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Review Article

A Review on Omega-3 and Omega-6 Essential Fatty Acids: Uses, Benefits and their Availability in Pumpkins (*Cucurbita maxima*) Seed and Desert Dates (*Balanites aegyptiaca*) Seed Kernel Oils

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Abstract

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INTRODUCTION

Vegetable oils unlike animal fat contain low amounts of Saturated Fatty Acids (SFA) and high amounts of mono and polyunsaturated **fatty acid**s including the Essential Fatty Acids (EFA): Linoleic acid (n6) and linolenic acid (n3) (Souci *et al*., 2000). The EFAs were known as nutritional factors since 1929 (Holman, 1998). EFAs are needed to build-up healthy cell membrane for development and functioning of the brain and the nervous system, in addition to production of hormone-like substance which regulate body functions as blood viscosity, **blood pressure**, immune and inflammatory responses (Williams, 2000).

The n-3 and n-6 **fatty acid**s are EFA as they cannot be produced within the human body and must come from dietary sources (Williams, 2000). The n-3 **fatty acid**s have positive implication for human health and have been described as the beneficial **fatty acid** (Chow, 1992; Sargent, 1997). Its main sources are fish and fish oil beside the plant sources including soybean oil, canola oil, walnut

and flax seed. While the main sources of n-6 are liquid vegetable oils including soybean oil, corn oil and safflower oil.

The ratio of n3-n6 **fatty acid**s is important for human health, that is why appropriate quantities of both should be considered for human dietary recommendations (Simopoulos, 2000). Current recommendations are to limit intake of fat from animal sources and to use appropriate edible vegetable oils in small amounts (WHO/FAO, 2003). However, body needs an adequate balance of omega 3 and omega 6 with a recommended ratio of 3.5:1 (Simopoulos, 2000).

VEGETABLE OILS

Dietary intakes of fat are important determinants of health, especially cardiovascular health (WHO/FAO, 2003). Saturated **fatty acid**s elevate plasma cholesterol concentration and increase the risk of **coronary heart disease**s, while mono and polyunsaturated **fatty acid**s have the opposite effect (Hu *et al*., 1997). Vegetable oils, of cultivated and wild plant species, are water insoluble, consisting of a mixture of triglycerides of **fatty acid**s and a small amount of other compounds such as sterols and tocopherols which are anti-oxidant with important roles in biological processes (Van der Vossen and Mkamilo, 2007). Most vegetable oils are obtained from seeds, or beans which in addition are a good protein source. At least forty different species of plants and trees, mainly of vegetable origin, have been used for the commercial production of fixed or fatty oils distinct from volatile oils. Hundreds of more species are known to contain reasonable oil quantities (Gunstone, 2002). In order to ensure oils and fats availability, it is suggested to look for new sources (Ziyada and EL-Hussien, 2008).

The promising, unconventional and new sources of oil in the Sudan are the available species of the family *Cucurbitaceae* (endogenous to Africa) (Boswell, 1949). Fatty acid composition of pearl millet seeds from Sudan showed a high linoleic acid (45%) and a linolenic acid (3%) content (Elhardallou and Haemavathy, 2004). *Cucurbita* seeds in Sudan were found to produce a considerable amount of edible oils, an unconventional new source of oil (Ziyada and EL-Hussien, 2008).

Rostami *et al*. (2012) reported that essential oils from aromatic and **medicinal plant**s are characterized by anti-fungal, anti-bacterial, anti-viral and anti-oxida activities. Post harvest apple fruits treatment with essential oil, was found to minimize fruit softening and weight losses (Shirzadeh and Kazemi, 2012).

Classification of vegetable oils: Vegetable oils are classified according to sources, groupings or uses (Fairman, 1992).

Nutritional value of vegetable oils: A balance for good nutrition status of oils depends on variety. Best oils include flaxseed, canola, soya bean, olive oil, pumpkin seeds oil; medium oils include safflower, sunflower, corn, peanut and relatively less nutritive oils include cotton seed, palm kernel and coconut oils (FAO, 1985).

Vegetable oils provide a number of nutrients needed by the human body. In fact, the appropriate amount of fat as a component of daily **food consumption** is subjected to some controversy. Oil is vital in many types of cooking and some fat is required in the diet. The FAO and WHO have listed the main roles of dietary oils as source of energy, essential **fatty acid**s, cell structure and membrane functions. Dietary oils provide means of oil-soluble vitamins and control of blood lipids (Alvarez and Rodriguez, 2009). Mckevith (2005) reported that protein content of oil seeds range from 14-32 g/100 g); carbohydrates from <1 g-to >34 g/100 g). Oil seeds are a good source of food energy as fat provides 9 kcal or 37 kJ g^{-1}). Oilseeds vary widely in their **fatty acid** composition but are relatively rich in Monounsaturated Fatty Acid (MUFA) as peanuts or Polyunsaturated Fatty Acid (PUFA) as sunflower seeds. Some seed oils contain significant amounts of the EFA linoleic and linolenic acids. From these two **fatty acid**s, the body can make the required **fatty acid**s. Arachidonic acid can be produced from linoleic while the long chain n-3 eicosapentaenoic acid (EPA) and docosahaexanoic acid (DHA) (present in fish oils in large quantities) can be made from

linolenic acid.

In addition, whole oil seeds are a source of fiber, phosphorus, iron and magnesium; vitamin E, niacin and folate. Also, whole oil seeds contain phytoestrogens, a group of substances including legnins and flavones. Phytoestrogens have a structure similar to the estrogen hormone, estradiol and can bind to estrogen receptors. Phytoestrogens may provide a protective effect against **coronary heart disease** as they have been shown to have a lowering effect on blood cholesterol, beside vegetable oils are a good source of plant sterol (Goldberg, 2003).

Stevenson *et al*. (2007) reported that vegetable oils are rich sources of Vitamin E, an antioxidant that could protect cells from **free radical**s that could damage them. However (Rinzler, 2009) showed that vegetable oils are low in saturated **fatty acid** high in mono and poly unsaturated **fatty acid**s including the essential **fatty acid**s, linolinec acid (Omega 3) and linoleic acid (Omega 6); polyun saturated **fatty acid**s are a good source of Vitamin E.

The significance of dietary fats and oils is that, they provide the essential **fatty acid**s and a carrier of the four fat-soluble Vitamins A, D, E and K. Inadequate fat results in the deficiency of these vitamins leading to serious metabolic effects followed by manifestations like night blindness, osteoporosis, bleeding from skin and mucus membranes, dry skin, eczema and infant susceptibility to infection (FAO/WHO, 1977).

Nutritional value of Omega-3 and Omega-6: Gunstone and Herslof (2000) reported that (n-6) and (n-3) polyunsaturated **fatty acid**s are essential for life and good health as they cannot be biosynthesized by human, they must be obtained from plant sources as part of the diet. Appropriate levels of omega-3 **fatty acid**s in the diet are also important for healthy pregnancy and proper neonatal growth and development (Lanting *et al*., 1994; Egeland *et al*., 1998; Martinez *et al*., 1998). Omega-3 **fatty acid**s have been suggested or shown to be important in the treatment and prevention of many diseases including elevated **blood pressure**, cholesterol, heart disease, stroke, diabetes, arthritis, depression and some cancers. While, Gurr (1999) indicates that a diet with a high omega-6 and omega-3 ratio is associated with certain disease states and an appropriate balance has implications for future diets and food and also suggests that only two **fatty acid**s linoleic and linolenic are truly essential. The Agency for Healthcare Research and Quality (AHRQ) assessed by research evidence that the benefits of omega-3 **fatty acid**s varied for a variety of disease conditions (MacLean *et al*., 2004). Numerous studies in Alaska have linked omega-3 **fatty acid**s with reductions in heart disease in general and specifically to low incidence of heart disease and other beneficial effects (Bang *et al*., 1976; Bang and Dyerberg, 1980; Dyerberg, 1989; Kris-Etherton *et al*., 2002). While several reports suggest that omega-3 PUFAs decrease the risk of sudden cardiac death following a heart attack (GISSI-Prevenzione Investigators, 1999; Albert *et al*., 2002).

Also a good evidence of health benefit of omega-3 **fatty acid** for a condition such as diabetes was illustrated by Kris-Etherton *et al*. (2002) and heart disease by Li *et al*. (2003).

Innis (2007) stated that n-3 and n-6 **fatty acid**s are essential for embryo development, infant brain development and retina development. In a review of the health benefits ofn-3 **fatty acid** by Ruxton *et al*. (2004), brain development and function were examined. These authors reported that the human nervous system contains a significant quantity of DHA. Animal studies have been conducted to examine the role of DHA in brain development where monkeys offered a diet that was deficient in n-3 (PUFA) had a poor visual acuity and an increased incidence of stereo types, thus suggesting an impaired brain development.

Simopoulos (2000) stated that many incidents of diabetes are associated with an increased production of different chemicals in the body, all of which are increased by a rise in n-6 **fatty acid** intake and decreased by increasing n-3 **fatty acid** intake (either alfa-linolenic acid or EPA and DHA).

Research by Iso *et al*. (2001) reported the possible benefits from increased n-3 **fatty acid** intake in the diet, against the incidence of stroke in human. However, in subsequent studies by Iso *et al*.

(2002), they stated that people with higher linolenic acid levels in their blood had a reduced risk of stroke. Simon *et al*. (1995) linked high serum level of lionlenic acid with a reduced risk of stroke in middle aged men, who had a high risk cardiovascular profile. Therefore omega- 6 **fatty acid**s are considered to be pro inflammatory, whereas the omega-3 **fatty acid**s are considered to be anti-inflammatory (Calder *et al*., 2002).

