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Utilization of Abu Leile *(Detarium Microcarpum (Guill&Perr))* Fruits in Jam Production

إستخدام ثمار ابوليلي في إنتاج المربى

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الآية

بسم الله الرحمن الرحيم

قال تعالى:

(هُوَ الَّذِي أَنْزَلَ مِنَ السَّمَاءِ مَاءً لَكُمْ مِنْهُ شَرَابٌ وَمِنْهُ شَجَرٌ فِيهِ تُسِيمُونَ* يُنْبِتُ لَكُمْ بِهِ الزَّرْعَ وَالزَّيْتُونَ وَالنَّخِيلَ وَالاَعْنَابَ وَمِنْ كُلِّ الثَّمَرَاتِ إِنَّ فِي ذَلِكَ لَآيَةً لِقَوْمٍ يَتَفَكَّرُونَ).

صدق الله العظيـــــــــــــــــــم

سورة النحل الآية (10-11)

DEDICATION

To our Families

Teachers

And Friends …

With respect.

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ABSTRACT

The main goal of this research was to encourage the industrial utilization of Abu leile (*Detarium Microcarpum Guill and perr*) fruits as raw material for production of jam with high nutritional value in order to improve and facilitate the domestic consumption of these fruits in Sudan. the pulp was extracted by scraping and then the powder resulting was collected and sifted ,the extract was blended with boiled water (1500 ml) for 5 mint.s Then the mixture was filtered, and fruits extract after filtration was used for production of jam. The results indicated that fruits Abu leile pulp contain high percentages of dry matter (91.93 %), total carbohydrates (83.45%), crude fiber (0.13%),Ash(4.23), total sugars (28%), and low percentages of protein (3.01%) and fat (1.23 %), on dry matter basis. Also, the fruits pulp was found to contain high percentages of calcium (1400 mg), sodium (36 mg), magnesium (1560 mg), phosphorous (225 mg), potassium (4780 mg),and manganese (226,54 mg), and cupper (0.248 mg) per 100g dry matter (DM). The study indicated that the fruits pulp could be easily extracted after scraping by using a sharp knife. The extract was found to contain appreciable amounts of total soluble solids (10 %),while the pH and the total yield of the blend were about (5.8)and 300 g respectively. After that, Abu leile jam was produced according to the chemical and physical characteristics of Abu leile fruits extract, and it was found to contain high energy value (78 Kcal/100gm, total sugars (64.8%) ,non reducing sugars (49.4%), protein (0.84%), fat (0.15), ash (0.19), reducing sugars (15.40%) and crude fiber (0.20%). In addition to appreciable amounts of sodium (40mg), potassium (775mg), magnesium (150 mg),phosphorous (72.5mg) and calcium (500 mg) per kg. Abu leile jam was found in accordance with the local and international specifications with respect to its sugar concentration (68.00%), pH (3.20) and of titrable acidity (0.4%). Finally, the sensory evaluation verified the quality of Abu leile jam samples especially those produced with strawberry flavor.

ملخص الدراسة

الهدف الأساسي لهذا البحث هو تشجيع الإستغلال الصناعي لثمار ابو ليلي كمادة خام لإنتاج مربى ذات قيمة غذائية عالية لتطوير وتسهيل طريقة الإستهلاك الغذائي لهذه الثمار في السودان.تم استخلاص اللب عن طريق الكشط ثم تم جمع المسحوق الناتج وخلط المستخلص المنخل مع الماء المغلي (1500مل)لمدة 5دقائق ثم تم ترشيح الخليط واستخدام مستخلص الفاكهة بعد الترشيح لأنتاج المربى.ولقد أوضحت نتائج الدراسة أن لب ثمار ابو ليلي يحتوي على نسب عالية من المادة الجافة (91.93 %)، الكربوهيدرات الكلية (83.45%)، الألياف الخام (0.13%)، الرماد (4.23)،السكريات الكلية(28%) ونسب قليلة من البروتين(3.01%) و الدهون (1.23 %) على أساس الوزن الجاف. كما يحتوى اللب أيضا على نسب عالية من الكالسيوم (1400 ملجم)، الصوديوم (36ملجم)، المغنزيوم (1560ملجم)، البوتاسيوم (4780ملجم) والفسفور (225ملجم) ونسب اقل من عنصري المنجنيز (226ملجم) والنحاس (0.248 ملجم) ، لكل كيلو جرام من المادة الجافة. أوضحت الدراسة سهولة إستخلاص لب ثمار ابو ليلي بعد كشطها بأستخدام (سكين). ولقد إحتوى المستخلص على نسب معقولة من المواد الصلبة الذائبة (10٪)، بينما وصلpH والعائد الكلي للمستخلص حوالي 5.8و 300جم على التوالي. وبعد ذلك تم تصنيع مربى أبو ليلي بناءً على الخواص الكيميائية والفيزيائية لمستخلص لب الثمار، حيث تميزت بإرتفاع قيمة الطاقة (78كيلوكالوري/100جم)) ،السكريات الكلية64.8،السكريات الغير مختزلة, 49.4 ، البروتين,84 .0الدهن0.15 , الرماد 0.19 ,السكريات المختزلة 15.40, والألياف الخام (0.20%)هذا إضافة إلي إحتوائها على كميات مقدرة من الصوديوم (40ملجم)، البوتاسيوم (775ملجم)، الماغنزيوم (150ملجم)، الفسفور (72.5ملجم) والكالسيوم (500ملجم)، لكل كيلوجرام، مربى ابوليلي مطابقة للمواصفات المحلية والعالمية من حيث تركيز السكر (68.00 %)، pH (3.20) الحموضة التنقيطية (0.4 %). وأخيرا أكد التقييم الحسي جودة مربى ثمار أبو ليلي خاصة تلك التي أضيف لها نكهة الفراولة.

