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Empowering Science Students with the Production of Oil from Watermelon Seed and its Importance Using Sohlex Extractor

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***Abstract*: The paper examined the processes involved in the production of oil from watermelons seed and its importance using sohlex extractor where N-hexane (Cyclohexane) was used as a solvent. Different variables of watermelons seeds were considered in term of particle sizes, ratio of solvent to seeds mass and quantity of oils that could produce from the process. The nutritional value of the oils and phytochemical analysis of the oil produced was carried out to determine if it's fit for human consumption, oil content, Fatty acid composition and Modification in watermelons seed oils were also examined. The findings revealed that the watermelon seed oils contain minerals salts such as Calcium, Phosphorous, Magnesium and Potassium in large amounts and it also contain vitamins such as Niacin, Thiamin, Riboflavin and vitamin B-6. Watermelons oil has some health benefits such as antioxidant against cancer. Can reduce cholesterol, high protein in vegetarian diet. Due to certain challenges identified from production processes some recommendations were made: government should encourage the science graduate to go into watermelon production by empowering them, make loan facility available, the research institutes should make public awareness on the health benefits of watermelon seed oils with its other numerous benefits.**

***Keywords*: Cyclohexane, extraction method, nutrition, watermelons seed.**

1. Introduction

Watermelons are one of the major underutilized fruits grown in warmer parts of the world (Oseni & Okoye, 2013). The watermelon plant is a warm season crop which requires long growing seasons and grows best on rich sandy loam soil, although it also grows on most other soil types provided it is well drained (Majaju, 2009). The crop is a natural and rich source of phytochemical compounds which are believed to be beneficial for human health and well-being (Abu-Reidah *et al.,* 2013). Little is documented about the watermelon and its seeds in Africa, but the indications are that it has versatile uses. The knowledge of the nutritive and the anti-nutritive content of various parts of the watermelon fruit will encourage their consumption in diverse ways and re-utilization of the vast amounts of seeds discarded as waste. The nutrient and anti-nutrient value of many fruits, seeds and their rind has not received much attention and these are at times discarded, even with their hidden nutrients (Johnson *et al.*2012). Recently, more attention has been paid to the utilization of by-products and wastes, as well as underutilized agricultural products. Such utilization will contribute to maximizing available resources and can also result in the production of new foods (Nyam *et al,* 2009).

The demand, production and utilization of biodiesel from vegetable seed oil has recently increased and is seriously affecting the supply or sustainability of the existing agricultural oil. These vegetable oils are paramount raw materials for most of our cosmetics, paints, and pharmaceutical industries. The global desire to minimize the release of greenhouse gases into the atmosphere and control of increasing cost of fossil fuel, had resulted into tremendous increase in the use of seed oils, as alternative energy source. Research has shown that over dependency on some popular seed oils, like, palm seed oil, peanut oil, soy bean seed oil, melon seed oil, palm kernel oil, etc., for edible, pharmaceuticals, oleo-chemicals, cosmetics, and other medicinal needs, had rapidly increased the pressure on vegetable oils.

There is an urgent need to explore some under, or non-utilized crop seed oils, as raw materials for both industrial and domestic applications because of over population in Nigeria. Watermelon is one of the underutilized oil seed plants in Nigeria and to due to high demands in the Nigeria market for more other sources of oil, there is need to produce oil from it to meet the demand of people.

With skills acquisition and training offered to NCE, science students can explore the production of oil from the watermelon seed by applying all the scientific skills learned to empowered themselves in other to create jobs instead of waiting for government jobs. By doing so, it allows them to live a better life by doing so they can also be employer of labour instead of being employed.

A. Aims of the Study

The main aim of the research is to discuss the process involved in the extraction of oil from watermelon seeds using Sohlex extraction and percolation to empower the science students in FCT College of Education, Zuba.

