Deanship of Graduate Studies
Al-Quds University

Effect of DC Electric Field On Oil Yield

Bara'a Ziad Mahmoud Khalil

M.Sc.Thesis

Jerusalem-Palestine

1439/2018

Electrical Current To Improve Oil Extraction Yield

Prepared by: Bara'a Ziad Khalil

B. Sc. Food science and technology, Al Quds University/ Palestine

Supervisor: Dr.Ibrahim Afaneh

Co-Supervisor: Dr.Rushdi Kitaneh

A thesis submitted in partial fulfillment of requirement for the degree of Master of Applied and Industrial Technology

1439/2018

Al-Quds University
Deanship of Graduate
Studies Applied and
Industrial Technology

Thesis Approval

Electrical Current To Improve Oil Extraction Yield

Prepared by: Bara'a Ziad Khalil

Registration Number: 21511359

Supervisor: Dr. Ibrahim Afaneh

Co-Supervisor: Dr. Rushdy Kitaneh

Master thesis submitted and accepted, Date: 25/7/2018

The names and signatures of the examining committee are as follows:

1. Dr. Ibrahim Afaneh Head of Committee Signature:..................
2. Dr. Rushdi Kitaneh Committee Member Signature:..................
3. Dr. Ziad Ayad Internal Examiner Signature:..................
4. Dr. Hisham Hidmi External Examiner Signature: ....

Jerusalem, Palestine

1438/2019

Declaration

I certify that this thesis submitted for the degree of master, is the result of my own research, except where otherwise acknowledged, and this thesis has not been submitted for the higher degree to any other university or institution.

Name: Bara'a Ziad Mahmoud Khalil

Signed: …………………….

Date:……………………….

Acknowledgments

At the end of my thesis, I would like to thank people at Al-Quds University for giving me the opportunity to achieve the M.Sc. degree. I wish to express my sincere gratitude to my supervisor Dr. Ibrahim Afaneh for his patience. His guidance helped me in all the time of research and writing of this thesis. Besides my advisor, I would like to thank the rest of my committee: Dr. Rushdi Kitaneh, for their comments. My thanks and appreciations also go to my colleagues and people who have willingly helped me out with their abilities.

My warmest thanks belong to my parents for their confidence in me and for being always so supportive and interested in my work and well-being.

Abstract:

The main goals of the present work were to study the impact of electrical current on extraction yield of olive oil, the effect of voltage, the effect of time, the effect of distance, and determination the quality of olive oil, were considered.

Olives samples were obtained from tree type Surry in Tulkarem _ Palestine. The collection was directly from the trees in the first day of November 2017. Several stages were applied to samples such as (washing cleaning and grinding), and then applying direct electrical field. The results showed that the highest rate extraction of olive oil was about 45%, obtained when the sample was treated with 20 kV for 1 minute and a distance of 2.5 cm.

The quality of oil were examined to determine its quality, the effect of DEC on chemical values of the oil: acidity, peroxide value and K factors K232, K270 were studied. Most of the olive oil was in the Extra Virgin stage according to EU legal standards (EVOO; extra virgin olive oil).

Table of contents

List of Tables:

List of figures

1.Introduction

1.1 Background :

Food is an essential part of everyone's life. It gives us the energy and nutrients to grow and develop, be healthy and active, to move, work, play, think and learn. Food is any substance normally eaten or drunk by living things. The term food also includes liquid drinks. Food is the main source of energy and of nutrition for animals, and is usually of animal or plant origin. Historically, humans secured food through two methods: hunting and gathering and agriculture. Today, the majority of the food energy required by the ever increasing population of the world is supplied by the food industry.

1.2 The history of food :

Early people probably ate food raw. At some point, they accidentally discovered that cooked food tasted better and was easier to digest. By trial and error, "sometime between 450,000 and 550,000 years ago," they learned to control fire and use it to prepare food. citing the works of Wu and Lin in 1983, Rowley-Conwy in 1993, and Megarry in 1995, "it does seem likely that at least by 230,000–460,000 years ago humans were using fire in the cave" (A. Zaccheo, 2017).

Eventually, early people found that could protect themselves and secure food more easily by living in groups. They formed tribes and began to hunt for food together. Some hunters (Weiss and Mann in 1968) became herders when they discovered they could capture and domesticate animals. People also discovered that could plant seeds to produce large amounts of food.

