KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI, GHANA

COLLEGE OF AGRICULTURE AND NATURAL RESOURCES

FACULTY OF AGRICULTURE

DEPARTMENT OF HORTICULTURE

ASCERTAINING THE GENERAL USES AND NUTRITIONAL COMPOSITION OF DESERT DATE (*Balanites aegyptiaca*) IDENTIFIED IN THE WEST GONJA DISTRICT OF GHANA

By

MUKAILA SALIA

AUGUST, 2016

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OF DESERT DATE (*Balanites aegyptiaca*) IDENTIFIED IN THE WEST GONJA DISTRICT OF GHANA

A THESIS SUBMITTED TO THE SCHOOL OF RESEARCH AND GRADUATE STUDIES, KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF PHILOSOPHY (POST- HARVEST TECHNOLOGY) DEGREE

BY

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AUGUST, 2016

DECLARATION

I hereby declare that, except for references to other people's work which have been duly acknowledged, this write-up, submitted to the School of Research and Graduate Studies, KNUST, Kumasi is the result of my own original research and that this thesis has not been presented for any degree elsewhere

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DEDICATION

This research is dedicated to God Almighty for giving me the energy and courage and also for seeing me through all my education. It is also dedicated to my lovely wife, Sawude Asumah and my entire family for the patience they had for me while I studied in school.

ACKNOWLEDGEMENT

I give glory to the Almighty Allah for His sufficient grace and strength in my life that enabled me to complete this work. I am also very grateful to my main supervisor, Dr. B.K. Maalekuu, my co-supervisor, Miss P.D. Kaledzi, Dr. Francis Appiah (Head of Department), all in the Department of Horticulture, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi for their guidance, encouragement and scrutiny of my work which ensured that the correct things were done. My special thanks go to Mr. Douglas Amoah of the Faculty of Renewable Natural Resources, KNUST Kumasi for his immense contribution in the analysis of the samples. I equally thank Mr. Ninfaa Augutus Dery a lecturer at the Bolga Polytechnic for scrutinising my work. My final thanks go to all friends who in one way or the other contributed to the success of this work.

ABSTRACT

A study was conducted to identify the general uses and determine the nutritional components of oil nuts, fruit pulp and leaves of *Balanites aegyptiaca*. Information on general uses of the plant (*Balanites aegyptiaca*) was collected through household survey using a semi structured questionnaire. A total of 100 respondents comprising both females and males were interviewed. The results indicated that 60% of respondents use the leaves of the plant for soup, 93% of respondents lick the pulp of the fruits and none of the respondents has ever extracted oil from the nuts. Fresh leaves and dried fruits of Desert date (*Balanites aegyptiaca*) were collected from the study area and their nutritional compositions were determined. The fruits pulp had 15.57% of moisture, 84.43% of dry matter, 8.87% of ash, 0.97% of crude fat, 6.71% of crude protein, 5.19% of crude fiber, 83.45% of carbohydrate, 348.61% of energy, 78.26% of nitrogen free extract and 0.453mg/g of vitamin C. However, the leaves had 61.78% of moisture,

38.21% of dry matter, 8.92% of ash, 1.94% of crude fat, 30.77% of crude protein, 14.22% of crude fiber, 58.37% of carbohydrate, 317.11% of energy, 44.16% of nitrogen free extract and 0.490mg/g of vitamin C. There were significant differences ($p < 0.05$) between the fruits and leaves with respect to nutritional composition except for ash content ($p > 0.05$). 12kg of dried nuts was processed to extract the oil. The percentage of oil extracted from the 12kg of nuts was 44%. Physicochemical properties that were determined from the oil were moisture content (0.15%), free fatty acid such as oleic (1.73%), peroxide value (7.96meq/kg) and vitamin C (52.22mg/g).The experimental design used was completely randomized design (CRD). In conclusion, the leaves and fruits pulp of the desert date plant contain some nutritional components for human consumption. I recommend that, further research should be conducted on the edible oil of the nuts of the plant.

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ACRONYMS

AOCS	(America oil chemistry society)
B.a	(*Balanites aegyptiaca*)
CPC	(Cooperative Patent Classification)
DEAS	(Draft East Africa Standard)
DM	(Dry Matter)
FFA	(Free Fatty Acid)
FNC	(Forest National Corporation)
NFE	(Nitrogen Free Extract)
NRC	(National Research Council)
PV	(Peroxide Value)

RSCU	(Regional Soil Conservation Unit)
VIT. C	(Vitamin C)

CHAPTER ONE

1.0 INTRODUCTION

1.1 BACKGROUND

Long time ago, the culture of gathering wild plants continued in many African communities (Teklehaymanot and Giday, 2010). Many rural communities make good use of wild plants by using them to supplement their diet which is based on rain fed cultivation of staples such as maize, cassava, sorghum, millet and wheat. Different kinds of wild consumable plant species offer a wide range of diet to rural communities.

Furthermore, wild foods are demanded mostly during shortage of food (Harris and Mohammed, 2003). According to Ogoye-Ndegwa and Aagaard-Hansen (2003), leafy vegetables harvested from the wild still form part of the diets in many rural households in Kenya. It is also significant to recognize that today, wild plants and animals form a significant proportion of the world food basket (Bharucha and Pretty, 2010). It is also stated that many people in the rural or urban communities use wild foods in their diet (Bharucha and Pretty, 2010). Many wild edible plants are nutritionally rich (Ogle and Grivetti, 1985) and can support nutritional requirements, especially vitamins and micronutrients. It is worth to know that a good number (Over 500 traditional communities) use about 800 different kinds of plant species for treating different diseases and as it stands, 80 % of the world population rely on plant-derived medicine for the first line of primary health care due to the fact that it has no side effects (Kamboj, 2000). Even though these wild plants play significant role in the lives of people especially in the rural communities, it is worrying to know that these wild resources in general are often neglected and receive little recognition from developing communities (Scoones, Melnyk and Pretty, 1992). There are so many woody plants in the Africa continent, however,

Balanites aegyptiaca is likely to be one of the most wide-spread woody plants of the Africa continent (Sands, 2001). Some of the African countries where the Desert date *(Balanites aegyptiaca)* is grown are Ghana, Gambia, Nigeria,

Togo, Uganda, Chad, Kenya, Mauritania, Cameroon and Niger (Booth and Wicken, 1988). The plant belongs to a family called *Balanitaceae* and it is usually semievergreen with spines, extremely variable shrub or small tree that has the potential of growing up to twelve meters (12m) high (Chapagain and Wiesman, 2005). Research shows that the plant can begin to flower and also bear fruits at the age of 5-7 years and can give maximum seed production if the tree is 15-25years old (Ndoye *et al.*, 2004).In terms of habitat, *Balanites aegyptiaca* can be found in many kinds of habitat, accepting a wide variety of soil types such as sandy soil to heavy clay (Abu-Al-Futuh, 1983). Even though the plant could begin to bear fruits and flowers at the age range of 5-7 years, there is no specific time for flowering in the Sahel, although flowering most likely takes place in the dry season. Flowering in Nigeria varies between November and April with ripe fruits becoming available in December and January and sometimes later, from March to July. Elsewhere, fruiting and foliage production take place at the peak of the dry season (Orwa *et al*., 2009). The flowering time generally occurs during November – April, while the fruiting takes place during December – July (El Amin, 1990; El Ghazali *et al*., 1994; Bein *et al*., 1996). The fruits of the plant are yellow and can bear as many as 10,000 fruits yearly on a mature tree that is in a good environmental condition (Chapagain and Wiesman, 2005). According to Okia (2010), places where the plants are found include in the wild (83%), on-farm (13.7%), on fallow land (2.1%) and around homes (0.7%).

The nuts of *Balanites aegyptiaca* have oil content of 30-60% and protein content of 2030%. The oil is non-smoking cooking grade type (Hall and Walker,1991; Shanks and

Shanks, 1991). The kernel meal is used as livestock feed (Abu-Al-Futuh, 1983). It has herbal medicinal uses (Babagana *et al*., 2011) for treatment of diarrhea, stomach pains, epilepsy, jaundice, yellow fever and syphilis (Ojo *et al*., 2006).

1.2 PROBLEM STATEMENT

In recent times, there is too low in quantity of edible oils and fats in the developing countries of the world and more so in Africa (Sam *et al*., 2008). In order to overcome this challenge, a lot of research is being carried out to discover and exploit new sources of oil bearing crops (Sam *et al.*, 2008).

In developing countries especially in the rural communities most of the people consume various kinds of wild plant products. It is obvious that some of these wild plants products are poisonous to be consumed by human beings. In addition, awareness of economic benefits of these wild plants in the rural communities is limited. This is confirmed by the report of Abbiw (1990), that there is a wide information gap for some plant species, but maintains that only 15% of tropical species have been catalogued and 1% screened for possible benefits to humanity.

Finally, there is a continuous rise in the price of animal feeds which is partly blamed on the over dependence on conventional feedstuff for feed manufacture (Ojewola and Udom, 2005), which has resulted in the continuous rise in the cost of animal products. This is because soya bean and groundnuts which are the usual sources of protein locally in animal feed formulation (Ghadge *et al*.,2009) are also used as food by humans (Singh and Singh, 1991**).**

1.3 JUSTIFICATION

The production of oil seeds is one of the most important agro industries in the world today. Formulation of food, drugs and cosmetics are derived from plants and animals oil (Nimet *et al.*, 2011). These oils act as insulators to the body protective layer or internal organ such as heart and lung, and also serve as a source of energy to the body in absence of carbohydrate. (Ochigbo and Paiko, 2011).

Wild plants such as *Balanites aegyptiaca* contributes greatly in improving the livelihoods of communities. For example, the plant provides materials for utensils, construction, and contributes to improve diets and health, food security, income generation and genetic experimentation (Kumar and Hamal, 2009). If the seeds are well processed could be a cheaper alternative source of protein for animals. Edible parts of wild plants (fruits, flowers, leaves, tubers, inflorescence, roots, rhizome, etc.) are nature's gift to mankind; these are not only delicious and refreshing but also provide vitamins, minerals and proteins (Kumar and Hamal, 2009).

In the light of these, the West Gonja District of Northern Region of Ghana is naturally gifted with these plants. There are a lot of several economic benefits that the people in the area could depend on to improve their lives yet no research has been made to bring to fore the contribution of the various products of the plant in the study area. It is therefore appropriate and timely that this research is being conducted with the hope that the outcome of this study will help to further expand the uses of *Balanites aegyptiaca* through exploitation of new uses in the study area. It is also hoped that the outcome of the research could improve the financial situation of the people in the study area and

Ghana as a whole in the long run.

1.4 GENERAL OBJECTIVE

To determine the nutritive properties of the oil of nuts, fruits pulp and leaves of the Desert date (*balanites aegyptiaca*)

1.4.1 Specific Objectives

1. Identify the general uses of Desert date (*Balanites aegyptiaca*) in the study area 2. Determine the nutritional components of the oil of nuts, fruits pulp and leaves of the desert date (*Balanites aegyptiaca*)

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 DESCRIPTION OF THE PLANT

According to Elfeel, (2010), *Balanites aegyptiaca* (L.) Del. also known as desert date shrub and belongs to the family *Zygophyllaceae (Balanitaceae).* It grows in arid and semi-arid regions to sub-humid savanna (Hall and Walker, 1991; Sands, 2008; NRC,

2008). It has been described as a semi-evergreen small growing to a height of 12 m. The trees produce 10,000 fruits annually when conditions are favourable (Chapagain and Wiesman, 2005).