The tested roots of Zea mays seedlings treated with different lead concentrations, showed an increased amount of unsaturated linoleic and linolenic **fatty acid**s as a tolerance for protecting membrane systems against lead toxicant stress (Heidari *et al*., 2005).

PUMPKIN

Pumpkin (*Cucurbeta maxima*) belongs to the family Cucurbetacea which include pumpkins, gourds, melons and squashes. They are characterized by their seed oil content (Fairman, 1992). The common name pumpkin is an English name derived from the Greek word pep on meaning ripe or cooked in the sun, while in Tshivenda it is named as "fhuri" and "ithanga" in IsiZulu. In Africa, it is called "pampoen" and "lasagna" in SiSwati (Donalson and Bolton, 1986). In Spanish, as named "Semillas de Calabaza". The Sajerska region in northeastern Solvenia and southern Austria has a long tradition of growing pumpkin (Cucurbita pepo) as an oil crop (Bavec *et al*., 2002) (Fig. 1).

Origin, distribution and description

Origin: Pumpkin plant has been grown since the earliest history of mankind (Brucher, 1989). Pumpkins are grown all around the world for a variety of agricultural purposes. The annual species is probably native to Asia but is now naturalized in many of the temperate and warmer areas of the world. Yadegari *et al*. (2012) reported that Pumpkin (*Cucurbita* spp.) has 5 domestic and 10 wild species; the most important species are *Cucurbita moschota*, *Cucurbita pepo* and *Cucurbita maxima*.

Moreover pumpkins are native to North and Central America.

Fig. 1: Pumpkin (*Cucurbita maxima*) seeds. Endogenous cultivar *Cucurbita maxima* (Kadogli) South Kordofan, Sudan)

Currently cultivation of pumpkins occurs throughout the world and commercial producers are the United States, Mexico, India and China. Styrian pumpkin seed oil extracted from seeds of the special Pumpkin variety *Cucurbita pepo* subsp. Styriaca, first emerged in Austria's south-eastern province of Styria. This species belongs to the *Cucurbitaceae* which is a diverse class of plants that consists of at least 119 genera and over 825 species (Andres, 2004). Within this family, there is a large **genetic diversity** both in vegetative and reproductive characteristics. The range of adaptation for *Cucurbita* species includes tropical and subtropical regions, deserts and temperate locations (Whitaker and Davis, 1962).

Distribution: A study on *Cucurbita moschota* seeds cultivated in Egypt showed that *Cucurbita mascota* is more tolerant to harsh environmental conditions than other species (FU *et al*., 2006). Most of pumpkins consumed in Sudan are grown in western Sudan (Hassan *et al*., 1984; El-Tahir,

1991).

Description: The pumpkin plant has large leaves and sprawling vines with coiled, modified leaves called tendrils. The root near the surface, the stem woody square, the flowers bright yellow and the fruit is more fibrous and less sweet than winter squash. Seeds vary significantly in size depending on variety and type (Fruhwirth and Hermetter, 2007). A study in Cameron showed that the cucurbits family has tremendous **genetic diversity**, extending to vegetable and reproductive characteristics (Ng, 1993).

Another study on *Cucurbita maxima* reported that fruits are variable in size, color, shape and weight. They have moderately hard rind with a thick edible flesh below and central seed cavity with numerous seeds. The fruit seeds are plump and tan or soft white, they are all covered with a testa that serves as protectant around the seed (Robinson and Decker-Walters, 1997). Pumpkin seeds have a natural protective coating called the hull. The hulls are edible but can be tough to chew (Casio, 2000).

Pumpkin seeds: Esuoso *et al*., (1998) reported that seeds belonging to cucurbitaceae family are known to be as rich in oil as Soybean, cotton seed or corn. While Lazos (1986) reported that pumpkin seeds are excellent sources in both oil 37.8-45.4% and protein 25.2-37%.

Pumpkin seeds (also known as pepitas) are small, flat, green with white husk although, some varieties produce seeds without them. The production of pumpkin seeds is on increase and production technique requires further research (Bavec, 2000). Pumpkins have considerable variation in nutrient content depending on the cultivation environment and species or part. A study in Korea was run for three major species of pumpkin *Pepo*, *Moschota* and *Maxima*; analyzed for tocopherols, carotenoid and beta sitosterol in the peel, flesh and seed of each pumpkin species. *Maxima* had significantly more carbohydrate, protein, fat and fiber while the **amino acid** arginine and the **moisture content** on all part of the pumpkin were higher on *pepo*. Moreover, the study reported that each pumpkin part contained a significant amount of antioxidant, tocopherol and carotenoids (Kim *et al.*, 2012).

In Egypt, a study on pumpkin (*Cucurbita moschota*) showed that fruit has many nutritional components including pumpkin polysaccharides, active proteins, essential **amino acid**s, carotenoids and minerals (Fokou *et al*., 2004). In addition, pumpkin seeds have high **nutritional value**, providing good quality oil and excellent source of protein (Mahasneh and El-Oqlahm, 1999). Pumpkin seeds are a good source of vitamins mostly the B Vitamins along with C, D, E and K beside zinc magnesium, manganese, phosphorus and phytofsterol. One gram of pumpkin seed protein contains considerable tryptophan. In another study (Casio, 2000) reported that pumpkin seeds are rich in minerals, calories and protein. Also, they are a rich source of iron, zinc and magnesium and contain omega 6 and omega 3 fats and high in fiber.

The **nutritional value** of pumpkin seeds is related to its high protein and oil content. The latter is 40-60% of which oleic acid (upto 40.9%), palmitic (upto 14.5%) and stearic (up to 7.4) with a ratio of mono to polyunsaturated **fatty acid** 0.60 : 0.75 (Murkovic *et al*., 1996; Nakic *et al*., 2006).

A study on twelve pumpkin seed cultivars showed that pumpkin seed oil varies from dark to brown in color to a dark green-red oil that is produced from roasted pumpkin seeds when used for cooking or as salad dressing. The study showed that the oil content is ranging from 10.9-30.9%, the unsaturated **fatty acid** content ranged from 73.1-80.5%. The predominant **fatty acid**s were linoleic, oleic, palmitic and stearic, with low level of linolenic acid. The tocopherol content of the oil ranged from 27.1-75 µg g^{-1} of oil (Stevenson *et al*., 2007). The oil content of the Sajerska region pumpkin seed (*Cucurbita pepo* L.) varies from 40-50% depending on genotype. The oil is dark green and contains free **fatty acid**s, Vitamin E content, especially gamma-tocopherol is very high (Idouraine *et al*., 1996).

A study on two cultivars of Iranian *Cucurbita maxima* pumpkin seed (zaria and gaboor) reported that it is considered to be an important oil crop. In Cameroon, a study on seed cultivated indifferent

bioclimatic regions on five varieties of pumpkin seed showed that the oil content about 50% (Martin, 1998) and 42-57% (Fokou *et al*., 2004). The study reported that most of the oil is made up of unsaturated **fatty acid**s with high amount of essential **fatty acid**s especially linoleic acid 68.5%.

Fokou *et al*. (2009) investigated the **chemical properties** of Cucurbitaceae: *Cucumeropsis mannii*, *Cucurbita maxima, Cucurbita moschata, Lagenaria siceraria* and *Cucumis sativus* seed oils, from different areas in Cameroon. Results showed that these oils have 4 main **fatty acid**s: Linoleic acid, C18:2 (49-69%); oleic acid, C18:1 (9-25%); stearic acid, C18:O (7-11%) and palmitic acid, C16:O (10-19%). The **chemical properties** of these oils are similar to those of corn, cottonseed, sesame and sunflower seed oils, suggesting their potential use as good table and cooking oils which can increase HDL and reduce serum cholesterol and LDL levels, thus participating in prevention of **cardiovascular disease**s.

In a study on the oil of ten pumpkin seed samples (Cucurbita maxima cultivars), the linolenic acid, omega-3, content was found in the range of 0.42-0.21% (Elawad, 2012).

Several studies reported that the **nutritional value** of pumpkin seeds is based on high protein and high energy potential due to high percentage of oil content and 40, 60, 98 and 99% of the oil content is from **fatty acid**s, oleic up to 46.9%, linoleic up to 60.8%, palmatic up to 14.5% and stearic up to 7.4% (Murkovic *et al*., 1996; Nakic *et al*., 2006).

A study on Styrian pumpkin seed oil showed that the high content of linoleic acid is an important nutritional aspect. Linoleic acid is an essential **fatty acid** for humans as it is required for the formation of cellular membranes, Vitamin D and various hormones (Yoshida *et al*., 2004). Also, Murkovic *et al*. (2004) reported that Tocopherols are the major lipophilic antioxidants found in pumpkin seeds oils. The seeds contain considerable amounts of vitamin E derivatives tocopherol and tocotrienol.

The study also reported that pumpkin seeds oil contain various minerals which are potassium, magnesium, calcium and sodium; they were reported to be 183, 105, 27 and 3.6 mg g^{-1} dry seeds, respectively.