This discovery led to the beginning of farming. The advances of herding and farming made the food supply much more dependable. As food became easier to obtain, not all people had to spend their time hunting and farming. Some were able to learn a craft. Others became merchants

Trading in its simplest form began, and with it came the development of civilization, (Lee and De Vore, 1968).

1.2.1 The types and importance of food:

There are four basic food energy sources: water, proteins, carbohydrates and fat.

Water is an essential constituent in which organisms' life processes occur. In food, water presents predominantly as an intracellular or extracellular component in plant and animal food products. Interaction of water with other food constituents results in controlling many chemical and physical reactions which significantly contributes to shelf life and quality values of food products (Luck, 1981).

Proteins play a central role in biological systems and food as well. All biologically derived proteins can be used as food proteins which must be easily digestible, nontoxic, nutritionally adequate, functionally usable in food products, available in abundance, and sustainable agriculturally. The functional properties of proteins in foods are related to their structural and other physicochemical characteristics. Protein - is needed to build, maintain and repair muscle, blood, skin and bones and other tissues and organs in the body (Wahyu Wijaya et al, 2015).

Carbohydrates are organic compounds that are mostly distributed and abundant on earth. They consist of carbon, hydrogen, and oxygen and can be simple or complex in structure. In food processing, a carbohydrate has functional role in its physical and chemical properties which act as sweeteners, thickeners, stabilizers, gelling agents, fat replacers, and precursors for aroma and coloring substances, especially in thermal processing. Carbohydrates are commonly divided into mono saccharides, oligosaccharides, and polysaccharides. Carbohydrate - provides the body with its main source of energy. Carbohydrates can be classified into two kinds; starches and sugars (Bhavbhuti M. Mehta et al, 2015).

Food lipids are generally non water soluble compounds referred to as fats (solid) or oils (liquid) indicating their physical state at ambient temperatures. Food lipids are also classified as nonpolar (e.g., triacylglycerol and cholesterol) and polar lipids (e.g., phospholipids) to indicate differences in their solubility and functional properties. Food lipids play an important role in food sensory quality by contributing to attributes such as texture, flavor, nutrition, and caloric density.
Fat - This is the body's secondary source of energy. Fat actually provides more energy/calories per gram than any other nutrient, but is more difficult to burn (Lewin 1974; Luck 1981).

Fats and oils are recognized as essential nutrients in both human and animal diets. Nutritionally, they are concentrated sources of energy (9 cal/gram); provide essential fatty acids which are the building blocks for the hormones needed to regulate bodily systems; and are a carrier for the oil soluble vitamins A, D, E, and K (O'Brian, R.D 2004).

Fats and oils are also functionally important in the preparation of many food products. They act as tenderizing agents, facilitate aeration, carry flavors and colors, and provide a heating medium for food preparation. Fats and oils are present naturally in many foods, such as meats, dairy products, poultry, fish, and nuts, and in prepared foods, such as baked goods, margarines, and dressings and sauces (O'Brian, R.D, 2004).

1.3 The types of oils:

A vegetable oil is a triglyceride extracted from a plant. The term "vegetable oil" can be narrowly defined as referring only to plant oils that are liquid at room temperature, or broadly defined without regard to a substance's state of matter at a given temperature (Frank Gunstone, 2002).

For this reason, vegetable oils that are solid at room temperature are sometimes called vegetable fats. In contrast to these triglycerides, vegetable waxes lack glycerin in their structure. Although many plant parts may yield oil, in commercial practice, oil is extracted primarily from seeds.

Vegetable oils of different types and qualities are widely used in homemade cooking and food industry. Apart from their different organoleptic properties, different performances are provided by the different types of oil. There is also an ongoing debate on the health properties of the food processed with different kinds of oil. Corn, soybean, sunflower, and olive oils are products widely used in the cooking as seasoning or frying agent (Ramón Artiaga et al, 2011).

Corn oil (maize oil) is oil extracted from the germ of corn (maize). Its main use is in cooking, where its high smoke point makes refined corn oil a valuable frying oil. It is also a key ingredient in some margarines. Corn oil is generally less expensive than most other types of vegetable oils.