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The objectives are,

1. To discuss all the processes involved in extraction of oils from watermelon seeds
2. To explain the benefit of watermelon seed oils to human
3. To analyze the Phytochemical composition and other contents of watermelon seed oil
4. To empower the science graduating students through skill acquisition

2. Literature Review

Watermelon is a vine-like (scrambler and trailer) flowering plant originally from southern Africa. Its fruit, which is also called watermelon, is a special kind referred to by botanists as a Pepo, a berry which has a thick rind (exocarp) and fleshy center (exocarp and endocarp). Pepos are derived from an inferior ovary and are characteristic of the Cucurbitaceae. The watermelon fruit, loosely considered a type of melon – although not in the genus Cucumis - has a smooth\exterior rind (usually green with dark green stripes or yellow spots) and a juicy, sweet interior flesh (usually deep red or pink, but sometimes orange, yellow, or white).

Watermelon belongs to Cucurbitaceae family, which consists of nearly 100 genera and over 750 species (Duduyemi et al 2013). They are widely distributed in the tropics and sub-tropics and a few species occur in the temperate region. Watermelon grows well in alluvial and sandy soils, even in arid regions and coastal saline areas. In Nigeria the planting start early in November and extended up to February, in South and Central India watermelon is grown almost throughout the year. Watermelon is a major cucurbit crop that accounts for 6.8% of the world's area (second behind tomato) devoted to vegetable production in 2005. A rough estimate of annual world value of watermelon exceeds $15 billion. The total production of cucumber, melon and watermelon has increased more than four folds in the last 40 years, watermelon is the most popular cucurbits, followed by cucumber and melon (FAO, 2011).

Watermelon is originally from Africa and grown in more than 96 countries worldwide. China is the world's leading producer of watermelon, with 70.3% of total production in 2015. Other leading producer countries are Turkey (4.7%), Iran (2.3%), United States (2.2%) and Egypt (1.7%). Watermelon is an economically important fruit crop and valuable alternative source of water in desert areas.

In Africa, watermelon is grown not only in dry, low altitude tropical areas like Cape Verde, Mali, Mauritania, Chad, Senegal and Nigeria, but also in equatorial countries like Gabon and Democratic Republic of Congo (De Lannoy, 2001). In Nigeria, watermelon production has increased significantly in the last one decade with the major production areas being located in the northern part of the country.

In recent times, its cultivation has extended down to the forest belts of southwestern Nigeria (NIHORT, 2006). However, the northern fringes of the Sudan and Sahel savanna ecological zones and the shores of the Lake Chad remain the major production areas (NIHORT, 2006).

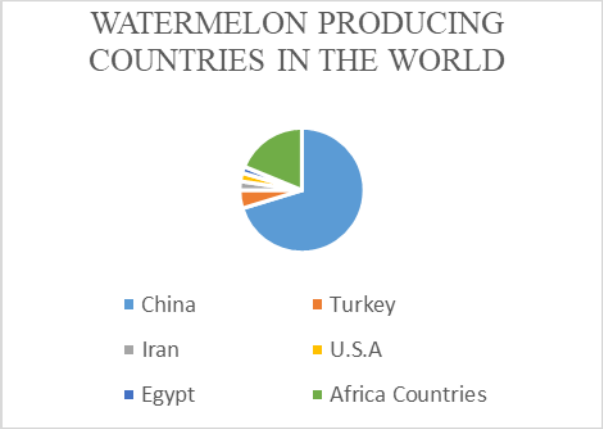

Fig. 1. Watermelon producing countries in the world

A. Watermelon Varieties

Watermelon is grown in more than 96 countries worldwide (Produce Pete, 2008). There are about 1200 varieties of watermelon grown worldwide; giving consumer's a wide choice to choose from. There is great variation within varieties ranging from small, big sweet or bitter, edible or inedible

Open-pollinated varieties are developed through several generations of selection. The selection can be based upon yield, quality characteristics and disease resistance. Open pollinated varieties have true-to-type seed (seed saved from one generation to the next that will maintain the same characteristics) and are less expensive than F1 hybrid varieties.

