1. INTRODUCTION

1.1. Baobab

Baobab is the common name of a genus of trees (***Adansonia***). There are nine baobab species. Six species live in the drier parts of Madagascar, two in mainland Africa and one in Australia. The baobab is the national tree of Madagascar (daily mail,2007).Other common names include 'boab', 'boaboa', 'bottle tree', 'the tree of life', 'upside-down tree', and 'monkey bread tree'. The trees reach heights of 5 to 30 metres and trunk diameters of 7 to 11 metres .Its trunk can hold up to 120,000 litres of water. In Sudan in Kordofan state the trunk of baobab tree is used as a reservoir for keeping water in the dry season For most of the year, the tree is leafless, and looks very much like it has its roots sticking up in the air(daily mail,2007).

Baobabs is one of the largest and most important trees, as they are, able to provide shelter and wood. The leaves of the tree are used for making soup and it has some medicinal purposes in some regions of Africa (daily mail,2007).

The trees are long-lived, but just how long is disputed. The owners of Sunland Farm in Limpopo, South Africa have built a pub called "The Big Baobab Pub" inside the hollow trunk of the 22 metres high tree. The tree is 47 m in circumference, and is said to have been carbon dated at over 6,000 years old). (daily mail,2007).Wickens and Lowe, (2008)reported that baobab (*Adansonia*) can live up to 1000 years.

The originates from tropical Africa and has a wide distribution range. Baobab species are rustic trees, which are characteristic of Sahelian prairies and Sudano-Sahelian savannas (Wickens and Lowe, 2008) as well as the semiarid tropical zone of the western part of Madagascar. The genus *Adansonia* belongs to the Bombaceae family and the Malvales order.

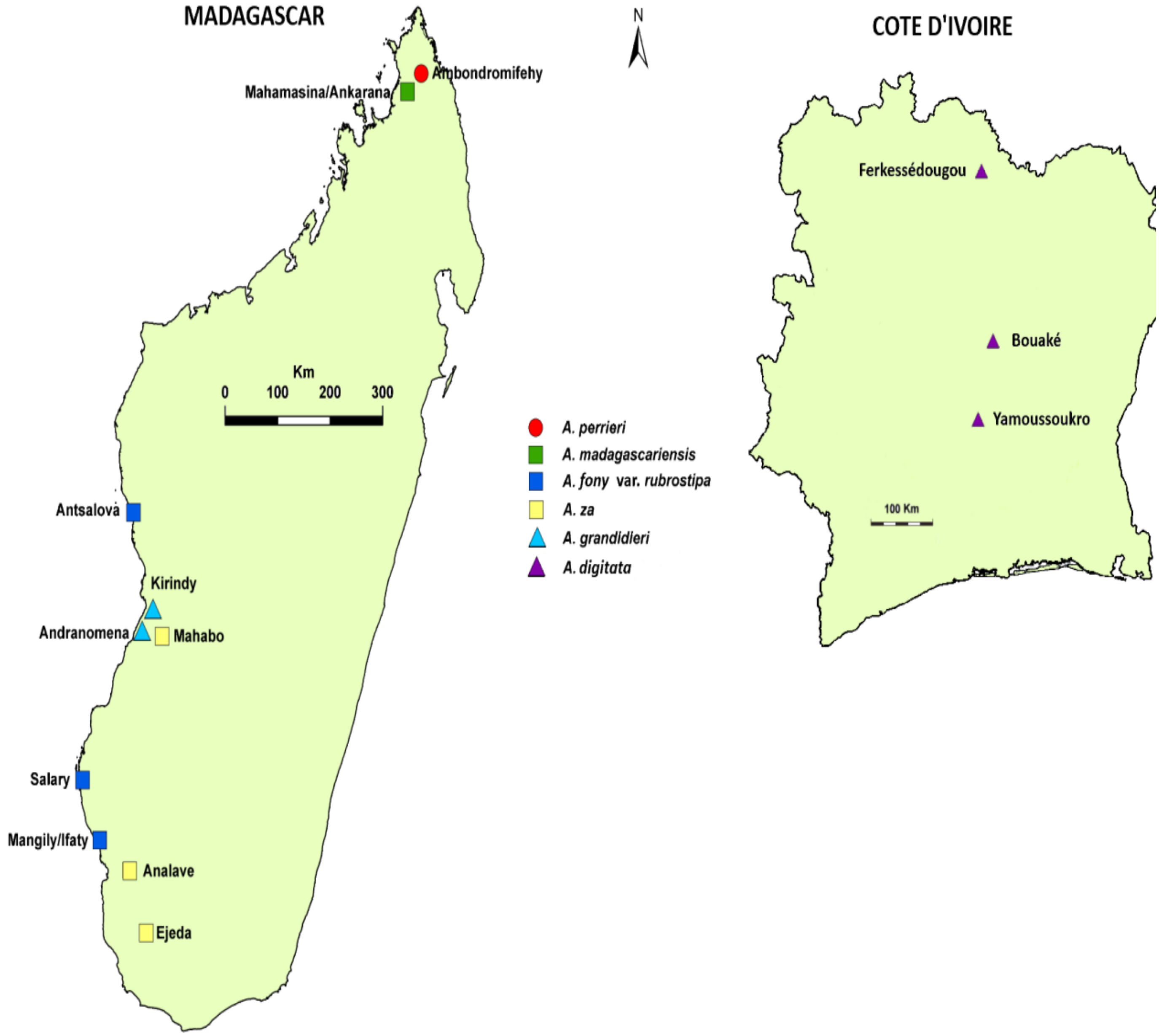


Fig (1.1) Zones of harvest of the six species of baobab; in Madagascar: *A. perrieri, A. Madagascariensis, A. fony var. rubrostipa, A. Za, A. Grandidieri;* in Côte-d'Ivoire : *A digitata*

It comprises eight species, six of which are endemic to Madagascar, theseare:*A. grandidieri* Baill., *A. madagascarensis* Baill., *A. perrieri* Capuron, *A. fony* var. *rubrostipa*, *A. suarezensis* H. *A. za* Baill.and *A. gregorii* F. Muell. is exclusively found in Northwestern Australia, whereas *A. digitata* L. is encountered in subtropical Africa as shown in figure 1.1 , where it plays key cultural roles in the beliefs of indigenous people (Kamatou et al., 2011; Sanchez et al., 2010). The ovoid fruit, called monkey's bread, contains black seeds embedded in a white and chalky pulp. It is consumed as basic food in many regions of Central Africa. For example, the Haoussa ethnic group uses the baobab fruit as the main ingredient in a soup called *miyar*.

1.2. plant classification

Kindom: Plantae

Clade: Angiosperms

Clade: Eudicots

Clade: Roside

Order: Malvales

Family: Malvaceae

Subfamily: Bombacoideae

Genus: Adansoni

1.3.Geographic disteribution

baobab is any one of the nine species of deciduous tree in the genus ***Adansonia***, found in arid regions of Madagascar, mainland Africa and Australia. The generic name honours Michel Adanson, the French naturalist and explorer, who, described *Adansonia digitata* (Wickens and Lowe, 2008).

From the nine species, six are native to Madagascar, two are native to mainland Africa and and one is native to Australia. One of the mainland African species also occurs on Madagascar, but it is not a native of that island. It was introduced in ancient times to south Asia and during the colonial era to the Caribbean. It is also present in the island nation of Cape Verde. The ninth species were described to be found in upland populations of southern and eastern Africa (pttigrew,2012). The African and Australian baobabs are almost identical despite having separated more than 100 million years ago, probably by oceanic dispersal (Baum and wendel,1998).

1.4. Description

The Glencoe baobab, a specimen of *A. digitata* in Limpopo Province, South Africa, was considered to be the largest living individual, with a maximum circumference of 47 m and a diameter of about 15.9 m .The tree has since split into two parts, so the widest individual trunk may now be that of the Sunland baobab, or Plat land tree, also in South Africa. The diameter of this tree at ground level is 9.3 m and its circumference at breast height is 34 m (J.H.Madian,2008).