CHAPTER ONE
INTRODUCTION

Detarium Microcarpum Guill. And Perr is an African tree belonging to the family Caesalpiniaceae (legumes) and to the genus *Dertarium* which is commonly known *Detarium Microcarpum.* Other names: Taura (Hausa), Ofo (Igbo), Ogbobgo (Yoruba) (Irvine, 1961; Keay*et* 1964; Dalziel 1955). In sudan it is found in Darfour, Blue Nile and Kordofan States it is locally known as Abu leile in sudan(Mariod, 2009). Its hard dark brown wood provides very good quality timber, which is very durable under water, and used in carpentry and construction. It is also used for good quality fuel wood and charcoal. The roots, stemsbark, leaves and fruits are all used to treat ailments e.g. tuberculosis, meningitis, itching and diarrhea. The fruit is edible and rich in vitamin C and the leaves and seeds are also used in cooking. However, The foliage is avoided by most large mammals. The roots are used in perfume. Fruits, plant bark and leaves are used not only for texture and flavour, but also for their chemical and nutritional properties (Abulude*et*, 2004). The seed which is used as a traditional soup thickener contain lipids, carbohydrates, proteins, crude fiber and the essential elements: Na, K, Mg, Ca, S, P and Fe (Abreu and Relva, 2002; Abreu, 1998). Through out western Africa the genus *Detarium*is believed to possess medico-magical powers. In African ethnomedicine, the bark, leaves and roots of *Detarium Microcarpum* are widely used throughout its distribution area because of their diuretic and astringent properties. They are prepared as infusions or decoctions to treat rheumatism, venereal diseases, urogenital infections, haemorrhoids, caries, biliousness, stomach-ache, intestinal worms and diarrhea including dysentery. They are also used against malaria, leprosy and impotence. The pulp is used in making cakes, as well as a substitute for sugar (Akah*et*, 2012). Therefore, efforts should be directed towards the industrial utilization of Abu Leile fruits in food processing in Sudan as the fruit is considered very rich in carbohydrates, crude fiber, minerals, and vitamins. The development of Abu Leile jam with high caloric value will add economic value to the raw material and facilitate their consumption and their different industrial utilization in Sudan.

General Objective:

To make use of local plant fruits in jam production (Abu leile).

Specific Objectives:

1. To study the nutritional value of Abu Leile fruits.
2. To study the suitability of Abu Leile fruits for Jam production.
3. To evaluate the chemical, physico-chemical and organoleptic characteristics of the end product.

CHAPTER TWO
LITERATURE REVIEW

2.1 Abu Leile tree

2.1.1 Taxonomy and nomenclature

Abu Leile tree is taxonomically belong to the genus (*Detarium*) which belong to sub-family Caesalpinioideae, under the family Fabaceae and kingdom Plantae(Bisby, 2007). Also, the species has been classified under different synonymous: *Detarium senegalense* (J. F. Gmel). In Linn. Syst. Nat, *Detarium Macrocarpum* Harms in Engl.Bot. Jahrb: and *Detarium* Senegalensis: (J.F. Gmelin) English: tallow tree (a corruption of The Gambian Mandinka name); Senegal dattock (from Wolof). (Burkill, 1995) It has different local names in the different languages and countries. For example: The name of the tree in English as sweet dattock, trees. *Detarium* microcarpum is known locally in Ghana asTakyi kyiriwa, Twutwiriwa; in Senegal as Kpagra, Kpayhga; in Nigeria Taura, (Hausa):Ofo, (Igbo): Ogbogbo, (Yoruba): Gungorochi, (Nupe): Ejiji (Igala) Konkehi, (Fulfulde):Galapo, (Kanuri): Agashidam, Tiv (Irvine, 1961; Keay 1964; Dalziel 1955).

2.1.2 Botanical description

In dry areas this species occurs as a small tree, reaching ca. 10 m high, with a dense rounded crown, while in wet areas it may grow up to 25 m high. The greyish bark breaks off into rectangular pieces to reveal a reddish inner surface. The twigs are covered with a smooth or peeling orange bark. The imparipinnate leaves are 8-12cm long and consist of 3-6 pairs of alternate, almost opposite leaflets. The leaflets are 5-10 cm long and 3-5 cm wide, they have a dull green upper surface and a greyish-green lower surface. The leaflets have a rounded,, often notched apex and a rounded or subcordate base. The inflorescence is an axillary raceme, ca. 2-5 cm in length and congested. The creamy white fragrant flowers consist of 4 largesepals and 8-10 cream coloured prominent stamens; petals absent ((Helen Vautier, 2007).Fruit and seed description fruit: A disc-shaped more or less flattened drupe, up to 4 cm diameter and 2.5 cm thick. The fruits are covered with a brown-brittle skin and contain a sweet green pulp, with tangled fibers and not very fleshy. This surrounds a hard wrinkled stone (the pyrene), which contains a single seed. Seed: The pyrene has a circular, flattened shape. Typical dimensions are 2-3 x 2 x 1 cm. The endocarp isdull, dark brown and faintly pitted. The seeds have no endosperm (Helen Vautier, 2007).

2.1.3 Phenology and reproductive biology

Plant phenology is to observe and record the periodically reoccurring growth stages such as leaf bud formation, flowering, fruiting etc and study the regularities and dependency of they early cycles of development on environmental condition. Sweet detar is deciduous and drops its leaves during the dry season. Timing of leaf fall varies from September to November. Leaves flush before the rainy season begins. Flowering occurs during the rainy season from July to September in the Sudanian zone and from July to November in the Sahelian zone. Each tree generally flowers for a period of about eight days. Fruit develops between the beginning of the fresh dry season (January), and the beginning of the rainy season (May). The fruits ripen between January and April. Trees often produce seedless fruit.The flowers are pollinated by insects. The main insect visitors are beetles, wasps and flies. The seeds are dispersed mainly by humans, monkeys, rodents and parrots (Kouyaté and Lamien, 2011).

2.1.4Geographical distribution

The natural distribution of sweet detar extends throughout arid sub-Saharan Africa from Senegal east to Sudan. The range includes Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Gambia, Ghana, Guinea, GuineaBissau, Mali, Niger, Nigeria, Senegal and Sudan (Kouyaté AM and Lamien N 2011.). In Sudan it is found in Darfour, Blue Nile and Kordofan States(Mariod, 2009).

2.1.5 Ecology and biology

Sweet detar is irregularly distributed across semi-arid areas in the Sahelian and Sudanian agro-ecological zones. It is very common locally in wooded savannahs; shrub savannahs and semi-cleared dry forest areas and is one of the most abundant species in fallows. Generally, it grows in sandy or hard soils with high iron content and in the presence of mycorrhizal fungi (Kouyaté and Lamien, 2011).

2.1.6 Biophysical limits

Sweet detar species can easily grow at an altitude of 25_15 meters, with an average annual temperature of 26 °C and an average annual rainfall of 1000_600 mm.

2.1.7 Propagation and management

2.1.7.1 Propagation from seed

Nursery production of seedlings is easy. Seeds are orthodox so can be stored after collection in jute bags at ambient temperature for up to five years. Seed must be scarified to break dormancy before they are planted in a compost based substrate. Seeds are scarified by immersing them briefly in boiling

water or in sulphuric acid, then soaking them in tepid water for 24 hours or by nicking the hard seed coat using a sharp object (Kouyaté and Lamien, 2011).

2.1.7.2 Vegetative propagation

The species has a great capacity of vegetative propagation by coppice regeneration and suckering from stumps or roots. It can also be propagated by rooted cuttings and grafted using scions from mature trees. Current forest management relies on cultivation and natural regeneration supported by direct seed. The semethods are often unsuccessful. To improve seed germination, the seeds can be chopped using scalpel, knife, file, or hot wire. If a lot of seeds are infected, effective sterilization is to immerse the seeds in10%bleachfor 5minutes, and drain by immersion in lukewarm water or sulfuric acid, soaking them in lukewarm water for 24 hours, or by removing the seed layer with a sharp object (Kouyaté and Lamien , 2011).

