# COMPARATIVE ASSESSMENT OF MECHANICAL AND SOLVENT EXTRACTION OF BENISEED (*Sesamum indicum*) OIL

BY


EGWURUBE, ODAGBA FRIDAY

2006/24102EA

DEPARTMENT OF AGRICULTURAL & BIORESOURCES ENGINEERING

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA



FEBRUARY, 2012

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MATRIC. NO 2006/24102EA

BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF ENGINEERING (B.ENG) DEGREE IN AGRICULTURAL AND BIORESOURCES ENGINEERING FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE

FEBRUARY, 2012

# CERTIFICATION

This is to certify that the project entitled "Comparative Assessment of Mechanical and Solvent Extracted Beniseed (*Sesamum indicum*) oil" by Egwurube, Odagba Friday meets the regulations governing the award of the degree of Bachelor of Engineering (B. ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

| | |
|---|---|
| Engr. Mrs. B.A Orhevba<br>Supervisor | 27/02/2012<br>Date |
| Engr. Dr. Peter A. Idah<br>Head of Department | 27/02/2012<br>Date |
| External Examiner | 22-02-2012<br>Date |

## DECLARATION

I hereby declare that this project work is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communication, published works were duly referenced in the text.

Egwurube Odagba, Friday

2006/24102EA

29/02/2012

Date

## DEDICATION

This project is dedicated to Jehovah the almighty God.

# ACKNOWLEDGEMENTS

My profound gratitude goes t Jehovah for his mercies, guidance, wisdom and blessings throughout these years, may his mercy continue to bless me in all endeavors.

My gratitude goes to my supervisor Engr. Mrs. B.A Orhevba who despite her tight schedule was still able to give me professional advice, understood and cared as a mother throughout the period of my project in making it a success. I also acknowledge my HOD., Engr. DR. Peter, A Idah, my honorable lecturers for their relentless efforts in imparting knowledge to me, especially Engr. Dr I.E Ahaneku for his fatherly advice, may God grant you success in all you do, also the technologists in the Agricultural and Bioresources Engineering Laboratory for their technical advice throughout these times.

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Egwurube, Odagba Friday.

## ABTRACT

This study was carried out to extract oil from beniseed using two methods of extraction, solvent and mechanical methods and determine the physicochemical properties as well as the proximate composition of these seeds in relation to the extraction methods. The moisture content of the oil was determined as 16.7% and 18.33% dry basis for solvent and mechanical methods respectively, the oil yield for both methods were 40% and 33.4% respectively for solvent and mechanically extracted oil. Physicochemical properties such as; Viscosity, Refractive index, Specific gravity, Colour, Odour, Acid value, Peroxide value, Saponification value, Iodine value and Free fatty acid, were obtained using the AOAC, 2(004) method and the mean values gotten respectively were; 64mm/s and 75mm/s (both at 20$^{o}$C), 1.478 and 1.693, 0.844 and 0.946, Bright yellow and Cloudy yellow, Beniiseedodour for both, 9.03mgKOH/g and 2.167mgKOH/g, 3.44meq/kg and 2.00meq/kg, 158.622mgKOH/g and 161.26mgKOH/g, 94.159wijis and 103.043wijis, 9.98Mkoh/g and 1.09mgKOH/g. The proximate composition of the oil were also determined for both oils, this includes; Ash content, 0.5% and 1%, Carbohydrate, 62.55% and 57.58%, Crude fibre, 6.6% and 6.6%, Crude protein, 13.65% and 16.50% and Energy value 304KJ and 296.28KJ respectively for solvent and mechanical extraction methods. From the results obtained from the comparison, it can be concluded that the solvent extraction method reduced the level of viscosity of the oil as well as the Iodine and Saponification values, other physicochemical properties such as Odour, specific gravity, refractive index, free fatty acid, Peroxide and Acid values were slightly affected. The proximate composition (Ash, Carbohydrate, Crude fibre, Crude protein, Moisture contents) were not affected largely by any of the oil extraction methods used. Therefore, based on the usage of the oil, any of the extraction methods can be used for instance, mechanically extracted beniseed (*sesamum indicum*) for consumption while solvent extracted beniseed (*sesamum indicum*) for production of paints.

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# CHAPTER ONE

## 1.0 INTRODUCTION

### 1.1 Background to the study

Beniseed *(Sesamum indicum l.)* is a flowering plant in the genus *Sesamum*. Numerous wild relatives occur in Africa and a smaller number in India. It is widely naturalized in tropical regions around the world and is cultivated for its edible seeds, which grow in pods. The flowers of the sesame seed plant are yellow, though they can vary in color with some being blue or purple. It is an annual plant growing to 50 to 100 cm tall, with opposite leaves 4 to 14 cm long with an entire margin; they are broad lanceolate, between 2 to 5 cm broad, at the base of the plant, narrowing to just 1 cm broad on the flowering stem. The flowers are white to purple, tubular, 3 to 5 cm long, with a four-lobed mouth (Wikipedia, 2010). Beniseed otherwise known as sesame seeds are believed to be one of the first condiments as well as one of the first plants to be used for edible oil (Barbra, 2003).

According to Barbra (2003), beniseed *(Sesamum indicum)* is grown throughout the world and cultivated for its edible seeds. Sesame oil, which is a source of Vitamin E, is derived from sesame seeds. There are many varieties of sesame oil that range in flavor and color. it is used as cooking oil in Asian dishes, in body massage, as a hair treatment, in food and drug manufacture, in various practices of worship and as an industrial solvent. Its oil is frequently used as a vehicle for pharmaceuticals and also by bodybuilders who inject steroids from beniseed oil solution. The oil may have antioxidant properties as a result of the presence of sesame lignans, such as sesamin and sesamolin, which may have a synergistic effect with tocopherols and subsequent enhancement of Vitamin E activity. It is this effect that is thought to offer benefit in cardiovascular disease risk, hypercholesterolemia, hypertension, cancer, and immune system disorders. Chemo-preventive properties of lignans have been shown in vitro. Sesamin, a lignan constituent of beniseed, has shown antihypertensive, antihyperlipidemic, and anticancer activities in animal and in vitro research. Lignans have also been shown to be phytoestrogens (plant compounds that exert estrogenic or female hormonal effects). The antibacterial and anti-diabetic effects of sesame oil have also been studied in vitro, animal, and early human study.Some who practice traditional and alternative medicines believe that topical application of sesame oil alleviates symptoms of anxiety, nerve and bone disorders, poor circulation, lowered immunity, bowel problems, and skin dryness (Nelstock, 2004).

There are various methods of oil extraction from beniseed with each method having differing effect on the quality of the oil produced, this several methods includes, mechanical pressing, cold press, supercritical fluid, solvent extraction, steam and high pressure, and aqueous extraction methods.

- Mechanical extraction method : This is the most widely used method in extracting oil from oil seeds, however, the oil produced with this method usually has a low price, since it is turbid and contains a significant amount of water and metal content.
- Cold press method: this method of extraction of oil is also called cold-drawn, or virgin, oil, it is purer and has a better flavor than oil expressed with the aid of heat. After pressing the meals made from oily seeds or nuts, the remaining cake contains about 5 to 15 percent oil.
- Enzymatic extraction method: these method involves the use of enzymes such as; cellulase, hemi-cellulase, pectinase and pectinex as well as by pressing, for the extraction of oil from oil producing crops (Bahr, 2000).
- Supercritical extraction method: this method involves the use of supercritical fluids. The oil produced has very high purity. However, the operating and investment costs are high.

- Solvent extraction method: extraction using solvent has several advantages, it gives higher yield of oil and less turbid oil than mechanical extraction, relatively low operating cost compared whit the super critical fluid extraction and cold pressed methods.

Beniseed oil is used in dipping sauces, in dressings for slaws and salads, or as a seasoning for soups, steamed fish, poultry, and stir-fries. Sesame oil is often used in cooking, contains polyunsaturated fats, is easily digested, and is highly resistant to oxidative deterioration when compared to other edible oils. Sesame oil is considered one of the most important sources of dietary fat in African countries.

## 1.2 Statement of problem

The derivatives of beniseed though many, remain unknown to many people. Though the seed is widely known, its immense benefits and importance remain largely untapped and non-utilized despite its abundance. Despite the widely acclaimed benefits of sesame seed oil, it has remained largely unreported and under exploited, most especially in Nigeria

## 1.3 Objective of the study

- To extract oil from beniseed (*Sesamum indicum l*) using mechanical method.
- To extract oil from beniseed (*sesamum indicum l.*)using solvent extraction method.
- To determine the physical properties of the extracted oil.
- To determine the chemical properties of the extracted oil.
- To determine the proximate composition f the extracted oils.
- To compare the properties of the oils obtained from both methods of extraction.

### 1.4 Justification of the study

Beniseed oil is a very useful product because of its wide and varied uses which includes; cooking, medicinal, soap manufacturing, cosmetics and lubricants. Due to the low level of cholesterol, the health benefits of this oil are numerous and this makes it very important and useful for various consumption processes, in the light of this; research is needed to determine how the processing methods affects these much talked about properties. This research would further serve as an eye opener to many people who know little or nothing about this wonderful crop.

### 1.5 Scope of study

Two methods will be used in the extraction of oil from beniseed, the solvent extraction method and the mechanical method. The physical and chemical properties as well as the proximate compositions of the oil that will be determined will be limited to the following;Viscosity,Refractive index, Specific gravity, Color, Odor, Saponification value, Acid value, Iodine value, Peroxide value and Free fatty acid, Crude fibre, Ash, Crude protein, Carbohydrate, Moisture content and Energy value.