Schuster *et al*. (1983) found that, in pumpkin seeds, magnesium, potassium and phosphorus correlated positively with one another and that the concentrations of both potassium and phosphorus depended on the variety and the location. Phytoesterols are compounds found in plant that have a chemical structure very similar to cholesterol and when present in the diet in sufficient amounts are believed to reduce cholesterol levels in blood, enhance the **immune response** and decrease risk of certain cancers. Pumpkin seeds were richest in phytosterols about 265 mg/100 g (Phillips *et al*., 2005). As phytosterols are present in pumpkin seed oils, it can be expected that these components together with the high content of linoleic acid can exert beneficial health effects in lipid-associated disorders like atherosclerosis (Fruhwirth and Hermetter, 2007). Phytosterols content of pumpkin seeds were found to about 1.5-1.9 mg g^{-1} dry seeds while pumpkin seed oil (3.5-4.0 mg g^{-1} oil) (Murkovic *et al*., 2004).

Alfawaz (2004) reported that *Cucurbita maxima* pumpkin seed kernel contained 39.25% **crude protein**, 27.83% crude oil, 4.59% ash and 16.84% crude fiber together with moderate concentrations of P, Mg, and K. The **amino acid**s methionine and tryptophan are limited while arginine, glutamic and aspartic acids were the most plentiful **amino acid**s. The unsaturated **fatty acid** value was 73.0 3% consisting of 18.14% oleic and 52.69% linoleic acid.

Studies indicated that pumpkin seeds provide a wide range of traditional nutrients, the Food Ranking System qualified them as a very good source of minerals such as magnesium, manganese and phosphorus and good source of iron, copper and zinc.

Snack of 32.25 g of pumpkin seeds provide 46.1% Daily Value (DV) for magnesium, 28.7% of the DV for iron, 52.0% of DV for manganese, 24.0% of DV for copper, 17.1% of the DV for zinc and 16.9% of DV for protein (Ensminger *et al*., 1983; Ensminger and Esminger, 1986; Hyun *et al*.,

2004; Jayaprakasam *et al*., 2003).

A recent study by Abd El-Aziz and Abd El-Kalek (2011) on pumpkin seeds placed them as rich in oil and protein and they could potentially become another source of vegetable oil and protein.

Uses and benefits: Fruit and seeds of *Cucurbita* have enormous edible and medicinal uses in the world. These plants have much **fatty acid**s, proteins, Se and Zn (Robinson and Decker-Walters, 1997).

Pumpkin seeds oil is used in cooking due to the nutty taste of the oil with various properties. Pumpkin seed oil is inexpensive when compared to other vegetable oils because of the abundance of seed per fruit and relative ease of growing pumpkin. Pumpkin seed oil and seeds are rich in unsaturated **fatty acid**s especially essential **fatty acid** (Murkovic *et al*., 1996).

Alfawaz (2004), showed that *Cucurbita maxima* is accepted for human consumption. Pumpkin orange flesh is used as soup, jams and pies and the pumpkin seed are used as snack food in many cultures throughout the world. The seeds are especially popular in Arabian countries after salting and roasting (Al-Khalifa, 1996). Moreover, pumpkin seeds have been utilized as additives to some food dishes (Nwokolo and Sim, 1987).

In Korea, pumpkin flesh is consumed in soups and juices or it is incorporated into various foods such as rice cakes, candies and breads. In the United State and Canada, pumpkin is a Halloween and snacks. Pumpkin seeds and pumpkin seed oil are also commonly consumed in some countries (Kim *et al*., 2012).

The healing powers of plants have been used for hundreds of years, about 80% of the available therapeutic substances are originated from **medicinal plant**s (Jones, 1996). Further more, scientists showed that the plants had medicinal properties for their biological activities ranging from antimicrobial to antitumor. The **antimicrobial activity** of plants has many applications including raw and processed food preservation, pharmaceuticals, alternative medicine and natural therapies (Rajakaruna *et al*., 2002; Reynolds, 1996; Reynold *et al*., 2006).

As pumpkin seeds were used frequently in folk medicines, scientists began to conduct research on the oil extracted from them. One study showed that pumpkin seed oil keep hormones from inflecting damage on the cell of the prostate which helps to reduce cancer development. Another study revealed that the seeds contain a significant amount of L-tryptophan which is beneficial in batting depression (although it is believed the seeds do not have enough to treat major depression, they can be used as a preventive measure). Other studies showed that pumpkin seeds can improve bladder and urethra function and can help stopping the formation of kidney stones. Even though the ingredient responsible is unknown, pumpkin seeds have pharmacological activities such as anti-diabetic (Fu *et al*., 2006); antifungal, antibacterial and anti-inflammation activities and antioxidant effect (Wang and Ng, 2003). Native Americans used pumpkin flesh/seeds for food, seeds to treat intestinal infection and various kidney problems and flowers to soothe minor injuries. Although the pulp is employed as food, the principal medicinal properties of the plant are in the seeds (Stuart, 2003). Pumpkins have long been used for traditional medicine in many countries such as China, Argentina, India, Mexico, Brazil and Korea (Stevenson *et al*., 2007).

In Korea, pumpkins have been used traditionally to relieve edema during pregnancy and after delivery. Among the three species in this study, extracts of *Cucurbita maxima* and *Cucurbita moschata* flesh are frequently used as a medicine (Kim *et al*., 2012).

The Iranian study showed that the main nutritionally relevant components of pumpkin seeds are protein and oil. Oil of this plant is very important in many countries. Seeds have essential oil and protein. Non-saturated oils, linoleic acid, â sytosterol and Vitamin E are used in making many medicinal drugs (Yadegari *et al*., 2012). Seeds of this plant are used for parasitic diseases cure in African countries (Younis *et al*., 2000).

Styrian oil pumpkin seed extracts are considered important phyto-therapeutical agents for the

treatment of Benign Prostate Hyperplasia (BPH) and have been used in the treatment of symptomatic micronutrition disorders (Sultan *et al*., 1984; Carilla *et al*., 1984). Mahasneh and El-Oqlah (1999) reported that in the traditional medicine in North America and Mexico, pumpkin seeds have been used as an anthelmintic agent and for supportive treatment in functional disorders of the bladder. Moreover, the constituents in pumpkin seed extract have reduced bladder pressure in rabbits (Zhang *et al*., 1994). Currently, pumpkin seed oil is not widely used commercially even though it has characteristics that are well suited for industrial application and contribute to healthy human diet. Pumpkinseed oil is, however, sold in most reputable health stores in the United States typically formulated in capsules containing 1 g of oil.

The critical health benefit attributed to pumpkin seed oil is preventing the growth and reducing the size of the prostate (Tsai *et al*., 2006; Gossell-Williams *et al*., 2006). There is an evidence that suggests pumpkin seed oil can retard the progression of hypertension (Al-Zuhair *et al*., 2000) and mitigate hypercholesterolemia (Al-Zuhair *et al*., 1997) and arthritis (Fahim *et al*., 1995). Reduced bladder and uraethal pressure and improved bladder compliance have been linked to pumpkin seed lipid component (Zhang *et al*., 1994; Suphakarn *et al*., 1987). Pumpkin seed oil has been found to alleviate diabetes by promoting hypoglucemic activity (Fu *et al*., 2006). Pumpkin seed oil has been found to provide a significant source of Vitamins E tocopherol (Imaeda *et al*., 1999).

Diets high in pumpkin seed have also been associated with lower levels of gastric, breast, lung and colorectal cancer (Huang *et al*., 2004). There are also potential health benefits to be gained from the various carotenoid pigments found in pumpkin seed oil (Matus *et al*., 1993) and carotenoid from all sources of pumpkins fruit have been linked to prevention of prostate cancer (Jian *et al*., 2005). Despite the aforementioned health benefits, pumpkin seed oil has been shown to exhibit **antimicrobial activity** (Hammer *et al*., 1999) In a multi-center controlled study, involving more than two thousand subjects, a product containing pumpkin seeds were evaluated for the treatment of Benign Prostate Hyperplasia (BPH). The results indicated that not only were pumpkin seeds effective in reducing symptoms associated with BPH, especially in its early stages but also no side effects of note were reported by the patients involved in the trial (Friederich *et al*., 2000).

In a Swedish study involving 53 patients, pumpkin seed reduced symptoms related to BPH without any side effects (Carbin *et al*., 1990). Other clinical trials also show that pumpkin seeds along with pumpkin plant have been used in the traditional medicine of many countries including India and Mexico for many years principally to eliminate tapeworms.

Pumpkin seed oil has shown to possess strong antioxidant properties in animal experiments (Fahim *et al*., 1995). The anti-oxidant properties of tocopherols could play a significant role in the therapeutic effects of pumpkin seed oil. Roasted pumpkin seed oil was containing higher levels of roasted alpha and gamma tocopherol than roasted sunflower oil (Jakovljevic *et al*., 1995). The constituents in pumpkin seed extracts have reduced bladder pressure in rabbits (Zhang *et al*., 1994). Clinical research in Thailand has shown that pumpkin seeds increase the level of inhibitors of crystal formation or aggregation that reduce the risk of bladder stone disease (urolithiasis) (Suphiphat *et al*., 1993; Suphakarn *et al*., 1987). The seed oil is used for salad dressings but also has uses in pharmacology and alternative medicine (Wagner, 2000).

The study of Styrian pumpkin seed oil reported that the seeds of the Styrian oil pumpkin contain considerable amounts of D7-phytosterols either in free form or bound to sugar molecules. A lipid-steroidal extract of hull-less seeds was also found to have an inhibitory effect on 5a-reductase in cultured human prostate fibroblasts (Sultan *et al*., 1984; Carilla *et al*., 1984). Furthermore, the same authors reported on an anti-inflammatory effect of this extract in carrageenan-or dextran-induced edema models.