2.1.8 Utilization

2.1.8.1 As Agroforestry

Detarium Microcarpum is well integrated in the traditional agroforestry systems of the Sahel, and it can be coppiced well (ABUBAKAR,2015).

2.1.8.2 As Food

The seeds and leaves are eaten as a condiment and vegetable (Kouyate and van Damme, 2006). The seed oil was reported to have low biogenic and oxidative rancidity; a desired property in oils meant for consumption, industrial purposes and pharmaceutical applications (Okorie , 2010).The kernel of the seed is deep purple brown, and is more or less oily and edible. Nutritionally, the seed which is used as a traditional soup thickener contain lipids, carbohydrates, proteins, crude fiber and the essential elements: Na, K, Mg, Ca, S, P and Fe (Abreu and Relva, 2002; Abreu , 1998). The fruit of *Detarium Microcarpum* is sweet and commonly eaten fresh, while the pulp is used in making cakes, as well as a substitute for sugar (NIMMA , 2015)

2.1.8.3 As Folk medicine

Detarium Microcarpum (Guill&Perr) **is catalogued as a major African medicinal plant** (Iwu, 1993).The bark leaves and roots of *Detarium Microcarpum* are widely used throughout its distribution area as diuretics and astrigents. They are prepared as infusions or a decoction to treat rheumantism, veneral diseases, urogenital infections, haemorrhoids, carries, biliousness, stomach-ache, intestinal worms and diarrhea including dysentery (Kouyaté, 2006).

Medicinal Uses

i. Fresh bark or leaves are applied to wounds, to prevent and cure infections; cutaneous, subcutaneous parasitic infection (ABUBAKAR,2015).

ii. In Mali the bark is also used to treat measles, nocturia, hypertension, itch and tiredness, while a decoction of the leaves or roots is taken against paralysis, meningitis, tiredness, cramps and difficult delivery.
iii. The powdered seeds are applied to skin infections and inflammations, whereas the fruit is eaten to cure meningitis and malaria.
iv. In Burkina Faso the fruit pulp is used for treating skin infections.
v. A preparation of the fruits is taken against dizziness in Niger and Togo.42
vi. In Senegal a mixture of the leaves of *Detarium Microcarpum*, Sclerocaryabirrea (A. Rich.) Hochst. and Acacia macrostachyaRchb. ex DC. Pounded in milk is considered very efficient for snakebites.
vii. In Benin a decoction of the leaves is taken to treat fainting and convulsions.
viii. In West Africa the roots are part of a medico-magical treatment for mental conditions, and for protection against bad spirits.
ix. In veterinary medicine the leaves and roots are used to treat diarrhea in cattlein southern Mali, and in Benin to treat constipation. In Niger cattle are made to inhale the smoke of the leaves to treat fever.
x. The plant as a whole is used in the treatment of arthritis, rheumatism, etc.;genital stimulants/depressants; leprosy; liver, etc. (Kouyaté, 2006).

2.1.8.4 As Fodder

The leaves and flower are used as fodder, and the seeds as pig feed (Kouyaté, 2006).

2.1.8.5 Other uses

West Africa the roots are part of a medico-magical treatment for men conditions, and for protection against bad spirits. In veterinary medicine the leaves and roots are used to treat diarrhea in cattle in southern Mali, and in Benin to treat constipation. In Niger cattle are made to inhale the smoke of the leaves to treat fever (Kouyate and van Damme, 2006). The seeds are used as frankincense and to make necklaces for women. *Detarium Microcarpum* produces timber which can serve as mahogany substitute. Its hard dark brown wood provides very good quality timber, which is used in carpentry and construction (Vautier , 2007). It is also used for good quality charcoal and fuel wood delivering 19 684 kJ kg-1 of calorific power (Kaboré, 2005). It is the most important commercial fuel wood species and is harvested preferentially from the state forests in Burkina Faso (Kaboré, 2005; Savadogo ,2007). Its foliage are avoided by animals and the roots used in perfume (Vautier ,2007). In southern Mali the leaves are used as roofing material, and as organic fertilizer. In Burkina Faso the leaves are used to make masks (Kouyaté, 2006).

2.2 Jam processing

2.2.1 Definition

Jam is generally defined as a solid gel made from fruit pulp or juice, sugar and added pectin. The jam can be made from a single fruit or a combination of fruits. The fruit content should be at least 40 % with a total sugars content of not less than 68% (ICUC, 2004).

2.2.2 Jam ingredients

For making a good jam three main ingredients are needed. These are pectin, sugar, and acid. The pectin forms the gel structure which makes the jam firmer rather than a runny pulp of juice. The sugar and acid are necessary to make the pectin set into a firm gel (Malcolum, 2005; Pradeep, 2013).

2.2.2.1 Pectin

Pectin is found in most fruits with different levels according to fruit type and maturity. Unripe fruits have a lot of pectin which gives the fruit its firm and hard texture. As a fruit ripens, the pectin is broken down and so the fruit becomes soft and easy to eat. Some fruits provide enough pectin for jam or jelly making whilst others need to have pectin added from another source. Usually, fruit with high pectin content can be added to fruit with a low pectin content to give an adequate amount of pectin (Kordylas, 1990; Pradeeb, 2013).

2.2.2.2 Sugar

Sugar is present in all fruits but it is not enough to preserve the jam or jelly. In order to preserve the jam or jelly a higher sugar concentration is needed, also it helps the pectin to form a firm gel structure. Normally an equal amount of sugar is added to the fruit pulp or juice and then any excess water is evaporated to give the required sugar concentration (Kordylas, 1990; Pradeeb, 2013).

2.2.2.3 Acid

Acid is necessary for three purposes: (1) It helps the pectin to set into a firm gel. (2) It prevents sugar crystallization. (3) It improves Jam colour and flavour. All fruits contain organic acids which differ in the different fruit varieties. Some fruits provide enough acid for a good jam, while, in others acid should be added from another source. The organic acids in fruits are usually citric acid, malic acid and tartaric acids. These acids are available in powdered form. If the powdered acids are not available, fruits with high acid content can be mixed with fruits with low acid content to give enough acid for a good gel formation. Lemon or lime juice is generally used, also, some

unripe fruit can provide a high acid content (Kordylas, 1990 and Pradeeb, 2013).