# CHAPTER TWO

## 2. 0 LITERATURE REVIEW

### 2.1 Historical Background of Beniseed

*Sesamum indicum,* (*indicum* meaning from India) is native to the East Indies. Usage dates back to 3000 B.C. Over 5,000 years ago, the Chinese burned sesame oil not only as a light source but also to make soot for their ink-blocks. African slaves brought sesame seeds, which they called *benné* seeds, to America, where they became a popular ingredient in Southern dishes. Through the ages, the seeds have been a source of food and oil. Sesame seed oil is still the main source of fat used in cooking in the near and Far East (Fillipone, 2003). The English term sesame traces back to the Arabic *simsim*, Coptic *semsem,* and early Egyptian *semsent*. Other Names includes; *Bene Seeds*, Beniseed, *Benne,Gingilli, Semsem, Simsim, Teel, Til,*French: *sesame*, German: *Sesam,* Italian: sesame, Spanish: *ajonjoli,sêsame*, Arabic*: tahina, tahine, tahini,*Chinese*: chimah, hak chi mah*, Indian: *gingelly,*Japanese: *goma, kurogoma,* Malay: *bene, bijanSesame* (Fillipone, 2003).

Beniseeds were one of the first crops processed for oil as well as one of the earliest condiments. The seeds contains up to 48 to 50% of oil (Bedigian, *et al,;* 1985, Ashri, 1989) prior to 600BC, the Assyrians used its oil as food, salve, and medication. The oil is composed of fatty acid, palmitic acid 12.0%, palmitoleic acid 0.5%, stearic acid 6.0%, oleic acid 50.0%, linolenic acid 1.0% and eicosenoic acid 1.0%. It is also a source of Vitamin E, which is an anti-oxidant and has been correlated with lowering cholesterol levels. The oil also contains Magnesium, Copper, Iron, Zinc, Calcium, and Vitamin B6.

The fruit serves as a symbol of wealth; when the fruit capsule opens; it releases a rare treasure of beniseeds. The seeds are protected by the capsule which does not open until the seeds are completely ripe. The ripening time tends to vary for this reason; the farmers cut plants by hand and place them together in upward position to continue ripeningfor a few days, the seeds are only shaken out onto a cloth after all the capsules have been opened. There are many variations in the color of the oil: cold pressed beniseed oil is pale yellow while Indian beniseed oil is golden, Chinese and Korean oils are commonly a dark brown color; the brown color is derived from roasted/toasted seeds (Wikipedia, 2011). Light beniseed oil has a high smoke point suitable for deep frying, while heavy (dark)oil has a slightly lower smoke point and is unsuitable for deep frying, instead, it can be used for stir frying of meat or vegetables or for making of an omelette (Microsoft Encarta, 2009).

Since the introduction into Nigeria, after the Second World War, it has been regarded as a crop of insignificant importance compared to groundnut and other cash crops (Onyibe, *et al.;* 2003). Beniseed is widely grown in the Northern Central part of Nigeria initially as a minor crop until 1974 when it became one of the major cash earners in many Northern states as Benue, Gombe, Kogi, Jigawa, Kano, Katsina, Nassarawa. It is an excellent source of high quality oil; the oil is very stable and free from undesirable nutrition and flavor components. The oil has a natural anti-oxidant such as sesame which prevent aging and vital for the production of the liver cells. Also, it is rich in protein; its protein has disable amino acid profile and good nutritional value similar to soya bean. It is this sterling attributes that stimulates the interest in the production of the crop (Onyibe, *et al*, 2003).The National Sesame Seed Association of Nigeria, stated that the increasing use of Sesame seeds for industrial use has resulted in its leading the oil and fats market such that Nigeria being the second largest producer of sesame seed in Africa, and ranking seventh in the World, should be deeply involved in exporting the commodity for economic gains (Onyibe, *et al.;* 2003).

### 2.2 Cultivation

Beniseed is grown in many parts of the world on over 5 million acres (20,000 $km^2$). The largest producers of the crop in 2007 were India, China, Myanmar, Sudan, Ethiopia, Uganda and Nigeria. Seventy percent of the world's beniseed crop is grown in Asia, with Africa growing 26% (Sesame profile, 2007). Beginning in the 1950s, U.S. production of the crop has been largely centered in Texas, with acreage fluctuating between 10,000 to 20,000 acres (40 to 80 km2) in recent years. The country's crop does not make up a significant global source; indeed imports have now outstripped domestic production (Sesame profile, 2007).

### 2.3 Climate

Beniseed is suitably planted at different times in different ecological zones, but adjustments needs to be made depending on when the rain is fully established (Onyibe, *et al,;* 2003). Some of these regions and their planting times are as shown on the table below;

**Table 2.1: Planting times and regions of sesame seeds**

| REGION | PLANTING TIME | |
|---|---|---|
| | Early Planting | Late Planting |
| Guinea savannah | March/April | July/August |
| Sudan savannah | Late June | Early July |
| Sahel Savannah | Early Rain | June/July |

Source: NAICPP (2003).

## 2.4 Diseases

Beniseeds like other crops are susceptible to pests and diseases, some of which are of economic importance. These diseases are classified into

- Fungal
- Bacterial, and
- Weed.

### 2.4.1Fungal Diseases

Beniseed plant is a host to many fungi pathogens on the field, but not all of them cause severe damage to the crop. There are four (4) important fungi pathogens that cause damage to the seed. They include:

- *fusariumsp:* this is a major fungi that affect the production of beniseed, it causes the collar and root rot of the plant leading to sudden death of the affected plant.
- *Cercospora:* this is also a major fungal disease which causes severe leaf spots
- *Phthiumsp:* these fungus causes damping off resulting in sudden death of young plants.
- *Seleroticumsp:* It affects the bases of their stems, producing a fan of silky white aeration and large round sclerotic. It is usually common on lands were beniseed is continually planted for several years (Uwala, 2002).

### 2.4.2 Bacterial disease

Bacterial disease is caused by xanthomonas sp. The initial symptoms are bright spots on the leaves resulting in drying of the growing tips.

### 2.4.3 Weeds

Weeds are very serious problem in beniseed production because they often cause drastic reduction in the yield. For optimum yield, the crop should be kept weed free from planting to harvesting as much as possible.

### 2.5 Harvesting

The beniseeds are harvested when more than fifty percent (50%) of the capsule changes from green to yellow, it is not allowed to be too dry before harvesting so as to reduce the loss of seeds by shattering and mixing with sand which is very difficult to separate (Onyibe,*et al,;* 2003).

### 2.6 Pests

Several pest attacks beniseed with the potential to reduce the yield of the crop,some of these causes moderate to severe yield losses, as a result of foliar feedings or damage to seeds, however, adopting appropriate cropping system may help curb these problems and check the pests. It is used as a food plant by the larvae of some Lepidoptera species, including the Turnip Moth (Onyibe, *et al;* 2003).

### 2.7 Nutrition and Health Benefits

The seeds are exceptionally rich in iron, magnesium, manganese, copper, and calcium and contain Vitamin B1 (thiamine) and Vitamin E (tocopherol) (WHF, 2007). They contain lignans, including unique content of sesamin, which are phytoestrogens with antioxidant and anti-cancer properties. Among edible oils from six plants, beniseed oil had the highest antioxidant content (Cheung, 2007), it also contains phytosterols associated with reduced levels of blood cholesterol. The nutrients of sesame seeds are better absorbed if they are ground or pulverized before consumption, as in *tahini*. It also contains a high amount of the anti-nutrient phytic acid (Bedigian, 1984).

Women of ancient Babylon would eat halva, a mixture of honey and beniseed seeds to prolong youth and beauty, while Roman soldiers ate the mixture for strength and energy (Wikipedia, 2010). Table 2.2 shows the nutritional values of beniseed kernels per hundred grams (100g).

**Table 2.2: Nutritional Values of Beniseed Kernels per Hundred Grams (100g)**

| Components | Amounts |
|---|---|
| Energy | 2,372 kJ (567 kcal) |
| Carbohydrates | 26.04 g |
| - Sugars | 0.48 g |
| - Dietary fiber | 16.9 g |
| Fat | 48.00 g |
| Protein | 16.96 g |
| - Tryptophan | 0.371 g |
| - Threonine | 0.704 g |
| - Isoleucine | 0.730 g |
| - Leucine | 1.299 g |
| - Lysine | 0.544 g |
| - Methionine | 0.560 g |
| - Cystine | 0.342 g |
| - Phenylalanine | 0.899 g |
| - Tyrosine | 0.710 g |
| - Valine | 0.947 g |
| - Arginine | 2.515 g |
| - Histidine | 0.499 g |
| - Alanine | 0.886 g |
| - Aspartic acid | 1.574 g |
| - Glutamic acid | 3.782 g |
| - Glycine | 1.162 g |
| - Proline | 0.774 g |
| - Serine | 0.925 g |

Source: USDA, (2006).

### 2.7.1Vitamins and Minerals

Sesame oil is a source of Vitamin E (CBS NEWS, 2004). Vitamin E is an anti-oxidant and has been correlated with lowering cholesterol levels. As with most plant based condiments, sesame oil contains magnesium, copper, calcium, iron, zinc, and vitamin B6. Copper provides relief for rheumatoid arthritis. Magnesium supports vascular and respiratory health. Calcium helps prevent colon cancer, osteoporosis, migraine, and PMS. Zinc promotes bone health. Besides being rich in Vitamin E, there is insufficient research on the medicinal properties of sesame oil.