Unlike most other vegetable oils, corn oil (maize oil) is obtained from seeds (kernels) that contain only 3–5% oil. Obtaining oil directly from the kernels is technically possible, but 'corn kernel oil' would be costly to produce, due to the low levels of oil in the kernels. Because corn kernels contain high levels of starch (60–75%), a process of ‘wet milling’ was developed to isolate pure starch efficiently from corn kernels (Frank Gunstone, 2002).

Extrusion has recently been employed as a means of germ preparation for solvent extraction, producing a crude corn oil of high quality and high yield (Maza 2001). Others have demonstrated that corn oil can be effectively extracted by supercritical fluid extraction (Ronyai et al. 1998).

Corn oil is also a feedstock used for biodiesel. Other industrial uses for corn oil include soap, salve, paint, rustproofing for metal surfaces, inks, textiles, nitroglycerin, and insecticides. It is sometimes used as a carrier for drug molecules in pharmaceutical preparations.

Soybean is the dominant oilseed produced in the world, due to its favorable agronomic characteristics, its high-quality protein, and its valuable edible oil. It contributes over a half of all oilseeds produced worldwide .The US ranks first in soybean production (8.24 million tonnes), followed by Brazil, Argentina, China and EU-15 (4.28, 3.28, 3.26 and 2.87) million tonnes, respectively.

The production of soybean oil is driven by the need for soy protein meal, which is used extensively in commercial feeds for poultry, swine and cattle. Soybean oil accounted for 80–90% of total edible oil consumption in the US (USDA–NASS) in 1998 because of its availability and many desirable characteristics, including compositional and functional properties. Soybean oil is the predominant vegetable oil produced in the world, side by side with palm oil (Gunstone 2001).

The common processes for soybean oil extraction are solvent extraction and mechanical pressing. Solvent extraction with hexane is the standard practice in today’s modern processing facilities, and its use has been reviewed by Woerfel (1995).

The major mechanical processes for soybeans are continuous screw pressing with extensive heating and extrusion-expelling (Nelson et al. 1987). Extrusion-expelling technology is used increasingly for processing identity preserved seeds for niche market soybean oil and protein products (Wang and Johnson 2001).

Sunflower (Helianthus annuus) oil is the most popular oil produced in the Russian Federation, Ukraine, Argentina and some European countries. Production of sun-flower oil amounted 530 million tons in 2010 and the export exceeded 340 million tons (Bonos et al. 2011).

Sun-flower oil is widely used in food processing, cooking, production of soap, mayonnaise, etc. The percentage of oil in this seed can range from 45 to 52%. Standard sunflower seeds mainly contain α-tocopherol, which accounts for more than 90% of the total tocopherols. β- and γ-tocopherols can be present in sunflower seeds usually in amounts below 2% of the total tocopherols (Demurin et al.1996). Moreover, sunflower seeds present high content of protein. The fatty acid content of this oil is composed mainly of linoleics, linolenic stearics, palmitic myristics and arachidic oleics. Pressing and solvent extraction are the most common processes used for oil extraction from seeds. Screw presses are usually used for industrial-scale pressing; however, the hydraulic presses can also be employed (Evoet al. 2007).

Olive oil is a major component of the diet of countries of the Mediterranean Sea. For the people living in this region, olive oil is the main source of fat in their kitchen. In the past few years the oil has also become more popular among consumers in Northern Europe, the US and Canada, in particular, although these new consumers are not always familiar with the properties and characteristics of this natural product. Growing enthusiasm for the Mediterranean diet and for olive oil is due largely to studies indicating that this diet plays a positive role in the prevention of certain diseases, especially coronary heart disease (Hamatschek, J,1995).

Extraction of olive oil from olives : Olive oil is obtained from the fruits of the olive tree (Oleaeuropaea) by mechanical or other physical means, under conditions that do not cause any changes in the oil. The oil is first released from the olives by crushing: in pressure systems, stone mills are generally used and in continuous centrifugation plants, metal crushers (hammer, roller, disc). After it has been crushed the olive paste is mixed (Kiritsakis, 1998).

Malaxation prepares the paste for separation of the oil from the pomace. This step is particularly important if the paste was produced in a hammer mill. The mixing process optimizes the amount of oil extracted through the formation of larger oil droplets and a reduction of the oil-water emulsion (Kiritsakis, 1998). The paste is slowly mixed, bringing small droplets of oil in contact with each other to form larger droplets. This improves the extractability of the oil. Optimally, the malaxator is designed to assure thorough mixing, leaving no portion unmixed. Malaxation usually requires 45 minutes to one hour. The longer the contact between the oil and the fruit water, the more the final polyphenol content of the oil is reduced (Fantozzi P,1994) .