F1 hybrids are developed from two inbred lines that have been self-fed for several generations and then crossed with the subsequent seed sold to growers. F1 hybrid seed will exhibit increased uniformity of type and time of harvest compared with open pollinated seed and can exhibit as much as 20 percent to 40 percent increase in yields over open-pollinated varieties grown under similar conditions. The disadvantages of F1 hybrid seeds are cost and not available. F1 hybrid seed will be as much as five to 10 times as costly as open-pollinated seed and mostly available.

B. Oil Content and Fatty acid Composition in Watermelon Seeds

Oilseeds such as soybean (*Glycine max*) seeds are valuable commercial sources of edible oil and protein with approximately 42% protein and 23% oil at maturity (Dombos & Mullen, 2002). The seeds of the watermelon are increasingly being used in the oil industry in semi-arid regions for use of oil in the cosmetic and pharmaceutical industry and also the prospect use of the seeds in the improvement of infant formulation due to their high protein and fat content (Nwanko et al., 2014).

Composition of oil seeds is affected by genotype, location and year. However, the relative contribution of each of these factors varies with seed component evaluated, the seed type and geographical area. Although these are cost-effective sources of protein and oil, there are problems facing the use of these. The seeds have a high nutritive value and have a potential source of unsaturated fat, vitamins, antioxidants, minerals and proteins. They contain about 35% protein, 50% oil, and 57% dietary

Table 1
Detected components in watermelon seeds oil using GCMS technique

S.No.	Name of compound	Mole formula	Mole weight	RT	% composition
1	Palmitic acid	$C_{16}H_{32}O_2$	256	18.H	3.80
2	Carbonic acid (Octadecylpropy ester	$C_{22}H_{44}O_3$	356	6.51	1.03
3	Delta Tocopherol	$C_{27}H_{46}O_2$	402	5.7	5.16
4	Oleic acid (9 octadecenoic acid)	$C_{18}H_{34}O_4$	282	19.8	17.84
5	Propanedioc acid	$C_{15}H_{24}O_4$	268	6.18	3.74
6	Dioctyl ester	$C_{24}H_{38O}4$	390	23.10	0.98
7	Linoleic acid chloride (19,12-octadecadienoylchloride)	$C_{18}H_{31}ClO$	298	22.50	13.77
	Unidentified compounds				53.68
	Total % composition				100

fibre. Some of the minerals found in these seeds are magnesium, calcium, potassium, iron, phosphorus, and zinc. Amino acid analysis of the seeds has shown that hydrophobic and acidic amino acids such as aspartic acid, glutamic acid, and serine dominated the composition of the protein fraction (Yadav et al*.,* 2011).

C. Importance of Watermelon

Watermelon is 92% water and 8% sugar. It is rich in lycopene, an antioxidant that gives it its characteristic color. It is fat free (Medicine Net, 2004). Watermelon can be processed and used for juice syrups and sweets. From the seeds it is possible to extract oil rich in vitamin D, their sugar content boosts energy. High water content cleans human organism and does well for the urinary and digestive system. It is obvious that using watermelons in our regular diet is very healthy as it has positive curing effect on coronary, liver, gall bladder and kidney. Half kg of fruit can satisfy our daily need in vitamin C. Other than 85% water content, it contains 7-15% of sugar, also minerals, vitamins and little bit of proteins as well. Vitamins present are carotenes, vitamin B complex and traces of vitamin C. Mineral content present are potassium, magnesium, phosphorus, calcium, zinc, iron, and cuprum. It is a good source of carotenes and lycopene as well. Apart from nutrient value, it is also important as natural medicine source (Ignjatovic, 2005).

Watermelon is rich in carotenoids. Some of the carotenoids in watermelon include lycopene, phytofluene, phytofluene, beta-carotene, lutein and neurosporene. Lycopene makes up the majority of the carotenoids in watermelon. The carotenoid content varies depending on the variety of the watermelon. Carotenoid content in red fleshed watermelon varies from 37 – 121 mg/kg fresh weight, whereas lycopene varies from 35 – 112 mg/kg fresh weight (HonCod, 2008). The varieties vary in vigour, earliness and productivity, shape, colour and marking of fruits thickness and texture of rind, flavour and sugar content of flesh, size and number of seeds (Oyeleke et al 2012). Watermelon varieties fall into three broad classes based on how the seed was developed: open-pollinated, F1 hybrid and triploid (seedless).