### 2.7.2 Blood Pressure

Sesame oil has a high percentage of polyunsaturated fatty acids (Kimchi, 2001) (omega-6 fatty acids)—but it is unique if kept at room temperature. This is because it contains two naturally-occurring preservatives, sesamol and sesamin. (Normally, only oils predominately composed of the omega-9 monounsaturated oil, like olive oil, are kept at room temperature.)

It has been suggested that due to the presence of high levels of polyunsaturated fatty acids in sesame oil, it may help to control blood pressure. It could be used in cooking in place of other edible oils and to help reduce high blood pressure and lower the amount of medication needed to control hypertension (Wikipedia, 2011).The effect of the oil on blood pressure may be due to polyunsaturated fatty acids (PUFA) and the compound sesamin, a lignan present in beniseed oil. Table 2.3 shows the fatty acid contents of the oil per 100g of the beniseed kernel.

**Table 2.3: Fatty Acid contents of Beniseed oil per 100g**

| Fatty acid | Nomenclature | Minimum | Maximum |
|---|---|---|---|
| Palmitic | C16:0 | 7.0% | 12.0% |
| Palmitoleic | C16:0 | Trace | 0.5% |
| Stearic | C18:0 | 3.5% | 6.0% |
| Oleic | C18:1 | 35% | 50% |
| Linoleic | C18:2 | 35% | 50% |
| Linolenic | C18:3 | Trace | 1% |
| Eicosenoic | C20:1 | Trace | 1% |

Source: USDA, (2009).

### 2.7.3 Oil pulling

Oil pulling is a traditional Indian folk remedy that involves swishing oil in the mouth for claimed oral and systemic health benefits. It is mentioned in the Ayurvedic text *CharakaSamhita* where it is called *KavalaGandoosha* (Asokan, 2008). It is also used to reduce enamel wear from stomach acid and from vomiting. Sesame oil is one of the few oils recommended for use in oil pulling (Vsant, 2001). Sunflower oil is the other oil recommended in addition to olive oil.

### 2.7.4 Stress and tension

Various constituents present in the sesame oil have anti-oxidant and anti-depressant properties. Therefore proponents encourage its use to help fight senile changes and bring about a sense of well-being (Wikipedia, 2011).

### 2.7.5 General claims

Beniseed oil when used in infant massage, it is claimed, helps to calm babies and lull them to sleep and improves growth of the brain and the nervous system. These are claims similar to other therapeutic medicines, that it has antioxidants, which explains the beliefs that it slows the aging process and promotes longevity. A medical study by Agarwal, (2000) showed that infant massage with sesame oil improved the weight, length, and midarm and midleg circumferences of infants at a statistically more favorable rate than all other oils tested (Agarwal, *et al.*; 2000).

It is suggested that sesame oil, when consumed and/or topically applied, should relieve dryness both externally and internally. The oil is sometimes recommended to alleviate the dryness associated with menopause (Encyclopedia, 2001). It is believed that its use "restores moisture to the skin, keeping it soft, flexible and young looking". It is suggested that it relieves "dryness of joints" and bowels, and eases symptoms of dryness such as irritating coughs, cracking joints, and hard stools. Since "dryness of joints" is not a medically classifiable condition, it would be difficult to medically comprehend or verify these claims of panacea (Wikipedia, 2011).

Other uses include as a laxative, as a remedy for toothaches and gum diseases and in the treatment of blurred vision, dizziness, and headaches (Castor, 2001). It is suggested that the oil could be used in the treatment of dry nose, reduction of cholesterol levels (due to presence of lignans which are phytoestrogens), anti-bacterial effects, and even slowing down certain types of cancer (due to the anti-oxidant properties of the lignans) (Braish, 2001).

### 2.7.6 Mineral Content of Beniseed Kernel

According to the American heart association, no more than 10% of a person's total caloric intake should be derived from polyunsaturated fats such as those found in sesame oil (Encyclopedia, 2001). Table 2.4 shows some of the mineral contents of beniseed kernel.

**Table 2.4: Mineral contents of Beniseed Kernel per hundred grams (100g)**

| Minerals | percentage |
| --- | --- |
| Water | 5.00 g |
| Calcium | 131 mg (13%) |
| Iron | 7.78 mg (62%) |
| Magnesium | 346 mg (94%) |
| Phosphorus | 774 mg (111%) |
| Potassium | 406 mg (9%) |
| Sodium | 39 mg (2%) |

Source: USDA, (2006).

**2.8 Uses of Beniseed**

Beniseed is one of the first recorded plants used for its seeds. It has been used for thousands of years and is still an oil seed of worldwide significance.The simplest and now commonest use of sesame is as whole seeds sprinkled over cakes and breads, like poppy seeds. In Syria and Lebanon it is mixed with sumac and thyme to make the condiment *zatar*. Sesame is a key ingredient in halva, the Middle Eastern confection, where the seeds are ground and pressed into blocks with various sweet or nutty ingredients. Sesame in its ground form, *tahini*, is widely used throughout the Middle East and Mediterranean. It is a flavoring for *hummus*, a sauce for kebabs and is often mixed with lemon and garlic to make a bread dip, a popular Arab appetizer or mezze. In Mexico, its oil is called *ajonjoli* which is frequently used for cooking. Black sesame appears frequently in Chinese, Japanese and Korean dishes where meat or fish is rolled in the seeds before cooking for a crunchy coating. Black sesame is an ingredient of *gomassio,* the Japanese table top condiment, and other colorful rice and noodle dishes. Sesame oil is mildly laxative, emollient and demulcent. The seeds and fresh leaves may be used as a poultice. The oil has wide medical and pharmaceutical application.The oil has been used as healing oil for thousands of years. It is mentioned in the Vedas as excellent for humans. It is naturally antibacterial for common skin pathogens, such as staphylococcus and streptococcus as well as common skin fungi, such as athlete's foot fungus. It is naturally antiviral. It is a natural anti-inflammatory agent. It has been used extensively in India as healing oil, including in experiments which showed it was useful in unblocking arteries. In recent experiments in Holland by Ayurvedic physicians, the oil has been used in the treatment of several chronic disease processes, including hepatitis, diabetes and migraines. Also, in vitro,the oil has inhibited the growth of malignant melanoma (a skin cancer) (Prostaglandin, 1992).

Also in vitro, sesame seed oil has inhibited replication of human colon cancer cells (Pidswick, 1992). Research shows that beniseed oil is a potent anti-oxidant. In the tissues beneath the skin, this oil will neutralize oxygen radicals. It penetrates into the skin quickly and enters the blood stream through the capillaries. Molecules of the oil maintain good cholesterol (HDL) and lower bad cholesterol (LDL). The oil is a cell growth regulator and slows down cell growth and replication.

In both the small intestine and the colon, some cells are nourished by fat instead of sugar. The presence of beniseed oil can provide those cells with essential nourishment. In an experiment at the Maharishi International College in Fairfield Iowa, students rinsed their mouths with sesame oil, resulting in an 85% reduction in the bacteria which causes gingivitis. As nose drops, sniffed back into the sinuses, sesame seed oil has cured chronic sinusitis. As a throat gargle, it kills strep and other common cold bacteria. It helps sufferers of psoriasis and dry skin ailments. It has been successfully used in the hair of children to kill lice infestations. It is a useful natural UV protector (Aiensten, 2004).

In India it is used in religious ceremonies and is used in festivals. In the Sandarn koil Tapasu Festival, the seeds are cooked very slowly in sugar creating a sugar coating around the individual seed. The treat is then given to friends and relatives to bring luck in the next year. The original wedding cakes used in the West come from sesame cakes served at weddings in ancient Greece. In China, it is sprinkled over rice and red beans and served at the exchange of wedding presents. The slaves in the US brought sesame from Africa and planted it at their doors to bring luck and ward off evil spirits. The seed is used in flower gardens because they provide flowers over a 30-40 day period. Gardeners use beniseed as a companionate plant because they inhibit root knot nematodes (Aiensten, 2004).

Used after exposure to wind or sun it will calm the burns. It nourishes and feeds the scalp to control dry scalp dandruff and to kill dandruff causing bacteria. It protects the skin from the effects of chlorine in swimming pool water. Used before and after radiation treatments, sesame seed oil helps neutralize the flood of oxygen radicals which such treatment inevitably causes. On the skin, oil soluble toxins are attracted to sesame seed oil molecules which can then be washed away with hot water and a mild soap. Internally, the oil molecules attract oil soluble toxins and carry them into the blood stream and then out of the body as waste. Used as a douche mixed with warm water, the oil controls vaginal yeast infections. The oil absorbs quickly and penetrates through the tissues to the very marrow of the bone. It enters into the blood stream through the capillaries and circulates. The liver does not sweep the oil molecules from the blood, accepting those molecules as friendly (Barbra, 2003).

Beniseed oil helps joints keep their flexibility. It keeps the skin supple and soft. It heals and protects areas of mild scrapes, cuts and abrasions. It helps tighten facial skin, particularly around the nose, controlling the usual enlargement of pores as skin ages chronologically. Teen boys and girls have learned, wrongly, that all oil is bad for their facial skin. Heavy oils and toxic oils and creams are bad for all facial skin. But sesame seed oil is the one oil which is actually good for young skin. It helps control eruptions and neutralizes the poisons which develop both on the surface and in the pores. With thisoil, no cosmetics are needed. The oil will cause young facial skin to have and display natural good health. Used on baby skin, particularly in the area covered by a diaper, the oil will protect the tender skin against rash caused by the acidity of body wastes. In the nose and ears, it will protect against common skin pathogens. For children going to school, who will be in the presence of other children with colds and sniffles, sesame seed oil swabbed in the nose can protect against air borne viruses and bacteria. Abhyanga, (2003) recommended that when using the oil as massage oil, the long limbs should be stroked up and down, he also recommended that circular motions should be used over all joints to stimulate the natural energy of those joints. Other use of this oil includes; hair treatment, food manufacture, drug manufacturing and also industrial purposes (Microsoft Encarta, 2009).