2.2.3 Jam processing methods

Jam can be commercially produced by using two methods. The first one is the open pan method which gives the product a traditional flavour with some carmelization of sugars. In the second commercial process, jam is produced under vacuum to reduce its boiling temperature to 65-80 °C. The lower boiling temperature retaining more of the volatile flavouring compounds from the fruit, preventing sugar carmelization and of course reducing the over-all energy required to make the product . All the ingredients must be added in carefully measured amounts. Too much pectin will make the spread of jam too hard, while, too much sugar will make the jam too sticky (Anwar, 2010).

2.2.3.1 Jam processing steps

2.2.3.1.1 Receiving of raw material

When the fruits arrive at the plant, it should be inspected for their quality characteristics, weight and impurities. After that, the fruits are loaded into a funnel-shaped hopper which carry the fruits into pipes for cleaning and crushing (Ward, 2000; Elsayaid, 2008).

2.2.3.1.2 Cleaning, crushing and chopping

As the fruit travels through the pipes, a gentle water spray clears away the dirts at the fruit surface. Some fruits, such as citrus and apples may be manually peeled, cored, sliced and diced. Cherries may be soaked and then pitted before being crushed (Elsayaid, 2008).

2.2.3.1.3 Cooking

Premeasured amounts of fruit and/or juice, sugar, and pectin are blended in steam cooking kettles and cooked until the mixture reaches the required thickness and sweetness. Then, the flavorings may be added and the mixture is pumped to the filling machines (Elsayaid, 2008).

2.2.3.1.4 Filling

Pre sterilized jars are filled with premeasured amounts of jam. Then, automatically sealed under vacuum condition to insure the sterility of the end product (Elsayaid, 2008).

2.2.3.1.5 Labeling and packaging

The sealed jars are mechanically conveyed to a labeling machine. These labels must list truthful and specific information about the product. The jars are then packed into cartons for marketing (Kopjar and Sajple, 2009).

2.2.3.1.6 Storage

The jam jars should be stored in a cool, dry, and dark place at temperature between 50 and 70 °F. The product will be kept well for at least one year (Kopjar and Sajple, 2009).

2.3 Jam Quality and specifications

As reported by SSMO (2006), fruits that used in jam production should be clean, uniform with high quality. Only mature fruits, without mould,excessive bruisingorinsectdamageshouldbeused.Alsostems,leaves,skinsshouldberemoved. Moreover, all jam ingredients should be accurately weighed. In addition to that, the pectin powder should be thoroughly mixed with some sugar and boiled water to prevent lumps which lead to a weak gel formation. according to the SSMO (2006) specifications, a good quality jams should have total soluble solids, pH, invert sugar, and titrable acidity, between 65 - 70 %, 3.1 - 3.4, 20 - 28 % and 0.5 - 0.7, respectively. as mentioned by Onsa (2007), good quality jams should have total soluble solids, pH, acidity and reducing sugars between 67-70%, 3.2-3.4, 0.3-0.8% and 20-28% or 28-32%, respectively. Elsayaid (2008) reported that a good quality jam should contain 66.0% total soluble solids, 3.6 pH, 0.56 acidity, 62.6% total sugars, 22.9% reducing sugars, and 0.5 colour. As stated bythe Codex (2009), the quantity of fruit pulp or fruit purée or both used for every 1000 grams of the finished product should be not less than:

(i) 250 grams in the case of redcurrants, blackcurrants, rosehips, rowanberries, sea buckthorns or quinces.
(ii) 150 grams in the case of ginger.
(iii) 160 grams in the case of cashew apples.
(iv) 60 grams in the case of passion fruit.
(v) 350 grams in the case of any other fruit.

According to the food processing regulations in the United States, jams should be made with 45 parts fruit or juice to 55 parts sugar. Also, the Federal Food and Drug Administration (FDA) mandates mentioned that all heat-processed canned foods must be free from live microorganisms (Codex, 2009). Javanmard (2010) reported that a good jam should contain total soluble solids, pH and titrable acidity between 67-70 %, 3.2 - 3.4 and 0.3 - 0.8 %, respectively. Numerous quality control checks at all points during the preparation process should be installed for testing taste, colour and consistency.

CHAPTER THREE
MATERIALS AND METHODS

3.1 Materials

Sample of ripe Abu leilefruits *(Detarium Microcarpum Guill& Perr)* was obtained from Ghubayshmarket in North kordofanState at the harvesting season (April-2019). The sample was tightly kept in polyethylene bags at 22C˚ until needed for the different investigations.

3.2 Methods:

3.2.1 The proximate analysis

3.2.1.1 Moisture determination:

Moisture content was determined according to AOAC (1990) as follows: Two grams of each sample were weighed in clean dry and pre-weighed crucible and then placed in an oven at 105C˚ and left overnight. The crucible was transferred to desiccators and allowed to cool and then weighed. Further placement in the oven was carried out until constant weight was obtained. Moisture content was calculated using the following formula:

$$MC\% = \frac{(W2-W1)-(W3-W1)}{W2-W1} \times 100$$

Where:

Mc: moisture content,

W1: weight of empty crucible

W2: weight of crucible with the sample,

W3: weight after drying.

3.2.1.2 Ash content:

Ash content of the sample was determined according to the method of AOAC (1990) as follows: Tow grams of sample were placed in a clean dry pre-weighed crucible, and then the crucible with its content ignited in a muffle furnace at about 550c for 3hours or more until light gray ash was obtained. The crucible was removed from the furnace to a10esiccators to cool and then weighed. The crucible was reignited in the furnace and allowed to cooling until a constant weight was obtained. Ash content was calculated using following equation:

$$AC\% = \frac{W2-W1}{W3} \times 100$$

Where:

Ac: ash content.

W1: weight of empty crucible.
W2: weight of crucible with ash.
W3: weight of sample.

3.2.1.3 Crude protein:

Crude protein of the sample was determined by using the micro-Kjeldahl method according to AOAC (1990) as follows:

1.Digestion:

Amount of 0.2 gram of sample was weighed and placed in small digestion flask (50 ml). About 0.4 gram catalyst mixture (96% anhydrous sodium sulphate and 3.5% copper sulphate) was added, 3.5 ml of approximately 98% of H2SO4was added. The contents of the flask were then heated on an electrical heater for 2 hours till the color changed to blue-green. The tubes were then removed from digester and allowed to cool.

2. Distillation:

The digested sample was transferred to the distillation unit and 20 ml of NaOH (40%) were added. The ammonia was received in 100 ml conical flask containing10 ml of 2% boric acid plus 3-4 drops of methyl red indicator. The distillation was continued until the volume reached 50 ml.