2.1.1 Fruit and Seed Description

The fruit is usually narrow and has a length between 2.5 to 7 cm and a diameter between 1.5 to 4cm.When the fruits are Immature they initially look green and later become yellow and glabrous when matured. Its pulp is quite bitter but tastes sugary when eaten. The seed is the pyrene (stone), and has a length of 1.5 to 3 cm long; light brown, fibrous, and extremely hard. It covers about 50 to 60% of the fruit. There are 500 to 1 500 dry, clean seeds per kg.(Chothani and Vaghasiya,2011).One could decide to eat the ripe fruit raw or sun-dried it and can be safely stored and sold as desert dates. Its pulp is rich in sugars, vitamins and a range of essential minerals. (Okia, 2008). According to the forest national inventory, Central Sudan alone contains more than 93 million trees (FNC, 1998).

2.1.2 Flowering and Fruiting Habit

Flowers are not easily seen or noticed because they are very tiny; they are also hermaphroditic and pollinated by insects. Seeds are spread by ingestion by birds and animals. When the tree is five or seven years old it begins to produce flowers and fruits, and more of these fruits are produced when the tree is fifteen to twenty five years old. (Chothani and Vaghasiya, 2011)

2.2 DISTRIBUTION AND HABITAT

According to Chothani and Vaghasiya (2011). It is indigenous to all dry lands south of the Sahara, stretching southward to Malawi in the Rift Valley, and to the Arabian Peninsula. It is shade-loving (Chothani and Vaghassiya, 2011). It grows well in open woodland or savanna for natural regeneration. It grows up to 1000 m altitude in areas with mean annual temperature of 20 to 30°C and mean annual rainfall of 250 to 400mm.

2.3 HISTORY OF CULTIVATION

Even though the *Balanites aegyptiaca* is a wide-spread woody plant in Africa and commonly found in the wild, it was cultivated in Egypt for over four thousand years ago. (Bishnu P.C., 2006). It can be propagated from seed but is quicker propagated by stakes (Irvine, 1961). *Balanites* is actively managed and planted in agroforestry and as a boundary marker. Excessive mismanagement and uncontrolled exploitation of *balanites* fruits, combined with low rate of natural regeneration has led to the drastic depletion of this species (Ndoye *et al*., 2004). For example, in Sudan, *Balanites* is greatly affected by mechanized cropping, overgrazing, and selective felling for furniture (Elfeel, 2004). Badi *et al.* (1989) also reported that there is a serious deterioration in the natural regeneration of *Balanites* and hence its disappearance from some parts of its habitat.

2.3.1 Dormancy and pretreatment

Adequate germination of *balanites* seeds are observed without pre-treatment provided they passed through the digestive tract of ruminants animals. Fresh seeds are also not needed to be pre -treated; however, seeds that have been stored for some time will usually need manual scarification to improve germination. There are other methods that can be

adopted to improve germination such as soaking in hot water for 12-18 hours, soaking in cold water for 24 hours at room temperature or boiling for 7-10 minutes and left to cool in the water. (Lars Schmidt *et al*., 2000)

2.3.2 Sowing and germination

Just as other crops have procedures of sowing; the seeds of *balanites* should be sown vertically with the stalk end down. Germination begins in 1-4 weeks if the conditions of the medium in which they are planted are favourable and the seedlings should be allowed in the nursery for about 12 weeks (Lars Schmidt *et al*., 2000)

2.4 SOIL REQUIREMENTS

According to RSCU (1992) *balanites aegyptiaca* can grow on a wide range of soils such as sandy soils, sandy loam, clay soil, black cotton, alluvial, gravelly, and stony soils. However, it prefers valley soils and also noted to tolerate heavy clay soils. (Teel, 1984).

2.5 USES OF THE PLANT PRODUCTS

2.5.1 Food

Literature available indicates that *balanites aegyptiaca* could serve as food in Africa and more so in the developing countries. According to Mohammed *et al.* (2002) many parts of the plant are use as famine food for example, the leaves could be eaten raw or cooked, and the oily seed bitterness could be reduced by boiling so that it could also be eaten, the flowers of the plant are not left out and the fruit could be fermented for alcoholic beverages. The fleshy pulp of the fruit is edible and it contains 64 – 72% carbohydrates, plus crude protein, steroidal saponins, vitamin C, ethanol and other minerals (Abu Al-Futuh, 1983**).** A report by Chikamai *et al.* (2005) and Teklehaimanot *et al.* (2008) stated

that, *balanites aegyptiaca* has hidden potentials and has been described as one of the underutilized and neglected indigenous species in the dry lands of Africa.

2.5.2 Fodder

Balanites aegyptiaca is eaten by livestock. In Burkina Faso, *B. aegyptiaca* contributed up to 38% of the dry-matter intake of goats in the dry season. The kernel meal is used for animal feeding in Senegal, Sudan, Uganda and India. (Grace *et al*., 2007).

2.5.3 Other uses

B.aegyptiaca has medicinal uses and used to treat illnesses including, laxative, diarrhoea, hermorrhoid, stomach aches, jaundice, yellow fever, syphilis and epilepsy (Ojo *et al.*, 2006).It is used as a confectionary (Barley and Croach, 1962). It is an important timber species for carpentering activities because it is hard, durable, worked easily and made into yokes, wooden spoons pestles, mortars, handles, stools and combs

(Grace and Sands, 2007).

2.6 CHARACTERISTICS OF EDIBLE OIL

2.6.1 Peroxide value of edible oil

The freshness of edible oils is determined by its peroxide value. It is worth to note that the lower the peroxide value the fresher the oil. Pressed crude oils have peroxide value (PV) between 5- 20 however, refined oils have peroxide value between 0-1(Swiss hand book of foods, chapter 7, research method 5.2).

In a similar development, the peroxide value according to (Juliet *et al*., 2011) determines the degree of oxidation of oil as well as gives an indication of the level of deterioration of

oils and fats and also stated that rancidity often begins to be noticeable when peroxide value is between 20 and 40meq/kg.

2.6.2 Fatty Acid

The quality of edible oil is not complete if its free fatty acid is not taken into consideration. The lower the free fatty acid, the better the quality of the oil. The acceptable limit for edible oils free fatty acid is ≤10 (Cynthia *et al*., 2012). In similar findings, fatty acids are normally found in the triglyceride form, however, during processing the fatty acids could get hydrolyzed into free fatty acid. The higher the acid value found, the higher the level of free fatty acids which translate into decreased oil quality. Acceptable levels of free fatty acid for all oils samples should be below
0.6mgKOH (AOCS Official, 2003). These findings are supported by Sunmola Afolabi, (2008). According to Sunmola Afolabi, (2008) free fatty acid maximum acceptable level is 4mgKOH/g oil, below which the oil is acceptable for consumption.

2.6.3 Vitamins in some edible oil

Our body doesn't store vitamin C, so we need to consume it every day to get its benefits. A healthy vitamin C intake will provide you with a boost of antioxidants, which, in turn, will preserve your cardiovascular and immune health (Uma oils, 2015). Avocados oil are very nutritious and contain a wide variety of nutrients, including 20 different vitamins (A, B,C,K etc) and minerals(Kris Gunnars, 2014). The avocado oil pressed from the flesh is rich in vitamins A, B, C, and E. It has a digestibility coefficient of 93.8% but has remained too costly to be utilized extensively as salad oil. The amino acid content has

been reported as: palmitic (7%), stearic (1%), oleic (79%), and linoleic (13%) (Morton 1987). Vitamin C is most sensitive to destruction when the commodity is subjected to adverse handling and storage conditions. Losses are enhanced by extended storage, higher temperatures, low relative humidity, physical damage, and chilling in-jury. It is important to know that in general freshly harvested fruits and vegetables contain more vitamin C than those held in storage. (Seung *et al.,* 2000)

2.7 PROXIMATE COMPOSITION OF SOME LEAFY VEGETABLES

2.7.1 Moisture Content

Moisture refers to the presence of water in trace amounts. When the moisture content in vegetables is high, it is an indication of its freshness and faster perishability (Adepoju O.E. and Oyewole O.T, 2008; Emebu and Anyika, 2011). Microorganisms that facilitate spoilage in foods develop well in foods with high moisture contents, therefore reducing the shelf life (Emebu and Anyika, 2011). There is a correlation between moisture content and value of fat. For example vegetables that contain high moisture content show that they have low fat values. For vegetables to be stored for a long time before use, the moisture content has to be reduced to slow or prevent the activities of the autocatalytic enzymes (Ladan *et al*., 1996). Amaranthus cruentus and Corchorus olitorius have been reported to have 86% and 27% moisture content respectively (Mensah *et al*., 2008)

2.7.2 Crude Protein

Crude Proteins are important organic compounds which have high molecular weight found in all living tissues. They are derived from amino acids and may be categorized

based on factors such as solubility and shape. Simple proteins contain only amino acids as building blocks whiles conjugated proteins consist of amino acids but in addition, a non- protein or prosthetic group which may be glycoprotein, lipoprotein, chromoprotein (Abugre, 2011). The leaves of Amaranthus have been noted to have a lower sulphur amino acid protein content but higher in lysine and tryptophane which could complement meals that have high carbohydrate content to provide a more balanced meal (Feine *et al.*, 1979). The World Health organization (WHO) recommends a protein intake of 56g of protein a day for a (75kg) man and 48g for a (64kg) woman. The recommendations of the UK Department of Health and Social Security (DHSS) are slightly higher, at about 68g a day for sedentary or moderately active men, and 54g a day for women.

2.7.3 Dietary Crude Fiber

Dietary fiber contains carbohydrate that cannot be digested and lignin that are extremely important and intact in plants. They include polysaccharides, oligosaccharides and lignin. Fiber is useful in facilitating free bowels, the removal of waste and toxins from the body, preventing them from sitting in the intestine or bowel for too long, which could accumulate and later lead to several diseases (Hunt *et al*., 1980). Fiber has high water-holding capacity which enables it play the role related to formation soft stools (Komal and Kaur, 1992). Mensah *et al*. (2008) reported crude fibre content of Amaranthus cruentus, Cochorus olitorius and Basella rubra as 1.8, 8.5 and 0.6 g/100 g D M respectively.

2.7.4 Crude Fat Content

Fat helps in provision of energy and plays an important role as antioxidants (Anhwange *et al.*, 2004; NAS, 2005). Human adults are expected to get 20 – 35% of their calories/energy from fat. Though the quantity of fat in *Balanites* leaves, flowers and fruits are somehow low (0.3 – 2.7%), this could still be vital as energy supplements during the dry season when alternatives are few. According to Okia *et al.* (2013) the fat content of *Balanites* leaves (2.29%) was higher than that in fruit pulp (0.37%).