### 2.9 Relationship between beniseed oil and other seed oils

Beniseed has the ability to produce oil and it is becoming widely known and embraced for all its nutritional values as well as health benefits. Some agricultural seeds also possess the ability of producing oil, making it possess similar properties and mode of extraction like beniseed. This seeds includes: castor seed, neem seeds, and soya bean seeds to mention a few.

#### 2.9.1 Castor seed oil (*Ricinus communis*)

Castor seed originated in Africa and grows wild in east and North Africa. Castor seeds requires warm climate and is killed by frost. It can be grown over a wide altitude range in the tropics and with both low and medium rain fall. The best soil for cultivation is rich well drained sandy or clayey loam. The castor varies greatly in its growth habits, color of foliage, stems, seed size, color and oil content. Castor seed contains between 40% and 60% oil that is rich in triglycerides mainly ricinoleic. The proximate compositionof castor ranges as follows; oil 45-51.8%, moisture 3.1%, protein 12-16%, and carbohydrate 3.1-7%, fiber 23.1-27.2%, ash 2-2.2%. Castor oil triglyceride is unique in that its major fatty acid is the unsaturated, hydroxylelated 12-hydroxy 2-octadecanoic acid, also known as ricinoleic acid. The fatty composition of typical castor oil is palmitic acid 2%, stearic acid 1%, oleic acid and linoleic acid 3%, ricinoleic acid 87% (Microsoft Encarta, 2009).

The oil from castor seeds is extracted by variety of processes or combination of processes such as hydraulic presses, continuous screw presses and solvent extraction. The most satisfactory approach is by hot pressing using a hydraulic press, followed by solvent extraction to remove bulk of oil remaining in the press cake. Hot pressing by hydraulic press extracts between 75-85% of oil contained in the castor seed while the remaining press cake has about 12% oil content (Wikipedia, 2008). The oil extracted from the hydraulic screw process is filtered and collected in a settling tank; the resulting cake contains 8-10% oil. It is crushed into coarse meal and subjected to solvent extraction with hexane or heptanes. The soxhlet apparatus is used for solvent extraction of castor oil from the seeds. After extraction, the solvent is removed by distillation and their resulting oil is processed in similar manner as oil from the pressing step. The castor oil can be used for medicines, lubricants, cosmetics, coatings and disinfectants (Wikipedia, 2008).

### 2.9.2 Neem seed oil (*Azadiricahiaindica a juss*)

The neem seed is one of the very few trees known in the Indian subcontinent, it is also found in Indonesia in several areas such as Bali, Lombok, West java and Nusa Tenrrara Barat. It grows on most kinds of soils and thrives better than most other plants on dry, stony and shallow soils (Dianne, 2006).

The neem seed is a part of the neem tree which has high concentration of oil (Ikasari and Indraswati, 2008). The seed contains approximately 45% oil which contains Ioeic acid (50-60%), palmitic acid (13-15%), stearic acid (14-19%), linolieic acid (8-16%) and arachidic acid (1-3%). The oil is brownish yellow, non-drying oil with an acrid tasted and unpleasant odor. There are various methods of oil extraction from the neem seed, but a most efficient way has been the solvent extraction method using the soxhlet apparatus for the process. The oil is widely used for insecticides, lubricants, drugs for a variety of diseases. A number of bitter components such as; nimbin (0.12%), nimbinin (0.01%), nimbidin (1.4%) and nimbidiol (0.5%), have been identified in neem oil. There are also pigments, polysaccharides, salts and the proteinaceous material which makes up the cellular matrix of the seed (Johnson and Morgan, 1997).

### 2.9.3 Soya beans (*Glycine max*)

Soybean oil is a vegetable oil extracted from the seeds of the soybean *(Glycine max)*. It is one of the most widely consumed cooking oils. Being one of the drying oils, it is used as a base for printing inks and oil paints.

To produce soybean oil, the soybeans are cracked, adjusted for moisture content, heated to between 140°F and 190°F, rolled into flakes, and solvent-extracted with hexane. The oil is then refined, blended for different applications, and sometimes hydrogenated. Soybean oils, both liquid and partially hydrogenated, are exported abroad, sold as vegetable oil, or end up in a wide variety of processed foods. Most of the remaining residue (soybean meal) is used as animal feed.

In the 2002–2003 growing seasons, 30.6 million tons of soybean oil were produced worldwide, constituting about half of worldwide edible vegetable oil production, and thirty percent of all fats and oils produced, including animal fats and oils derived from tropical plants (USDA, 2004).

100g of soybean oil has 16g of saturated fat, 23 g of mono unsaturated fat, and 58g of poly unsaturated fat. The major unsaturated fatty acids in soybean oil triglycerides are 7–10% alpha-Linolenic acid (C-18:3); 51% linoleic acid (C-18:2); and 23% oleic acid (C-18:1). It also contains the saturated fatty acids 4% stearic acid and 10% palmitic acids which are long chain saturated fatty the high-proportion of oxidation-prone linolenic acid is undesirable for some uses, such as cooking oils in restaurants. In the early nineties, Iowa State University developed soybean oil with 1% linolenic acid. Soybean oil is mostly used for frying and baking. It is also used as a condiment for salads (Barnard and Xue, 2004).

### 2.10 Methods of Oil Extraction

Many oil-bearing seeds and nuts are broken up by grinding, flaking, or rolling and then subjected to mechanical pressing to liberate the oil. The methods of extraction is likely to affect the composition of oil, since the method used such as pressing (expelling)or solvent extraction are unlikely to remove exactly the same mix of components in the same proportions. The oil yield that can be obtained from beniseed kernels also varies widely in literature from 48 - 50%. The oil can be obtained through pressing (grinding) of the seed kernels by cold pressing or through a process incorporating temperature controls. The oil is also extracted by traditional kneading and alternate wetting with hot water until the oil in the dough-material begins to ooze out (Olaifa and Adenuga, 1998).

#### 2.10.1 Mechanical Extraction Method

This method entails extracting oil from oil bearing seeds with the use of mechanical screw-presses. The NIFOR mechanical screw-press is the latest used by the small-scale oil processing industry in Nigeria. This consists of a perforated tube inside which a transport screw rotates. The pitch of the screw flights gradually decreases towards the discharge end, to increase the pressure on the pulp as it is carried through the barrel (Fellows, 1996). The press outlet is more or less closed by a cone that regulates the pressing pressure. The worm transports and gradually compresses the macerated seeds. Released oil drains through the perforations in the tube. The press is mounted directly below a feed conveyor, which is fed by gravity by the horizontal digester. The body of the feed conveyor is perforated to allow oil released in the digester to drain away.

### 2.10.2 Solvent Extraction Method

Solvent extraction processes can be divided into three main unit operations: kernel pre-treatment, oil extraction, and solvent recovery from the oil and meal. The soxhlet apparatus is used for the solvent extraction of oil. The operation of the soxhlet apparatus is mainly on the use of appropriate solvent to extract out of the feed material.This apparatus was designed by Franzvon Soxhlet in 1939, firstly with automated extraction apparatus and in later years, several modifications of the apparatus were developed. Solvent extract are prepared by treating a solid or liquid with asolvent that will dissolve the desired components selectively. For example the vanilla flavoring is produced by using a solvent (usually alcohol) to dissolve and separate the compounds that produce the vanilla flavor and aroma from the vanilla seed pods. The process called solvent extraction is widely used in the commercial production of plants and animal by-products. In the soxhlet apparatus extraction, the solvents used must meet several requirements. They must dissolve the maximum amount of desired components and minimum of undesired materials. The solution must be easy to separate from the un-dissolved substance. In the extraction of solids, the separation is usually not difficult, but in liquid extraction, a solvent must be chosen that will separate quickly and completely from the liquid being extracted. The final requirement is that the solvent must be easy to separate from the extracted material, usually by distillation without affecting the quality of the product (Microsoft Encarta, 2009).

### 2.10.3 Super Critical Extraction Method

This process utilizes carbon dioxide at critical temperatures and pressure to extract the active ingredients of the beniseed seeds without the usual high temperature or harmful chemicals. The result is far more concentrated extracts which resembles the herb more closely. Supercritical extracts are superior for many reasons. Beneficial phytochemicals are easily damaged by heat and there is a growing desire for alcohol and solvent fire natural extracts (Olaofe *et al.;* 1994).

The supercritical extracts process enables delivery of a broad spectrum of phytochemicals including both lipophobia (water soluble) and lipophilic (oil soluble) isolates. In addition, this extraction process uses only carbon dioxide as solvent which once the pressure is let off evaporates completely from the extract leaving it totally pure and free of any solvent residues. The supercritical point is the extract temperature and pressure at which a gas becomes a liquid (Wikipedia, 2008). Hannay and Hogarth's early observations of the dissolution of solutes in supercritical fluids (SCF) media introduced the possibility of a new solvent medium. However, it is only recently that commercial process application of supercritical fluid extraction has been extensively examined (Grandison and Lewis, 1996).

# CHAPTER THREE

## 3.0 MATERIALS AND METHODS

## 3.1. MATERIALS

### 3.1.1 Sample Collection and Preparation of samples

The sesame seeds that were used for this study were obtained from a local farm in Agila village of Ado local government area of Benue state, Nigeria. The seeds were thoroughly screened so as to remove foreign materials and stones, samples of the seeds are shown in Plate 3.1;

**Plate 3.1 Sesame seeds**

### 3.1.2 Apparatus

The following apparatus were used in the extraction of oil and in the analysis of its physicochemical properties.