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 ages. Radiocarbon dating has provided data on a few individuals. A specimen of *A. digitata* known as Grootboom was dated and found to be at least 1275 years old, making it one of the oldest known angiosperm trees (Kew,2014)

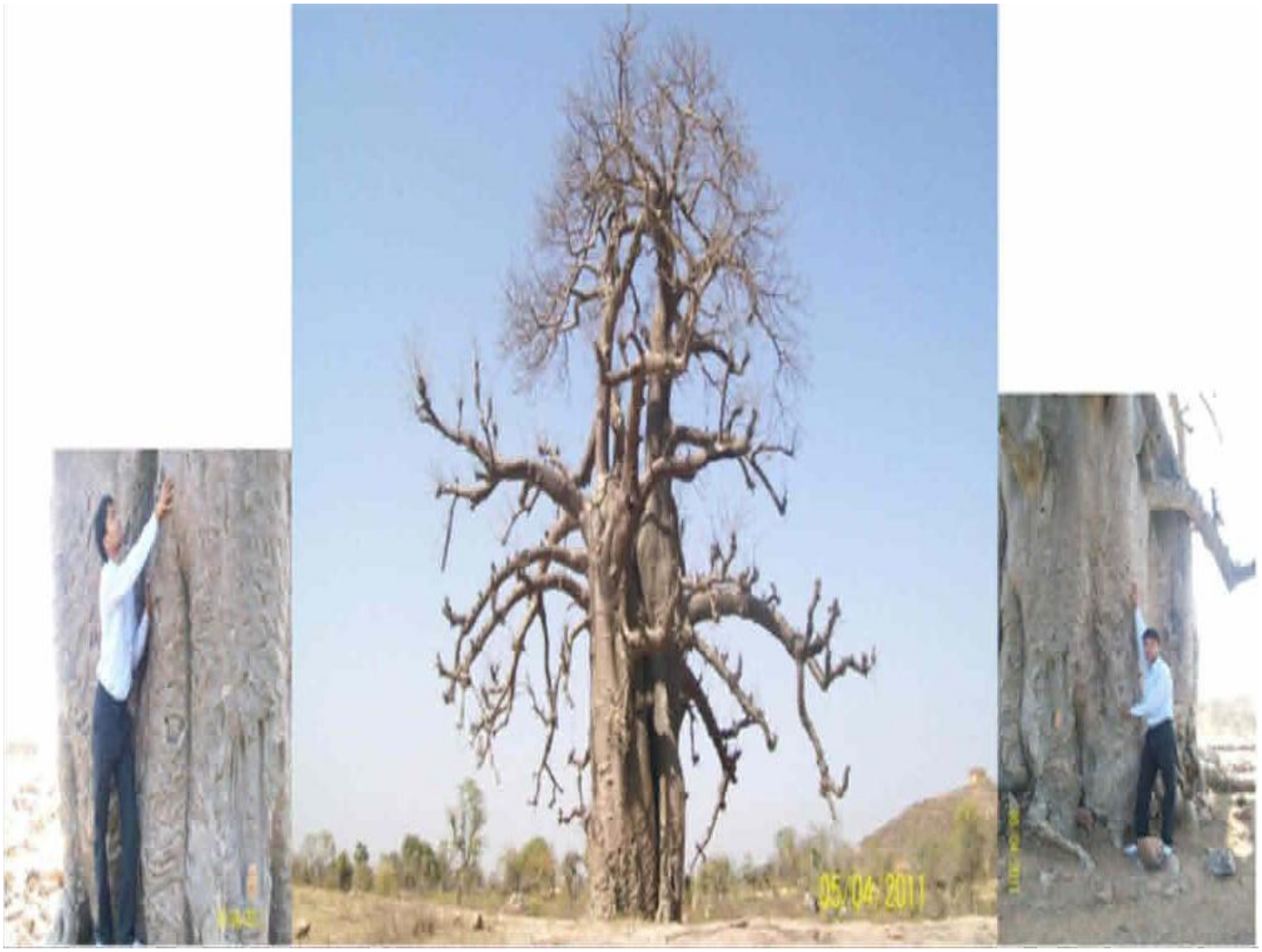
1.5. The baobab tree species

According to waston,(2007) baobab species include:

- *Adansonia digitata*L. – African baobab, dead-rat-tree, monkey-bread-tree (western, northeastern, central & southern Africa, in Oman and Yemen in the Arabian Peninsula, Asia and in Penang, Malaysia)
- *Adansonia grandidieri*Baill. – Grandidier's baobab, giant baobab (Madagascar)
- *Adansonia gregorii*F.Muell. (syn. *A. gibbosa*) – boab, Australian baobab, bottletree, cream-of-tartar-tree, gouty-stem (northwestern Australia)
- *Adansonia kilima* Pettigrew, et al. – montane African baobab (eastern & southern Africa)
- *Adansonia madagascariensis* Baill. – Madagascar baobab (Madagascar)
- *Adansonia perrieri*Capuron – Perrier's baobab (northern Madagascar)
- *Adansonia rubrostipa*Jum.&H.Perrier (syn. *A. fony*) – fony baobab (Madagascar)
- *Adansonia suarezensis* H.Perrier – Suarez baobab (Madagascar)
- *Adansonia za* Baill. – za baobab (Madagascar)

Fig(1.2) African baobab

Fig(1.3) Madagascar baobab



Fig(1.4) Australian baobab

1.6. Habitat and Ecology

The Malagasy species are important components of the Madagascar dry deciduous forests. Within that biome, *Adansonia madagascariensis* and *A. rubrostipa* occur specifically in the Anjajavy Forest, sometimes growing out of the tsingylimestone itself. *A. digitata* has been called "a defining icon of African bushland"(Kew,2014) .

Baobabs store water in the trunk (up to 120,000 litres or 32,000 US gallons) to endure harsh drought conditions (EM Cruyangen,2008). All occur in seasonally arid areas, and are deciduous, shedding their leaves during the dry season.

Baobabs are important as nest sites for birds, in particular the mottled spinetail] and four species of weaver (H diter,2014).

Fig(1.5) Baobab fruit and pulp(18cm)

1.7. Traditional information

The various parts of the plant (leaves, bark and seeds) are used as a panacea, that is, to treat almost any disease and specific documented uses include the treatment of malaria, tuberculosis,

fever, microbial infections, diarrhoea, anaemia, dysentery, toothache, *etc*. The leaves and fruit pulp are used as febrifuge as well as an immune stimulant (Rawy and gergis,1997).

In some countries in West Africa, the leaves, fruit pulp and seeds are the main ingredients in sauces, porridges and beverages recently, baobab has been referred to as a "super fruit" based on its nutritional profile (*e.g*. vitamin, fatty acid, mineral) (Gruenwald, 2009).

The nutritional value of baobab is only briefly discussed since a comprehensive report on the nutritive aspects is already available(vertuani, Braccioli and Buzzoni,2002).

The major interest in baobab products is as a result of its ascorbic acid and dietary fiber content. The level of vitamin C contained in fruit pulp is high and can range from2.8 to 3 g/kg. It was noted that baobab fruit pulp has very high vitamin C content (280–300 mg/100 g), which is seven to ten times more than oranges (51 mg/100 g). One study demonstrated that the consumption of 40 g of baobab pulp provided 100% of the recommended daily intake of vitamin C in pregnant women (19–30years)(chadare, lineman,Nout and Van Boekel,2002).