2.7.5 Ash Content

Ash shows the mineral content of foods. Higher ash content suggests the presence of high amount of minerals in food. Nnamani *et al.* (2009) reported that low ash content indicates that the mineral content is low for any product. Higher ash content suggests the presence of large group of mineral elements as well as high molecular weight elements (Onot *et al.*, 2007). Adeniyi *et al.* (2012) also reported that the ash content of *Balanites* leaves and flowers was 8.07% while that of the fruit pulp was 6.97%.

2.7.6 Carbohydrates

Carbohydrates refer to polyhydroxy aldehydes or ketones and their specialized and other compounds that produce them on hydrolysis (Abugre, 2011) and are essential food energy provider among the macronutrients, giving between 40 and 80 percent of total energy intake. Carbohydrate also serves as stored forms of energy as glycogen in liver and muscles. It also provides major source of energy and responsible for breaking-down of fatty acids inhibiting ketosis (Hassan *et al.*, 2006).

2.7.7 Dry matter

The internal quality of apples and pears is depended on constituents of their flesh and their concentration. Fruits contain a lot of constituents such as minerals, carbohydrate, proteins, lipids, organic acid, vitamins and phenolic compounds. However, the dominant constituent of fruit is water (Ackermann *et al*., 1992; Colaric *et al*. 2007; Kader, 2002). Once water is not part, these constituents can together be referred to as 'dry matter'. Dry matter can also be explained as the ratio of fruit dry weight to fresh weight and is expressed as a percentage (DW/FW*100). The term dry matter is sometimes used interchangeably with other definitions such as dry matter concentration (Shipley and Vu, 2002).

Approximately 90 % of fruit dry matter is made up of carbohydrates – in soluble and insoluble forms (Suni *et al*., 2000). When a fruit is harvested too early it compromises its final sugar content. In contrast, fruit such as avocados, kiwifruit, apples and pears also store insoluble carbohydrate, primarily as starch, which is hydrolysed into soluble sugars as fruit mature and ripen after harvest. This permits greater efficiency in the accumulation of carbohydrate, as starch is a more compact and osmotically inactive metabolite (Kavakli *et al*., 2000). According to the findings of Okia *et al.* (2013) the dry matter content of leaves of desert date was 98% while that of the fruit pulp was 95%. Dietary study in northern Nigeria by Lockett *et al.* (2000) revealed equally high dry matter content in *B. aegyptiaca* fruits (90.9%). High dry matter content has also been reported in some of the commonly consumed vegetables in rural areas (Dhello *et al*.,

2006).

Table 2.1: Nutrient content of some commercially available fruits (Gopalan *et al.*, 1985)

Fruit	protein(%)	carbo.(%)	fat(%)	fiber(%)	vitamin A(Iu)	vitamin C(mg/100g)
Apple	0.2	13.4	0.5	1.0	-	1
Banana	1.2	27.2	0.3	0.4	78	7
Orange	0.7	10.9	0.2	0.3	1104	30
Papaya	0.6	7.2	0.1	0.8	666	57
Grape	0.5	16.5	0.3	2.9	-	1
Mango	0.6	16.9	0.4	0.7	2743	16
Date (fresh)	1.2	33.8	0.4	3.7	-	- Date
(dried)	2.4	75.8	0.4	3.9	26	3

Table 2.2: Some nutritional components of fresh leaves and fruits pulp of the desert date.

	% composition of leaves	% composition of fruits pulp
Crude protein	17.06	3.85
Crude fat	2.32	1.38
Crude fibre	16.02	8.72
Carbohydrates	30.92	59.53
Moisture	41.41	24.63
Iron	0.05	0.04

Sodium	0.03	0.06
Potassium	0.52	1.11
Ash	8.27	10.63
Nitrogen free extract	14.9	50.81
Total energy	277.02cal/100g	231.02 Cal/100g

Source: Ninfaa, (2011)

However, the findings of Nour *et a*l. (1985) revealed that the nutrient content of *Balanites aegyptiaca* fruits were as follows Protein 4.9%, Carbohydrate 69.9%, Fat 0.1%, Fiber 3.5%, Vitamin A nil, Vitamin C 46(mg/100g), Vitamin B2 0.07(mg/100g) and Energy 300.1(kcal/gm).

2.8. PHYSICOCHEMICAL PROPERTIES OF KERNEL OIL OF DESERT DATE (BALANITES AEGYPTIACA)

According to Manji *et al*. (2013) the seed oil of *Balanites aegyp*tiaca peroxide value (PV), free fatty acid (%FFA) and moisture content was 6.0meq/kg, 0.18mgKOH/g, and (0.27%) respectively. However, the findings of Aliyu *et al.* (2011) indicates that peroxide value of *Balanites aegyptiaca* seed oil was 8.0 meq/Kg, and the moisture content was 8.73% which is little above that of the rapeseed oil (7.5%). Low moisture content is a sign of a reasonable shelf life for the oil; this is because hydrolysis cannot occur in the oil due to little or absence of water. According to Abu-Al Futuh (1983), the kernel oil yield of

Balanites was 45% containing four major fatty acids: Linoleic, oleic, stearic and palmitic; the level of unsaturated fats (65%) was higher than that of saturated (34.4%). The oil remains stable when heated and has a high smoking point, and

therefore its free fatty acid content is low (Orwa *et al*.,2009).

Table 2.3: Physicochemical properties of unrefined shea butter

	Grade 1	Grade 2	Grade 3
	Min. Max	Min. Max	Min .Max
Moisture content (%)	- 0.05	> 0.05 – 0.2	> 0.2 – 2.0
Free fatty acid (%)	- 1.0	> 1.0 – 3.0	> 3.0 – 8.0
Peroxide value (meq/kg)	- 10.0	>10.0 – 15.0	>15.0 – 50.0

Source (Nahm H.S., 2011)

According to Nahm H.S. (2011) the best quality unrefined shea butter of grade 1 can be used by the cosmetic and pharmaceutical industries, and for direct consumption. The shea butter of grade 2 can also serve the needs of food industry for manufacturing confectionary, chocolate, edible oil, and a basis for margarines. The shea butter of grade 3 is recommended to be used in soap-making or further refined for direct consumption (Nahm H.S., 2011).

However, the findings of Frances Omujal (2009), the proximate analysis carried out showed that the shea fruit pulp, crude oil, crude fiber, crude protein, total carbohydrate, vitamin C and caloric value contents ranged between 1.5-3.5%, 10-15%; 3.1-4.2%, 6164%, 85.59-124.86mg/100g and 248-256 Kcal/100g, respectively.

2.9 PHYSICOCHEMICAL PROPERTIES OF GROUNDNUT OIL

According to DEAS, (2013) moisture content of groundnut oil should be 0.2%, maximum acid value of oil should be 0.6mgKOH/g for non-virgin oil and 4mgKOH/g for virgin oil. However, the maximum peroxide value (PV) should be 10meq/g

Table 2.4: Chemical properties of oil extracts from five selected Nigerian seed oils

Plant	% free fatty acid	Peroxide value (meq/kg)
Pentaclethra macrophylla	1.4	2.35
Treculia Africana	4.22	1.75
Persea gratesima	5.77	5.73
Telferia occidentalis	1.98	2.90
Cocus nucifera	4.80	0.39

(Akubugwo I.E., *et al*., 2008)

Table 2.5: Physicochemical properties of some plants oils

Plant	peroxide value (meq/kg)	moisture (%)	free fatty acid (%)

Boabab	10.15	0.20	0.24
Peanut	5.12	1.02	0.9
Turkey vegetable oil	8.50	0.25	0.32
Palm	16.08	0.20	0.53

(Birnin U.A. *et al*., 2011)

2.9.1 Chemical characteristics of Palm oil sold in three (3) markets

The mean free fatty acid (FFA) of these palm oils ranged from 2.67% to 4.20%. While the mean Peroxide value (PV), Iodine value (IV) and moisture content (MC) ranged from 32.4eq/kg to 35.5meq/kg, 0.69 to 1.27 and 0.69% to 1.27% respectively. (Juliet *et al*., 2011)

2.9.2 Some quality guide lines for refined fish oils

According to the findings of Hamm, (2009) free fatty acid (oleic acid) of refined fish oil was < 0.10% and the peroxide value was < 0.1meqO2/kg. However, the findings of Bimbo, (1998) revealed crude fish oil properties as follows, fatty acid (oleic acid) range was 1-7% but usually it is 2-5%, peroxide value range was 3-20 (meq/kg) and moisture and impurities content was also 0.5-1%

2.10 NUTRITION AND HEALTH VALUE OF BALANITES AEGYPTIACA

Nutritionally, *Balanites aegyptiaca* leaves, flowers and fruits are good sources of protein and minerals (K, Mn, Zn and Cu). It contains about 64-72% carbohydrates plus

crude protein, steroidal, saponnins, vitamin C, ethanol and other minerals (Abu-Alhttp://scialert.net/fulltext/?doi=pjbs.2014.1195.1208&org=11 - 56767_anFutuh, 1983).

CHAPTER THREE

3.0 MATERIALS AND METHODS

The experiment was carried out in two phases: a survey and laboratory experiment

3.1 STUDY AREA

The study area (West Gonja District) is located in the Northern Region of Ghana. It lies on longitude 1^0 5^1 and 2^0 58^1 West and Latitude 8^0 32^1 and 10^0 2^1 North. It shares boundaries with Central Gonja District to the south, Bole and Sawla-Tuna-Kalba Districts to the West, Wa East District to the North West, West Mamprusi District to the North and Tolon Kumbungu District to the East.

3.2 EXPERIMENT ONE: SURVEY

Purposive sampling was used to collect data from people who have been using the desert date (*Balanites aegyptiaca*) plant leaves and fruits pulp for different purposes in the Northern region.

Key informants such as farmers (males and females), and others within the community who knew the plant and have used its products were identified. Structured questionnaires were administered.

The multi-stage technique was used for the study. First of all, the District was selected followed by the communities all at random and finally laboratory analysis of the edible parts of the plant was carried out. Communities selected were Larabanga, Busunu, Yipala and Sori number 2. Twenty five questionnaires were administered in each community to collect background information of respondents and the uses of the Desert date plant in general. In all a total of 100 questionnaires were used for the study.

3.3 EXPERIMENT TWO: LABORATORY EXPERIMENTS

3.3.1 Proximate analysis of leaves and fruit pulp of *Balanites aegyptiaca*

Samples of leaves and fruits were collected from the study area during the period of December-January 2014/15 for proximate analysis to assess the percentage composition of some nutrients. The parameters studied on leaves and fruits pulp include percentage of moisture content, percentage of crude protein, percentage of crude fat, percentage of crude fiber, percentage of ash content, percentage of Nitrogen free extract, percentage of energy, percentage of carbohydrate and percentage of vitamin C.