Temperature of the paste during malaxation is very important. It should be warm (26.6° to 30° C, which is still cold to the touch) to improve the viscosity of the oil and improve extractability. Temperatures above 30° C can cause problems such as loss of fruit flavors, increases in bitterness, and increases in astringency.

Sometimes it is difficult to get good oil extraction from certain pastes and it is usually because the olives have too much moisture. The solution is to let the olives sit for a few days in a well-ventilated area, raise the temperature of the paste, or add talc to absorb the excess moisture. A paste moisture content of < 45% is easily worked but moisture content of > 50% is more difficult to extract oil (Vossen, P.M, 1992) .

The International Olive Oil Council (IOOC), has a United Nations charter to develop standards for quality and purity criteria for olive oil. Their main focus is regulating the legal aspects of the olive oil industry and preventing unfair competition. Olive oil quality according to IOOC were classified as:-

Extra virgin olive oil: Contains no defects and has some positive attributes, as evaluated by the mean of a certified taste panel. Extra-virgin oil also must have a free acidity percentage of less than 0.8 and a peroxide value of less than 20 meq/kg.

Virgin Olive Oil: Oil with a sensory analysis rating of the mean of tasters to have defects from 0 to < 2.5, a free acidity of < 2% and a peroxide value of < 20. An oil of slightly lower quality.

Ordinary Virgin Olive Oil: Oil with a slightly lower organoleptic rating (defects from the mean of tasters 2.5 to < 6.0) and a free acidity of < 3.3% with a peroxide value of < 20.

Virgin Lamp-Oil (Lampante): Oil with many defects, not fit for human consumption, and intended for refining. These oils come from bad fruit.

Olive-Pomace Oil: Blend of refined olive-pomace oil and virgin olive oil fit for human consumption. In no case shall this blend be called "olive oil.

1.4 The importance of olive oils global and local:

1.4.1 At Global Level:

World olive oil production, consumption, and trade is highly concentrated in the Mediterranean region, primarily in southern EU countries.

During 2007/08–12/13, about 97 percent of the world's olive oil production and 80 percent of global olive oil consumption was centered in countries bordering the Mediterranean. Within the Mediterranean region, both production and consumption was highly concentrated in the EU, with the bulk produced and consumed in Spain, Italy, and Greece. During 2008–12, the EU accounted for 87 percent of global olive oil exports by volume, made up largely of exports from Spain (52 percent) and Italy (23 percent) (Figure 1.1). However, intra-EU trade flows comprise the majority of global exports, accounting for 57 percent of global export volume during 2008–12. The largest bilateral trade flows during this period were Spanish exports to Italy, which accounted for roughly one-quarter of global olive oil exports (USITC, 2013).