The ascorbic acid content was evaluated in the fruit of *A.digitata* and it was found to contain 337 mg/100 g of ascorbic acid Sidibe and Williams recommended that baobab leaves should be stored as whole leaves rather than ground leaf powder in order to preserve the high vitamin content although *A. digitata* is mostly regarded as a fruit-bearing forest tree, it is a multipurpose and widely-used species with medicinal properties, numerous food uses of various plant parts, and bark fibers that are used for a variety of purposes. Centuries ago the products were traded: it was well known in Cairo markets in the sixteenth century (Sidibe and wiliams,2002).

1.7.1. Leaves of A. digitata

Leaves are 2-3-foliate at the start of the season and they are early deciduous, of which more mature ones are (5-7-9)-foliate. Leaves are alternate at the ends of branches or occur on short spurs on the trunk. Leaves of young trees are often simple. Leaflets are sessile to shortly petiolulate with great variation in size. Overall mature leaf size may reach a diameter of 20 cm and the medial leaflet can be 5-15 ×2-7 cm, leaflet elliptic to ovate-elliptic with acuminate apex and decurrent base. Margins are entire and leaves are stellate pubescentbeneath when young becoming glabrescent or glabrous. Stipules are early caducous, subulate or narrowly triangular, 2-5mmlong, glabrous except for ciliate margins. (Sidibe and wiliams,2002).

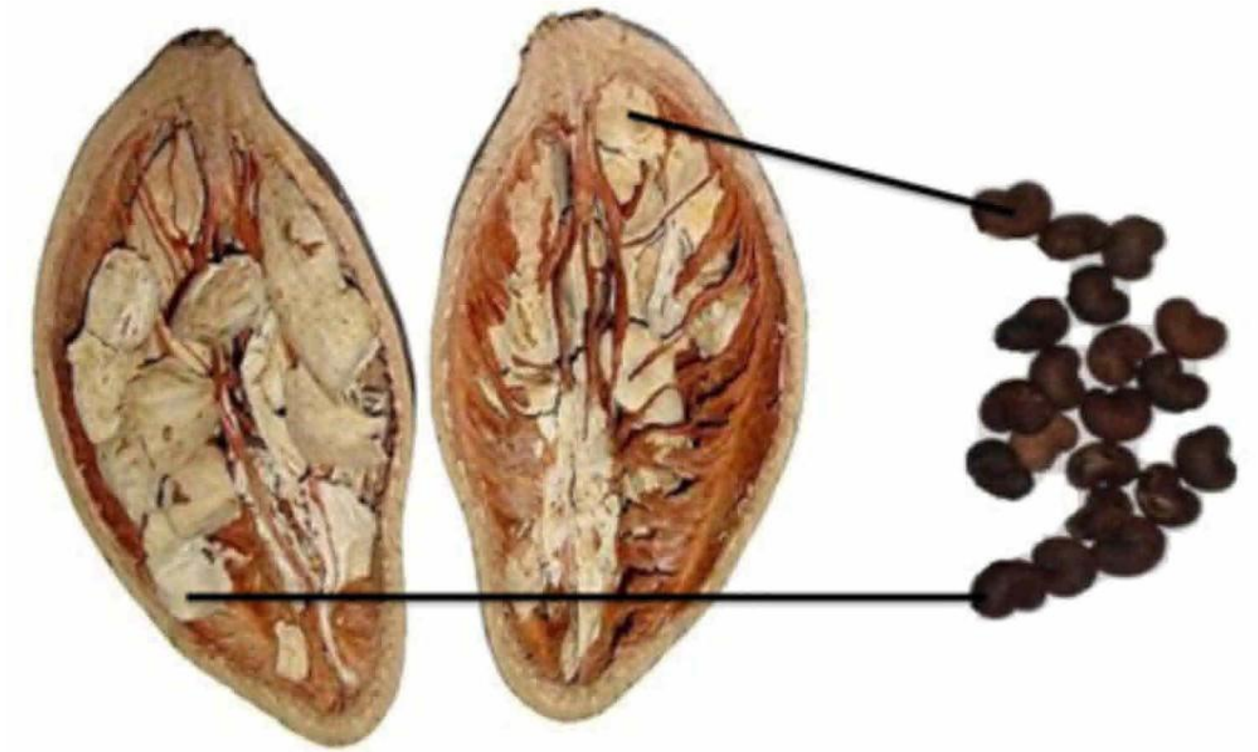
Fig (1.6) Leaves of *A. digitata.*

The leaves of baobab tree are a staple for many populations in Africa, especially the central region of the continent. During the rainy season when the baobab leaves are tender, people harvest a fresh batch of leaves. During the last month of the rainy season, leaves are harvested in great abundance and are dried for domesticuse and for marketing during the dry season. The leaves are typically sun-dried and either stored as whole leaved or pounded and sieved into a fine powder[38]. Young leaves are widely used, cooked as spinach, and frequently dried, often powdered and used for sauces over porridges, thick gruels of grains, or boiled rice (Sidibe and wiliams,2002).

1.7.2.. Fruits pulp of A. digitata

There is no doubt that baobab pulp is a valuable source of vitamin C. If an added value would be given to the pulp by improving its handling quality and storage stability by using adequate methods, this might help to enhance the interest of pulp uses and thus, it can lead to a better organization of food chain in developing countries (Ethiopia, Nigeria, Tanzania, Kenya, Ghana and India).

At present, the preservation of the pulp is beyond the control of population, which leads to undesirable losses of it. It is important to overcome problems in prolonging the shelf-life of the pulp in order to retain its nutritive value and sensorial properties. Bioavailability studies are necessary for a better appreciation of the contribution to human health since the dietary intake can never be fully utilized by the human body (Chadare,2010).



Fig(1.7)seeds and pulp of *A. digitata*.

1.7.3. Seeds of A. digitata

The seeds of *A. digitata* are uniformed and embedded in the pulp, the color is dark brown to reddish black with smooth testa . Seed kernels are widely used. They are eaten fresh, dry or ground and used in cooking. Kernels have an energy value of 1 803kJ/100 g, approximately 50% higher than leaves. The proximate mineral compositions of baobab seed shown in Table 5. The seed is a good source of phosphorus, calcium and magnesium. Seed oils are important sources of nutritional oils, industrial and pharmaceutical importance(Burkil,1985) .

1.8.The traditional uses of baobab

The fruit has a velvety shell and is about the size of a coconut, weighing about 1.5 kilograms (3.3 lb). It has an acidic, tart flavor, described as "some where between grapefruit, pear, and vanilla". The fresh fruit is said to taste like sherbet (Muller and von,2014).

The dried fruit powder of *A. digitata* contains about 12% water and modest levels of various nutrients, including carbohydrates, pectin, riboflavin, calcium, magnesium, potassium, iron, and phytosterols, with low levels of protein and fats. Vitamin C content, described as variable in different samples, was in a range of 74–163 mg per 100 g of dried powder (Muller and von,2014).

The powdery white interior may be used as a "thickener in jams and gravies, a sweetener for fruit drinks, or a tangy flavor addition to hot sauces"(Chadar,2009). The fruit pulp and seeds of *A. grandidieri* and *A. za* are eaten fresh(Ambrose and Mugho,2007) .

In Tanzania, the dry pulp of *A. digitata* is added to sugarcane to aid fermentation in beer making.(Sidibe,2002).The seeds of some species are a source of vegetable oil and leaves may be eaten as a leaf vegetable (Kew,2014).

In Angola, the dry fruit is usually boiled and the broth is used for juices or as the base for a type of ice cream known as *gelado de múcua*. In Zimbabwe, the fruit is used in traditional food preparations which include "eating the fruit fresh or crushed crumbly pulp to stir into porridge and drinks". Malawi women have set up commercial ventures harvesting the baobab to earn their children's school fees.