3.3.1.2 Moisture Determination

An amount of 2 g of each fruit pulp and leaf samples were weighed and placed in preweighed moisture can. It was dried to constant weight at 105°C in a drying oven. The moisture content of each sample was determined by the formula**:**

$$\boldsymbol{moisture\ content} = \frac{(\boldsymbol{weight\ of\ fresh\ sample - weight\ dry\ sample})}{\textbf{weight of fresh sample}} \times \mathbf{10}$$

3.3.1.3 Crude Protein (Kjeldahl Method)

Digestion

An amount of 2g of each fruit pulp and leaf samples were weighed and placed into a 500ml long – necked kjeldahl flask and10ml of distilled water was added to moisten the sample. One spatula full of kjeldahl catalyst [mixture of l part Selenium + 10 parts $CuSO_4$ + 100 parts Na_2SO_4] was added. A 20 ml conc. H_2SO_4 was added to digest the sample until the fluid was clear and colourless. The flask was left to cool and the fluid decanted into a 100 ml volumetric flask and distilled water added to make up to the 100ml mark**.**

Distillation

An aliquot of 10ml of digested fluid was transferred by means of pipette into a kjeldahl distillation apparatus. An amount of 90mls of distilled water was added to make it up to 100ml in the distillation flask. A 20ml of 40% NaOH was added and placed in a distillation unit. The distillate was collected (100ml) over 10ml of 4% Boric acid containing three (3) drops of mixed indicator in a 200ml conical flask**.**

Titration

A 100ml of the distillate collected was titrated with 0.1 NHCl till blue colour changes to grey and then suddenly flashes to pink. A blank determination was carried out without the sample.

Calculation

The weight of 2g sample used, the dilution and the aliquot taken for distillation were considered in the crude protein calculation. The weight of the sample used was determined as:

$$\text{Weight of sample used} = \frac{2g \times 10ml}{100ml}$$

$$= 0.2g$$

Thus, the percentage of Nitrogen in the fruit and leaf samples was express as,

$$\% N = \frac{14 \times (A - B) \times N \times 100}{1000 \times 0.2}$$

Where:

A = volume of standard HCl used in the sample titration

B = volume of standard HCl used in the blank titration

N = Normality of standard HCl

% Crude Protein (CP) = Total Nitrogen (N_T) x 6.25(Protein factor)

3.3.1.4 Crude Fat

An amount of 2 g of grounded mass of fruit pulp and leaf samples were weighed into an extraction thimble. The thimble was placed inside the Soxhlet apparatus. A dried preweighed solvent flask was connected beneath the apparatus and 200ml of petroleum ether was added and connected to condenser and extracted for 4 hrs. On completion, the thimble was removed and the ether reclaimed using the apparatus. The removal of ether was completed on a boiling bath and the flask dried at 105°C for 30 min. it was cooled in a desiccator and weighed. The percentage crude fat of each sample was determined as:

$$\text{Crude fat (\% of DM)} = \frac{\text{Weight of fat}}{\text{Weight of Sample}} \times 100$$

3.3.1.5 Crude Fiber

An amount of 2 g of dried, fat-free fruit and leaf samples were transferred into a digestion flask. 200 ml of hot sulphuric acid was added and the digestion flask was placed under a condenser and brought to boiling within 1 min. It was boiled gently for exactly 30 min. It was filtered immediately through a linen cloth and washed with boiling water. The residue was transferred back into the digestion flask and 200 ml of hot sodium hydroxide solution added. It was replaced under the condenser and again brought to boil within 1 min. After boiling for exactly 30 min, it was filtered through porous crucible and washed with boiling water and about 15ml of 95% alcohol. Then it was dried at 105°C until constant weight

obtained, cooled, and weighed. The residue was ashed at 550°C for 30min, cools, and weighed. The weight of fiber was by

difference as:

$$\text{crude fibre} = \%\text{of fat} - \text{free DM}$$

$$= \frac{(\text{Weight of crucible} + \text{dried residue}) - (\text{Weight of crucible} + \text{ashed residue})}{\text{Weight of sample}} \times 100$$

3.3.1.6 Ash Content

An amount of 2 g of fruit and leaf samples were weighed into a dried, tared porcelain dish and then place in a muffle furnace at 550°C for 4hrs. It was cooled in a desiccator and weighed. The total ash content was determined as:

$$\text{Ash} = \frac{weight\ of\ ash}{weight\ of\ sample} \times 100$$

3.3.1.7 Nitrogen-Free Extract (NFE)

Nitrogen-Free Extract (NFE) represents the non-structural carbohydrates such as starches and sugars, and is found by difference. NFE was determined by calculation after the determination of the various components of the proximate analysis using the formula below:

%NFE (on dry matter basis) = 100 – (%CP + %CF + %Ash + %EE)

Where,

NFE = nitrogen free extract

DM = dry matter

EE = ether extract or crude lipid

CP= crude protein

CF = crude fiber

3.3.1.8 Energy

The total energy of the various treatments was also determined by calculation using the values determined for protein, NFE and fat in the formula below:

Energy (Kcal/100g) = (4 x % Protein) + (4 x % NFE) + (9 x % Fat)

The determination of percentage total carbohydrate was carried using the values obtained

3.3.1.9 Carbohydrate

For NFE and crude fiber in the formula below:

% Carbohydrate = % NFE + % Fiber

3.3.1.10 Extraction of vitamin C (Fruit and leaf samples)

An amount 2.5g samples were added to 10ml of distilled water to dissolve it followed by heating in an oven at 50-60^{o}C for 30 minutes and volume top with distilled water to make 100ml after it was allowed to cool. A 1ml volume of 10% trichloroacetic acid (TCA) was added to 0.5ml of the sample to precipitate any protein available and the mixture centrifuged at 3000 rpm for 5 minutes.

Reading of Absorbance and Vitamin C determination

The protein-free supernatant (0.5ml) was mixed with 0.1ml of reaction mixture (2g of dinitrophenyl hydrazine (DNPH), 230mg thiourea and 270 $CUSO_4.5H_2O$ in 100ml of 5M H_2SO_4) and incubated at 37oC for 3 hours. Following the addition of 1.6ml of 65% (v/v) H_2SO_4, the absorbance was measured with a spectrophotometer at 520nm. Serial standards of 5, 10, 25, 50 and 100 mg/L were also prepared from standard ascorbic acid and their absorbance read at 520nm. The vitamin C content of the sample was subsequently calculated using vitamin C standard curve obtained from the serial standards.

3.3.2 Extraction and chemical composition of oil of the nuts of *Balanites aegyptiaca*

3.3.2.1 Procedure for local extraction of oil from nuts of *Balanites aegyptiaca* First of all, well dried nuts were picked from the wild within the study area during the period of December-January 2014/2015. Dried nuts were sorted by removing damaged or inferior nuts which were believed to lower the quality of the oil. After sorting the bad ones, the good ones (nuts) were weighed 12kg.

Second step involved cracking the nuts to obtain seed kernels. Nuts were cracked by hitting with stones and a hammer. Nut cracking was said to be a delicate process and was performed with extra caution to avoid breaking the kernel. The kernels were dried in the sun for two days and weighed 2kg.

The third step involved frying the kernels in a pot on fire for twenty minutes for the colour to change from light yellow to brown. After which, they were allowed to cool for one hour before milling into paste using grinding mil. The paste was weighed 1.8kg.

The last step was oil extraction. Oil was immediately extracted from the kernel powder by pouring hot water gradually onto the paste in a basin while kneading with the hand until such a time that little or no more oil was flowing from the paste into the container in which it was kneaded (Balami *et al*.,2009). The oil was heated to reduce the moisture content and also for other impurities to settle to the bottom of the pot. After which it was allowed to cool for decantation and filtration to further remove other impurities. The oil was weighed 0.8kg and the percentage was determined as follows:

$$\% \text{ of extracted oil} = \frac{\text{weight of extracted oil (kg)}}{\text{weight of paste (kg)}} \times 100$$

3.3.2.2 Determiknation of the chemical composition of the oil of the nuts of *Balanites aegyptiaca.*

The parameters determined for the chemical composition of the oil of nuts of *Balanites aegyptiaca* include percentage of free fatty acid, peroxide value (PV), percentage of moisture content and vitamin C. Thus:

3.3.2.2.1 Determination of Free Fatty Acids (FFA) profile

Desert date nut oil sample of 1g was weighed into a titration vessel. The sample was dissolve into 50 ml of solvent mixture (1:1ethanol and diethyl ether). Phenolphthalein solution (0.2ml) was added and titrated while shaking with 0.1N potassium hydroxide solution until a pink colour persisted for at least 10 seconds. Simultaneously a blank test was carried out without any sample. Free fatty acids of the various samples were determined by the calculation as**:**

Free Fatty Acid % = mL KOH x N x MW (fatty acid) /10 x Wt of sample in gms Where: N=normality of KOH (0.1N), mLKOH =titre value of KOH used,

MW= molucalar weight of fatty acid

Calculations for different components of the free fatty acid values were determined by substituting each of the acid molecular weight in the equation using the following molecular weights:

MW of oleic = 282, MW of palmitic = 256, MW of stearic = 184, MW of linoleic= 280, MW of linolenic = 278

3.3.2.2.2 Determination of Peroxide value

An amount of 3g of desert date nut oil was weighed into a 250ml Erlenmeyer flask. The sample was dissolved with 10ml of chloroform by swirling the solution-sample mixture. Then 15ml of acetic acid and 1ml KI solution were added and the mixture placed in a dark place for 15 minutes. After the 15 minutes period, 30ml of distilled water and 1ml starch solution were added and titrated with 0.01N sodium thiosulfate until blue colour disappeared. A blank determination was carried out without a sample. The peroxide value of the various samples was determined as:

$PV = (V_1 - V_0) \times T \times 1000 / m$ [miliequivalent availableoxygen/kg_{sample}] [meq. / Kg]

Where:

V_1 – volume of thiosulfate solution required to titrate the sample [ml];

V_0 – volume of thiosulfate solution required to titrate the blank determination [ml];

T - titre of the sodium thiosulfate solution [normality]; m – Mass of sample [g]

3.3.2.2.3 Determination of moisture and volatile matter content

Procedure

Weigh in a previously dried and tared dish about 5g of oil or fat which has been thoroughly mixed by stirring. Loosen the lid of the dish and heat in an oven at 105-1 for

1 hour. Remove the dish from the oven and close the lid. Cool in desiccators and weigh. Heat in the oven for a further period of 1 hour, cool and weigh. Repeat this process until change in weight between two successive observations does not exceed 1 mg.

Carry out the determination in duplicate

Moisture and volatile matter = W1 x 100/W

Where

W1= loss in gm of the material on drying

W = weight in gm of the material taken for test

Ref: I.S.I. hand book of food analysis (part XIII)-1984, PAGE 62

3.3.2.2.4 Extraction of vitamin C from oil of *Balanites aegyptiaca*

Oil sample:

A volume of 10ml sample was heated in an oven at 50-60oC for 30 minutes and topped with distilled water to 100ml after it is allowed to cool. A 1ml volume of 10% trichloroacetic acid (TCA) was added to 0.5ml of the sample to precipitate any protein available and the mixture centrifuged at 3000 rpm for 5 minutes.