Soxhlet Apparatus (Pyrex England)

Thomas willey Milling Machine (model ED-5)

Set of muslin cloth

Test tubes (Pyrex England)

Hydraulic Screw press (Apex 438510 model S15145 by Dor Kent)

Beaker (Pyrex England)

Desiccators (Pyrex England)

Electronic air oven (Gallenkamp furnace)

Electronic hot plate (Gallenkamp)

Digestion block (Kjeldahl)

Pipette

Petri dish

Refractometer

Reflux condenser

Silica dish

Spatula

Thimbles

Viscometer

Weighing balance (analytical balance machine by Salter, model 250, sensitivity, ± 0.005)

### 3.1.3 Reagents

The following reagents were used during the determination of the chemical composition of the extracted beniseed oil

Acetic acid

Alcoholic potassium Hydroxide solution

Aqueous Potassium Iodide solution

Carbon tetrachloride

Chloroform solution

Distilled water

Hydrochloric acid

Petroleum ether

Phenophtahalein indicator

Potassium Hydroxide (KOH) solution

Saturated potassium Iodide solution

SodiumThiosulphate solution

Sodium Hydroxide (NaOH) solution

Starch indicator

Tetraoxosulphate(VI) acid

### 3.2 Methods

#### 3.2.1 Solvent extraction Method

The seeds were separated from the pods by hands. The removed seeds were then cleaned to remove any foreign materials. The seeds were then crushed into powder using the Thomas Willey milling machine then sieved (0.5mm sieve) then one liter of normal hexane was added to this to soak and was covered for twenty four hours. Five grams of grinded sample were weighed into a clean thimble and plugged with cotton wool. The soxhlet apparatus was then assembled and 60ml of petroleum ether was then added to the flask and placed on water bath 40-70$^0$c and allowed to reflux for six hours. The flask was removed and oven dried at 105°C to vaporize the solvent. The sample was subjected to hot pressing using hydraulic press to remove the bulk of the oil remaining in the press cake. This was cooled in the desiccator and weighed.

#### 3.2.2 Mechanical Extraction

The seeds were separated from the pods by hands. The removed seeds were then cleaned to remove any foreign materials from the separated sesame seeds. The cleaned seeds wereweighed and oven dried to a moisture content of 22%. The oven dried seeds were put into the Thomas Willey milling machine and grinded, this crushed sample was then putinside a muslin bag and put into the hydraulic screw press and pressed to expel the oil from the seeds, the extracted oil from the seed was then collected.

### 3.3 Determination of the Physicochemical Properties

The determination of the physicochemical properties of the beniseed oil which includes;viscosity,specific gravity, refractive index, color, odour, acid value, free fatty acid, iodine value, peroxide value and saponification value were carried out using the methods of

AOAC (2004). The percentage oil content was also determined as described by AOAC (2004). These physicochemical properties of the oil and the percentage oil yield were determined for the two oils, that is, the oil that was extracted using the soxhlet apparatus and n-hexane as the solvent and the oil that was extracted using the hydraulic screw press.

### 3.3.1 Determination of Refractive Index

The refractive index was determined by setting up the Abbes' refractometer with a light compensator. A drop of the oil sample was applied on the lower prism of the instrument and closed. Light was passed by means of the angled mirror and the reflected light appeared in form of a dark background. The fine adjustment was used to move the telescope tubes until the black shadow appeared central in the cross wire indicator. The control knob was adjusted and readings were recorded and obtained. This is the angle which a beam of light is bent when passing through a thin film of melted fat or oil. To determine the Abbes' refractometer and sodium vapour lamp, 20$^{o}$C was employed as the vapour temperatures. Equations for correction readings for temperature are given by the international unit of pure and applied chemistry (IUPAC 1987).

### 3.3.2 Determination of Specific Gravity

50ml of specific gravity bottle was thoughrouly washed with detergent, water and petroleum ether, dried and then weighed. The bottle was filled with water and weighed. The bottle was dried, filled with the oil sample and then weighed. The same procedure was carried out for both oils.

$$\text{Specific gravity} = \frac{\text{Weight of Xml of oil}}{\text{weight of Xml of water}}$$

$$\text{Density} = \frac{\text{weight of oil}}{\text{volume of oil}}$$

### 3.3.3 Determination of Viscosity

A clean, dried viscometer with a flow time above 200 seconds for the fluid to be tested was erected. The samples were filtered through a sintered glass to eliminate dust and other solid materials in the liquid samples. The viscometer was charged with the samples by inverting the tubes thinner arm into the liquid sample and suction force was drawn up to the upper timing mark of the viscometer, after which the instrument was turned into its vertical position. The viscometer was placed into a holder and inserted to a constant temperature bath set at 20$^{o}$C and allowed to stand approximately ten minutes for thesample to come to bath at 20$^{o}$C. The suction force was then applied to the thinner arm to draw the sample above the upper timing mark. The afflux time by timing the flow of the sample as it flowed freely from the upper timing mark to the lower timing mark was recorded. This process was carried out for both oils.

### 3.3.4 Determination of Colour and Odour

The colour and odour of the produced oil was determined through physical observation and compared with internationally accepted standards.

### 3.3.5 Determination of Acid Value

The acid value is the number of milligram of potassium hydroxide required to neutralize one gram of a sample. The acid value measures the extent to which the glycerides in the oil have been decomposed by lipase action. To determine the acid value of the oil, the following procedure was carried out three grams of the sample was weighed. 25ml diethyl ether with 25ml alcohol and 1ml phenolphthalein solution were mixed and carefully neutralized with 0.1M sodium hydroxide NaOH. Three grams of the oil was dissolved in the mixed neutral solvent and titrated with aqueous 0.1M NaOH shaking constantly until a pink colour of the solution persist for 30 seconds. This procedure was carried out for both oils extracted.

$$AcidValue = \frac{\text{Titration (ml) x 5.61}}{\text{weight of sample}}$$

Acid value = FFA × 2

### 3.3.6 Determination of Free Fatty Acid (FFA)

Rancidity is usually accompanied by free fatty acid formation; the determination is often used as a general indication of the condition and edibility of oils. The FFA figure is usually calculated as oleic acid 25ml of alcohol and 1ml of phenolphthalein were mixed to neutralize 0.1M NaOH. 2g of the oil was dissolved into the mixed neutral solvent and titrated with aqueous 0.1M NaOH shaking constantly until a pink colour was obtained after twenty seconds. The same procedure was carried out for both oils extracted using the different methods.

(1ml 0.1M sodium hydroxide = 0.0282g oleic acid) = 0.0282g

$$\text{FFA Value} = \frac{\text{Titer value x 0.0282 x 100}}{\text{weight of sample}}$$

### 3.3.7 Determination of Saponification Value

The saponification value is the number of milligram of potassium hydroxide required to neutralize the fatty acids resulting in the complete hydrolysis of 1g of the sample. 2g of the sample was weighed into a conical flask. 25ml of alcoholic potassium hydroxide solution was then added. A reflux condenser was attached to the flask containing the mixture which was constantly stared and was allowed to boil gently for 60mins. Few drops of phenolphthalein indicator was added to the warm solution and then titrated with 0.5M hydrochloric acid to the end point until a pink colour of the indicator just disappeared The same procedures were used for other samples and blank. The same procedure was carried out for both oils.

$$\text{Saponification Value} = \frac{(b-a) \times 28.05}{\text{weight of sample}}$$

**3.3.8 Determination of Iodine Value**

Iodine measure the degree of unsaturation in oil. Iodine value is the weight of iodine absorbed by 100 parts by weight of the sample. 0.4g of the sample was weighed into a conical flask and 20ml of carbon tretrachloride was added to dissolve the oil. 25ml of wijis' solution was added to the flask using a safety pipette in fume chamber. A stopper was inserted and the content of the flask was vigorously swirled. The flask was placed in the water bath for 30 minutes. At the end of this period, 20ml of 10% aqueous potassium iodide and 100ml water were added using a measuring cylinder and titrated with 0.1M of sodium thiosulphate solution using starch as indicator until the yellow colour almost disappeared. The same procedure was also carried for blank at the same time commencing with 10ml of carbon tetrachloride. This procedure was carried out for both oils.

$$\text{Iodine Value} = \frac{(b-a) \times 1.269}{\text{weight of sample}}$$

**3.3.9 Determination of Peroxide Value**

Fats/oils undergo changes during storage which results in production of an unpleasant taste and odour which is commonly referred to as rancidity. The peroxide value of oil is the measure of its oxygen. This is used to monitor the development of rancidity through the evaluation of the quantity of peroxide in the product. The test is a volumetric one was $I_2$ formed from potassium iodide in the presence of peroxide is titrated with thiosulphate. This means $meq._{perioxide}$ =

$meq._{thiosulphate}$ at the equivalence point. 1g of the sample was weighed into a 250ml erlemmeyer flask. 30ml acetic acid and chloroform solution (3:2) were added under a fume hood and swirled to dissolve the oil. 0.5ml iodide solution was added and swirled for one minute. 1ml of indicator was also added and titrated using starch. The same procedure was performed for blank at the same time. This procedure was carried out for both oils.

$$\text{Peroxide Value} = \frac{\text{S} - \text{B x 0.1 x 1000}}{\text{weight of sample}}$$

### 3.3.10 Determination of Proximate Compositions

The proximate composition moisture content, crude fibre, crude protein, ash, carbohydrate, and energy value of the beniseed oil were determined using the AOAC (2004) methods.