Schilcher *et al*. (1987) reported that orally administered D7-phytosterol-rich Cucurbita pepo subsp. Pepo seeds (3-4 days before prostatectomy) decreased the amount of dihydrotestosterone in prostate tissue of patients. In addition, the same authors detected D7-phytosterols in the prostate tissue of these patients. In castrated rats, a lipid-steroidal extract antagonized testosterone-induced prostate

development in a dose-dependent manner has also been used to treat learning disorders and general recommended in some countries as a brain food. Zimmerman (1997) reported that the seeds and the oil of pumpkin have been claimed to promote HIV/AIDS wellness while the lignin and phytosterol such as delta 7-sterol and delta 5-sterol are of special interest (Nakic *et al*., 2006). Antioxidative compound such as Vitamins E especially gamma-tocopherol are also high in fresh dried seeds. Concentration of alpha-tocopherol is 37.5 microgram/g and gamma-tocopherol is 383 microgram-/g (Murkovic *et al*., 2004). Pumpkin seed oil has shown to possess strong antioxidant properties in animal experiment (Fahim *et al*., 1995).

Pumpkin seed oil is typically highly unsaturated oil with predominance of oleic and linoleic acids. It contains very low level of linolenic acids and highly unsaturated **fatty acid**s which provide high oxidative stability for storage or industrial purposes and production of low **free radical** human diets (Stevenson *et al*., 2007). The highly unsaturated **fatty acid** composition of pumpkin seeds oil make it well-suited for improving nutritional benefits from food. Pumpkin seed oil has been implicated in providing many health benefits (Fu *et al*., 2006).

DESERT DATES, HEGLIG (*BALANITES AEGYPTIACA*) KERNEL OIL

Balanites aegyptiaca belongs to the family Zygophyllaceae (Balanitaceae). It has many common names. In English, the fruit has been called desert date, in Arabic it is known as “heglieg” and “laloub” (Elfeel, 2010). Orwa *et al*. (2009) reported that *Balanites aegyptiaca* in Amharic is named “kudkuda”, “jemo”, “bedeno” and in Arabic the tree is named “zachun”, “zaccone”, “heglig” and the fruit is called “zacon”, “kuge”, “lalob” while in Bengali it is named “Hin” and the English name “soap”, “berry”. The Egyptians named the tree “lalob” and “heglig”. The French names, “myrobalou de”, “Egypte”, “dattier sauvage”, “dattier du desert”. In India, it is called “engua”, “ingudi”, “betu”, “hingan”, “hingn”, “hingot”, “hongot”, “hingota”. The Swahili name is “mjunju” and “mwambangoma” while “adua” and “tanni” in Nigeria. In the Sudan, the tree is called “heglig” (Elhardallou, 2011). The trade name of the fruit is zaccone, zachun, desert date and dried fruit (Hardman and Sofowora, 1972) (Fig. 2).

Description and distribution: *Balanites aegyptiaca* (L.) Del. belongs to the family Balanitaceae. It is a multibranches, evergreen tree distributed throughout the drier parts of India (Anonymous, 1986). It is widely grown in the Sudano-Sahielian region of Africa, the Middle East and South Asia (Yadav and Panghal, 2010; Sands, 2001; Hall and Walker, 1991; Shanks, 1991).

Fig. 2: Desert date (*Balanites aegyptiaca*) seed kernel. Endogenous trees (*Balanites aegyptiaca*), Blue Nile state, Sudan

It is also found in Arabian Peninsula, India, Iran and Pakistan (Arbonnier, 2004). Elfeel *et al*. (2009) reported that *Balanites aegyptiaca* is a deep rooted arid zone tree with a very wide natural range. The tree is valued for its fruits and seeds. The seed kernel is rich in oil, protein, minerals and edible

as snacks after boiling. The tree is widely distributed all over the world such as tropical, Africa, Sudan, Egypt, Morocco and Algeria, Arabian Peninsula and Latin America, showing a wide ecological distribution.

Balanites aegyptiaca is a multi-branched, spiny shrub or tree which grows up to 10 m in height. The leaves are alternate, two foliate, petioles are 3-6 mm long, leaflets are elliptic and have broadly pointed petioles up to 5 mm long. The spines of the plant are simple, straight, stout, rigid, green, alternate, supra-axilary, up to 5 cm long. Inflorescence is supra-axilary clusters or rarely supra-cemose. The flowers are small, bisexual, greenish white, fragrant in axillary clusters, few or many in number, cymes or fascicles. The sepals are five in number (free), ovate and 3 mm long. The petals are five in number (two free), oblong-obovate and longer than the sepals. The stamens are ten in number, filaments glabrous and anthers are dorsi-fixed. The ovary is ovoid, silky, five-celled and ovules are solitary in each cell, the style is short and conical. Fruit is an ovoid drupe, 2-5.6 cm long, found on a short thick stalk and is faintly 5 grooved. The ripe fruit is brown or pale brown with a brittle coat enclosing a brown or brown-green sticky pulp and a hard stone seed (Yadav and Panghal, 2010).

***Balanites aegyptiaca* in Sudan:** In Sudan, this plant is found in all the regions of the country in *wadis* (sandy lands) and river banks. Its fruits in Sudan are called Lalob rather long narrow drupe 2.5-7 cm long, 1.5-4 cm diameter. Young fruits are green then become yellow or cream color when mature. The seeds are extremely hard, each is 1.5-3 cm long, light brown. It makes upto 50-60% of the fruit. In Sudan, it is the species with widest natural range, occuring in all zones except in very high altitudinal areas or at rain fall exceeding 1100 mm/annum (Badi *et al*., 1989). It makes up one third of the total tree population in central region of Sudan (NRC, 2008).

Nutrition and health value of *Balanites aegyptiaca*: Nutritionally, *Balanites aegyptiaca* leaves, flowers and fruits are a 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-Al-Futuh, 1983).

Balanites aegyptiaca seed kernel is considered as an oil source. The fleshy plump of the fruit can be extremely useful edible product. It contains good quality oil and high protein content. The kernel oil yield was 45% containing four major **fatty acid**s: Linoleic, oleic, stearic and palmitic; the level of unsaturated fats (65%) was higher than that of saturated (34.4%) (Abu-Al-Futuh, 1983).

A study investigated the fixed oil composition of *Balanites aegyptiaca*. The Results showed remarkable biological activity of fixed oil and proved its importance as natural bioactive source. Three major **fatty acid**s in *Balanite aegyptiaca* oil are unsaturated linoliec acid (C18:2) (75.86%), saturated palmitic acid (C16:0) (14.73%) and stearic acid (C18:0) (9.40%). The overall oil sample contained saturated and unsaturated acids of 24.13-75.86%, respectively (Nour *et al*., 1985). Studies conducted on some parts of the plant indicated the presence of many flavanoids, saponins and other important phytochemicals (Maksoud and El Hadidi, 1988). The alcoholic extract of the pulp and kernel contained sterols, terpenes and saponins as predominant compounds whereas tanins, alkaloids and resins were found in slightly small amounts (Abdel-Rahim *et al*., 1986). A study on two samples of *Balanites aegyptiaca* fruit collected from different regions of Sudan showed that the edible mesocarp contained 1.2-1.5% protein, 35-37% sugars of which 81.3-91.1% are reducing sugars. The kernel contains 45-46% oil of which palmitic, stearic, oleic and linoleic acids were the main **fatty acid**s. The ratio of saturated to unsaturated **fatty acid**s 10:26 in two samples (Nour *et al*., 1985).

An investigation conducted to evaluate the toxicity of *Balanites aegyptiaca* seed oil on rats did not show any toxicological concern but should be used with caution having indicated subtle hepatotoxics effects in the treated group (Obidah *et al*., 2009).

According to Elfeel (2010) findings, a very high significant variation in all seed kernel chemical contents analyzed among and within locations; the oil content ranges from 50-20% while protein

varied from 37-27%. In comparison, appreciable amount of linolenic acid was detected in the seed oil of ***Moringa oleifera*** (Obeid and Khairi, 2012).

Uses of *Balanites aegyptiaca*: *Balanites aegyptiaca* is a perennial tropical plant used in food preparations and herbal medicine especially in Africa and some **developing countries**. It had been used over thousands of years for multiplicity of uses and almost every part of the plant is useful including leaves, thorns, bark, root and fruit. However, its traditional roles and values were well known for thousands of years as fruits and found in tombs of the 12th Egyptian dynasty (Von Maydell, 1986). In Sudan, the bark is used as a traditional body purgative factor (Elhardallou, 2011).

Balanites aegyptiaca seed kernel is considered as an extremely useful edible product. It contains good quality oil and high protein content (Mohamed *et al*., 2002; Abu-Al-Futuh, 1983).

The de-bittered kernel is used as snacks (nuts) by humans. The extracted oil used for many purposes and the remaining cake is used as animal feed (Nour *et al*., 1985). Furthermore, both fruits and kernel were widely used in many countries during the dry season and drought periods including Nigeria (Lockett *et al*., 2000), Ethiopia (Guinand and Lemessa, 2001) and Sudan (Grosskinsky and Gullick, 2001). The seed kernel contains high amount of oil and protein that varies among different sources (Elfeel, 2010). The oil is very similar to sesame and groundnuts oils in quality and quantity (Abu-Al-Futuh, 1983) and has no any serious safety concern (Obidah *et al*., 2009). A study in Nigeria showed that *Balanites aegyptiaca* seed oil has been used as ingredient and substitute to groundnut oil in the preparation of local foods. The study attempted to evaluate the toxicity of the oil after dietary exposure in rats for four weeks. The results showed that dietary exposure of crude *Balanites aegyptiaca* seed kernel oil in rats did not result in marked changes in assayed toxicological parameters. Thus, consumption of the crude oil at the present level of exposure may be of no serious safety concern, especially on liver and kidney injury. Also the study reported that oil is used for frying food and adding flavor to the food. It was also used to add flavor to tea (Obidah *et al*., 2009).