Reading of Absorbance and Vitamin C determination

The protein-free supernatant (0.5ml) was mixed with 0.1ml of reaction mixture (2g of dinitrophenyl hydrazine (DNPH), 230mg thiourea and 270 CUSO4.5H2O in 100ml of

5M H2SO4) and incubated at 37oC for 3 hours. Following the addition of 1.6ml of 65% (v/v) H2SO4, the absorbance was measured with a spectrophotometer at 520nm. Serial standards of 5, 10, 25, 50 and 100 mg/L were also prepared from standard ascorbic acid and their absorbance read at 520nm. The vitamin C content of the sample was subsequently calculated using vitamin C standard curve obtained from the serial standards.

3.4 EXPERIMENTAL DESIGN AND DATA ANALYSIS

The experimental design used was Completely Randomized Design (CRD). The treatments (leaves, fruit pulp and oil of the nuts of *Balanites aegyptiaca*) were replicated three times. The data obtained from both the survey and laboratory were analyzed using Statistical Package for Social Science (SPSS) version 16

CHAPTER FOUR

4.0 RESULTS

4.1 SURVEY

4.1.1 Background information about Respondents

4.1.1.1 Sex of Respondents

Table 6 shows the sex distribution of the respondents that use *Balanites aegyptiaca* in the west Gonja district of the Northern region of Ghana. The Table indicates that, out of the hundred respondents, forty one (41) are males and fifty nine (59) are females representing 41% and 59% respectively for males and females.

4.1.1.2 Age Distribution of Respondents

Table 6 shows that, percentage of respondents in the age bracket of (30-39) and (40-49) are the same (25%) and higher than the others; followed by age bracket of (20-29) which has 17% of the respondents. The least age bracket (10-19) has 2% of the respondents.

4.1.1.3 Occupation of Respondents

Table 6 indicates that 90 of the respondents are farmers representing 90% while 8 of the respondents are employed by Government representing 8% while 2 are unemployed representing 2%.

4.1.1.4 Marital status of respondents

Table 6 shows the marital status of the respondents. Seventy six (76) of the respondents are married representing 76%, twelve (12) respondents are single representing 12%, three (3) are divorced and nine (9) are widowed representing 3% and 9% respectively.

4.1.1.5 Religious Affiliation of Respondents

Table 6 shows that 39 of the respondents are Christians representing 39% while 69 are Muslims and 1 of the respondents is a traditionalist representing 69% and 1% respectively.

4.1.1.6 Educational Background of the Respondents

Table 6 indicates that, 63 of the respondents are illiterates representing 63%, 1 has non-formal education and 36 have formal education representing 1% and 36% respectively.

Table 4.1: Background information of respondents

	Frequency (*n*)	**Percentage (%)**
Sex of respondents		
Male	41	41.00
Female	59	59.00
Total	**100**	**100**
Age of respondents (years)		
10 – 19	2	2.00
20 – 29	17	17.00
30 – 39	25	25.00
40 – 49	25	25.00
50 – 59	14	14.00
60 – 69	5	5.00
70+	12	12.00
Total	**100**	**100**
Occupation		
Public service (Government)	8	8.00
Farming	90	90.00
Unemployed	2 **100**	2.00
Total		**100**
Marital status		
Married	76	76.00
Single	12	12.00
Divorced	3	3.00
Widowed	9 **100**	9.00
Total		**100**
Religious affiliation		
Christian	39	39.00
Muslim	60	60.00

Traditionalist	1 **100**	1.00
Total		**100**
Educational background		
illiterate	63	63.00
Non-formal education	1	1.00
Middle School	3	3.00
Primary	9	9.00
JHS	17	17.00
SHS	4	4.00
Tertiary	3 **100**	3.00
Total		**100**

4.1.2 Knowledge of the uses of *Balanites aegyptiaca* leaves

Figure 1 shows that out of the hundred respondents, 52 of them do not know the uses of the leaves while 48 of them know the uses of the leaves representing 52% and 48% respectively.

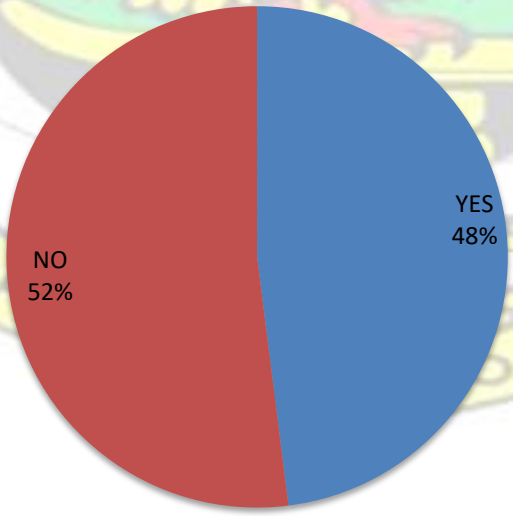

Figure 4.1: Knowledge of the uses of the *Balanites aegyptiaca* leaves.

4.1.3 Uses of the leaves

Figure 2 indicates that 60 of the respondents use the leaves to prepare soup and 40 of them use the leaves for other purposes such as feeding livestock and for medicinal purposes representing 60% and 40% respectively.

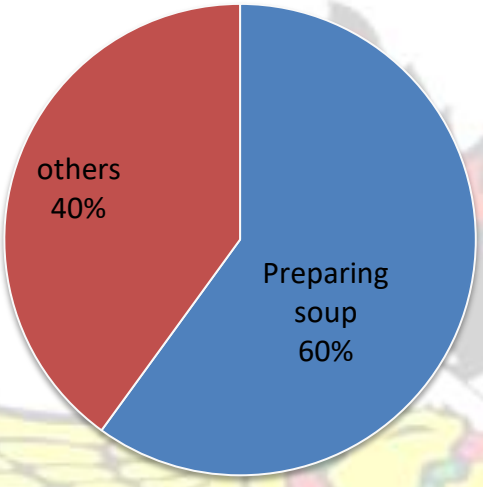

Figure 4.2: Uses of leaves.

4.1.4 Knowledge of the use and Processing of Fruits Pulp

Table 7 shows that 96% of the respondents use the fruits pulp while 4% of them do not know the uses of the fruits pulp. The Table also indicates that 9% of the respondents did process the fruits by drying them in the sun before using while 91% of them use the fruits without processing.

Table 4.2: Knowledge of the use and processing of fruits pulp after harvesting

	YES (%)	NO (%)	Total
Knowledge of the use of plant fruits pulp	96.00	4.00	**100**

The processing of fruits pulp before usage	9.00	91.0	**100**

4.1.5 Uses of the fruits pulp

Table 8 shows that 93 of the respondents lick the pulp of the fruit representing 93% while 2 of them soak the fruits pulp in water and drink as beverages and 5 of them use the fruits pulp for other purposes such as brewing of pito and preparing of porridge representing 2% and 5% respectively.

Table 4.3: Uses of the fruits pulp

	Frequency	Percentage (%)
Lick Pulp	93	93.00
Soak in water and drink	2	2.00
Others (brewing pito)	5	5.00
Total	100	100.00

4.1.6 Usefulness of *Balanites aegyptiaca* Nuts as a source of oil

Table 9 shows that 75 of the respondents representing 75% said the nuts have no oil while 25 of them representing 25% said the nuts have oil. Table 9 also indicates that 100 of the respondents representing 100% have never extracted oil from the nuts.

Table 4.4: Usefulness of the Nuts

	YES (%)	NO (%)	**Total**
Do the nuts have oil	(25.00)	(75.00)	**100**
Have you ever extracted oil from the nuts	(00.00)	(100.00)	**100**

4.1.7 Other uses of the plant besides using it as food

Figure 3 shows that 43% of the respondents use the plant parts as medicine, 32% of them do not use the plant for anything except for food, 12% of them use the plant part for firewood, 8% of them use part of the plant for fencing, 2% of them use part of the plant for charcoal while 3% of the respondents use parts of the plant for hoe handle, roofing and others (pestles and mortars) .

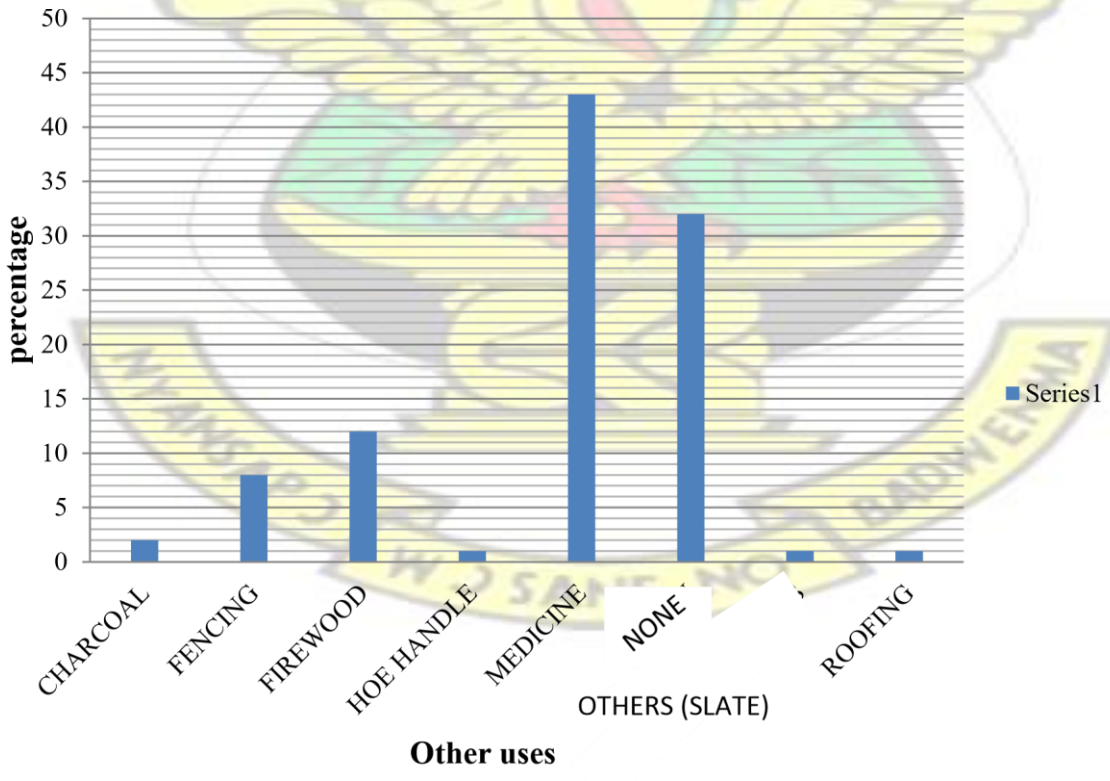

Figure 4.3: Other uses of *Balanites aegyptiaca* besides its usage for food.

4.1.8 Scope of medicinal use of *Balanites aegyptiaca*

Figure 4 Shows that 43% of the respondents use the fresh leaves of the plant to treat general body pains, 20% of them use the bark of the plant to treat fever, 14% of them use the fresh leaves of the plant to treat malaria, 6% of the respondents use the roots and the fresh leaves of the plant to treat crippleness while 9% of the respondents use the fresh leaves and the bark of the plant to treat convulsion, constipation and tooth ache.