Since 2008, interest has been increasing for developing baobab seeds or dried fruit powder for consumer products. In the European Union (EU) prior to commercial approval, baobab fruit powder was not available for ingredient uses, as legislation from 1997 dictated that foods not commonly consumed in the EU would have to be formally approved first. In 2008, baobab dried fruit pulp was authorized in the EU as a safe food ingredient, and it was later granted GRAS status in the United States (Vicker, Calaudia and Jack,2008).

According to Lange and Karen, 2010, the baobab tree is known as the tree of life, with good reason. It can provide shelter, clothing, food, and water for the animal and human inhabitants of the African savannah regions. The cork-like bark and huge stem are fire resistant and are used for making cloth and rope. The leaves are used as condiments and medicines. The fruit, called "monkey bread", is edible, and full of vitamin C. As of 2010 experts estimate the potential international market at a billion dollars($US) a year.

The tree can store hundreds of litres of water, which is an adaptation to the harsh drought conditions of its environment. The tree may be tapped in dry periods (The Baobab tree in senigal,2008).

Mature trees are usually hollow, providing living space for many animals and humans. Trees are even used as bars, barns, wine and beer shops and more(Dance of the Boab,1996).

1.9. Medicinal uses of baobab

Treat various ailments such as diarrhoea, malaria and microbial infections ,Several plant parts have interesting anti-oxidant and anti-inflammatory properties, and baobab has been used extensively since ancient times in traditional medicine (Decaluwe, Halamova and Vandamm,2010)

The seeds, leaves, roots, flowers, fruit pulp and bark of baobab are edible. Baobab leaves are used in the preparation of soup. Seeds are used as athickening agent in soups, but they can be fermented and used as a flavoring agent or roasted and eaten as snacks(Diop,Frank and Grimm,1988)

The flora from Tikamgarh District in Bundelkhand Region has immense pharmaceutical and commercial potential India has about more than 45 000 plants species and among them several thousand are claimed to possess medicinal properties(Chadar,2010).

Medicinal plants play an important role in providing knowledge to the researchers in the field of ethnobotany and ethnopharmacology (Chadar,2010).

Baobab trees are indigenous to Africa. The trees can tolerate to high temperatures and long spans of drought, and are grown for their sour fruit and leaves. The fruit consists of pulp and large seeds embedded in the dry acidic pulp and shell. The leaves are used to make soup, and the pulp is used to make beverage and for food preparation(Yazzie and vander, 1994).

In recent years, due to industry seeks natural alternatives, demand for seed oils as ingredients for food and bio fuel has been greatly increased. A study on biodiesel production and fuel properties was conducted by Modiba *et al*. The seeds are pressed for oil, but the by-product baobab oil seed meals typically underutilized. Most of previous studies on the baobab fruit have focused on the seed oil (Burkill,1985).

The total land area of Orchha wild life sanctuary in Madhya Pradesh is about 40-45 km2, which is very rich in medicinal plant species(Burkill,1985).

1.10.Benefits of baobab

Baobab is the fruit of Africa's 'Tree of Life'. It is the only fruit in the world that dries naturally on the branch. Baking in the sun for 6 months, baobab’s green, prickly, velvet-like coating transforms into a smooth, brown, coconut-like shell. Inside it’s hard casing (we use a hammer to crack it open) is the dry white-ish pulp of the fruit which contains no moisture whatsoever. To produce our award-winning Baobab range, we simply harvest and sieve to produce a 100% natural and organic powder that is exceptionally nutrient-rich, with an equally impressive range of benefits.

Baobab powder is a rich source of vitamin C, which contributes to normal: Energy release Immune function ,Healthy and glowing skin

It is also almost 50% fibre (two thirds soluble and one third insoluble, making it a powerful prebiotic) and contains more antioxidants than any other whole fruit.

As it is a natural source of these nutrients, it is more bio available than manufactured vitamin supplements, meaning our bodies can absorb the nutrients more easily, ensuring a greater uptake.

Amazingly, baobab has a natural shelf-life of 3 years so there are no additives or preservatives added to our products, just 100% pure baobab fruit pulp powder. It also has a delicious sweet and citrussy flavour - a bit like healthy sherbet! .

1.11. The top health and beauty benefits:

1.11.1Immune 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 the foods we eat every day.

A single serving of Baobab Powder (10g or 2-3 teaspoons) provides:

33% of your daily vitamin C requirement.

One of the key benefits of vitamin C is that it helps to keep our immune system strong, supporting our body's defence against infections, diseases and other illnesses. Try shaking baobab powder into your orange juice or water bottle for an extra dose of vitamin C on the go (Jakemanl and Maxwell,1993).

1.11.2.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 activity and exercise” Sub your morning coffee for a sprinkle of baobab powder on your breakfast to keep you energised and awake throughout the day. We like ours stirred into porridge or blended into our morning smoothies (Jakemanl and Maxwell,1993).

1.11.3.Blood Sugar

Aduna Baobab Powder contains 34% soluble fibre, this helps to slow down the release of sugars 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 organs in your abdominal).

The Functional Food Centre of Oxford Brookes University conducted a trial using Aduna Baobab Powder and found that human participants who consumed a milk containing baobab had a lower blood glucose response than those who had a control drink with no baobab.

A later study by Oxford Brookes University also showed that baobab significantly reduced the rate at which sugar was released into the blood after digestion. As such, baobab is considered ideal for those following a low GI diet. It could also be beneficial for people with Type 2 Diabetes.

Add Aduna Baobab Powder into your juices to help slow down the release of fruit sugars into your blood stream(Jakemanl and Maxwell,1993).

1.11.4. Absorption of Iron

Over 30% of the world's population are deficient in iron – making it the most common nutritional disorder (World Health Organisation, 2017). Many turn to various iron supplements to increase their intake. A less known fact is that vitamin C is needed to help the body to absorb iron so pairing iron with vitamin C actually increases absorption.

Human body 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.

1.11.5.Digestive health

Approximately 40% of people have at least one digestive symptom at any one time. 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 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.

Try adding Aduna Baobab into your daily meals to get your fibre fix, this Red Lentil & Baobab Curry is one of our favourite baobalicious recipes(Jakemanl and Maxwell,1993 .

1.11.6.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 (Jakemanl and Maxwell,1993).

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” (Independent, 2017). One of their key staples? That’s right you guessed it – the baobab fruit. Could eating baobab explain why the Hadzas have such good gut health?

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(Antioxidant food table,2010).

1.11.7.For skin radiant

According to The Journal of Nutrition 2011, Baobab has the highest antioxidant content than 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 (Akbari, 2016) .

1.11.8.for pregnant women

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.

If that wasn't enough to convince you of baobab's super-powers, it is also a good source of fibre. Nutritional Therapist, Eve Kalinik explains how this helps to "support bowel movements and a great addition for new mums to help fight fatigue that comes with having a newborn"(Schwalfenberg,G. 2012)).

1.11.9.Alkalinity

Baobab is considered to be one of the highest alkaline foods available as it has a PRAL (Potential Renal Acid Load) rating of Eating highly alkaline foods helps to balance our body's pH levels.

Also it was found that alkaline foods can also help defend our bodies from chronic diseases and ailments (such as hypertension, arthritis and deficiency in vitamin D) (Schwalfenberg,G. 2012))

1.12.Chemical composition

1.12.1.Moisture contents

Moisture contents varied among the different species from 11.7 to 13.5% (12.5% on average). For the Malagasy species, the highest content was observed in *A. grandidieri*, whereas *A. fony* var. *rubrostipa* had the lowest. Our results were similar to those reported for *A. digitata* in previous studies (Murray et al., 2001; Soloviev et al., 2004) where average moisture contents were 12%.