All parts of the tree have medicinal uses including fruits, seeds, barks and roots. The most important is steroidal saponins which yield diosgenin, a source of steroidal drugs such as corticosteriods, contraceptives and sex hormones (FAO, 1985; Farid *et al*., 2002). Traditionally, various parts of *B. aegyptiaca* have been reported to possess medicinal properties in different ethnobotanical surveys (Ojo *et al*., 2006; Hamid *et al*., 2001; Neuwinger, 2004; Bukar *et al*., 2004). It finds its place in the Ayurvedic pharmacopoeia of India and has also been described in some monographs but none have described the complete traditional uses, phytochemistry and pharmacology of this plant (Yadav and Panghal, 2010).

Orwa *et al*. (2009) showed that the roots of *Balanites aegyptiaca* boiled in soup are used against oedema and stomach pains. Beside they are used as an emetic; bark infusion is used to treat heartburn. The wood gum mixed with maize meal porridge is used to treat chest pains. The bark is used to deworm cattle in Rajasthan. Beit-Yannai *et al*. (2011), Farid *et al*. (2002) and FAO (1985) reported that the most important parts are fruit pulp and kernel that contain saponin which have wide industrial and medicinal values.

Balanites aegyptiaca is used to treat many illnesses including, laxative, diarrhea hermorrhoid, stomach aches, jaundice, yellow fever, syphilis and epilepsy (Ojo *et al*., 2006) and has anticancer activities (Al Ashaal *et al*., 2010). For instance, the fruit is used to treat liver disease and as a purgative and sucked by schools children as a confectionary in some countries (Barley, 1962; Croach, 1962). The bark is used in the treatment of syphilis, round worm infections and as a fish poison. The aqueous leaf extract and saponins isolated from its kernel cakes have anti-bacterial activity (Bashir *et al*., 1984; Doughari *et al*., 2007) and potent larvicidal activity (Zarroug *et al*., 1988), respectively. In Nigeria, a study reported that the seed oil obtained from *Balanites aegyptiaca* has been used for treatment of skin disease and rheumatism (Obidah *et al*., 2009). Also, it can be used for biodiesel production (Chapagain *et al*., 2009). Recent studies showed that the

kernels of *Balanites aegyptiaca* are good source of oil which can be used as a diesel substitute. In these studies, the oil yield was 34.52%; three **fatty acid**s: Palmitic, Linoliec and Stearic acid with 14.73, 75.86 and 9.40%, respectively. The oil exhibited good physical and **chemical properties** which can be used in biodiesel production as the fuel properties were within ASTM 6751 standard specifications (Gutti *et al*., 2012). The seeds are used for rosary beads, necklaces and in the game of *Warri* played in Sudan. In Tigray region of Ethiopia. *Balanites aegyptiaca* tree is preferred by farmers for fuel wood, provision of shade, fodder and as a **medicinal plant** (Kindeya, 2004). An emulsion made from the fruit or bark is lethal to the freshwater snails that are the host of *miracidia* and *cercaria* stages of bilharsia, in addition to a water flea that acts as a host to the guinea worm (Khiri, 1985).

References

Abd El-Aziz, A.B. and H.H. Abd El-Kalek, 2011. Antimicrobial proteins and oil seeds from pumpkin (*Cucurbita moschata*). Nat. Sci., 9: 105-119.
Direct Link |

Abdel-Rahim, E.A., S.S. El-Sandany and M.M. Wasif, 1986. Biochemical dynamics of the hypocholestrolemic action of *B. aegyptiaca* fruit. Food Chem., 20: 69-87.

Abu-Al-Futuh, I.M., 1983. *Balanites aegyptiaca*: An unutilized raw material potential ready for agroindustrial exploitation. UNIDO Document No. 12419, Project TF/INT/77/021,UNIDO of the United Nations.

Al Ashaal, H.A., A.A. Farghaly, M.M. Abd El Aziz and M.A. Ali, 2010. Phytochemical investigation and medicinal evaluation of fixed oil of *Balanites aegyptiaca* fruits (Balantiaceae). J. Ethnopharmacol., 127: 495-501.
CrossRef | Direct Link |

Al-Khalifa, A.S., 1996. Physicochemical characteristics, fatty acid composition and lipoxygenase activity of crude pumpkin and melon seed oils. J. Agric. Food Chem., 44: 964-966.
CrossRef | Direct Link |

Al-Zuhair, H., A.A.A. El-Fattah and H.A.A. El-Latif, 1997. Efficacy of simvastatin and pumpkin-seed oil in the management of dietary-induced hypercholesterolemia. Pharmacol. Res., 35: 403-408.
CrossRef | PubMed | Direct Link |

Al-Zuhair, H., A.A.A. El-Fattah, M.I. El-Sayed, 2000. Pumpkin-seed oil modulates the effect of felodipine and captopril in spontaneously hypertensive rats. Pharmacol. Res., 41: 555-563.
CrossRef | Direct Link |

Albert, C.M., H. Campos, M.J. Stampfer, P.M. Ridker, J.E. Manson, W.C. Willett and J. Ma, 2002. Blood levels of long-chain n-3 fatty acids and the risk of sudden death. N. Engl. J. Med., 346: 1113-1118.
CrossRef | Direct Link |

Alfawaz, M.A., 2004. Chemical composition and oil characteristics of pumpkin (*Cucurbita maxima*) seed kernels. Food Sci. Agric. Res. Bull., 129: 5-18.
Direct Link |

Alvarez, A.M.R. and M.L.G. Rodriguez, 2009. Lipids in pharmaceutical and cosmetic preparations. Grsas Y Aceites, 51: 74-96.
Direct Link |

Andres, T.C., 2004. Website for the plant family cucurbitaceae and home of the cucurbit network.

http://www.cucurbit.org/family.html.

Anonymous, 1986. The Useful Plants of India. CSIR., New Delhi, India.

Arbonnier, M., 2004. Trees, Shrubs and Lianas of West African Dry Zones. 1st Edn., CIRAD, Margraf Publishers GMBH MNHN, USA., ISBN: 2876145790, Pages: 574.

Badi, K.H., A.E. Ahmed and A.M. Bayoumi, 1989. The Forests of the Sudan. Agricultural Research Council, Khartoum, Sudan.

Bang, H.O. and J. Dyerberg, 1980. Lipid Metabolism and Ischemic Heart Disease in Greenland Eskimos. In: Advances in Nutritional Research, Draper, H.H. (Ed.). Springer, New York, USA., ISBN-13: 9781475744484, pp: 1-22.

Bang, H.O., J. Dyerberg and N. Hjorne, 1976. The composition of food consumed by Greenland Eskimos. Acta Medica Scandinavica, 200: 69-73.
CrossRef | PubMed | Direct Link |

Barley, S., 1962. Zygophyllaceae. In: The Medicinal and Poisonous Plants of Southern and Eastern Africa: Being an Account of their Medicinal and other Uses, Chemical Composition, Pharmacological Effects and Toxicology in Man and Animal, Watt, J.M. and M.G. Breyer-Brandwijk (Eds.). E. and S. Livingstone, London.

Bashir, A.K., G.H.M. Ahmed, S.M. Suliman and Y.M. Eikheir, 1984. Mollus-cicidal and other biological activities of *Balanites aegyptiaca*. Proceedings of the 1st Arab Conference on Medicinal Plants, November 17-21, 1984, Cairo, Eagypt -.

Bavec, F., 2000. Navadna buea, oil pumpkins (*Cucurbita pepo* L. convar. *giromantiina* var. *oleifera Pietsch*., syn. Convar. *Citrullina* (L.) Greb. var. *Styriaca* Greb.). Some of Disregarded and/or New Field Crops (Slovene Language), University Maribor, Faculty of Agriculture.

Bavec, F., L. Gril, S. Grobelni K-Mlakar and M. Bavec, 2002. Production of Pumpkin for Oil Trends. In: New Crops and New Uses, Janick, J. and A. Whipkey (Eds.). Ashs Press, Alexandria, USA.

Beit-Yannai, E., S. Ben-Shabat, N. Goldschmidt, B.P. Chapagain, R.H. Liu and Z. Wiesman, 2011. Antiproliferative activity of steroidal saponins from *Balanites aegyptiaca*: An *in vitro* study. Phytochem. Lett., 4: 43-47.
CrossRef | Direct Link |

Boswell, V.R., 1949. Our vegetable travelers. Natl. Geogr. Mag., 96: 145-217.

Brucher, H., 1989. Useful Plants of Neotropical Origin: And their Wild Relatives. Springer-Verlag, Berlin, Heidelberg, Germany, ISBN-13: 9780387187433, Pages: 296.