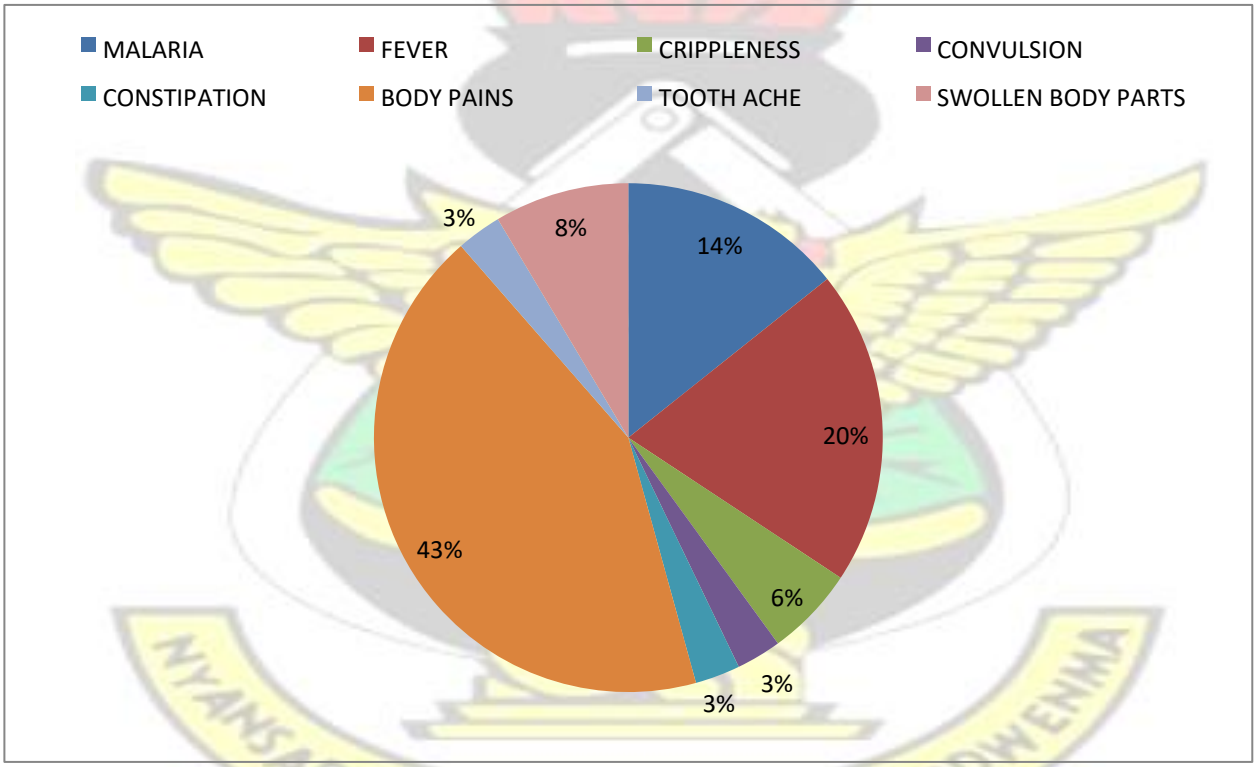

Figure 4.4: Scope of medicinal use of *Balanites aegyptiaca*.

4.1.9 Parts of *Balanites aegyptiaca* that generate income

Figure 5 indicates that 79% of the respondents generate income from the fruits, 18% of them generate income from the trunk and 3% of them generate income from the leaves.

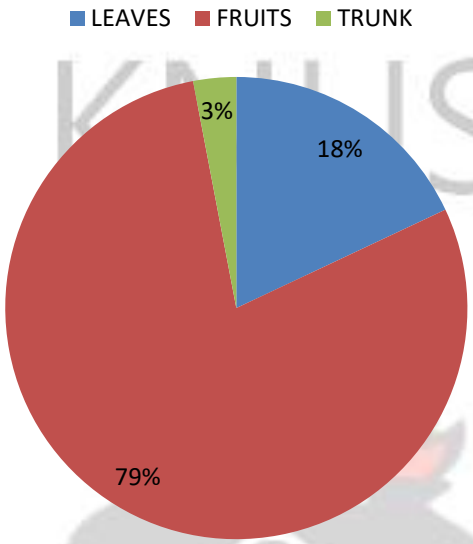

Figure 4.5: Parts of *Balanites aegyptiaca* that generate income

4.2 Laboratory Experiment

4.2.1 Proximate Analysis of leaves and fruits pulp of desert date

The results in Table 12 show that there was significant difference($p<0.05$) in moisture content, dry matter, crude fat, crude protein, nitrogen free, carbohydrate ,vitamin C and in energy between fruit pulp and leaves of *Balanites aegyptiaca*. However, there was no significant difference ($p>0.05$) in ash content between fruit pulp and leaves of *Balanites aegyptiaca*.

Table 4.5: Proximate composition of leaves and fruit pulp of *Balanites aegyptiaca.*

Parameter label	Moisture%	Dry Matter %	Ash%	Crude Fat%	Crude Protein %	Crude Fibre %	Carbohydrate%	Energy %	Vit. C mg/g	Nitrogen Free Extract%
FRUIT pulp	15.57_a	84.43_a	8.87_a	0.97_a	6.71_a	5.19_a	83.45_a	348.61^a	0.453_a	78.26_a
LEAF	61.78_b	38.21_b	8.92_a	1.94_b	30.77_b	14.22_b	58.37_b	317.11^b	0.49_b	44.16_b
p-value	0.000	0.000	0.689	0.000	0.000	0.000	0.000	0.000	0.003	0.000

Values in columns with similar subscripts are not significantly different whiles values with different subscripts are significantly different ($p<0.05$)

4.2.2 Chemical Composition of Oil of *Balanites aegyptiaca* Nut

The moisture content of the oil was (0.15%), free fatty acid (oleic) content was (1.73%), stearic acid content (1.13%), palmitic acid content (1.57%), linoleic acid content (1.72%), linolenic acid content (1.71%), peroxide value was (7.96meq/kg) and vitamin C content was (52.22mg/l).

Table 4.6 Chemical composition of oil of desert date nut

Parameter	value
Moisture	0.15%
FFA (Oleic Acid)	1.73%
FFA (Stearic Acid)	1.13%
FFA (Palmeitic Acid)	1.57%
FFA (Inoleic Acid)	1.72%
FFA (Linolenic Acid)	1.71 %
PV	7.96meq/kg
Vitamin C	52.22 Mg/L

CHAPTER FIVE

5.0 DISCUSSION

5.1 BACKGROUND INFORMATION

With respect to type of sex involved in the research, 59% of the respondents were females while 41% were males. This can be explained in terms of the role females play at home. In the Northern Region of Ghana, more often than not females have to ensure that food is kept on the table for the family to eat. In this regard, the leaves of the plant are available both in the dry and rainy season and can be used as vegetables to prepare soup hence majority of the females in the study area harvest the leaves especially in the dry season to prepare soup for their families. They also pick the ripe fruits in the dry season as they harvest the leaves for their children to lick the pulp.

Age plays a very important role in determining the productivity of agriculture. Both the youth and the elderly are engaged in farming in the study area. The findings revealed that those who were in the age group of 30-49 years dominated with 25%. This age bracket dominate in the agriculture sector. No wonder 90% of the respondents are farmers. Also, (76%) of the respondents are married so they have large families to take care of and for this reason they depend on the plant to supplement their food for their families.

In terms of educational background most of the respondents in the area are illiterate so they have no choice but to take advantage of farming and anything they could rely on to earn a living. This was revealed as the statistics showed that 63% of the respondents were illiterate. It is worth to note that on the educational ladder, the number begins to drop from SHS to tertiary which means that majority of the youth after JHS is engaged on other activities including farming than furthering their education to and this may go a long way to affect production in the agriculture sector in the area since majority of them will not have the technical knowhow to improve on their production.

5.2 USES OF THE LEAVES OF THE PLANT

In the tropics, it is common to find most plants shedding their leaves during the dry season and for this reason, fresh vegetables become scarce especially in the rural areas hence most of the women find it difficult to obtain fresh vegetables to prepare soup for their families. In the light of this, most of the women in the study area take advantage of the availability of *balanites aegyptiaca* leaves in the dry season to prepare soup for their families.

The study revealed that, majority (60%) of the respondents use the leaves to prepare soup. The women in the study area boil the leaves partially and latter cook it with groundnuts paste as soup. However, some of the women mix the cooked leaves with

'koose' for consumption. 'Koose' is a type of fried food made of flour of leguminous crops. This agrees with the findings of Ninfaa (2011), that some people in his study area (Jirapa and Nadowli) in the upper west region of Ghana use the leaves to prepare groundnut soup and also mix the leaves with 'koose' for consumption. In a similar report, Okia *et al.* (2011) stated that *Balanites* leaves are harvested for consumption as vegetable during the dry season (November-March). Furthermore, Mohammed *et al.* (2002) also stated that fruits pulp of the plant is use as famine food. Women and children especially girls harvest the leaves using simple hand tools such as winnower, basket, basin or sack, machetes and sometimes an axe.

5.3 USES OF THE FRUITS PULP

The study revealed that majority (93%) of the respondents lick the pulp of the fruits especially during the dry season. This agrees with a report of Orwa *et al.* (2009) that ripe

fruits become available in December and January and occasionally latter from March to July. The reason why majority of the respondents lick the pulp of the fruit could be attributed to the taste of the pulp. This is supported by a report of Okia *et al.* (2008) that the pulp of the fruit is rich in sugar. However, some of the respondents soak the pulp of the fruit in water and drink as beverages. This also agrees with the findings of Orwa *et al.* (2009) that the fruit can be processed into drink.

5.4 USEFULNESS OF THE NUTS

Even though the study area is naturally endowed with these multi-purpose wild plants, majority of the respondents (75%) were not aware that the nuts of the plant fruits have oil. So after licking the pulp, they throw the nuts away. Even the few who are aware that the nuts have oil, none of the respondents has ever extracted oil from the nuts. This confirmed the report of National Research Council, (2008) that the Desert date (*Balanites aegyptiaca*) is one of the underutilized wild plants in Africa and that its full potentials have not been explored. Even though these wild plants play significant role in the lives of people especially in the rural communities, it is worrying to know that these wild resources in general are often neglected and receive little recognition from developing communities (Scoones *et al.*, 1992).

5.5 OTHER USES OF THE PLANT IN THE STUDY AREA

Other uses of the plant were identified in the study area besides using the fruits and leaves as food. The study revealed that majority (43%) of the respondents use the plant parts as medicine to treat various sicknesses such as malaria, fever, stomach pain, tooth ache and

many others. Mostly, the first point of call for treatment of sickness is the use of herbs within the community. This corresponds with the report of Kamboj (2000), that more than 500 traditional communities use about 800 plant species for curing different diseases and currently 80 % of the world population depends on plant-derived medicine for the first line of primary health care because it has no side effects. In a similar report, Ojo *et al.* (2006) confirmed that *B. aegyptiaca* is a medicinal plant and that is used to treat so many illnesses including, laxative, diarrhoea, hermorrhoid, stomach pain, jaundice, yellow fever, syphilis and epilepsy. Apart from the medicinal benefits, some of the respondents use dried branches of the plant as fire wood. In the rural communities most of the women rely on it for fire wood because they cannot afford to buy charcoal or cooking gas hence they rely on fire wood to prepare food for their families. This agrees with a report by Bishnu (2006), that the wood of the plant burns without smoke. Some of the respondents also use the plant to construct mortars for grinding and hoe handles for farming and other agricultural activities. This also agrees with the report of Bishnu (2006), that in Chad the plant is used in the construction of houses and agricultural equipment. According to Mokhtar *et al*. (2013) *Balanites aegyptiaca* is rich in useful products with multi-uses in rural lives and industry. The research has also indicated that 79% of the respondents in the study area generate income from the fruits of the plant while 18% of the respondents generate income from the leaves of the plant and 3% of them generate income from the trunk of the tree. This is supported by National Research Council of US, that *Balanites aegyptiaca* products could provide raw materials for small and medium-scale enterprises otherwise inconceivable in the dry areas where it grows (NRC, 2008).