3. Titration:

The content of the flask were titrated against 0.02 N HCL. The titration reading was recorded. The crude protein was calculated using the following:

$$CP\% = \frac{(T - B) \times N \times 14 \times 100 \times 6.2}{Ws \times 1000}$$

Where:

CP= crude protein
T= Titration reading
B= Blank titration reading
N= normality of HCL
W_s= sample weight
1000 = to convert to mg

3.2.1.4 Fat content:

Fat was determined according to the method of AOAC (1990) using soxhlet apparatus follows:

An empty clean and dry exhaustion flask was weighed. About 2 gram of sample was weighed and placed in a clean extraction thimble and covered with cotton wool. The thimble was placed in an extractor. Extraction was carried out for 8 hours with petroleum ether. The heat was regulated to obtain

at least 15 siphoning per hour. The residual ether was dried by evaporation. The flask was placed in an oven at 105°C till it dried completely and then cooled in a desiccators and weighed. The fat content was calculated using the following equation:

$$FC\ (\%) = \frac{W2 - W1}{Ws} \times 100$$

Where

FC= Fat content

W1= Weight of extraction flask

W2= Weight of extraction flask with fat

Ws= Weight of sample

3.2.1.5 Total carbohydrates

Total carbohydrates were calculated by difference according to the following equation:

Total carbohydrates = 100% - (Moisture + Protein + Fat + Ash).

3.2.1.6 Crude fiber:

Crude fiber was determined according to AOAC (1990). Two grams of defatted sample were treated successively with boiling solution of H_2SO_4 and KOH (0.26 N and 0.23 N, respectively). The residue was then separated by filtration, washed and transferred into a crucible then placed into an oven adjusted to 105°C for 18 – 24 hours. The crucible then with the sample was weighed and ached in a muffle furnace at 500°C and weighed. The crude fiber was calculated using the following equation:

$$CF\ (\%) = \frac{W1 - W2}{Ws} \times 100$$

Where:

CF = Crude fiber

W1 = Weight of crucible with sample before ashing

W2 = Weight of crucible with sample after ashing

Ws = weight of sample

3.2.1.7Total, reducing and non-reducing sugars

The total sugars as well as reducing and non-reducing sugars were determined according to Lane and Eynontitrometric method as described by the Association of Official Analytical Chemists (**AOAC, 1984)**.

Principle: Reducing sugars in pure solution in plant materials after suitable pre-treatment (to remove interference substances) may be estimated by using copper sulphate as oxidizing agent in a standard Fehling's solution.

Sample preparation:

(A) Reducing sugars

A sample of 10 gm + 1 mg was weighted and transferred to 250 ml volumetric flask. 100 ml of distilled water was carefully added and then neutralized with 1.0 N NaOH to a pH 7.5 – 8.0. Then, about 2 ml of standard lead acetate (NO. 23500, BDH, England) was added and the flask was shaked and left to stand for 10 min. After that, 2 ml of sodium oxalate were added to remove the excess amount of lead acetate and the solution was made up to volume (250 ml) with distilled water and filtered.

(B)Total sugars

From the previous clear sample solution, 50 ml was pipetted into a 250 ml conical flask and 5 gm citric acid and 50 ml distilled water were added slowly. Then, the mixture was gently boiled for 10 min to complete the inversion of sucrose and left to cool at room temperature. After that, the solution was transferred to 250 ml volumetric flask, neutralized with 20% NaOH solution in the presence of few drops of phenolphthalein (NO. 6606 J. T Baker, Holland) until the colour of the mixture disappeared and the sample was made up to volume before titration.

Procedure:

A volume of 10 ml from the mixture of Fehling's (A) and (B) solutions was pipetted into 250 ml conical flask. Then, sufficient amount of the clarified sugars solution was added from burette to reduce Fehling's solution in the conical flask. After that, the solution was boiled until a faint blue colour is obtained. Then, few drops of methylene blue indicator (S-d-FINE-CHEM LIMITED) were added to Fehling's solution and titrated under boiling with sugars solution until brick-red colour of precipitate cuprous oxide was observed. Finally, the titer volume was recorded and the amount of inverted sugars was obtained from Lane and Eynon Table. The total sugars, reducing and non-reducing sugars were calculated by using the following formulas:

Calculation:

$$\text{Total sugars \{\% DM\}} = \frac{\{\text{invert sugar (mg)} \times \text{dilution factor}\}}{\text{Titre} \times \text{sample weight (g)} \times (100\% - \text{moisture \%}) \times 1000} \times 100$$

[eq.7]

$$\text{Reducing sugars \{\% DM\}} = \frac{\{\text{invert sugar (mg)} \times \text{dilution factor}\}}{\text{Titre} \times \text{sample weight (g)} \times (100\% - \text{moisture \%}) \times 1000} \times 100$$

[eq.8]

Non-reducing sugars {% DM} = {Total sugars (%) – reducing sugars (%)}

Where: Titre = (Sample – blank).

[eq.9]

3.2.1.8 Minerals content

Ten milliliters (10 ml) of HCL (2N) were added to the remaining ash sample and placed in a hot sand path for about 10-15 min. After that, the sample was diluted to 100 ml in a volumetric flask and filtered. The trace elements ferrous manganese (Mn^{++}) were determined according to **Perkin Elmer (1994)** by using Atomic Absorbance Spectroscopy (JENWAY 3110, UK). Sodium (Na) and potassium (K) were determined by using Flame Photometer (Model PEP7 JENWAY). While, calcium (Ca), magnesium (Mg), and phosphorus (P) were determined as described by **Chapman and Parratt (1961)**

3.2.1.9 Titrable acidity

The titrable acidity of **Abu leile** jam was determined according to **Ranganna (1979).**

Procedure:

50 gm ± 1g sample was diluted to 100 ml, and boiled in water for 30 min. Then 20ml of the diluted solution was titrated against (0.1N) sodium hydroxide using phenolphthalein solution (1%) as an indicator. The titrable acidity was calculated as percent citric acid according to the following equation:

Titrable acidity (%) =

$$\frac{[\,(\text{Titre} \times \text{N}\,(\text{NaOH}) \times \text{equivelent wt of cetric acid} \times 100)] \times 100\%}{\text{sample volume}\,(\text{ml}) \times \text{initial wt. of sample}(\text{g}) \times 1000}$$

[eq.12]

3.2.1.10 Food energy value

The energy value of **Abu leile** jam product was calculated based on Atwater factors as indicated by **Leung (1968).** factors as indicated by **Leung (1968).**