1.12.2. Lipids

The lipid contents of different baobab species were very low, varying from 0.5 to 2.1 g lipid / 100 g dry matter (DM) .*A. madagascariensis* had the highest lipid content with 2.1 g / 100 g. These values were comparable to those reported by Nour et al. (1980), and Lockett et al. (2000), who observe lipid contents as low as 0.21 and 0.41 g /100 g DM with gravimetric and Soxtec methods, respectively. However, these values are low compared to 15.5 g lipid / 100 DM reported by Glew et al. (1997) for *A. digitata*. This result is very surprising because the lipid content is higher than that found in baobab seeds, that is, 9 g lipid /100 g DM. The Soxtec method used gave 0.94 g /100 g DM of lipid in *A. digitata*, that is, twice the values reported by Lockett et al. (2000) in the same species with the same method. Therefore, the observed variations may result from the analytical methods used, but also from the different baobab ecotypes and species studied.

1.12.3. Proteins

The protein content of the six baobab species varied from 2.5 to 6.3 g protein /100 g DM. *A. fony* var. *rubrostipa* had the highest protein content (6.3 g/100 g DM), and *A. za* the lowest (2.5 g/100 g DM). The results were very similar to those reported by Lockett et al. (2000), and Osman, (2004) who obtain 5.3 g/100 g DM in *A. digitata.* All investigated species, except *A. fony* var. *rubrostipa (*6.3%), had similar protein content. With the same analytical procedures and 6.25 as conversion factor, Chadaré et al. (2009) report a protein content comprised between 2.5 and 17 g/100 DM for *A. digitata*. Only Sena et al. (1998) and Obizoba and Amaechi (1993) report a very high protein contents, 17 and 19.1 g/100 g DM, respectively, but the values were not observed in all other studies realized on *A. digitata*.

1.12.4.Fibers

Fiber content of different baobab species varied from 17.2 to 27.9 g/100 g DM. Excepted *A. perrieri* with 17.2 g/100 g DM, all the species had fiber content around 26 g/100 g DM. Chadaré et al. (2009) note variability between 0.6 and 45.1 g/100 g DM. In fact, this variability could be explained by the method used. The average value observed by these authors is 13.7 g/100 g DM.

1.12.5.Carbohydrates

As in most fruits, in two studied species (*A. perrieri* and *A madagascariensis*), carbohydrates represented more than 60% of the dry matter and consisted of soluble sugars for half of it. In baobab fruits, among the soluble sugars, glucose was the least represented, but the content of reducing sugars (glucose + fructose) was greater than the sucrose content. Results showed variability in carbohydrate contents, especially for starch, as two species, *A. perrieri* and *A. madagascariensis*, had high values, 71.7 and 60.8 % DM, respectively, compared to the others, from 26.1 to 43.9 %. The highest sugar contents were found in *A. grandidieri* with 8.9% for glucose, 9.9% for fructose and 5.2% for sucrose, followed by *A. digitata* with 7.9% for glucose, 7.0% for fructose and 1.70% for sucrose. We thus observed that the species with the highest starch contents had the lowest free sugar contents. The presence of sugar was similar to that mentioned by Soloviev et al. (2004), who found a total of soluble sugar content ranging between 7.2 and 11.2 g/100 g DM in the pulp of baobab, whereas Nour et al. (1980) report a 23.2% total sugars and 19.9% reducing sugars. According to Murray et al. (2001), simple sugars represent about 35.6% of total carbohydrates. This explains the considerably sweet taste of the pulp. However, sweetness can vary depending on the species, maturity of the fruits, and environmental soil and climate.

1.13. physical propereties of baobab oil

1.13.1.Density

Density is proportion between weights of specific volume of material divisor on weight of volume for normativeness material.

1.13.2. Viscosity

Viscosity of a fluid is a measure of its resistance to flow expressed as the ratio of the absolute viscosity of the fluid to that of reference fluid(usually water)

1.13.3.pH value

pHis numeric scale used to specify the acidity or basicity of an aqueous solutions.

1.13.4.Refractive index

Refractive index of oil is a function of molecular structure and impurity.

1.14.Chemical propereties of baobab oil

1.14.1.Acid value

This is the number, that, expresses, in milligrams the quantity of potassium hydroxide required to neutralise the free acids present in 1 g of oil.

1.14.2.Saponification value

This is the number of milligrams of potassium hydroxide required to neutralise the free acids and to saponify the esters in 1 g of oil.

1.14.3.Peroxide value:

Measure of extent to which an oil sample has undergone primary oxidation.

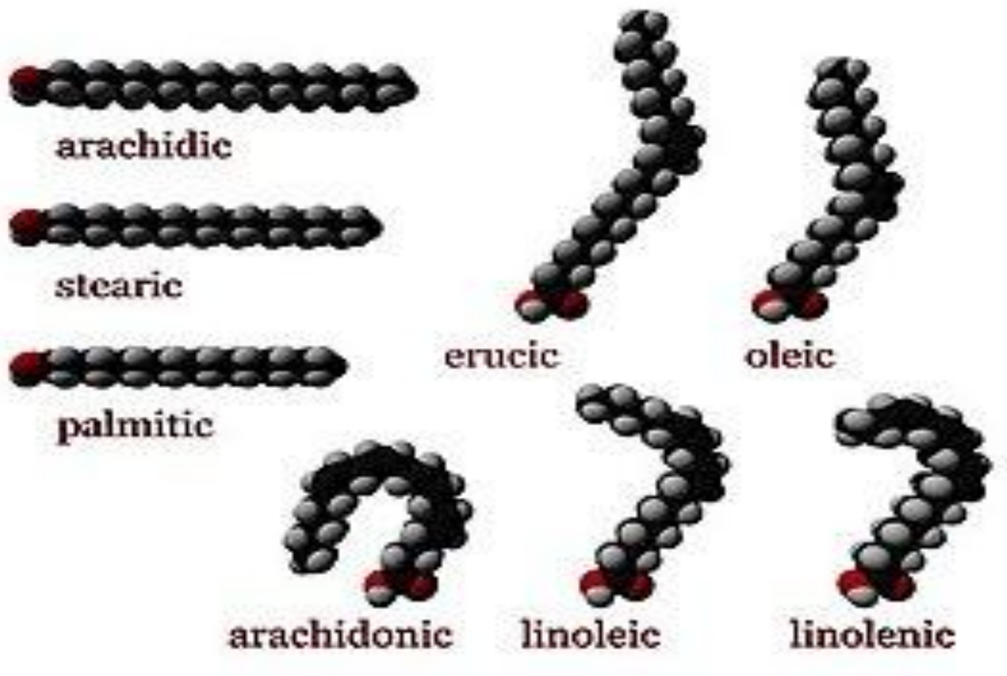
1.14.4. Ester value:

Is the difference between saponification value and acid value.

1.15.Fatty acids in baobab oil

In chemistry, particularly in biochemistry, a fatty acid is a carboxylic acid with a long aliphatic chain, which is either saturated or unsaturated. Most naturally occurring fatty acids have an unbranched chain of an even number of carbon atoms, from 4 to 28. Fatty acids are usually derived from triglycerides or phospholipids. Fatty acids are important dietary sources of fuel for animals because, when metabolized, they yield large quantities of ATP. Many cell types can use either glucose or fatty acids for this purpose. Long-chain fatty acids cannot cross the blood–brain barrier (BBB) and so cannot be used as fuel by the cells of the central nervous system,however, free short-chain fatty acids and medium-chain fatty acids can cross the BBB, in addition to glucose and ketone bodies (Chevreul M. E,1823).

The concept of fatty acid (*acide gras*) was introduced by Michel Eugène Chevreul, though he used initially some variant terms, *graisse acide* and *acide huileux* ("acid fat" and "oily acid").



Fig(1-8)Three-dimensional representations of several fatty acids

Fatty acids that have carbon–carbon double bonds are known as unsaturated. Fatty acids without double bonds are known as saturated. They differ in length as well(Chevreul M. E,1823).