5.6 NUTRITIONAL COMPOSITION OF FRUIT PULP AND LEAVE OF

DESERT DATE (*Balanites aegyptiaca*)

5.6.1 Protein content of fruit pulp and leave

There was significant difference ($p > 0.05$) between the fruit pulp and leave in the protein content. The study revealed that the leaves had 30.77% of protein while the fruits pulp had 6.71% of protein. The difference in protein contents between the fruit pulp and leave could be attributed to the fact that the leaves probably contain more amino acid than the fruits pulp and since amino acids are building blocks of protein the leaves should have more protein than the fruits pulp. According to the findings of Ninfaa (2011), the protein content of the desert date leaves was 17.06% while that of the fruit pulp was 3.85%. From Ninfaa (2011) findings, the leaves again had more protein than the fruits pulp. However, in terms of comparison, the protein contents of both the leaves and fruits pulp of the present findings are higher than the protein contents of the leaves and fruits pulp reported by Ninfaa (2011). This could be as a result of locations differences. Basically, from these findings, both the leaves and fruits pulp are good sources of protein; however, the leaves are better source of protein than the fruits pulp.

5.6.2 Carbohydrate contents of leaves and fruits pulp of desert date

There was significant difference ($p > 0.05$) in the content of carbohydrate between the leaves and fruits pulp. The findings indicate that the leaves had 58.37% of carbohydrate while the fruits pulp had 83% of carbohydrate. The findings of Ninfaa (2011) indicate that the carbohydrate content of the fruit was 59.53% while that of the leaves was 30.92%. Even though these figures vary in percentages, it is clear in both findings that the fruits pulp is better source of carbohydrate than the leaves. This could be attributed to the taste

of the pulp of the fruits. This is confirmed by Okia *et al.* (2008) that the pulp of the fruit is rich in sugar than the leaves. In terms of energy, the fruit gives more energy than the leave. According to the present findings, the fruits pulp has 348.61kca/100g while the leaves have 317.11kcal/100g. This high energy level in the fruits could be attributed to the high carbohydrate content in the fruits pulp.

5.6.3 Dry matter contents of fruits pulp and leaves of the desert date

According to Shipley and Vu (2002), dry matter can be defined as the ratio of fruit pulp dry weight (DW) to fresh weight (FW) and is expressed as a percentage (DW/FW X 100). The research revealed that the fruit pulp of the desert date (*Balanites aegyptiaca*) has 84.43% of dry matter while the leaf has 38.21%. These percentages of the dry matter do not entirely conform to the findings of Okia *et al.* (2013) who reported that the dry matter content of desert date fruit was 95% and the leaf dry matter content was 98%. However, the dry matter content of the fruit pulp (84.43%) of the present finding is closer to the finding of Lockett *et al.* (2000) who reported that the dry matter content of desert date fruit pulp was 90.9%. Basically, the desert date tree is a good source of dry matter especially the fruit pulp and this high dry matter content could be attributed to the hardy nature of the tree. This is supported by Okia *et al.* (2013) that high dry matter in *Balanites aegyptiaca* products is not surprising given the hardy nature of the *Balanites aegyptiaca* tree.

5.6.4 Ash content of *Balanites aegyptiaca* leaves and fruits pulp

There was no significant difference ($p < 0.05$) in the ash content between the fruits pulp and leaves of *Balanites aegyptiaca*.

The study indicates that the ash content of the leaves was 8.92% while that of the fruits pulp was 8.87%.These figures almost agree with the findings of Okia et *al.* (2013) who reported that the ash content of the leaves of desert date was 8.07% while that of the fruits pulp was 6.97%. According to a report by Ninfaa (2011), the ash content of desert date leaves was 8.27% while that of the fruits pulp was 10.63% which is quite higher than the 8.87% found in the fruits pulp. This could be as a result of environmental differences in locations.

5.6.5 Crude fat of *Balanites aegyptiaca* fruits pulp and leaves

The study indicates that the fruits of the plant have 0.97% of crude fat while the leaves have 1.94%. According to Okia *et al.* (2013) the fat content of the leaves of desert date was 2.29% while that of the fruits pulp fat was 0.37%. However, Lockett *et al.* (2000) stated that the fat content of the leaves was 3.34% while that of the fruits pulp was 1.34%. The differences of fat contents in these findings could be due to environmental differences in locations and the processes and methods used to determine the crude fat.

5.6.6 Crude fiber of *Balanites aegyptiaca* fruits pulp and leaves

There was a significant difference ($p > 0.05$) in the fiber content between the fruits pulp and the leaves. The findings of the research revealed that the fiber content of the plant leaves was 14.22% while that of the fruit pulp fiber content was 5.19%. However, these findings are closer to the findings of Ninfaa (2011) who also stated that the fiber content of the leaves was 16.02% and that of the fruits pulp was 8.72%. Even though these figures vary in percentages, one could see that the leaves have higher fiber contents than the fruits. The reason could be due to the variations in terms of calories between the fruits and leaves.

The research indicated that the caloric content of the fruits pulp was 348.61kcal/100g while that of the leaves was 317.11kcal/100g. This agrees with the findings of Komal and Kaur (1992), that food containing a high amount of dietary fiber is very low in caloric content.

5.6.7 Vitamin C content of *Balanites aegyptiaca* fruits pulp and leaves

There was a significant difference ($p > 0.05$) in the vitamin C content between the leaves and fruits pulp. The results indicate that the vitamin C content of the leaves was 0.490mg/g while that of the fruits pulp was 0.453mg/g. This significant difference could be attributed to the fact that the leaves were harvested fresh while the fruits were harvested dried. This is confirmed by Seung *et al.* (2000), that generally, freshly harvested fruits and vegetables contain more vitamin C than those held in storage. It is clear from the results that both the leaves and fruits pulp vitamin C content is low as compare to recommended daily intake of 90mg for adult (Bellows and Moore 2012).

This low content of vitamin C in both the fruits pulp and leaves could be due to many factors such as high temperature and physical damage. This is supported by Seung *et al.* (2000) that vitamin C is most sensitive to destruction when the commodity is subjected to adverse handling and storage conditions.

5.7 CHEMICAL COMPOSITION OF THE OIL OF THE NUTS OF DESERT DATE (*Balanites aegyptiaca*)

The research indicates that the quantity of oil extracted manually from 12kg of nuts was 44%. This means that the plant nuts have potential of providing commercial quantity of oil for industrial use. This quantity was closer to the findings of Manji *et al.* (2013) that

the quantity of oil found from nuts of *balanites aegyptiaca* was 49.9%. This suggests that the women who mostly depend on shear nuts in the study area for shear butter in order to generate income can also depend on *balanites aegyptiaca* nuts oil for income.

5.7.1 Moisture content of the oil of nuts of Desert date (*Balanites aegyptiaca*)

The study indicates that the moisture content of the desert date oil was 0.15%. According to the findings of Manji *et al.* (2013) the moisture content of the desert date oil was 0.27%. In both findings, the moisture content of the oil was low. Comparatively, these moisture contents have close link with the moisture content of palm oil founded by Birnin *et al.* (2011) who stated that the moisture content of palm oil was 0.20%. The low moisture content of the oil of the desert date could be due to the hard nature of the nuts. What these figures suggest is that the oil can be stored for a long time before it will begin to go bad. This is supported by Manji *et al.* (2013) that low moisture content is an indication of a reasonable shelf life for the oil, because there is little or no water for the hydrolysis of the oil to take place.

5.7.2 Free Fatty Acid of the Nuts Oil of the Desert date

The study indicates that the free fatty acid (oleic) value of the oil was 1.73%, palmitic acid value was 1.57%, stearic acid value was 1.13%, linoleic acid value was 1.72% and linolenic acid value was 1.71%. According to the findings of Manji *et al*. (2013) free fatty acid of desert date nut oil was 0.18% which is lower than all the values revealed by the research. However, Cynthia *et al*. (2012) stated that free fatty acid value of edible oil should be less than or equal to 10%. In the light of this, all the values (1.73%, 1.57%, 1.13%, and 1.72% and1.71%) are low and fall within the range stated by Cynthia *et al*.

(2012). This is also supported by Orwa *et al*. (2009) that desert date oil remains stable when heated and has a high smoking point, and therefore its free fatty acid content is low. What all these figures mean is that the oil is good for consumption in the study area and even beyond. This agrees with the findings of Mohammed *et al*. (2002) that the kernel contain good quality oil and high protein.

5.7.3 Peroxide value of desert date nuts oil

The research revealed that the peroxide value of the oil was 7.96meq/kg. According to the findings of Aliyu *et al.* (2011) who stated that the peroxide value of desert dates oil was 8.0 meq/kg. In similar findings, Manji *et al.* (2013) stated that the peroxide value of desert date oil was 6.0meq/kg. From these findings, one could see that the peroxide values of all the findings (7.96meq/kg, 8.0meq/kg and 6.0meq/kg) are within a close range. What this means is that the oil of the desert date is good for consumption and can be stored for a long time before it will begin to deteriorate. This is supported by a report by Juliet *et al.* (2011) that rancidity of oil begins when the peroxide value is between 20meq/kg to 40meq/kg.

5.7.4 Vitamin C content of the desert date nuts oil

The results indicated that the vitamin C content of the desert date nut oil was 52.22mg/g. Comparatively, the vitamin C content of the oil (52.22mg/g) is higher than those of the fruits pulp and the leaves (0.453mg/g and 0.490mg/g respectively). Even though vitamin C is water soluble, it can be found in some oils. This is supported by Gunnares (2014), that Avocados oil is very nutritious and contains a wide variety of nutrients, including 20

different vitamins (A, B, C, k etc.) and minerals. In a similar finding, Morton (1987) also stated that avocado oil pressed from the flesh fruit pulp is rich in vitamins A, B, C, and E.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 CONCLUSION

- The Desert date (*Balanites aegyptiaca)* is a multi-purpose plant since the fresh leaves can be used as vegetables, the fruit pulp is edible and the trunk can be used as fire wood. The fruits pulp also serve as beverages if they are soaked in water and allowed to ferment.
- Nutritiously, the leaves had protein content of 30.77%, carbohydrate content of 58.37% and vitamin C content of 0.49meg/g while the fruit pulp had protein content of 6.71%, carbohydrate content of 83.45% and vitamin C content of 0.45meg/g
- The nuts of the Desert date have the potential of providing commercial quantity of oil for industrial uses. The oil is edible and has free fatty acids such as oleic acid of 1.73%, palmitic acid of 1.57%, stearic acid of 1.13%, linoleic acid of 1.72%, linolenic acid of 1.71%, peroxide value of 7.96 meq/kg and vitamin C content of 52.22 Mg/L.