Protein = 3.87 K. cal/g

Fat = 8.37 K. cal/g

Carbohydrate = 4.12 K. cal/g

K. cal = 4.184 kj

3.3 Method of Processing of Abu leile fruits jam

3.3.1 Extraction of Abu leile fruit pulp

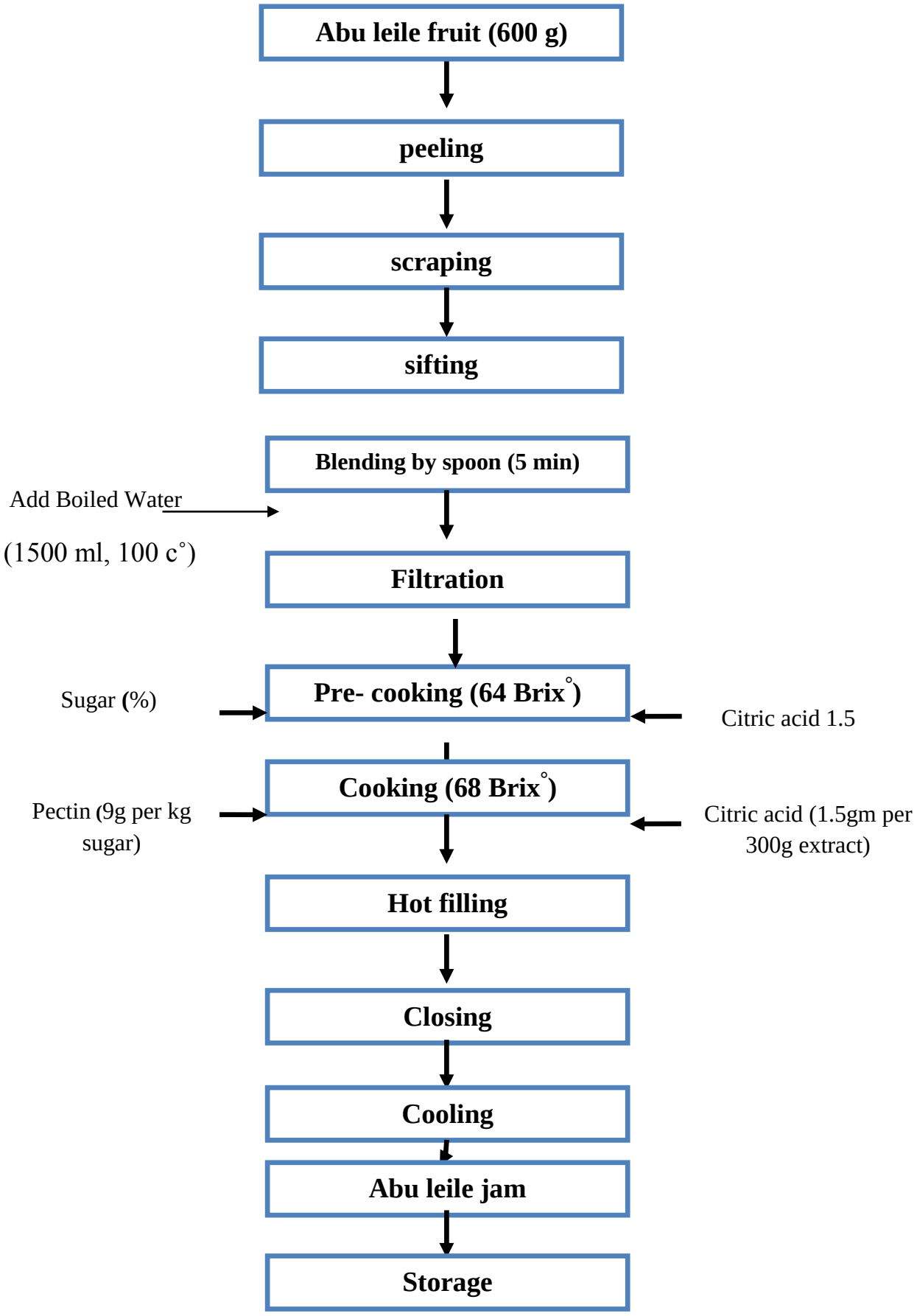
The healthy ripe fruits were selected and peel the fruit, then the pulp was extracted by scraping using (knife) and then the powder resulting from

scarping process was collected and sifted to get remaining peels and fibers.

3.3.2 Processing of Abu leile fruits jam

After determination of the suitable method and processing conditions for production of Abu leile fruits extract, 300g of the extract was then blended with boiled water (1500 ml) for 5 mint.s Then the mixture was filtered, and fruits extract after filtration was used for production of Abu leile jam.

Fig (1) shows the follow diagram of Abu leile jam processing .



3.3.3 Physio-chemical methods

3.3.3.1 Total soluble solids

The total soluble solids as percent (T.S.S %) in the different samples were measured as described by **Ranganna (2001)**.

Principle: The index of refraction of a substance is a ratio of light velocity under vacuum to its velocity in the substance which is largely dependent on the composition, concentration and temperature of the sample solution.

Procedure: After the adjustment of the Hand-Refractometer (No.002603, BS-eclipse, UK) with distilled water, the sample was placed on the surface of the refractometer prism, the prism was closed and the reading was recorded to the nearest 0.01 as T.S.S %.

3.3.3.2 Hydrogen ions concentration

The hydrogen ions concentration (pH) of the different samples was determined as described by **Ranganna (2001).**

Principle: The pH value of the different samples was measured with a pH-meter. After standardization of the pH-meter electrodes with buffer solutions, the reading of the sample is recorded as pH value.

Procedure: After standardization of the pH-meter (N0.478530, Hanna, India) with buffer solutions (pH 4.01 and 7.01), the electrode of the pH-meter was rinsed with distilled water, immersed in the sample and left to stand until a staple reading was achieved. All the readings were expressed as pH to the nearest 0.01-pH units.

3.3. 4 Jam organoleptic evaluation method

Abu leile jam products were sensory evaluated as described by **Ranganna (2001).** In this method, 20 trained panelists (Quality control engineers) from Saeed Food Factory, were tested to evaluate the products with regard to their colour, flavour, taste, consistency and overall Quality using the following Quality scales :

1= excellent, 2= very good, 3= good, 4= acceptable, 5= unacceptable.

3.3.5 Statistical analysis method

The results were subjected to Statistical 8 by using Completely Randomized Design . The Mean values were also tested and separated by using Duncan's Multiple Range Test (DMRT) as described by Steel, (1997).

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Nutritional value of Abu leile fruits

4.1.1 Chemical composition of Abu leile fruit

Table (1) shows the chemical composition of Abu leile fruits pulp on dry basis. The dry matter, total carbohydrates, crude fiber and total sugars were found to be 91.93%, 83.45%,0.13 % and 28%, respectively on dry basis. Among the total Sugars the reducing sugars and non-reducing sugars constitute about 6.6% and21.4%, respectively.

4.1.2 Minerals content of Abu leile fruit

Table (2) shows the minerals content of Abu leile fruits pulp on dry basis as mg/kg. From the results, the fruits pulp was found to be very rich in calcium (1400mg), sodium (36 mg), magnesium (1560 mg), phosphorous (225mg), potassium (4780 mg), on dry weight basis. In general, the results of this study are in a good agreement with those reported earlier ASEAN Manual of Food Analysis First Edition2011**.**

4.2 Suitability of Abu leile fruits for jam production

4.2.1 Extraction of Abu leile fruit pulp

examined for its hydrogen ions concentration (5.8 pH), total soluble solids and yield (10%) .