Bukar, A., I.S. Danfillo, O.A. Adeleke and E.O. Ogunbodede, 2004. Traditional oral health practices among Kanuri women of Borno State, Nigeria. Odontostomatol. Trop., 27: 25-31.
PubMed |

Calder, P.C., P. Yaqoob, F. Theis, F.A., Wallace and E.A. Mile, 2002. Fatty acids and lymphocyte functions. Br. J. Nutr., 87: 31-48.
PubMed |

Carbin, B.E., B. Larsson and O. Lindahl, 1990. Treatment of benign prostatic hyperplasia with

phytosterols. Br. J. Urol., 66: 639-641.
CrossRef | Direct Link |

Carilla, E., M. Briley, F. Fauran, C. Sultan and C. Duvilliers, 1984. Binding of permixon, a new treatment for prostatic benign hyperplasia, to the cytosolic androgen receptor in the rat prostate. J. Steroid Biochem., 20: 521-526.
CrossRef | Direct Link |

Casio, J., 2000. Pumpkin seeds. M.Sc. Thesis, The University of Alaska Fairbanks, USA.

Chapagain, B.P., Y. Yehoshua and Z. Wiesman, 2009. Desert date (*Balanites aegyptiaca*) as an arid lands sustainable bioresource for biodiesel. Bioresour. Technol., 100: 1221-1226.
CrossRef | PubMed | Direct Link |

Chow, C.K., 1992. Fatty Acids in Food and their Health Implications. Marcel Dekker Inc., USA., ISBN-13: 9780824786229, Pages: 890.

Croach, P., 1962. Zygophyllaceae. In: The Medicinal and Poisonous Plants of Southern and Eastern Africa, Watt, J.M. and M.G. Breyer-Brandwijk (Eds.). Livingstone Ltd., London, UK., pp: 1064.

Donalson, J.M. and M.C. Bolton, 1986. H.3 pest of cucurbits: 1-4. Department of Agriculture and Water Supply, Pretoria.

Doughari, J.H., M.S. Pukuma and N. De, 2007. Antibacterial effects of *Balanites aegyptiaca* L. Drel. and *Moringa oleifera* Lam. on *Salmonella typhi*. Afr. J. Biotechnol., 6: 2212-2215.
Direct Link |

Dyerberg, J., 1989. Coronary heart disease in Greenland Inuit: A paradox. Implications for western diet patterns. Arctic Med. Res., 48: 47-54.
PubMed |

Egeland, G.M., L.A. Feyk and J.P. Middaugh, 1998. The use of traditional foods in a healthy diet in Alaska: Risks in perspective. Bulletin No. 6, Section of Epidemiology, Alaska Division of Public Health, Department of Health and Social Services, State of Alaska, Anchorage, Alaska.

El-Tahir, I.M., 1991. Okra genetic resources in Sudan. International Crop Network Series No. 5, International Board for Plant Genetic Resources (IBPGR), Rome, Italy, pp: 34-35.

Elawad, A.M., 2012. Omega-3 and Omega-6 essentiai fatty acids in pumpkins (*Cucurbita maxima*) seed and desert dates (*Balanites aegyptiaca*) seed kernel oils. Ph.D. Thesis, Food Research Centre, Sudan.

Elfeel, A.A., 2010. Variability in *Balanites aegyptiaca* var. Aegyptiaca seed kernel oil, protein and minerals contents between and within locations. Agric. Biol. J. N. Am., 1: 140-174.
Direct Link |

Elfeel, A.A., E.L. Warag and H.A. Musnad, 2009. Effect of seed origin and soil type on germination and growth of heglig tree (*Balanites aegyptiaca* L. (Del) var. aeyptiaca). J. Sci. Technol., 10: 56-65.

Elhardallou, S.B. and J. Haemavathy, 2004. Lipid content and fatty acid composition of pearl millet seeds, broad beans and fenugreek seeds broad beans and fenugreek seeds grown in Sudan. J. Oil Technol. Assoc. India, 36: 55-58.

Elhardallou, S.B., 2011. Cytotoxicity and biological activity of selected sudanese medicinal plants. Res. J. Med. Plant, 5: 201-229.

CrossRef | Direct Link |

Ensminger, A.H. and M.K.J. Esminger, 1986. Food for Health: A Nutrition Encyclopedia. Pegus Press, California.

Ensminger, A.H., M.E. Ensminger, J.E. Kondale and J.R.K. Robson, 1983. Food and Nutrition Encyclopedia. Pegus Press, Clovis, California.

Esuoso, K., H. Lutz, M. Kutubuddin and E. Bayer, 1998. Chemical composition and potential of some underutilized tropical biomass. I: Fluted pumpkin (*Telfairia occidentalis*). Food Chem., 61: 487-492.
CrossRef |

FAO, 1985. An all-purpose tree for Africa offers food and income. Ceres, 18: 6-7.

FAO/WHO, 1977. Dietary fats and oils in human nutrition. A Joint FAO/WHO Report, Food and Nutrition Paper No. 3. Rome, Italy.

Fahim, A.T., A.A. Abd-El Fattah, A.M. Agha and Z.M. Gad, 1995. Effect of pumpkin-seed oil on the level of free radical scavengers induced during adjuvant-arthritis in rats. Pharmacol. Res., 31: 73-79.
CrossRef | Direct Link |

Fairman, R.M., 1992. Minor oil crops. Minor oil crops. FAO Agricultural Services Bulletin No. 94. Food and Agriculture Organization of the United Nations.

Farid, H., E. Haslinger, O. Kunert, C. Wegner and M. Hamburger, 2002. New steroidal glycosides from *Balanites aegyptiaca*. Helvetica Chimica Acta, 85: 1019-1026.
CrossRef | Direct Link |

Fokou, E., M.B. Achu and M.F. Tchouanguep, 2004. Preliminary nutritional evaluation of five species of egusi seeds in cameroon. Afr. J. Food Agric. Nutr. Dev., 4: 1-11.
Direct Link |

Fokou, E., M.B. Achu, G. Kansci, R. Ponka, M. Fotso, C. Tchiegang and F.M. Tchouanguep, 2009. Chemical properties of some cucurbitaceae oils from Cameroon. Pak. J. Nutr., 8: 1325-1334.
CrossRef | Direct Link |

Friederich, M., C. Theurer and G. Schiebel-Schlosser, 2000. Prosta fink forte capsules in the treatment of benign prostatic hyperplasia. Multicentric surveillance study in 2245 patients. Forsch Komplementarmed Klass Naturheilkd, 7: 200-204, (in German).
PubMed |

Fruhwirth, G.O. and A. Hermetter, 2007. Seeds and oil of the Styrian oil pumpkin: Components and biological activities. Eur. J. Lipid Sci. Technol., 109: 1128-1140.
CrossRef | Direct Link |

Fu, C., H. Shi and Q. Li, 2006. A review on pharmacological activities and utilization technologies of pumpkin. Plant Foods Hum. Nutr., 61: 70-77.
CrossRef | PubMed | Direct Link |

GISSI-Prevenzione Investigators, 1999. Dietary supplementation with n-3 polyunsaturated fatty acids and vitamin E after myocardial infarction: Results of the GISSI-Prevenzione trial. Lancet, 354: 447-455.
CrossRef | Direct Link |

Goldberg, G., 2003. Plants: Diet and Health. Wiley-Blackwell, Oxford, UK.

Gossell-Williams, M., A. Davis and N. O'Connor, 2006. Inhibition of testosterone-induced hyperplasia of the prostate of sprague-dawley rats by pumpkin seed oil. J. Med. Food, 9: 284-286.
CrossRef | Direct Link |

Grosskinsky, B. and C. Gullick, 2001. Potential of indigenous food plants to support and strengthen livelihoods in southern Sudan. Proceedings of the Potential of Indigenous Wild Foods, January 22-26, 2001, Mombassa, Kenya -.

Guinand, Y. and D. Lemessa, 2001. Wild food plants in Ethiopia: Reflections on the role of wild foods and famine foods at a time of drought. Proceedings of the Potential of Indigenous Wild Foods, January 22-26, 2001, Mombassa, Kenya -.

Gunstone, F.D. and B.G. Herslof, 2000. Lipid Glossary 2. Bridgwater, England.

Gunstone, F.D., 2002. Vegetable Oils in Food Technology: Composition, Properties and Uses. Blackwell Publishing Ltd., UK.

Gurr, M.I., 1999. Lipids in Nutrition and Health: A Reappraisal. Woodhead Publishing, UK.

Gutti, B., S.S. Bamidele and I.M. Bugaje, 2012. Characterization and composition of balanite aegyptiaca seed oil and its potential as biodiesel feedstock in Nigeria. J. Appl. Phytotechnol. Environ. Sanitation, 1: 29-35.
Direct Link |

Hall, J.B. and D.H. Walker, 1991. *Balanites aegyptiaca* Del.-A Monograph. School of Agricultural and Forest Science, University of Wales, Banger, UK., ISBN: 9780904390759, Pages: 65.

Hamid, O., M. Wahab and E. Hassan, 2001. Balanites aegyptiaca extract for treatment of HIV/AIDS and leukemia. International Publication Number WO 2001/49306 A1.

Hammer, K.A., C.F. Carson and T.V. Riley, 1999. Antimicrobial activity of essential oils and other plant extracts. J. Applied Microbiol., 86: 985-990.
CrossRef | PubMed | Direct Link |

Hardman, R. and E.A. Sofowora, 1972. A reinvestigation of *Balanites aegyptiaca* as a source of steroidal sapogenins. Econ. Bot., 26: 169-173.
CrossRef | Direct Link |

Hassan, M.S., H.M. Dinar, S.A. El Hussein, M.K. Ahmed and A.A. Geneif, 1984. Indigenous horticultural germplasm of western Sudan. Plant Genet. Resour. New., 156: 33-59.