6.2 RECOMMENDATIONS

1. Ministry of food and Agriculture should encourage people to use the leaves as vegetables for soup and also lick the pulp of the *Balanites aegyptiaca*.

2. Research should be conducted on the physico-chemical properties of the desert date oil on different locations to ascertain if the different locations have influence on the oil properties
3. Research should equally be conducted by breeders on how to reduce the age at which the plant fruits in order to encourage farmers to cultivate it.
4. For easy extraction of the oil, postharvest technologists should research on appropriate simple machines that can be designed to crack the fruits, grind the nuts and extract the oil.

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APPENDICES

APPENDIX ONE

A questionnaire designed to help collect information from users of the desert date in the

West Gonja District of Northern Region, Ghana

All information provided will be treated confidentially and objectively as possible

DISTRICT:…….

COMMUNITY:…….

BIODATA OF RESPONDENT

1. Sex of respondent A. Male [ ] B. Female [ ]
2. Age (years)

   A. 10 – 19 [ ] B. 20 – 29 [ ] C. 30 – 39 [ ] D. 40 – 49 [ ]

   E. 50 – 59 [ ] F. 60 – 69 [ ] G. 70 and above [ ]

3. Occupation:……
4. Marital Status A. Married [ ] B. Single [ ] C. Divorced [ ] D. Widowed [ ]
5. Religious background A. Christian [ ] B. Muslim [ ]C. Traditionalist [ ]

D. Others (specify)……..……

6. Educational background A. None [ ] B. Non-formal [ ]

C. Middle school [ ] D. Primary [ ] E. JHS [ ] F. SHS [ ]

G. Tertiary [ ] H. Others (specify)…….

7. Do you know the use(s) of the plant leaves? A. Yes [ ] B. No [ ]
8. If Yes, what do you use the leaves for?

A. For preparing soup [ ] B. fodder C. others (specify)…….

9. How do you process the leaves for what you have mentioned in question 8 above?.....……

……

10. Do you harvest the leaves at all times of the year? A. No [ ] B. Yes [ ]
11. If No, what time of the year do you harvest the leaves?

    A. January – March [ ] B. April – June [ ]

    C. July – September [ ] D. October – December [ ]

12. Why do you harvest the leaves during these months of the year as mentioned in question 11 above?.....

……

……

13. What do you use to harvest the leaves?

A. Cutlass [ ] B. Sticks [ ] C. Others (specify)……

14. Do you preserve the leaves after harvesting?

A. yes [ ] B. No [ ]

15. If yes how do you preserve the leaves?

A. by boiling [ ] B. by drying [ ] C. boiling and drying [ ]

D. others specify ……

16. How long does the leave take to go bad after preserving?

A. 1-2 months [ ] B.2-3 months [ ] C. above 3 months 17. Do you know the use(s) of the plant fruits? A. Yes [ ] B. No [ ]

18. If yes, what do you use the fruits for?

A. lick pulp [ ] B. Soaked in water and drink [ ] C. Others (specify) ……..……..

19. Do you process the fruits before using it for what you have mentioned in question 18 above? A. Yes [ ] B. No [ ]

20. If Yes, how do you process the fruits before using?

.....……

……

21. Do preserve the fruits after harvesting?

A. yes [ ] B. No [ ]

22. If yes how do you preserve the fruits?

A. by boiling [ ] B. by drying [ ] C. by boiling and drying

D. others specify …….

23. How long does the fruit take to go bad after preserving?

A. 1-2 months [ ] B.2-3 months [ ] above 3 months [ ]

24. Do you harvest the fruits at all times of the year? A. Yes [ ] B. No [ ]

25. If No, what time of the year do you harvest the fruits?

A. January – March [ ] B. April – June [ ] C. July – September [ ] D. October – December [ ]

26. At what stage do you harvest the fruits?

A. When they are green [ ] B. when they are yellow [ ]

C. others (specify)……..

27. What do you use to harvest the fruits?

A. cutlass [ ] B. sticks [ ] C. picking it on the ground

D. others (specify)……..

28. Do the nuts of the fruits have oil? A. Yes [ ] B. No [ ]

29. If yes, have you ever extracted oil from the nuts? A. Yes [ ] B. No. [ ]

30. If yes how do you extract the oil?.....

……

……

31. What do you use the oil for? A. for cooking [ ] B. for soap making [ ]

C. for fueling engines [ ] D. others (specify)……..

32. Can you store the oil for a long time? A. Yes [ ] B. No. [ ]

33. If yes how long can you keep the oil? A. 1 – 3months [ ] B. 4 – 7months [ ]

C. 8 – 12months [ ] D. 13month and above [ ]

34. If No, why can't you keep it for long?.....……

……

……

35. Do you have challenges processing the nuts into oil? A. Yes [ ] B. No [ ]

36. If Yes mention them

(i) ……

(ii) ……

(iii) ……

(iv) ……

(v) ……

37. Besides using the fruits, nuts and leaves as food do the plant have other uses?

A. Yes [ ] B. No. [ ]

38. If yes, what are the other uses?

A. firewood [ ] B. Fencing [ ] C. medicine [ ] D. Roofing

E. charcoal [ ] F. hoe handle [ ] G. others (specify)……

39. Which part(s) of the plant do you use for what you have mentioned in question 38 above?

A. the roots [ ] B. leaves [ ] C. trunk [ ] D. bark of the tree [ ]

E. branches [ ] F. Others (specify)……..

40. Is the *Balanites aegyptiaca* a medicinal plant? A. Yes [ ] B. No [ ]

41. If yes mention the sicknesses it can treat?

(i) ……..…

(ii) ……

(iii) ……

(iv) ……

(v) ……

42.Which part(s) of the plant is/are used to treat the sickness mentioned in question 41 above?

A. Leaves [ ] B. Roots [ ] C. others (specify)…..... 43. Do you cultivate the plant? A. Yes [ ] B. No [ ]

44. If yes, which part of it do you use to cultivate?

A. Roots [ ] B. stem [ ] C. Seeds [ ]

D. Other (specify)…….....

45. If Yes which period of the year do you cultivate it? A. Rainy season [ ] B. Dry season [ ]

46. How long does the plant take to mature?

A. 1 – 2years [ ] B. 3 – 5years [ ] C. others (specify)……

47. If No, why don't you cultivate it?

A. waste of time [ ] B. needs more attention [ ]

C. other (specify)……..

48. Do you make income from the plant?

A. yes [ ] B. No [ ]

49. If yes which part(s) of the plant do you make income from?

A. the leaves [ ] B. the fruits [ ] C. the trunk [ ]

D. the leaves, fruits and trunk E. others specify ……

50. If no, why are you not making income from the plant?

A. no readily market [ ] B. difficult to harvest in commercial quantity

C. others specify …….

APPENDIX TWO

Group Statistics

T-TEST GROUPS=CODE ('F' 'L')
/MISSING=ANALYSIS
/VARIABLES=MOISTURE DRYMATTER ASH CRUDEFAT PROTEIN CRUDEFIBER NFE CARBOHYDRATE ENERGY VITC
/CRITERIA= CI (.9500).

Group Statistics

	CODE	N	Mean	Std. Deviation	Std. Error Mean
MOISTURE	F	3	15.5733	.92544	.53430
	L	2	60.6400	1.32936	.94000
DRYMATTER	F	3	84.4267	.92544	.53430
	L	2	39.3600	1.32936	.94000
ASH	F	3	8.8700	.27221	.15716
	L	2	8.9600	.04243	.03000
CRUDEFAT	F	3	.9733	.02517	.01453
	L	2	1.9450	.02121	.01500
PROTEIN	F	3	6.7067	.25403	.14667
	L	2	31.2800	.31113	.22000
CRUDEFIBER	F	3	5.1933	.17474	.10088
	L	2	14.3200	.14142	.10000
NFE	F	3	78.2567	.10116	.05840
	L	2	43.4950	.38891	.27500
CARBOHYDRATE	F	3	83.4500	.18520	.10693
	L	2	57.8150	.24749	.17500

ENERGY	F	3	3.4861E2	.82282	.47506
	L	2	3.1657E2	.55154	.39000
VITC	F	3	.4527	.00351	.00203
	L	2	.4890	.00566	.00400

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
								Std. Error Difference	95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2tailed)	Mean Difference		Lower	Upper
MOISTURE	Equal variances assumed	.740	.453	-45.837	3	.000	-45.06667	.98320	-48.19565	-41.93768
	Equal variances not assumed			-41.681	1.664	.002	-45.06667	1.08124	-50.74706	-39.38627
DRYMATTER	Equal variances assumed	.740	.453	45.837	3	.000	45.06667	.98320	41.93768	48.19565

	Equal variances not assumed			41.681	1.664	.002	45.06667	1.08124	39.38627	50.74706
ASH	Equal variances assumed	2.663	.201	-.441	3	.689	-.09000	.20412	-.73961	.55961

	Equal variances not assumed			-.563	2.143	.627	-.09000	.16000	-.73630	.55630
CRUDEFAT	Equal variances assumed	.087	.787	-44.496	3	.000	-.97167	.02184	-1.04116	-.90217
	Equal variances not assumed			-46.528	2.609	.000	-.97167	.02088	-1.04414	-.89919
PROTEIN	Equal variances assumed	.150	.724	-98.105	3	.000	-24.57333	.25048	-25.37048	-23.77619
	Equal variances not assumed			-92.937	1.899	.000	-24.57333	.26441	-25.77106	-23.37560
CRUDEFIBER	Equal variances assumed	.268	.641	-60.819	3	.000	-9.12667	.15006	-9.60423	-8.64910

	Equal variances not assumed			-64.250	2.682	.000	-9.12667	.14205	-9.61059	-8.64274
NFE	Equal variances assumed	60.395	.004	159.164	3	.000	34.76167	.21840	34.06662	35.45672
	Equal variances not assumed			123.648	1.091	.003	34.76167	.28113	31.82288	37.70046
CARBOHYDRATE	Equal variances assumed	.450	.550	134.978	3	.000	25.63500	.18992	25.03059	26.23941
	Equal variances not assumed			124.999	1.763	.000	25.63500	.20508	24.62870	26.64130
ENERGY	Equal variances assumed	1.315	.335	47.213	3	.000	32.04333	.67870	29.88342	34.20325
	Equal variances not assumed			52.134	2.937	.000	32.04333	.61464	30.06316	34.02350
VITC	Equal variances assumed	1.292	.338	-9.158	3	.003	-.03633	.00397	-.04896	-.02371

	Equal variances not assumed			-8.102	1.529	.031	-.03633	.00448	-.06260	-.01007

APPENDIX THREE

PICTURES OF BALANITES AEGYPTIACA PLANT

APPENDIX FOUR

CRACKING THE FRUITS OF DESERT DATE TO EXTRACT OIL