### 3.3.11 Determination of Percentage oil yield

The percentage oil yield was gotten by subtracting the final weight of the sample (cake) from the initial weight of the sample. It was calculated as follows;.

**Percentage oil yield**= $\frac{initialweight - finalweight}{initialweight} X\ 100$

## CHAPTER FOUR

## 4.0 RESULTS AND DISCUSSION OF RESULTS

### 4.1 Results

The results of the Physicochemical Properties and proximate composition of solvent and mechanically extracted beniseed oil are presented on Tables 4.1 to 4.4 respectively.

#### 4.1.1 Physicochemical Properties of Solvent Extracted Beniseed oil

The results of the physicochemical properties of the solvent extracted oil are presented on Table 4.1

**Table 4.1: Physicochemical Properties of Solvent Extracted Beniseed oil**

| Parameters | Mean values |
|---|---|
| Colour | Bright Yellow |
| Odour | Beniseed odour |
| Refractive index | 1.478± 0 |
| Specific gravity | 0.844± 0 |
| Viscosity | 64Ns/m at 20°C± 0 |
| Acid value | 9.03mgKOH/g ± 0.33 |
| Free fatty acid | 9.98mgKOH/g ± 0.33 |
| Peroxide value | 3.44meq/kg ± 0.002 |
| Iodine value | 94.159wjis (g/100g) ± 0.61 |
| Saponification value | 158.622mgKOH/g± 2.28 |
| Oil yield | 40% |

### 4.1.2 Physicochemical Properties of Mechanically Extracted Beniseed oil

The results of the physicochemical properties of the mechanically extracted oil are presented on Table 4.2

**Table 4.2: Physicochemical Properties of Mechanically Extracted Beniseed oil**

| Parameters | Mean values |
|---|---|
| Colour | Cloudy yellow |
| Odour | Beniseed odour |
| Refractive index | $1.693 \pm 0$ |
| Specific gravity | $0.946 \pm 0$ |
| Viscosity | 75Ns/m at 20°C ± 0 |
| Acid value | 2.167mgKOH/g ± 0.03 |
| Free fatty acid | 1.09mgKOH/g ± 0.001 |
| Peroxide value | 2.00meq/kg ± 0.0006 |
| Iodine value | 103.043wijis (g/100g) ± 5.54 |
| Saponification value | 161.26mgKOH/g ± 1.105 |
| Oil Yield | 33.4% |

### 4.1.3 Proximate Composition of Solvent Extracted Beniseed oil

The results for the proximate composition of solvent extracted Beniseed oil are shown on Tables 4.3.

**Table 4.3: Proximate Composition of Solvent Extracted beniseed oil**

| Composition | Percentage |
|---|---|
| Ash | 0.5 ±0 |
| Carbohydrate | 62.55 ± 9.63 |
| Crude fibre | 6.6 ± 0.32 |
| Crude protein | 13.65 ± 0.073 |
| Moisture content | 16.7± 1.37 |
| Energy value | 304.8 KJ ± 2.7 |

### 4.1.4 Proximate Composition of Mechanically Extracted Beniseed oil

The results for the proximate composition of mechanically extracted Beniseed oil are shown on Tables 4.4.

**Table 4.4: Proximate composition of Mechanically Extracted beniseed oil**

| Composition | Percentage |
|---|---|
| Ash | 1.0 ± 0 |
| Carbohydrate | 57.58 ± 3.63 |
| Crude fibre | 6.6 ± 0.32 |
| Crude protein | 16.50± 0.57 |
| Moisture content | 18.33± 0.25 |
| Energy value | 296.28 ± 2.76 |

### 4.2 Discussion of Results

#### 4.2.1 Discussions of Results for Solvent Extraction Method

The percentage yield of the oil that was extracted using the solvent method was found to be 40 %. This amount is promising and agrees with earlier findings (Tashiro *et al.,* 1990), thus confirming the suitability of the yield of the beniseed variety used in the study, The refractive index was obtained to be1.478 at 20°C, this shows the angle through which a beam of light is bent when passing through the oil and is very applicable at different temperatures. The specific gravity and viscosity values of the oil were obtained as 0.844 and 64Ns/m at 20°C respectively, the value of the viscosity was close to that of soybean oil, 66Ns/m obtained by Venter, *et al,;* (2007). The viscosity is a property of beniseed oil which is very important during packaging and storing. The colour was ascertained as yellow, and the odour was characteristic beniseed odour which is like groundnut.

The acid value and the free fatty acid were found to be 9.03mgKOH/g and 9.98mgKOH/g respectively this value is comparable to that of palm kernel oil 11.60mgOH/g and 8.83mgKOH/g respectively (Aremu *et al.; 2006*), and also that of neem oil which was foundto be 13.95mgKOH/g and 6.95mgKOH/g (Yusuf, 2010). The iodine value was gotten to be 94.159wijis; this is comparable to the values earlier obtained for Arachis oil and Cottonseed oil, 98.55wijis and 91.7wijis respectively (Pearson, 1976). From the value gotten, it can therefore be concluded that beniseed oil is a drying oil, this is so because, Duel (1951) reported that oil with iodine values below 100wijis are drying oils and those above 100wijis, are categorized as non-drying oil and as such it is unsaturated thus making it suitable for utilization in certain industrial formulatory and dietary purposes (Ibiyemi et al., 1992). The saponification value was found to be 158.622mgKOH/g, this value falls within the range of values obtained for some vegetable oils ranging from 148 – 255 mgKOH/g (Aremu *et al.*, 2006). This is close to that of castor seed oil reported by Olaofe (1994). Saponification value gives information about the fatty acid present in the beniseed oil and particularly informs on the solubility of soap derived from water. Pearson(1976) reported that high saponification value contains high proportion of lower fatty acid. The quality of this oil therefore qualifies its use in soap production. The peroxide value was found to be3.44mEq/kg. Fresh oils usually have peroxide values well below10mEq/kg thus, the value obtained falls between recommended values for fresh oils. One should note that a rancid taste begins to be noticeable when the peroxide value is between 20 and 40mEq/kg. In interpreting such figures, it is necessary to take into account the particular oil involved. The energy value was calculated as 304.8KJ which agrees with the 297.9KJ gotten for beniseed by Fallon et al,; (2001).The value obtained for crude fiber is slightly higher than that of palm kernel oil, 5%, determined by Faborode and Favier (1996).Moisture content was obtained to be 16.70%, this result is slightly below that of Jatropha seed oil 19%, as found by Sadowska, *et al,;* (1996). Crude protein obtained was 13.65%, which is comparable to 19.4%, for cotton seed (Pritchard, 1991). The ash content which is the amount of solid remaining after a substance undergoes heat of above 600°C was obtained to be 0.5%, this agrees with 0.91%, determined for beniseed as carried out by Egbekun and Ehieze (1997). Finally, the carbohydrate content in the beniseed oil was found to be 62.55% which is greater than the result gotten by Egbekun and Ehieze (1997), as 17%, the variance may be due to the variety of the beniseeds that were used in carrying out the analysis as well as the extraction method.

### 4.2.2 Discussions of Results for the Mechanical Extraction Method

The percentage yield of the oil that was extracted using the mechanical method of oil extractionwas found to be 33.4%, this is close to the 38.8% obtained by Abe *et al.*;(2001) and the 30% oil yield for walnut obtained by Graig, (2006), thus confirming the suitability of the yield of the beniseed variety used in the study.The refractive index was obtained to be1.478 at 20°C, this shows the angle through which a beam of light is bent when passing through the oil and is very applicable at different temperatures. The specific gravity of the oil was gotten as 0.946 as well as the viscosity of 75Nm/s at 20°C. The viscosity is a property that of beniseed oil which is very important during packaging and storing. The colour was ascertained as cloudy-yellow, and the odour is characteristic beniseed odour which is like groundnut.

The acid value and free fatty acid was found to be 2.167mgKOH/g and 1.09mgKOH/g respectively.Acid value is an indicator for edibility of oil and suitability for industrial use, the value falls within the recommended codex of 0.6 and 10 for virgin and non-virgin edible fats and oil respectively (Adelaja, 2006), this essence suggests that the oils are suitable for edible purposes and also in the manufacture of paints and vanishes (William, 1966).The iodine value was gotten to be 103.043wijis; this shows the degree of unsaturation of oil, this result is close to the 110wijis gotten for sunflower seeds by Goli *et al.;* 2008. The value for the iodine shows its high drying qualities of the oil, this result is slightly greater than 97wijis, the value gotten by Marter (1981) for castor seeds. The saponification value was found to be 161.26mgKOH/g this gives information about the fatty acid present in the beniseed oil and in particular concerning the solubility of soap derived from it in water. This result is close to those found by Lew (1989); he found it to be 181mgKOH/g for castor seeds. The quality of oil qualifies its use in soap production. The peroxide value was found to be 2.01mEq/kg. Fresh oils usually have peroxide values well below10mEq/kg thus, the value obtained falls between recommended values for fresh oils. One should note that a rancid taste begins to be noticeable when the peroxide value is between 20 and 40mEq/kg. In interpreting such figures, it is necessary take into account the particular oil involved. The value for the ash content for the beniseed oil was gotten to be 1% which is close to the 2% gotten for palm kernel oil as found by Faborode and favier (1996). Crude fibre was determined as 6.6%, which is almost the same as that of palm oil 6.5% gotten by Pritchard, (1991). The moisture content of 18.33% obtained is similar to that of oyster nut(*Telfairia occidentallis)* which was found to be 16.78% by Dawodu and Omole (2009), this shows that, the oil will have a longer shelf life because of the low moisture content. The crude protein was obtained as 13.50% which is comparable to the 19.1% gotten for beniseeds by Nzikou, *et al,;* (2007). The carbohydrate content for the beniseed oil was gotten to be 57.58%, this results agrees with that of African locust bean (*Parkia biglobosa*) which was found to be 52.87% by Barter, (1985); *Alabi et al,;*(2004). Finally, the energy value for the mechanically extracted beniseed oil was calculated to be 296.28KJ which agrees with the 297.97 found for beniseed by Fallon *et al,;* 2001.