Heidari, R., M. Khayami and T. Farboodnia, 2005. Effects of Pb toxicity on the membrane stability and fatty acids changes of *Zea mays* seedlings root. Int. J. Bot., 1: 38-40.
CrossRef | Direct Link |

Holman, R.T., 1998. The slow discovery of the importance of ω3 essential fatty acids in human health. J. Nutr., 128: 427S-433S.
PubMed | Direct Link |

Hu, F.B., M.J. Stampfer, J.E. Manson, E. Rimm and G.A. Colditz *et al*., 1997. Dietary fat intake and the risk of coronary heart disease in women. N. Engl. J. Med., 337: 1491-1499.
CrossRef | Direct Link |

Huang, X.E., K. Hirose, K. Wakai, K. Matsuo and H. Ito *et al*., 2004. Comparison of lifestyle risk factors by family history for gastric, breast, lung and colorectal cancer. Asia. Pac. J. Cancer Prev., 5: 419-427.
PubMed | Direct Link |

Hyun, T.H., E. Barrett-Connor and D.B. Milne, 2004. Zinc intakes and plasma concentrations in men with osteoporosis: The Rancho Bernardo Study. Am. J. Clin. Nutr., 80: 715-721.
PubMed | Direct Link |

Idouraine, A., E.A. Kohlhepp, C.W. Weber, A. Warid and J.J. Martinez-Tellez, 1996. Nutrient constituents from eight lines of naked seed squash (*Cucurbita pepo* L.). J. Agric. Food Chem., 44: 721-724.
CrossRef | Direct Link |

Imaeda, N., Y. Tokudome, M. Ikeda, I. Kitagawa, N. Fujiwara and S. Tokudome, 1999. Foods contributing to absolute intake and variance in intake of selected vitamins, minerals and dietary fiber in middle-aged Japanese. J. Nutr. Sci. Vitaminol., 45: 519-532.
PubMed |

Innis, S.M., 2007. Dietary (n-3) fatty acids and brain development. J. Nutr., 137: 855-859.
CrossRef | Direct Link |

Iso, H., K.M. Rexrode, M.J. Stampfer, J.E. Manson and G.A. Colditz *et al*., 2001. Intake of fish and ω-3 fatty acids and risk of stroke in women. J. Am. Med. Assoc., 285: 304-312.
PubMed |

Iso, H., S. Sato, U. Umemura, M. Kudo and K. Koike *et al*., 2002. Linoleic acid, other fatty acids and the risk of stroke. Storks, 33: 2086-2093.
CrossRef | PubMed | Direct Link |

Jakovljevic, L.J., Z. Basic, M. Slavic and M. Kis, 1995. Quantification of vitamin E content in some oil plant seeds and corn products by HPLC technique. Proceedings of the 8th European Conference on Food Chemistry, September 18-20, 1995, Vienna, Austria, pp: 395-397.

Jayaprakasam, B., N.P. Seeram and M.G. Nair, 2003. Anticancer and antiinflammatory activities of cucurbitacins from *Cucurbita andreana*. Cancer Lett., 10: 11-16.
CrossRef | PubMed | Direct Link |

Jian, L., C.J. Du, A.H. Lee and C.W. Binns, 2005. Do dietary lycopene and other carotenoids protect against prostate cancer? Int. J. Cancer, 113: 1010-1014.
CrossRef |

Jones, F.A., 1996. Herbs-useful plants. Their role in history and today. Eur. J. Gastroenterol. Hepatol., 8: 1227-1231.
PubMed | Direct Link |

Khiri, A.N., 1985. Studies on the oil of *Balanites aegyptiaca* kernel. M.Sc. Thesis, University of Khartoum, Sudan.

Kim, M.Y., E.J. Kim, Y.N. Kim, C. Choi and B.H. Lee, 2012. Comparison of the chemical compositions and nutritive values of various pumpkin (*Cucurbitaceae*) species and parts. Nutr. Res. Pract., 6: 21-27.
CrossRef | Direct Link |

Kindeya, G., 2004. The development of agro forestry in the dry lands of environ manage Ethiopia. Proceedings in the Dry Lands Agroforestry Workshop, September 1-3, 2004, Nairobi, Kenya, pp: 1-45.

Kris-Etherton, P.M., W.S. Harris and L.J. Appel, 2002. Fish consumption, fish oil, omega-3 fatty acids and cardiovascular disease. Circulation 106: 2747-2757.
CrossRef | Direct Link |

Lanting, C.I., M. Huisman, E.R. Boersma, B.C.L. Touwen and V. Fidler, 1994. Neurological differences between 9-year-old children fed breast-milk or formula-milk as babies. Lancet, 344: 1319-1322.
CrossRef | PubMed | Direct Link |

Lazos, S.E., 1986. Nutritional, fatty acid and oil characteristics of pumpkin and melon seeds. J. Food Sci., 51: 1382-1383.
CrossRef | Direct Link |

Li, D., O. Bobe, H. Drummond and A.J. Sinclair, 2003. Omega-3 (n-3) Fatty Acids. In: Lipids for Functional Foods and Nutraceuticals, Gunstone, F.D. (Ed.). Oily Press, England, pp: 225.

Lockett, C.T., C.C. Calvert and L.E. Grivetti, 2000. Energy and micronutrient composition of dietary and medicinal wild plants consumed during drought. Study of rural Fulani, Northeastern Nigeria. Int. J. Food Sci. Nutr., 51: 195-208.
CrossRef | Direct Link |

Maclean, C.H., W.A. Mojica, S.C. Morton, J. Pencharz and R. Hasenfeld Garland *et al*., 2004. Effects of omega-3 fatty acids on lipids and glycemic control in type II diabetes and the metabolic syndrome and on inflammatory bowel disease, rheumatoid arthritis, renal disease, systemic lupus erythematosus and osteoporosis. Evid. Rep. Technol. Assess. (Summ)., 89: 1-4.
PubMed |

Mahasneh, A.M. and A.A. El-Oqlah, 1999. Antimicrobial activity of extracts of herbal plants used in the traditional medicine of Jordan. J. Ethnopharmacol., 64: 271-276.
CrossRef | Direct Link |

Maksoud, S.A. and M.N. El Hadidi, 1988. The flavonoids of *Balanites aegyptiaca* (Balanitaceae) from Egypt. Plant Syst. Evol., 160: 153-158.
CrossRef | Direct Link |

Martin, F.W., 1998. Cucurbit seed as possible oil and protein sources. ECHO Technical Note, ECHO, Myers FL., USA., pp: 1-7.

Martinez, M., A. Ballabriga and J.J. Gil-Gibernau, 1998. Lipids of the developing human retina. I. Total fatty acids, plasmalogens and fatty acid composition of ethanolamine and choline phosphoglycerides. J. Neurobiol. Res., 20: 484-490.
CrossRef |

Matus, Z., P. Molnar and L.G. Szabo, 1993. Main carotenoids in pressed seeds (cucurbita semen) of pumpkin oil (*cucurbita pepo*. convav, pepovav, styriaca). Acta pharm. Hung., 63: 247-256.

McKevith, B., 2005. Nutritional aspects of oilseeds. Nutr. Bull., 30: 13-26.
CrossRef | Direct Link |

Mohamed, A.M., W. Wolf and W.E.L. Spieβ, 2002. Physical, morphological and chemical characteristics, oil recovery and fatty acid composition of *Balanites aegyptiaca* Del. Kernels. Plant Foods Hum. Nutr., 57: 179-189.
CrossRef | Direct Link |

Murkovic, M., A. Hillebrand, J. Winkler, E. Leitner and W. Pfannhauser, 1996. Variability of fatty

acid content in pumpkin seeds (*Cucurbita pepo* L.). Zeitschrift fur Lebensmittel-Untersuchung und-Forschung, 203: 216-219.
CrossRef | Direct Link |

Murkovic, M., V. Piironen, A.M. Lampi, T. Kraushofer and G. Sontag, 2004. Changes in chemical composition of pumpkin seeds during the roasting process for production of pumpkin seed oil (Part 1: Non-volatile compounds). Food Chem., 84: 359-365.
CrossRef |

NRC, 2008. Lost Crops of Africa: Fruits. Vol. III, National Academies Press, Washington, DC., ISBN-13: 978-0-309-10596-5.

Nakic, S.N., D. Rade, D. Skevin, D. Strucelj, Z. Mokrovcak and M. Bartolic, 2006. Chemical characteristics of oils from naked and husk seeds of *Cucurbita pepo* L. Eur. J. Lipid Sci. Technol., 108: 936-943.
CrossRef |

Neuwinger, H.D., 2004. Plants used for poison fishing in tropical Africa. Toxicon, 44: 417-430.
CrossRef | Direct Link |

Ng, T.J., 1993. New Opportunities in the Cucurbitaceae. Wiley, New York, pp: 538-546.

Nour, A.A.A.M., A.H.R. Ahmed and A.G.A. Abdel-Gayoum, 1985. A chemical study of *Balanites aegyptiaca* L. (Lalob) fruits grown in Sudan. J. Sci. Food Agric., 36: 1254-1258.
CrossRef |

Nwokolo, E.N. and J.S. Sim, 1987. Nutritional assessment of defatted oil meals of melon (*Colocynthis citrullus* L.) and fluted pumpkin (*Telfaria occidentalis* Hook) by chick assay. J. Sci. Food Agric., 38: 237-246.
CrossRef | Direct Link |

Obeid, M. and N.A. Khairi, 2012. Chemical characteristics of Moringa olefra and seed oil. Ph.D. Thesis, Faculty of Agriculture, University of Khartoum, Sudan.