D. Nutritional and Chemical Composition of Watermelon Seed Oils

Watermelon seeds are very rich in vitamins B and minerals, while fruit pulp is a source of vitamins A, B1, B2, B3, B6 and mostly vitamin C. The most abundant minerals in the seeds are magnesium and potassium, ranging values between 86.67-109.63mg/100g and 55.15-82.63mg/100g, respectively, depending on the location where they are found, whole seed, peeled seed or seed husk. *Citrulluslanatus* also present in high quantity (48.26%). The high iodine values of seed oils (135.39±12.84g100g oil) were related with their abundance in unsaturated fatty acids, indicating that these oils are appropriate for edible and/or drying oil purposes. Seed oils showed high quantity of unsaturated fatty acids (~82.32%), mainly oleic (C18:1) and linoleic (C18:2) acids. These two acids offer nutritional advantages and when mixed with other edible oils, can enhance nutritional values. Palmitic and stearic acids present in high concentrations although they are saturated fatty acids, they can be useful in cosmetic applications especially in the manufacture of shaving creams.

According to some of the researchers, the values of the physicochemical of watermelon seed oil are within their recommended limits and therefore it could be a good source of cooking and frying oil, as well as an ingredient in cosmetic formulations. Watermelon seed oil has high antioxidant activity, helping to prevent certain chronic diseases such as diabetes, cardiovascular disease and obesity, watermelon seeds oil contains several fatty acids, mainly mono-and poly unsaturated, showing up as a potential functional food. Thus, seeds oil can be used in cooking, as well as in pharmaceutical and cosmetic industries.

Watermelon seed as an Antioxidant: Watermelon seeds contain an antioxidant known as Cucurbocitrin, which is extracted and used in lowering blood pressure and improvement of kidney function.

Watermelon seed as antioxidant against cancer: Watermelon seed is a good source of phytochemicals and lycopene, which acts as an antioxidant during normal metabolism and protects against cancer. The red carotenoid pigment may act as an antioxidant by quenching free radicals formed during normal metabolism and may deactivate DNA chain-breaking agents that are implicated in some cancers

Mineral nutrients in watermelon seeds: The seeds of the watermelon are said to contain considerable amounts of minerals such as calcium, iron, manganese, phosphorus, potassium, sodium, zinc, copper and magnesium, which assist in growth and development of a healthy body, these minerals take part in various metabolic activities of living organisms

Great for High-Protein Vegetarian Diet: Watermelon seeds offer 4.7 grams of protein per ounce, giving them a perfect place in a high-protein vegetarian diet.

Health benefits of watermelon and watermelon seeds: Medicinally, watermelon seed had been used in treating dropsy and renal stones, reducing hypertension, preventing erectile dysfunction, acting as an antioxidant and treating enlarged

liver, jaundice and giardiasis

Reduce the Cholesterol: Watermelon seed oils also shown to have fatty acids that are of importance in the brain, the retina, liver, kidney and the gonads. Some of the fatty acids within the watermelon seed oil have also been shown to increase HDL cholesterol, which is beneficial to the human blood stream while oleic and linoleic acids are known to reduce LDL which is the bad cholesterol.

3. Methodology

A. Sample Collection and Preparation

The water melon fruit was purchased from Zuba fruits market, Abuja district Nigeria.

B. Samples Preparation

Seeds was carefully picked from watermelon fruits, Particle impurities such as dust, sands, stones, spoiled seeds, small weed seeds and other extra materials was separated by mechanical sieves then washed with water for further cleaning and left to dry at room temperature for 48 hours.

C. Materials Needed

Round bottom flask, conical flasks, spatula, pipettes, beakers, capillary tube, funnel, filter paper, measuring cylinder, water bath, sample bottles, test tube, watermelon seed, cellophane paper, large burette, distillation, rotary evaporator, Sohlex extractor, fume cupboard and milling machine or laboratory blender.

Chemicals:

All reagents needed are. N-hexane solution (Cyclohexane) and distilled water.