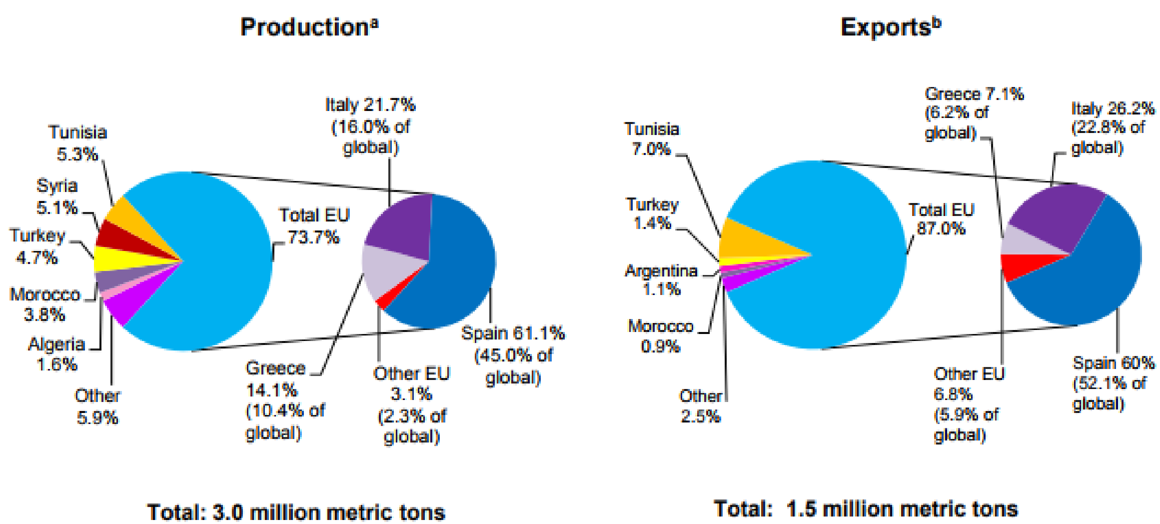


Figure 1.1 Olive oil: Share of global production and exports, 2008–12 average (USITC, 2013).

[a] Data covers marketing years 2007/08 through 2011/12. A marketing year spans October 1 to September 30 the following year.

[b] Trade data is presented on a calendar year basis, and includes intra-EU trade.

Most of the recent growth in olive oil consumption occurred outside the traditional Mediterranean producing and consuming countries.

A substantial and increasing share of global consumption is by countries that are not traditional olive oil producers. In particular, the United States, which accounted for about 9 percent of world olive oil consumption during 2007/08–11/12, is now the world's third-largest olive oil consuming country, behind Italy and Spain. U.S. consumption has risen by more than 50 percent since 2000/01 and continues to grow at 4–5 percent annually. A key driver of growth is promotional campaigns directed toward health conscious, high-income consumers highlighting the nutritional benefits of olive oil. Australia, Canada, China, and Japan have experienced strong consumption growth as well (USITC, 2013).

1.4.2 At Local Level:

Olives are a centuries-old mainstay of the Palestinian economy, with the soil and climate producing some of the of the world's highest quality olive oil. The olive is also symbolic of Palestinians roots in, and attachment to, the land. Some 45% of agricultural land (over 900,000 dunums) is planted with an estimated 10 million olive trees, with the potential to produce between 32,000 – 35,000 metric tons of oil. Approximately 93% of the olive harvest is used for olive oil, and the remainder for pickles, table olives, and soap. Up to 100,000 families depend upon the olive harvest for their livelihoods to some extent (UNDP, 2008).

The vast majority of the harvest is consumed domestically, with a small amount exported abroad, principally to Jordan, with increasing interest and demand from the international organic and free trade markets. The olive industry promises to contribute over US$ 123 million (based on 2006) to the fragile West Bank economy - 18% of total agricultural production. However, the movement restrictions and obstacles imposed by the Israel Defence Forces (IDF), which reduce access to land and markets; the Barrier which separates many farmers from their olive groves; the closure of the Gaza Strip crossings; and the increasing attacks and destruction by Israeli settlers against farmers and olive trees, combined raise concerns about the potential success of the olive season (UNDP, 2008).

Olive and olive oil production in the State of Palestine is concentrated in the north and northwest of the West Bank (as shown in Figure 1.2), where soil and climate conditions are most favorable.

Olives are cultivated throughout the State of Palestine, but planting density can approach a high of 200 trees per hectare in the northern half of Ramallah governorate and nearly all of Jenin, Nablus, Tulkarem, Qalqilyia, and Salfit governorates. Only 8% of the State of Palestine's agricultural land is in Gaza, and its climatic conditions are not conducive to the higher planting densities of the West Bank (Qutub et al,. 2010).