### 4.2.3 Discussion on the comparison of the two methods of beniseed oil extraction

Comparing the two results gotten from the two different methods of oil extraction, it was seen that there are some relative differences that occurred as a result of the extraction methods. The solvent method of extraction was observed to produce more oil than the mechanical extraction method it was seen that while the solvent method produced an oil yield of 40% the mechanical method produced an oil yield of 33.4%. The physical appearance in this case the colour for the solvent extracted oil is more attractive and clearer than the mechanically extracted oil, it was observed that the solvent extracted oil was more bright yellow than the mechanically extracted oil which was cloudy-yellow. The odour for both oils was the same. Refractive indexis the rate at which a beam of light bends when it passes through the oil, it was found out that the refractive index for the mechanically extracted oil was higher than that of the solvent extracted oil, the results gotten were 1.693 and 1.478 respectively. The specific gravity of any oil is the weight of oil compared to the weight of water, the specific gravity of the two oil thus obtained were 0.844 and 0.946 for solvent extracted oil and mechanically extracted oil respectively. Viscosity of oil is a very important quality that is put into consideration during packaging and storing of oil, it was determined and seen that the mechanically extracted oil was more viscous with a viscosity of 75Nm/s than the solvent extracted oil whose value was 64Nm/s at 20°C.

The difference in acid value was also enormous which shows that the oil extracted using the solvent method had a high acid value of 9.03mgKOH/g compared to the mechanical method which had an acid value of 2.167mgKOH/g. Comparing the free fatty acid which is a general indication of the condition and edibility of oils, the oil extracted using solvent was higher than that of the mechanical method which was determined to be 9.98mgKOH/g and 1.02mgKOH/g respectively thereby showing that the oil with the low free fatty acid is more edible than that with the high free fatty acid.

The peroxide values which is the measure at which oils undergo changes during storage which results in production of an unpleasant taste and odour which is commonly referred to as rancidity, was gotten to be 3.44meq/kg for solvent extraction and 2.00meq/kg for mechanical extraction, The peroxide value of oil is the measure of its oxygen. This is used to monitor the development of rancidity through the evaluation of the quantity of peroxide in the product, the results shows that the mechanical extraction method has less oxygen compared to the solvent extracted oil. The iodine value is the degree of unsaturation in oil. Iodine value is the weight of iodine absorbed by 100 parts by weight of the sample, the mechanical method showed a high level of unsaturation than the solvent extracted oil, 103.043wijis and 94.159wijis respectively The saponification value is the number of milligram of potassium hydroxide required to neutralize the fatty acids resulting of the complete hydrolysis of 1g of the sample, after the extraction of the oil it was seen that the values required to completely neutralize the fatty acid for solvent extracted oil was slightly higher than that ofthe mechanically extracted oil, 158.622mgKOH/g and 161.26mgKOH/g respectively.

From the analysis carried out, it can be seen that the methods of oil extraction had an effect in the proximate composition of the extracted oil as seen in the values of the results gotten. According to Egbekun and Ehieze (1997), Variation in oil yield and proximate composition may be due to the differences in variety of plant, cultivation climate, ripening stage, the harvesting time of the seeds and the extraction method used. For the methods of extraction used, it was seen that the solvent and mechanical methods used for the oil extraction had a little or no effects on the crude fibre, but there were variations in the ash content as shown on Table 4.3 and 4.4 respectively, i.e.0.5% and 1.0% other variations on the crude protein and moisture content as shown on Tables 4.3 and 4.4 could be as a result of the presence of the solvent used which reduced theamount of the crude protein and due to the oven drying of the oil, so as to remove any remnant of the solvent present in the oil, the moisture content was reduced from 18.33% for mechanical extraction method and 16.7% for the solvent extraction method compared to the mechanically extracted oil which does not need any oven drying after extraction. Finally, the Carbohydrate content for the solvent extracted oil was higher than that of the mechanically extracted oil, 62.55% and 57.58% respectively; this could be due to the low ash content of the solvent extracted oil which justifies the high energy content of the solvent extracted oil over the mechanically extracted oil which has higher ash content.

The graph below summarizes the entire effect of the two methods used for the extraction of the benised oil showing the major differences in the physicochemical properties. The graph was plotted with the mean values against the physicochemical properties.

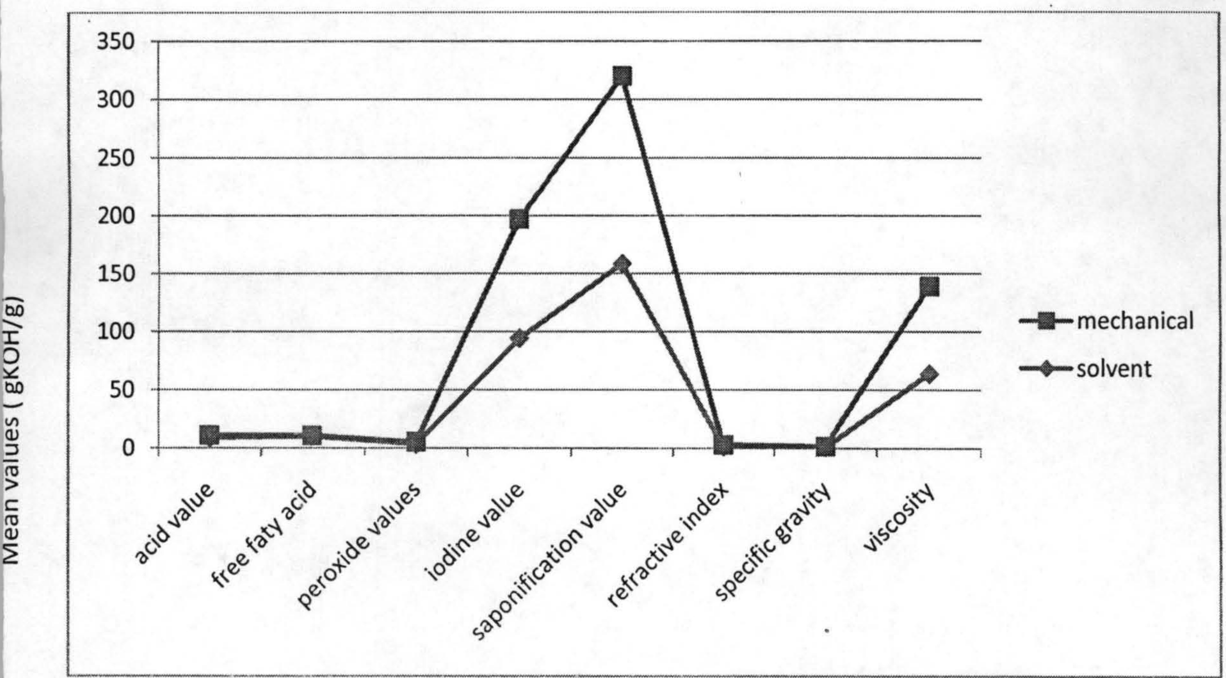


**Figure 4.1: Graph of mean values against physicochemical properties of solvent and mechanical extraction methods of beniseed oil**

From the graph it was deduced that there were only a slight difference in the acid value, free fatty acid, peroxide values refractive index and the specific gravity, while a huge difference was seen in the iodine value, saponification value as well as the viscosity. It can therefore be said that the method of oil extraction has a bearing on some properties of the oil, this may be due to the use of a solvent in the extraction of the oil.

The graph for the proximate composition is plotted below showing the percentages against the composition and the difference in the resultingvalues from the different extraction of oil methods.

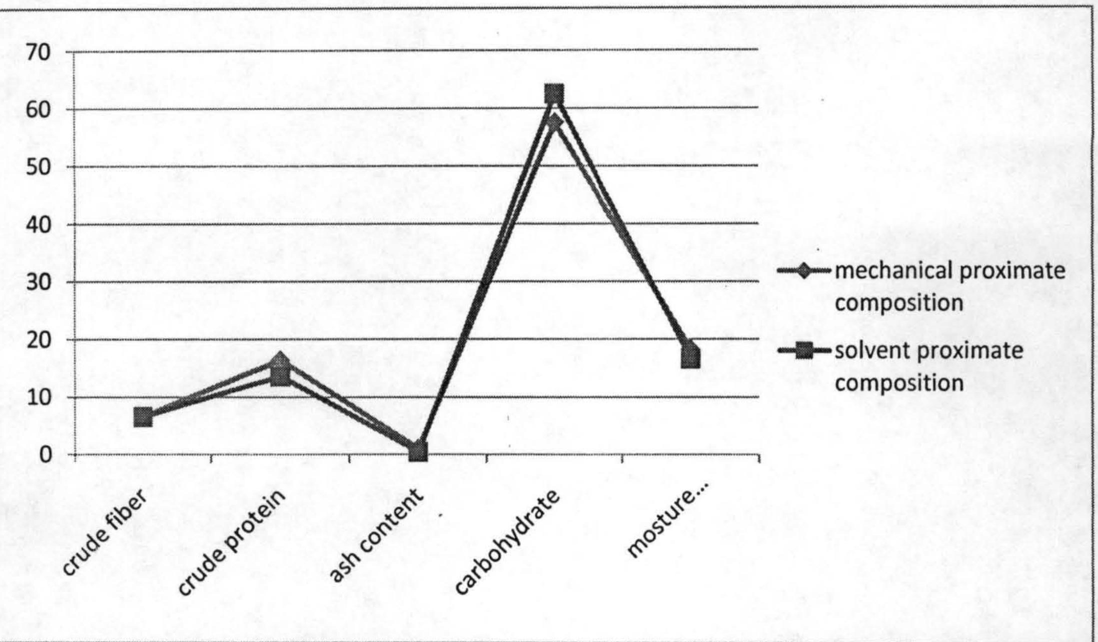


**Figure 4.2: Graph showing percentages against proximate compositions of solvent and mechanically extracted beniseed oil**

From the graph above, it can be deduced that the variation in the crude protein of the mechanically extracted oil and the solvent extracted oil, 16.50% and 13.65% respectively, as well as the percentage carbohydrate, 57.58% and 62.55 respectively for mechanical and solvent extraction methods respectively were very infinitesimal, other compositions such as the crude fibre, ash content, and moisture content were stable, that is to say, the extraction methods had little or no effects on the proximate composition of the beniseed oil.