The processes involve in Watermelon Seed Oil Extraction

Watermelon seed → Shelling → Crushing or milling → Solvent extraction (Cyclohexane Solution) → Distillation (Rotary evaporator) → Extraction of oils

Extraction Process Variables:

In this research, various operating parameters that the researchers believe play important roles in the extraction of oils from watermelon was investigated, this includes particle size, ratio of solvent to watermelon seeds mass, sohlex extraction and packaging. Conditions of each parameter was presented:

Particles Size:

Samples size of watermelon seeds that highly rich in oils was carefully selected for the extraction.

Powdered seed to Solvent Mass Ratio:

The seed was washed and air-dried at (50°C) for 24 hours. The whole seed was milled into flour in machine mill, the milled powdered was kept in an air-tight plastic container at 4°C prior to extraction. 5kg of powdered watermelon seed to 10 litres of solvent extractor (Cyclohexane solution) was used for the extraction process

Sohlex extraction of watermelon seeds into oils:

The 5kg of powdered watermelon seed was accurately weighed in an empty thimble of known weight. The thimble with materials was placed in a sohlex extractor, a dry and accurate weigh bottom flask was fitted in to the extractor. The 10 Litres of solvent (Cyclohexane solution) was poured in to the flask until it filled approximately into two thirds of the flask. The flask, the extractor and condenser was fitted together, water was allowed to flow through the condenser and heating was continued for 6hrs until the sohlex extractor extracts all the oil from the solution, the extracted oil was then separated from the hexane solution using distillation (Rotary evaporator). The extracted oils were passed through the rotary evaporator to free the extracted oil from the solvent i.e., solvent (Cyclohexane Solution).

Fig. 2. Source: SHETCO Abuja

The extracted oils were further keep inside the fume cupboard for 24 hours to remove any residual solvent from the extracted oils and finally stored in a clean keg for use. The extraction and characteristics of oils from fruit seed have been carried out, the physiochemical properties and fatty acid composition of the oils from watermelon seed revealed that the oils extracted from the watermelon as it has shown in the table below is free from the chemical and fit for human consumption.

Table 2
Result of phytochemical analysis of watermelon seed oil

Phytochemicals	Watermelon seed oil
Saponins	+
Flavonoids	+
Alkaloids	+
Terpenoids	+
Tannins	+
Steroids	+
Phenols	+
Volatile oils	+
Balsams	-
Phlobatannins	-

Solvent extraction (Sohlex), provide higher yields—98% - 99%, oils, it is nowadays the dominant technique applied in most extraction processes. Solvent extraction becomes the commonly used commercial technique and the preferred solvent throughout the world due to its extraction efficiency and ease of availability to recover oils from oil seeds. In comparison, solvent extraction with hexane (the primary solvent used worldwide) will re-move all but about 0.5% of residual oil.

4. Conclusion

Watermelon as a valued oil seed appears to have numerous industrial applications. It is therefore important to fully develop

Industrial processing and utilization of watermelon seed at a substantial quantity to meet the current demands. In addition to other uses of the oil, like cooking as well as for medicinal purposes such as for the treatment of ulcers and burns, the oil extract could equally be used in making soap and skin moisturizers.

Recommendations:

Based on the outcome of the production of edible oil from watermelon seeds the following recommendations were made:

- Government should encourage farmers to plant this crop in a large scale.
- Unemployed science student graduates should be empowered to go into farming and production of watermelon seed oils because of its nutritional value
- Government to encourage anyone that wants to farm the seed by providing cheap, reliable means of processing the seed into other useful products.
- The organic food production in the country should promote and educate the public on the use and consumption of oil from watermelon seed that it is safe for human consumption. Nigeria can possibly export refined quality oils from watermelon seed.
- Private companies engaged in oil seed refining should also incorporate the extraction of watermelon seeds so as to utilize the potential opportunity of it.
- The oil seed extraction companies available in Nigeria should work closely with the universities and research centres to promote the extraction of oils from watermelon seed, analyze it to be fit into Nigeria market

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