1.15.1Unsaturated fatty acids

Unsaturated fatty acids have one or more double bonds between carbon atoms. (Pairs of carbon atoms connected by double bonds can be saturated by adding hydrogen atoms to them, converting the double bonds to single bonds. Therefore, the double bonds are called unsaturated.)

1. The two carbon atoms in the chain that are bound next to either side of the double bond can occur in a *cis* or *trans* configuration((Leray.2017).

2. configuration means that the two hydrogen atoms adjacent to the double bond stick out on the same side of the chain. The rigidity of the double bond freezes its conformation and, in the case of the *cis* isomer, causes the chain to bend and restricts the conformational freedom of the fatty acid. The more double bonds the chain has in the *cis* configuration, the less flexibility it has. When a chain has many *cis* bonds, it becomes quite curved in its most accessible conformations. For example, oleic acid, with one double bond, has a "kink" in it, whereas linoleic acid, with two double bonds, has a more pronounced bend. α-Linolenic acid, with three double bonds, favors a hooked shape. The effect of this is that, in restricted environments, such as when fatty acids are part of a phospholipid in a lipid bilayer, or triglycerides in lipid droplets, cis bonds limit the ability of fatty acids to be closely packed, and therefore can affect the melting temperature of the membrane or of the fat . (Leray.2017).
3. A *trans* configuration, by contrast, means that the adjacent two hydrogen atoms lie on *opposite* sides of the chain. As a result, they do not cause the chain to bend much, and their shape is similar to straight saturated fatty acids(Leray, 2017).

In most naturally occurring unsaturated fatty acids, each double bond has three *n* carbon atoms after it, for some **n**, and all are cis bonds. Most fatty acids in the *trans* configuration (trans fats) are not found in nature and are the result of human processing (e.g., hydrogenation).

1. The differences in geometry between the various types of unsaturated fatty acids, as well as between saturated and unsaturated fatty acids, play an important role in biological processes, and in the construction of biological structures (such as cell membranes) (Leray.2017).

1.15.2Essential fatty acids

Acids that are required by the human body, but cannot, be made in sufficient quantity from other substrates, and therefore must be obtained from food, are called essential fatty acids. There are two series of essential fatty acids; one has a double bond three carbon atoms away from the methyl end; the other has a double bond six carbon atoms away from the methyl end. Humans lack the ability to introduce double bonds in fatty acids beyond carbons 9 and 10, as counted from the carboxylic acid side. Two essential fatty acids are linoleic acid (LA) and alpha-linolenic acid (ALA). These fatty acids are widely distributed in plant oils. The human body has a limited ability to convert ALA into the longer-chain omega-3 fatty acids — eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), which can also be obtained from fish. Omega-3 and omega-6 fatty acids are biosynthetic precursors to endocannabinoids with antinociceptive, anxiolytic, and neurogenic properties(Roth karl,2013).

1.15.3. Saturated fatty acids

Saturated fatty acids have no double bonds. Thus, saturated fatty acids are saturated with hydrogen (since double bonds reduce the number of hydrogens on each carbon). Because saturated fatty acids have only single bonds, each carbon atom within the chain has 2 hydrogen atoms except for the omega carbon at the end that has 3 hydrogens (Roth karl,2013).

Arachidic acid is a saturated fatty acid

1.15.4.Common names and structures

Caprylic acid	$CH_3(CH_2)_6COOH$
Capric acid	$CH_3(CH_2)_8COOH$
Lauric acid	$CH_3(CH_2)_{10}COOH$
Myristic acid	$CH_3(CH_2)_{12}COOH$
Palmitic acid	$CH_3(CH_2)_{14}COOH$
Stearic acid	$CH_3(CH_2)_{16}COOH$
Arachidic acid	$CH_3(CH_2)_{18}COOH$
Behenic acid	$CH_3(CH_2)_{20}COOH$
Lignoceric acid	$CH_3(CH_2)_{22}COOH$
Cerotic acid	$CH_3(CH_2)_{24}COOH$

1.16.Objectives of the study

The aim of this study is the analysis of baobab fruit powder, seeds and oil. The analysis aimed to determine the mineral contents, vitamin C content as well as the extraction and physicochemical characterization of baobab oil.

2. Materials and methods

2.1.Collection of samples

five newly harvested fruit samples of different sizes were collected from Alobayed market (Northern Kordofan).The hard outer shells of the fruits were broken and the white baobab powder and it's black seeds were separated.

2.2.Chemicals

- Potassium hydroxide(KOH) -99.9%- BDH chemicals ltd poole-England.
- Sodium hydroxide(NaOH)-99.6%. Lab tech chemicals.
- Sulfuric acid- 99.5%- d=1.84 g/cm^3- ALPHA CHEMIKA – India.
- Ethanol(CH_3CH_2OH)- 96%- African Modern Distillation for ethanol-Sudan.
- Chloroform- 99.8% - Lab tech chemicals- India.
- Glacial acetic acid - 99%- d= 1.040 g/cm^3- S D fine chem limited – India.
- Hydrochloric acid (HCl)- 35%- d= 1.200 g/cm^3- ALPHA CHEMIKA – India.
- Sodium thiosulphate-98%- S D fine chem limited – India.
- Phenolphthalein indicator - S D fine chem limited – India.
- Starch- Chadwell health ESSEX – ENGLAND.
- Potassium iodide(KI)-66%- S D fine chem limited – India.
- Petroleum ether- 95%- d= 1.049 g/cm^3- S D fine chem limited – India.
- Indophenol solution - Brand Edvotek chemwatch.

- Acetone- 96.5%- d= 0.7845 g/cm^3- BDH chemicals ltd poole-England.

- Nitric acid(HNO_3)- 99.9%- d= 1.5129 g/cm^3 ALPHA CHEMIKA – India.

- Sodium chloride(NaCl)- . 99.9%- Lab tech chemicals.

- Metaphsphoric acid-36.5%-2.00 g/cm^3- Brand Edvotek chemwatch.

- Normal hexane-97%-d= 0.6606g/ml- Chevron philipes chemical company.

2.3. Instruments

- Moistur analyzer (Dsh-50 -10Auto).

- Electric muffle furnace 575(TAPP T211 om-39

- Soxhelt extraction system (Duran UK)

- Rotatory evaporator(Buchi Switzerland)

- Viscometer(HAAKE 6plus)

- Refractometer (Switzerland).

- pHmeter(14163 Germany).

- Inductivity Coupled Plasma(ICP –OES725 ES)(Vista-MPX-CCD).

- Gas chromatography-Mass spectrometer(GC/Mass) QP2010-Ultra'Simadzu Company-Japan.

- Sensitive balance(GH252) UK.

2.4. Methods of analysis

2.4.1. Determination of Moisture content

About 2 grams of baobab powder and crushed seeds were analyzed by using Moisture analyzer device, the experiment was repeated three times and the everage weight were recorded.

2.4.2. Determination of Ash content

About 2grams were accurately weighed from baobab powder and crushed seeds sample and ignited in an electric muffle furnace at 575^0 C for 3 hours, then the sample were cooled and weighed .The ash content was calculated ,the process of heating cooling and weighing was repeated antil constant weight was obtained.

2.4.3. Determination of minerals (ICP Analysis)

0.5g/50 ml of sample was burned for five hours by using furnace, then 5 ml of hydrogen peroxide and 5ml of nitric acid and 5 ml of hydrochloric acid were added.

Aprepared solution containing analyte elements is aspirated into the plasma generated by inductively coupled plasma source, the optimized elements produced characteristic emission spectral lines, which are separated by simultaneous optical spectrometer. the intensity of spectral line of an element is proportional to its concentration.