4.2.1.1Chemical and physio-chemical characteristics of Abu leile fruits

The chemical and physic-chemical characteristics of Abu leile fruits are indicated in Table (3). From the results obtained in this study, weight of raw material 600g, water weight 1500g, weight of Abu leile extract 300g, total soluble solids (10%), hydrogen ions concentration (5.8).

Table (1): Chemical composition (%) of Abu leile fruits pulp

Chemical composition	On wet basis [n = 2 ± SD]
Moisture	8.07±0.05
Protein	3.015±0.00
Fat	1.23±0.155
Crude fiber	0.13±0.014
Total sugars	28 ±0.00
Reducing sugars	15.7±0.42
Ash	4.235±0.049

SD ≡ Standard deviation.

n≡ Number of independent determinations.

Table (2): Minerals content (mg/100g) of Abu leile fruits pulp

Minerals		On wet basis
		[n= 3± SD]
Sodium	[Na]	36±2
Potassium	[K]	4780±10
Calcium	[Ca]	1400±10
Magnesium	[Mg]	1560±10
Phosphorus	[P]	225±2

SD ≡ Standard deviation.

n ≡ Number of independent determinations.

4.2.2 Chemical and physio-chemical characteristics of Abu leile jam

The chemical and physic-chemical characteristics of Abu leile jam are indicated in Table (4). From the results obtained in this study, the product was found to meet the recommended levels of total soluble solids (68%), hydrogen ions concentration (3.20) and titratable acidity (0.4%) as reported by the **SSMO, 2006**, **Onsa (2007)** and **Javanmard (2010).**

4.2.3 Nutritional value of Abu leile jam

4.2.3.1 Chemical composition and energy value of Abu leile jam

The chemical composition and energy value of jam are shown in Table (5). From the results, moisture content (80.75%), protein (0.84%), fat (0.15%), total sugars (64.80 %), Reducing Sugars (15.7%), crude fiber (0.2%), ash (0.19 %), on wet basis. Therefore, the product was found to provide an adequate caloric value (78 k.cal/100g). The results obtained in this study are in good agreement with those published by **1-D-person-The Chemical Analysis of Food 6th edition 1972**.

Table (3):Physical and physio-chemical characteristics of Abu leile fruits extract

Parameter	Abu leile fruits extract
Weight of raw material	600 g
Water weight	1500 g
Weight of Abu leile extract	300 g
Total soluble solids (T.S.S %)	10
Hydrogen ions concentration (pH)	5.8

Table (4): Chemical and Physio-chemical properties of Abu leile jam

Chemical composition	**On wet basis**
	[n = 3 ± SD]
Total soluble solids (T.S.S %)	068.00 ± 0.00
Hydrogen Ion concentration (pH)	003.20 ±0.62
Titratable acidity (%)	000.41 ± 1.06

Table (5): Chemical composition and energy value of Abu leile jam

Chemical composition (%)	On wet basis
	[n = 2 ± SD]
Moisture	80.75±1.91
Protein	0.84±0.00
Fat	0.15±0.00
Total sugars	64.8±0.00
Reducing sugars	15.7±0.42
Crude fiber	0.2 ±0.00
Ash	0.19 ±0.02
Caloric value	78 k.cal

SD ≡ Standard deviation.
n ≡ Number of independent determinations.

4.2.3.2 Minerals content of Abu leile jam

Table (6) gives the minerals concentration in Abu leile jam as mg/kg on dry basis. The product was found to provide appreciable amounts of sodium (40mg), potassium (775mg), magnesium (150mg) and calcium (500mg). Therefore, the product was found with high nutritional value .

4.3.3 Organoleptic evaluation of Abu leile jam

The organoleptic evaluation of Abu leile jams was carried out by using 20 trained panelists (Quality control engineers) from Saeed Food Factory. Abu leile jam products with or without flavour were sensory evaluated as described by **Ranganna (2001).**

The results in Table (7) show the recorded scores by the panelists for the different Abu leile jam samples with respect to their colour, taste, flavour, consistency and overall quality. In general, both Abu leile jams that produced with or without flavour were highly accepted by the panelists. But, significant differences were found between the two products with respect to their colour, consistency and overall quality. However, Abu leile jam that produced with strawberry flavour was highly preferred by the panelists in comparison with that produced without any flavour.

Table (6): Minerals content of Abu leile jam

Minerals		**On wet basis** (mg/100g) (n =3± SD)
Sodium	[Na]	40.0 ± 1.0
Potassium	[K]	575.3 ± 2.51
Calcium	[Ca]	500.0± 5.0
Magnesium	[Mg]	150.0 ± 3.0
Phosphorous	[p]	72.5 ± 0.50

SD ≡ Standard deviation.
n ≡ Number of independent determinations.

Table (7): Organoleptic evaluation of Abu leile jam product

Jam samples	Quality characteristics				
	Colour	Taste	Flavour	Consistency	Overall quality
	(Score, n = 20± SD)				
A	2.43[a] ±0.97	2.71[a] ±1.10	2.86±1.06[a]	2.71 [a] ± 0.84	3.10 [a] ± 0.70
B	3.29 [b] ±1.18	3.38 [b] ±1.32	3.90[a] ±1.17	3.67 [b] ± 1.39	3.67 [b] ± 1.06
$Lsd_{0.05}$	0.68[*]	0.76[NS]	0.70[*]	0.71[*]	0.56[*]
SE±	0.34	0.38	0.35	0,36	0.28

Scale: 1 = excellent, 2 = very good, 3 = good, 4 = acceptable, 5 = unacceptable
A ≡ Abu leile Jam without flavour.
B ≡ Abu leile Jam with strawberry flavour .
SD ≡ Standard deviation.
Mean ± S.D value (s) bearing different superscript letter(s) within columns are significantly different (P≤0.05).
* ≡ Significant at (P≤0.05).
n.s ≡ Not significant.
$Lsd_{0.05}$ ≡ Least significant difference at (P≤0.05).
SE± ≡ Overall experimental error

CHAPTER FIVE
CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From the results obtained in this study it can be concluded that Abu leile fruits are found to be suitable for production of jam with high nutritional value and energy value and with appreciable amounts of sodium, potassium, magnesium, calcium and highly accepted by the panelists.

5.2 Recommendations

1. Awareness of people to nutritional value, economical importance of Abu leile fruits is recommended.
2. Utilization of Abu leile fruit in jam production will make the product very cheap and affordable especially for low income groups in Sudan.
3. The industrial utilization of Abu leile fruits in jam production in Sudan should be encouraged.
4. We recommend Adding flavor to product (Abu leile jam) because consumer Acceptance of it has been so great.

