrate of pulp and seed when utilized well could serve as a boost for food security (NRC,2006). The seed of *Adansonia digitata* is a potential source of edible oil and is highly in minerals such as potassium (K), sodium (Na), calcium (Ca), magnesium (Mg) as well as phosphorous (P) respectively.

RECOMMENDATION

From the above research study, the following recommendation were made

1. Biodiesel /biofuel from *Adansonia digitata* seed should be carryout.
2. The comparative analysis of vitamin C in tablet and that from *Adansonia digitata* pulp should also be carryout
3. The amino acid determination of the sample should also be carryout
4. The antinutritional analysis of Adansonia digitata leaves, bark and flower should be also carryout.

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