2.4.4. Extraction of Baobab oil

250 grams of baobab seeds were crushed to acoarse powder by using mortar and pestle. The coarsely powdered sample was successively extracted by petroleum ether using soxhlet extractor .Extraction was carried out for five hours till the

colour of solvent at the last siphoning time turned colorless. Solvent was then evaporated under reduced pressure using rotary evaporator. The extracted oil was left in open beaker at room temperature for complete evaporation of the solvent . the yield percentage were calculated as follow:

(Weight of oil obtained / weight of plant sample) X100

2.4.5.Oil Density

Cleaned and well dried 5ml density bottle was weighed, filled with baobab oil and reweighed.

Density = weight of oil/volume of oil

2.4.6. Oil Viscosity

40 ml of baobab oil was analyzed by viscometer device and the result was recorded.

2.4.7. Oil pH

The pH electrode was cleaned with distilled water, well dried and immersed in 30 ml of baobab oil, the obtained value was recorded.

2.4.8. Oil Refractive Index

The refractometer was cleaned and well dried by acetone, spot of the baobab oil was put in the device cell and the value was recorded.

2.4.9. Determination of Acid value

2 grams of baobab oil was weighed in 25 ml of a mixture of equal volumes of ethanol andlight petroleum, previously neutralised with 0.1 M potassium hydroxide, 0.5 ml of phenolphthalein solution was used as indicator. The solution

was titrated against 0.1M potassium hydroxide until the pink colour persists for 15 s (n ml of titrant). The acid value was calculated as follow

$$I_A = \frac{5.610n}{m}$$

Where:

n: is the volume of titrant

M: is the weight of oil

2.4.10. Determination of Saponification value

35 grams of potassium hydroxide were weighed and dissolved in 20 ml of water, Sufficient ethanol (96%) was added to complete the volum to 1000 ml. the mixture was allowed to stand overnight and pour off the clear liquid.

2 g of the baobab oil were weighed into a 250-ml flask, 25 ml of the ethanolic of potassium hydroxide solution were added ,the mixture was refluxed for 1 hour. While the solution is still hot, the excess of alkali was titrated against 0.5M hydrochloric acid, using phenolphthalein indicator. The method was repeated for blank sample. The saponification value was then calculated as follow

$$\text{Saponification value} = \frac{28.05\,(V2-V1)}{m}$$

V1 : is the volume of titrant used in oil titration

V2 : is the volume of the titrant used in blank titration

m : is the weight of the oil

2.4.11. Determination of Peroxide value

1 g of baobab oil was weighed in a 250 ml conical flask fitted with a ground-glass stopper. 30 ml of a mixture of(2:3)volume of chloroform and glacial acetic acid were added .the flask content was well Shaken, then 0.1 ml of saturated potassium iodide solution was added . the mixture was Shaked for exactly 1 min then titrated against 0.01 M sodium thiosulphate, until the yellow colour is almost discharged. 3 ml of starch solution were added and the titeration was continued with vigorous shaking, until the colour discharged. The blank titeration was Carried under the same conditions.peroxide value was calculated as follow

$$\text{Peroxide value} = \frac{10\ (V2 - V1)}{m}$$

V1 : is the volume of titrant used in oil titration

V2 : is the volume of the titrant used in blank titration

m : is the weight of the oil

2.4.12. Determination of Ester value

Ester value was obtained by substracting the acid value from saponification value.

2.4.13. Determination of Vitamin C content

50 mls of the saturated baobab juice were prepared by dissolving excess grams of baobab powder in 50 ml of distilled water ,the solution was filtered and transfered by pipette into 100 ml volumetric flask,25 ml of metaphosphoric acid were added as stabilizing agent and the solution was diluted to the mark with distilled water.10 ml of the solution was transferred into titeration flask and 2.5 ml of acetone were added. The solution was titerated against indophenol solution until faint pink

colour persist for 15second,the experiment was repeated three times until constant value was reatched.

Vitamin C =20*v*c

where:

v= volume of indophenols solution from titeration.

C= equivelant of mg of(vit.c) per 100ml indophenol .

2.4.14.GC-MS Charactrization of baobab oil

2ml of baobab oil were transferred to test tube ,7 ml of alcoholic sodium hydroxide (2%). 7 mls of methanolic sulphuric acid (1%) ml methanol) were added and the mixture was well Shaked by vortex for 3 minutes and left over night. 2mls of supersaturated sodium chloride and 2mls of normal hexane were then added. the mixture was diluted with 5ml diethyl ether.1gram of sodium sulphate was added as drying agent,the mixture was then filtered through syringe filter 0.45 µm. 1 ml of the filterate was injected directly to the GC-MS and results were recorded.

3. Results and Disscution

3.1.Moisture and Ash contents of baobab fruit and seeds

In this study percentage of moisture content is18.39% and 7.47% for baobab fruit and seeds respectively and percentage of ash is9.37% and 4.39% for baobab fruit and seeds respectively as shown in table(3.1) and table(3.2) .

Alia Mutasim(2016)reported that percentage of moisture in baobab fruit is23.7%3 and percentage of ash in baobab fruit is 2.99%

Table(3.1) Moisture and Ash contents of baobab fruit Powder

Test	Result(1)	Result(2)	Result(3)	Average
Moisture content%	18.47%	18.52%	18.19%	18.39%
Moisture content fraction	0.8153	0.8148	0.8181	0.8161
Ash content%	9.32%	9.14%	9.64%	9.37%

Table(3.2) Moisture and Ash contents of baobab seeds

Test	Result(1)	Result(2)	Result(3)	Average
Moisture content%	7.55%	7.15%	7.70%	7.47%
Moisture content fraction	0.9245	0.9285	0.9230	0.9253
Ash content%	4.39%	4.34%	4.45%	4.93%

3.2.Mineral contents of baobab fruit (powder and seeds)

The results obtained by using inductively coupled plasma (ICP) analysis showed that The percentage of heavy metals were: Arsenic < 2.54×10^{-3} ppm < 1.339 ppm, Cadmium < 2×10^{-3} ppm < 2×10^{-3} ppm respectively for the seeds and the fruit. The average concentration of trace elements in the seed were; Alu- minium (41.89 ppm) Barium (4.938 ppm) Cobalt (<2×10^{-6} ppm), Copper (10.45 ppm), Iron(64.73 ppm), Manganese (9.656ppm), Sodium (1.459ppm), Vanadium (5.168ppm), and Zinc (25.19ppm), while the average percentage of Aluminium (988.5ppm), Barium (8.533ppm), Cobalt (<2×10^{-3}ppm), Copper (4.657ppm), Iron (939.56ppm), Manganese (13.2ppm), Sodium (3.377ppm), Vanadium (9.672ppm), and Zinc (9.6722ppm) were determined for the dried fruit pulp.The minerals concentration of the baobab fruit and seeds were characterized with high concentration of potassium, calcium, magnesium [K (17406ppm), Ca (2282ppm) and Mg (1707ppm), for the fruit pulp and K (10995ppm), Ca (1919ppm) and Mg (3212ppm), for the seed]as shown in tables (3.3)(3.4)(3.5).

Isaac Kwasi Baidoo (2016) repoted that: Mineral element compositions of Baobab fruit and seed have been determined using Instrumental Neutron Activation Analysis. Total of 15mineral elements were determined of which 10 are not normally reported using other methods. The concentrations of heavy metals were: Arsenic < 0.06ppm ,< 0.04ppm, Cadmium < 0.08ppm , < 0.04 respectively for the seeds and the fruit. The average concentration of trace elements in the seed were; Aluminium (11.50ppm), Barium (17.3ppm), Cobalt (0.07 ppm), Copper (28.6ppm), Iron (<42ppm), Manganese (17.7ppm), Sodium (23.53ppm), Vanadium (0.035ppm), and Zinc (12.06ppm), while the average percentages of Aluminium

(27.74ppm), Barium (13.10ppm), Cobalt (0.08ppm), Copper (14.9ppm), Iron (26.05ppm), Manganese (7.05ppm), Sodium (52.06ppm), Vanadium (0.08ppm), and Zinc (0.79ppm) were determined for the dried fruit pulp. The minerals content of the baobab fruit and seed were characterized with high concentration of potassium, calcium and magnesium [K (2135ppm), Ca (3170ppm) and Mg (3210ppm), for the fruit pulp and K (12240ppm), Ca (2360ppm) and Mg (4720ppm) for the seed].