REFERENCES

Abreu P, Relva A (2002). Carbohydrates from *Detarium Microcarpum* bark extract. Carbohydrate Research 337: 1663-1666.

Akpata, MI, Miachi OE (2001). Proximate composition and selected functional properties of *Detarium Microcarpum* Plant Foods Human Nutr. 56: 297-302.

Anwar, F. Tasnim, Jr. Hossain, M. Kamal, M. Hossain, D. LopaandFormuzul, K. Haque. (2010). Quality Assessment of Industrially Processed Fruit Juices Available in Dhaka City, Bangladesh Council of Scientific and Industrial Research, Dhanmondi, Dhaka, Bangladesh, 1205, pp 431-438.

AOAC (1990). Official Methods of analysis, 14th edition, Washington D.C. Association of Official Analytical chemists.

ASEAN Manual of Food Analysis First Edition 2011.

Cavin AL.(2007). Contribution à la connaissance taxonomi queetchimique de fruits africains du genre *Detarium* (Fabaceae–Caesalpinioideae): *Detarium Microcarpum Guill&Perr*. et des formes comestibles et toxiques de *Detarium* senegalenseJ.F. Gmel.Thèse de Doctorat. Univiversité de Génève, Suisse. 277 pp.

Codex (2009). Codex General Standard for Jams, Marmalade and Jelly. CODEX STANDARD, France. (240), P12.

D-person-The Chemical Analysis of Food 6th edition 1972.

Elsayaid, E. Eshtiag. (2008). Using Roselle as Natural Colorant

FAO (1992). Codex Alimentarius: Volume 6, Fruit Juices Related Products.

FAO (1995). Fruit and Vegetable Processing. FAO Agric. Serv. Bull. p. 119.

FAO (1997). Guidelines for Small-scale Fruit and Vegetable Processors. FAO Agric. Serv. Bull. p.127.

Helen Vautier, M. S. (2007, September). *Detarium Microcarpum Guill. & Perr.* Seed Leaflet.

ICUC (2004). Processing of Jam and Jelly. International Center for Underutilized Crops, UK in Jam Making. M.Sc. in Food Science and Technology, Dept. of Food Technology, Khartoum University, Khartoum, Sudan.

Ikhiri A, Ilagouma AT (1995)._ Constituents of *Detarium Microcarpum* bark. Fitoterapia 46: 274.274.

Kopjar, M. and Sajple, M. (2009). Strawberry Jams: influence of different pectins on colour and textural proprities. Journal of Food Science. (27): 20-28.

Kordylas, J. M. (1990). Processing and preservation of tropical and sub-

tropical foods. Mac Millan, Education Ltd, Hong Kong.

Kouyaté AM and Lamien N 2011.*Detarium Microcarpum*, sweet detar.Conservation and Sustainable Use of Genetic Resources of Priority Food Tree Species in sub-Saharan Africa. Bioversity International (Rome, Italy).

Kouyaté AM and van Damme P. 2006. *Detarium Microcarpum Guill*. &*Perr*. [Oniline].Record from Protabase. Schmelzer GH and Gurib-Fakim A, editors. PROTA (Plant Resources of Tropical Africa/Ressourcesvégétales de l'Afriquetropicale), Wageningen, The Netherlands. Available at: http://database.prota.org/se arch.h tm. Accessed 18 February 2010.

Kouyaté AM, van Damme P, de Meulenaer B and Diawara H. 2009. Contributiondesproduits de cueillettedansl'alimentationhumaine. Cas de *Detarium Microcarpum*. Afrika Focus 22(1):77–88.

Kouyaté AM. 2005. Aspects ethnobotaniquesetétude de la variabilité morphologique ,biochimique et phénologique de *Detarium Microcarpum* Guill &Perr. au Mali. Thèse de Doctorat. FacultédesSciencesBiologiquesAppliquées,Université de Gand, Belgique. 207 pp.

Ky-Dembele C, Tigabu M, Bayala J, Ouédraogo JS and Odén PC. 2008. Comparison between clonal and sexual plantlets of *Detarium Microcarpum* Guill&Perr. asavanna tree species in Burkina Faso. African Journal of Ecology 46(4):602–611.

Larmond E (1982). "Laboratory Methods for Sensory Evaluation" Research Branch, Canada Department of Agriculture. Publication 1636, Ottawa, Canada.

Malcolm, B. D.(2005). Science and Technology of Jams and Jellies. The Northeast Center for Food Entrepreneurship , New work State. Food Venture Center, Cornell University, USA.

Mariod, A. A. (2009). *Detarium Microcarpum Guill*&Perr fruit proximatechemical analysis and sensory characteristics of. African Journal of Biotechnology, 8 ((17)), 4217-4221.

Meda AL, Lamien CE, Compaore MMY, Meda RNT, Kiendrebeogo M, Zeba B, Millogo JF, Nacoulma OG (2008). Polyphenol Content and Antioxidant Activity of Fourteen Wild Edible Fruits from Burkina Faso. Molecules. 13: 581-594.

Nimma,y, R (2015). Effect of The Extracts of stem bark of *detarium microcarpum* and leaves of *vitexdoniana* on alpha glucosidase and alpha amylase acticvivity.

Onweluzo J.C; Obanu Z.A and Onuoha K.C (1994). Functional properties of some lesser known tropical legumes. J. Food. Sci. Technol. 31: 302-306.

Onweluzo J.C, Vijayalakshmi M.R, Vijayanand P, Eipeson W.E (1999).*Detarium Microcarpum* polysaccharide as a stabilizer in processed fruit products. Lebensm-Wiss. u.-Technol. 32: 521-526.

Ranganna, S. (2001). Handbook of Analysis and Quality Control for Fruits and Vegetables Products. 2nd ed., Tata. Mc-Grow Hill Published Company Limited, New Delhi, India.

SSMO (2006). Standards Specification of Jams Jellies and Marmalade. Sudanese Standardization and Metrology Organization, Khartoum , Sudan. 34,23.

Umar K.J, Hassan L.G;and ADO Y (2007). Minerals composition of *Detarium Microcarpum* grown in Kwatarkwashi, Zamfara State, Nigeria. Int. J. Pure Appl. Sci. 1(2): 43-48.

Vautier H, Sanon M and Sacande M. 2007. *Detarium Microcarpum Guill* &*Perr*. Seed Leaflet 122. Forest & Landscape Denmark, Hørsholm, Denmark. Availableat: http://en.sl.life.ku.dk/upload/122net.pdf. Accessed 18 February 2010.

Ward, K. A. (2000). Canning and Preserving for Dummies**.**2nd ed., Published by John Willey and Sons, New York, USA.

APPENDICES

Appendix 1: Abu Leile Fruit

Appendix 2: Abu Leile jam

Appendix 3: Sensory evaluation of Abu Leile jam