Obidah, W., M.S. Nadro, G.O. Tiyafo and A.U. Wurochekke, 2009. Toxicity of crude *Balanites aegyptiaca* seed oil in rats. J. Am. Sci., 5: 13-16.
Direct Link |

Ojo, O.O., M.S. Nadro and I.O. Tella, 2006. Protection of rats by extracts of some common Nigerian trees against acetaminophen-induced hepatotoxicity. Afr. J. Biotechnol., 9: 755-760.

Orwa, C., A. Mutua, R. Kindt, R. Jamnadass and A. Simons, 2009. Agroforestry Tree Database: A tree reference and selection guide. Version 4.0, Nairobi, Kenya. http://eolspecies.lifedesks.org/node/3416.

Phillips, K.M., D.M. Ruggio and M. Ashraf-Khorassani, 2005. Phytosterol composition of nuts and seeds commonly consumed in the United States. J. Agric. Food Chem., 53: 9436-9445.
CrossRef | PubMed |

Rajakaruna, N., C.S. Harris and G.H.N. Towers, 2002. Antimicrobial activity of plants collected from Serpentine outcrops in Sri Lanka. Pharm. Biol., 40: 235-244.
CrossRef | Direct Link |

Reynold, J.E., D.L. Wetzel and T.M. O'Hara, 2006. Human health implications of Omega-3 and Omega-6 fatty acids in blubber of the bowhead whale (*Balaena mysticetus*). Arctic, 59: 155-164.
Direct Link |

Reynolds, J.E.F., 1996. Martindale-the Extra Pharmacopoeia. 31st Edn. Royal Pharmaceutical Society of Great Britain, London.

Rinzler, C.A., 2009. The New Complete Book of Food: A Nutritional, Medical and Culinary Guide. Infobase Publishing, USA., ISBN-13: 9781438126869, pp: 412-415.

Robinson, R.W. and D.S. Decker-Walters, 1997. What are Cucurbits. In: Cucurbits, Robinson, R.W. and D.S. Decker-Walters (Eds.). CAB International, New York, pp: 1-22.

Rostami, H., M. Kazemi and S. Shafiei, 2012. Antibacterial activity of *Lavandula officinalis* and *Melissa officinalis* against some human pathogenic bacteria. Asian J. Biochem., 7: 133-142.
CrossRef | Direct Link |

Ruxton, C.H.S., S.C. Reed, M.J.A. Simpson and K.J. Millington, 2004. The health benefits of omega-3 polyunsaturated fatty acids: A review of the evidence. J. Hum. Nutr. Diet., 17: 449-459.
CrossRef | PubMed | Direct Link |

Sands, M.J.S., 2001. The desert date and its relatives: A revision of the genus balanites. Kew. Bull., 56: 1-128.
Direct Link |

Sargent, J.R., 1997. Fish oils and human diet. Br. J. Nutr., 78: S5-S13.
CrossRef | PubMed |

Schilcher, H., U. Dunzendorfer and F. Ascali, 1987. The prostatotropic principle of pumpkin seeds. Urol. B, 27: 316-319, (In French).
Direct Link |

Schuster, W., W. Zipse and R. Marquard, 1983. Effect of genotype and place of cultivation on various ingredients of oil-gourd seeds (*Cucurbita pepo* L.). Fette Seifen Anstrichm., 85: 56-64.

Shanks, E., 1991. *Balanites aegyptiaca*: A Hand Book for Extension Workers. University of Wales, UK., ISBN-13: 978-0904390902, Pages: 35.

Shirzadeh, E. and M. Kazemi, 2012. Effect of essential oils treatments on quality characteristics of apple (*Malus domestica* var. Gala) during storage. Trends Appl. Sci. Res., 7: 584-589.
CrossRef | Direct Link |

Simon, J.A., J. Fong, J.T. Bernert and W.S. Browner, 1995. Serum fatty acids and the risk of stroke. Stroke., 26: 778-782.
CrossRef | Direct Link |

Simopoulos, A.P., 2000. Human requirement for N-3 polyunsaturated fatty acids. Poult. Sci., 79: 961-970.
PubMed | Direct Link |

Souci, S.W., W. Fachmann and H. Kraut, 2000. Food Composition and Nutrition Tables. 6th Edn., CRC Press, Stuttgart, Germany.

Stevenson, D.G., F.J. Eller, L. Wang, J.L. Jane, T. Wang and G.E. Inglett, 2007. Oil and tocopherol content and composition of pumpkin seed oil in 12 cultivars. J. Agric. Food Chem., 55: 4005-4013.
CrossRef | PubMed | Direct Link |

Stuart, A.G., 2003. Pumpkin seeds. University of Texas, El Paso, USA.

Sultan, C., A. Terraza, C. Devillier, E. Carilla, M. Briley, C. Loire and B. Descomps, 1984. Inhibition of androgen metabolism and binding by a liposterolic extract of Serenoa repens B in human foreskin fibroblasts. J. Steroid Biochem., 20: 515-519.
CrossRef | PubMed | Direct Link |

Suphakarn, V.S., C. Yarnnon and P. Ngunboonsri, 1987. The effect of pumpkin seeds on oxalcrystalluria and urinary compositions of children in hyperendemic area. Am. J. Clin. Nutr., 45: 115-121.
Direct Link |

Suphiphat, V., N. Morjaroen, I. Pukboonme, P. Ngunboonsri, T. Lowhnoo and S. Dhanamitta, 1993. The effect of pumpkin seeds snack on inhibitors and promoters of urolithiasis in Thai adolescents. J. Med. Assoc. Thai., 76: 487-493.
PubMed |

Tsai, Y.S., Y.C. Tong, J.T. Cheng, C.H. Lee, F.S. Yang and H.Y. Lee, 2006. Pumpkin seed oil and phytosterol-F can block testosterone/prazosin-induced prostate growth in rats. Urol. Int., 77: 269-274.
CrossRef | PubMed |

Van der Vossen, H.A.M. and G.S. Mkamilo, 2007. Plant Resources of Tropical Africa 14. Vegetable oils. Vol. 14, PROTA Foundation, Wageningen, Netherlands, pp: 141-144.

Von Maydell, H.J., 1986. Trees and shrubs of the Sahel: Their Characteristicts and Uses. Deutsche Gesells Chaft Fuer Technischezusammenarbeit, Eschborn, Germany.

WHO/FAO, 2003. Fat and oil in human nutrition. Report of a Joint Expert Consultation, World Health Organization/Food and Agriculture Organization.

Wagner, F.S., 2000. The health value of Styrian pumpkin-seed oil-science and fiction. Cucurbit Genet. Crop., 23: 122-123.
Direct Link |

Wang, H.X. and T.B. Ng, 2003. Isolation of cucurmoschin: A novel antifungal peptide abundant in arginine, glutamate and glycine residues from black pumpkin seeds. Peptides, 24: 969-972.
CrossRef | PubMed | Direct Link |

Whitaker, T.W. and G.N. Davis, 1962. Cucurbits. Interscience Publishers, New York.

Williams, C.M., 2000. Dietary fatty acids and human health. Ann. Zootech., 49: 165-180.
Direct Link |

Yadav, J.P. and M. Panghal, 2010. *Balanites aegyptiaca* (L.) Del. (Hingot): A review of its traditional uses, phytochemistry and pharmacological properties. Int. J. Green Pharm., 4: 140-146.
Direct Link |

Yadegari, M., A.R. Golparvar and R. Barzegar, 2012. Multivariate analysis of quantitative traits in Iranian pumpkin lines (*Cucurbita* spp.). Afr. J. Agric. Res., 7: 764-774.
CrossRef | Direct Link |

Yoshida, H., Y. Shougaki, Y. Hirakawa, Y. Tomiyama and Y. Mizushina, 2004. Lipid classes, fatty acid composition and triacylglycerol molecular species in the kernels of pumpkin (*Cucurbita* spp) seeds. J. Sci. Food Agric., 84: 158-163.
CrossRef | Direct Link |

Younis, Y.M.H., S. Ghirmay and S.S. Al-Shihry, 2000. African *Cucurbita pepo* L. Properties of seed

and variability in fatty acid composition of seed oil. Phytochemistry, 54: 71-75.
CrossRef | PubMed | Direct Link |

Zarroug, I.M.A., A.D. Nugud, A.K. Bashir and A.A. Mageed, 1988. Evaluation of Sudanese plant extracts as mosquito larvicides. Pharm. Biol., 26: 77-80.
CrossRef |

Zhang, X., J.Z. Ouyang, Y.S. Zhang, B. Tayalla, X.C. Zhou and S.W. Zhou, 1994. Effect of the extracts of pumpkin seeds on the urodynamics of rabbits: An experimental study. J. Tongji Med. Univ., 14: 235-238.
PubMed |

Zimmerman, J., 1997. Optimal nutrition for HIV/AIDs wellness. J. Am. Diet. Assoc., 97: A18-A18.
CrossRef |

Ziyada, A.K. and S.A. EL-Hussien, 2008. Physical and chemical characteristics of *Citrulla slonatus* vav. colocynthoide seed oil. J. Phys. Sci., 19: 69-75.