CHATER FIVE

# 5.0 CONCLUSIONS AND RECOMMENDATIONS

## 5.1 CONLUSIONS

This study was carried out to determine the effect of methods of extraction on the proximate composition and physicochemical properties of the beniseed oil. The following parameters were determined for the solvent and mechanical methods respectively; Refractive index (1.478, 1.693), specific gravity (0.844, 0.946), viscosity (64Nm/s , 75Nm/s), colour (Bright-Yellow, cloudy-yellow), odour (characteristic beniseed odour for both).Acid value (9.03mgKOH/g , 2.167mgKOH/g), Free fatty acid (9.98mgKOH/g , 1.09mgKOH/g), Peroxide value (3.44meq/kg , 2.00meq/kg) Iodine value (94.159 wijis, 103.043 wijis), Saponification value (158.622mgKOH/g , 161.26mgKOH/g), Some proximate compositions were also determined and gotten for the two oils respectively; moisture con tent (16.70%, 18.33%), crude protein (13.65%, 16.50%), crude fiber (6.6% , 6.6%), ash content (1% , 0.5%) and carbohydrate (62.55% , 57.57%). A proper knowledge of these parameters will further enhance scientific research and development as regards processing and usage of the oil.

From the comparison of the results , it was seen that the solvent method yielded more oil than the mechanically extracted oil, although both oils have a wide usage for consumption, production of soaps, detergents and for pharmaceuticals, solvent extracted oil is more economical. Taking a close look at the results for the physicochemical properties of the extracted oil, there was a huge difference in the Viscosity, the Iodine value and the Saponification values; these may be as a result of the presence of the extraction method. Other properties were not really affected by the extraction methods. The proximate composition was not affected by the extraction method exceptfor the very slight difference in the values for the crude protein and carbohydrate, other parameters were constant. The Energy values for both oil was another parameter that showed a slight variance, this could be the extraction method used.It can therefore be concluded that any of the methods can be used depending on the usage the oil is intended for.

**5.2 Recommendations**

From the following study, the following recommendations were made

1. Further research should be done on other extraction methods of oil from beniseed as well as the effects that this extraction method has on the physicochemical properties of the extracted oil.
2. Analysis should be carried out on the mineral contents of the beniseeds
3. People should be sensitized on the importance of this seed.

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# APPENDICES

Calculations for Parameters of Extraction Methods of Beniseed oil

## Percentage Oil Yield

Percentage Oil yield for extraction of Beniseed Oil

Initial Weight of sample, = 5g

Final Weight of sample, = 3g

**Percentage oil yield=** $\frac{initialweight - finalweight}{initialweight} X\,100$

**Percentage oil yield=** $\frac{5-3}{5} X\,100$

**Percentage oil yield=** $40\%$

## Specific Gravity

$SG_{S1}$ = Weight of Specific Gravity bottle = 50g

Weight of Specific Gravity bottle + Water = 73.58

Weight of Specific Gravity bottle + Oil = 62.12

$$\text{Specific gravity} = \frac{\text{Weight of Xml of oil}}{\text{weight of Xml of water}}$$

$$\text{Specific gravity} = \frac{62.12}{73.58}$$

Specific Gravity = 0.844

Mean Iodine Value, ẍ, = ($SG_{S1} + SG_{S2} + SG_{S3}$)/ 3

= 0(.844 + 0.844 + 0.844) / 3

= 0.844

Standard Deviation for Acid value= $\sum_{x=1}^{n}$((x – ẍ)^2 )/ 3

= ((0.844 - 0.844) ^2 + (0.844 – 0.844) ^2 + (0.844 – 0.844) ^2) / 3

= 0 + 0 + 0

= ± 0

## Acid Value

First Acid value $AV_{S1} = AcidValue = \frac{\text{Titration (ml) x 5.61}}{\text{weight of sample}}$

$$AcidValue = \frac{3.49(\text{ml})\ \text{x}\ 5.61}{2}$$

$$AcidValue = \frac{18.06}{2}$$

$AV_{S1}$ = 9.03mgKOH/g

Mean Acid Value, ẍ, = $(AV_{S1} + AV_{S2} + AV_{S3})/ 3$

= (9.03 + 9.04 + 9.02) / 3

= 9.03mgKOH/g

Standard Deviation for Acid value $= \sum_{x=1}^{n} \frac{((x-\ddot{x})^2)}{3}$

= ((9.03 – 9.03) ^2 + (9.04 – 9.03) ^2 + (9.02- 9.03) ^2) / 3

= (1 + 0.0001 + 0.0001) / 3

= ± 0.33

## Free Fatty Acid

(1ml 0.1M sodium hydroxide = 0.0282g oleic acid) = 0.0282g

$FFA_{S1}$ = FFA Value $= \frac{\text{Titre x titre x 0.0282 x 100}}{\text{weight of sample}}$

$$\text{FFA Value} = \frac{2.03 \text{ x } 3.49 \text{ x } 0.0282 \text{ x } 100}{2}$$

$$\text{FFA Value} = \frac{19.97}{2}$$

$FFA_{S1}$ = 9.98 mgKOH/g

Mean FFA Value, ẍ, = ($FFA_{S1}$ + $FFA_{S2}$ + $FFA_{S3}$)/ 3

= (9.98 + 9.96 + 10.01) / 3

= 9.98mgKOH/g

Standard Deviation for FFA value = $\sum_{x=1}^{n}((x - \ddot{x})^{\wedge}2)/3$

= ((9.98 – 9.98) ^2 + (9.96 – 9.98) ^2 + (10.01- 9.98) ^2) / 3

= (1 + 0.0004 + 0.0009) / 3

= ± 1.0003

## Saponification Value

$SV_{S1}$, Sponification Value = $\frac{(b-a) \text{ x } 28.05}{\text{weight of sample}}$

Where b = Blank reading, a = Sample reading.

$$\text{Saponification Value} = \frac{(11.5 - o.34) \text{ x } 28.05}{2}$$

$$\text{Saponification Value} = \frac{313.04}{2}$$

Saponification Value = 156.55mgKOH/g

Mean Saponification Value, ẍ, = $(SV_{S1} + SV_{S2} + SV_{S3})/ 3$

= (156.55 + 160.12 + 159.20) / 3

= 158.62mgKOH/g

Standard Deviation for Acid value = $\sum_{x=1}^{n}((x - ẍ)^2) / 3$

= ((156.55–158.62)^2+(160.12–158.62)^2+(159.20- 158.62)^2)

= (4.28 + 2.25 + 0.3364) / 3

= ± 2.28

**Peroxide Value**

$PV_{S1}$= Peroxide Value $= \frac{\text{S−B x 0.1 x 1000}}{\text{weight of sample}}$

Where , S = Sample, B = Blank

$$\text{Peroxide Value} = \frac{1.72 - 1.69 \text{ x } 0.1 \text{ x } 1000}{1}$$

$$\text{Peroxide Value} = \frac{3.44}{1}$$

$$\text{Peroxide Value} = 3.44\text{meq/kg}$$

Mean Peroxide Value, ẍ, = $(PV_{S1} + PV_{S2} + PV_{S3})/ 3$

= (3.44 + 3.50 + 3.40) / 3

= 3.44meq/kg

Standard Deviation for Acid value = $\sum_{x=1}^{n}((x - ẍ)^2) / 3$

= ((3.44–3.44) ^2 + (3.50–3.44) ^2+ (3.40- 3.44) ^2)

= 0.0036 + 0.0016 + 0.0016

= ± 0.002

## Iodine Value

$IV_{S1}$ = Iodine Value $= \frac{(b-a) \text{ x } 1.269}{\text{weight of sample}}$

Where, b = blank titre, a = sample titre

$$\text{Iodine Value} = \frac{(174.50 - 26.11) \text{ x } 1.269}{2}$$

$$\text{Iodine Value} = \frac{188.31}{2}$$

$$\text{Iodine Value} = 94.156$$

Mean Iodine Value, ẍ, = ($IV_{S1}$ + $IV_{S2}$ + $IV_{S3}$)/ 3

= (94.156 + 93.210 + 95.125) / 3

= 94.159wijis

Standard Deviation for Acid value = $\sum_{x=1}^{n}((x - ẍ)^2) / 3$

=( (94.156–94.159)^2 +(93.210–94.159)^2 + (95.125- 94.159) ^2) / 3

= (0.000009 + 0.9006 + 0.9331)

= ± 0.16

Note that the above solutions are for the solvent extracted oil but the solutions also applies to the mechanically extracted oil