Very high content of some toxic elements such as aluminum and silicon due to presence of wedges fungus that increase the absorption of these elements by baobab tree.(farog abdalaziz, 2015)

Table (3.3) Macronutrients contents of baobab

Elements	Concentration in powder (ppm)	Concentration in seeds (ppm)
Na	3.377	1.549
K	17.406	10995
Ca	2282	1919
Mg	1707	3212
P	537.3	4623

Table (3.4) Micronutrients contents of baobab

Elements	Concentration in powder (ppm)	Concentration in seeds (ppm)
Co	$<2x10^{-3}$	$2x10^{-6}$
Cu	4.657	10.45
Fe	939.5	64.37

Mn	13.20	9.656
Mo	<0.0002.77x10^{-4}	2.7x10^{-8}
Ni	5.285	0.8197
Se	<4.993x10^{-3}	0.2799
Zn	9.672	25.19

Table (3.5) Toxic and hazardous elements in baobab

Elements	**Concentration in powder (ppm)**	**Concentration in seeds (ppm)**
Al	988.5	41.18
As	1.339	<2.547x10^{-3}
Ba	8.533	4.938
Be	<3x10^{-5}	<3x10^{-5}
Cd	<2x10^{-3}	<2x10^{-}3
Cr	4.426	<5.83x10^{-4}
Li	<1.279x10^{-3}	<1.279x10^{-3}
Pb	0.3	6.198
Sb	<4.72x10^{-3}	<6.078x10^{-3}
Si	312.7	<1.068x10^{-2}
Sn	0.320	01499
Sr	17.56	7.427
Ti	27.19	<1.47x10^{-4}
V	9.652	5.168

3.3. physical and chemical properties of baobab oil

In this study it was found that physical properties of baobab oil were : density(0.760g/cm3), viscosity(63.032pas.s),refractive index(1.466) as shown in table(3.6) and chemical properties of baobab oil were : peroxide value(1.23mg/g), acid value(5.610mg/g), saponification value(235.62mg/g)and ester value (230.01mg/g) as shown in table(3.7).

Alia Mutasim (2016) reported that physical properties of baobab oil as: density, viscosity, refractive index are 0.748g/cm3,64.597pas.s,1.373 respectivly. and chemical properties of baobab oil are: peroxide value, acid value .saponification value and ester value as 1.72mg/g,5.797mg/g , 406.725mg/g and 400.928mg/g.

Porta(2014) Reported that the pH of baobab oil is 4.3 while in this study it was found that baobab oil's pH is 5.6

High saponification value in baobab oil suggests, that, it could be used for production of soap.

It was found to be the oil percentage in baobab seeds is 10.3%.

Table (3-6) physical properties of baobab oil

Property	**Value**
pH	5.6
Density	0.760 g/cm^3
Viscosity	63.032 pas.s
Refractive Index	1.466.01 at 28.9^o C

Table(3-7) chemical properties of baobab oil

Property	Value
Acid value	5.61mg/g
Saponification value	235.62mg/g
Peroxide value	1.23mg/g
Ester value	230.01mg/g
Vitamin C content	290mg/100 g

3.1.7. GC-MS Charactarization of baobab oil

The results obtained in this study found that there were high percentages of essential fatty acids : palmatic acid (21.14%), linoleic acid(25.10%),oleic acid(17.34%) , stearic acid (7.92%) ,methyl arachisate (1.47%), methyl dihydrosterculate(4.81%) and behenic acid (1.23%), these fatty acids play an important role in modulating human metabolism and reduce cholesterol levels, this suggests that baobab oil may be useful as cooking oil.

Porta(2014)reported that in baobab oil percentage of essential fatty acids : palmatic acid(31.6%), linoleic acid(18.2%),oleic acid(34.3%) , stearic acid (3.5%) and behenic acid (0.5%).

Baobab fruit contain 290 mg/100ml of vitamin C content that are essential for skin care.

Table (3.8) GC-MS Results of baobab oil

Peak Report TIC

Peak#	R.Time	Area	Area%	Name
1	14.274	5846129	0.87	Methyl tetradecanoate
2	15.134	254921	0.04	cis-5-Dodecenoic acid, methyl ester
3	15.244	348581	0.05	5-Octadecenoic acid, methyl ester
4	15.411	1262873	0.19	Pentadecanoic acid, methyl ester
5	16.190	346580	0.05	7,10-Hexadecadienoic acid, methyl ester
6	16.255	937670	0.14	7-Hexadecenoic acid, methyl ester, (Z)-
7	16.299	3543234	0.53	9-Hexadecenoic acid, methyl ester, (Z)-
8	16.568	142576637	21.14	Hexadecanoic acid, methyl ester
9	17.248	6099327	0.90	8,11-Octadecadienoic acid, methyl ester
10	17.301	8251517	1.22	cis-10-Heptadecenoic acid, methyl ester
11	17.530	5066431	0.75	Heptadecanoic acid, methyl ester
12	18.027	45672189	6.77	Methyl 2-octylcyclopropene-1-heptanoate
13	18.352	169303409	25.10	9,12-Octadecadienoic acid (Z,Z)-, methyl e:
14	18.410	116965127	17.34	9-Octadecenoic acid (Z)-, methyl ester
15	18.555	53387207	7.92	Methyl stearate
16	18.981	20538490	3.05	cis-11,14-Eicosadienoic acid, methyl ester
17	19.358	32414614	4.81	Cyclopropaneoctanoic acid, 2-octyl-, methy
18	19.462	574969	0.09	Nonadecanoic acid, methyl ester
19	19.683	1021603	0.15	2-Dodecen-1-yl(-)succinic anhydride
20	19.967	8018324	1.19	Tricyclo[20.8.0.0(7,16)]triacontane, 1(22),7
21	20.025	2450206	0.36	9,12,15-Octadecatrienoic acid, methyl este
22	20.165	9915944	1.47	cis-11-Eicosenoic acid, methyl ester
23	20.371	18713747	2.77	Eicosanoic acid, methyl ester
24	20.749	945947	0.14	Cyclopropanedecanoic acid, 2-octyl-, meth
25	21.138	489193	0.07	13-Docosenoic acid, methyl ester, (Z)-
26	21.233	669034	0.10	Heneicosanoic acid, methyl ester
27	21.892	371289	0.06	cis-10-Nonadecenoic acid, methyl ester
28	22.070	8327628	1.23	Docosanoic acid, methyl ester
29	22.874	1599779	0.24	Tricosanoic acid, methyl ester
30	23.649	5759828	0.85	Tetracosanoic acid, methyl ester
31	24.410	1046587	0.16	Pentacosanoic acid, methyl ester
32	24.455	681394	0.10	Squalene
33	25.235	1062907	0.16	Hexacosanoic acid, methyl ester

Conclusion

The obtained results showed that baobab fruit and seeds have considerable contents of essential minerals that, are, important for human health. Baobab fruit powder contain high content of vitamin (C) .The percentage of baobab seeds oil was 10.3%. According to results obtained by this study ,baobab oil has good quality when compared with edible oils and also have potential for medicinal uses.

Recommendations

More researches on the issue, may be needed to get the maximum amount of baobab oil by extraction from wider range of samples covering different geographic areas.

Different types of solvent may also be needed to show if there is any effect of solvent type on the oil extraction.

More specific chemical and physical analysis may be required to obtain more detailed informations about baobab tree, fruit and seeds.

In Sudan no young baobab trees are observed therefore real agricultural efforts out to be exerted for keeping the growth of new generation of baobab trees.

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