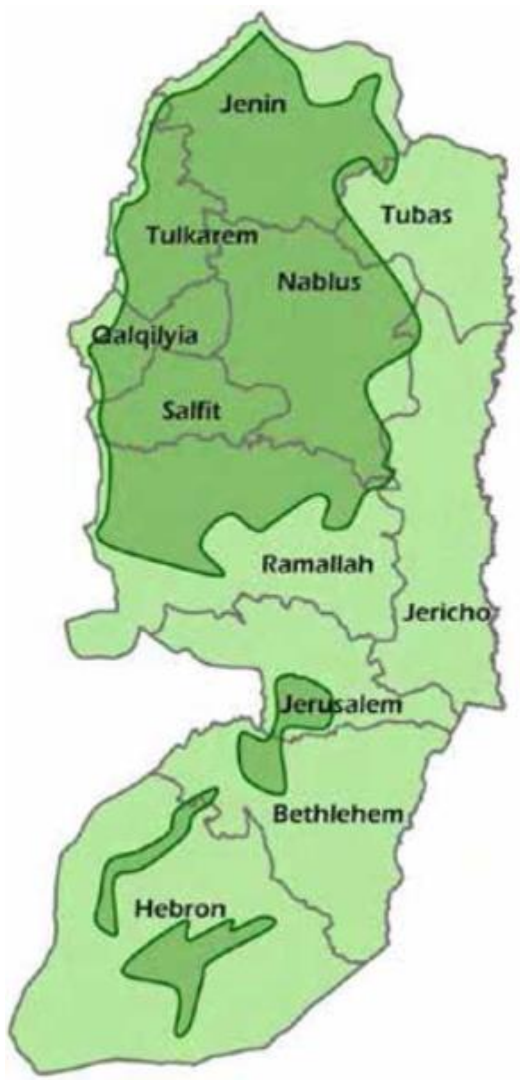


Figure 1.2 Most productive regions of the West Bank for olive cultivation (more productive regions in darker green) (Qutub et al,. 2010).

Table 1.1 Quantity of Olive Pressed and Oil Extracted for Olive Presses Activity in Palestine by Automation Level and Governorate, 2012

(Quantity in Metric Ton)

Governorate	المجموع Total			معاصر أوتوماتيك Full Automatic Olive Presses			معاصر قديمة ونصف أوتوماتيك Traditional & Half Automatic Presses			المحافظة
	كمية الزيت Quantity of Oil Extracted	كمية الزيتون Quantity of Olive Pressed	العدد Number	كمية الزيت Quantity of Oil Extracted	كمية الزيتون Quantity of Olive Pressed	العدد Number	كمية الزيت Quantity of Oil Extracted	كمية الزيتون Quantity of Olive Pressed	العدد Number	
Palestine	**22951.1**	**104762.6**	**279**	**21452.0**	**97820.1**	**246**	**1499.1**	**6942.5**	**33**	فلسطين
West Bank	**21356.9**	**95215.8**	**258**	**20079.7**	**89596.3**	**233**	**1277.2**	**5619.5**	**25**	الضفة الغربية
Jenin and Tubas*	**7835.2**	**33846.0**	**69**	7538.6	32460.9	67	296.6	1385.1	2	جنين وطوباس*
Tulkarm	**2787.4**	**13267.4**	**35**	2657.5	12634.3	32	129.9	633.2	3	طولكرم
Nablus	**2597.2**	**11300.5**	**46**	2338.9	10150.9	37	258.3	1149.6	9	نابلس
Qalqiliya	**1045.8**	**4355.9**	**16**	623.8	2602.1	10	422.0	1753.8	6	قلقيلية
Salfit	**1773.8**	**7791.7**	**25**	1773.8	7791.7	25	0.0	0.0	0	سلفيت
Ramallah and Al-Bireh	**2429.4**	**10521.4**	**30**	2279.6	9892.9	26	149.8	628.4	4	رام الله والبيرة
Jerusalem	**472.9**	**2012.8**	**4**	472.9	2012.8	4	0.0	0.0	0	القدس
Bethlehem	**618.0**	**2656.9**	**7**	597.4	2587.5	6	20.6	69.4	1	بيت لحم
Hebron	**1797.2**	**9463.1**	**26**	1797.2	9463.1	26	0.0	0.0	0	الخليل
Gaza Strip	**1594.2**	**9546.8**	**21**	**1372.3**	**8223.8**	**13**	**221.9**	**1323.0**	**8**	قطاع غزة
Gaza and Deir Al-Balah*	**995.6**	**5992.8**	**13**	881.8	5272.5	8	113.8	720.3	5	غزة ودير البلح*
Khan Yunis and Rafah*	**598.6**	**3554.0**	**8**	490.5	2951.3	5	108.1	602.7	3	خانيونس ورفح*

* The Data of some Governorates were merged to maintain data confidentiality as stated in the general Statistics Law 2000

Table 1.2 Main Economic Indicators for Olive Presses Activity in Palestine by Governorate and Automation Level, 2016

(Quantity in Metric Ton and Value in USD 1000)

Governorate	القيمة المضافة Gross Value Added	الاستهلاك الوسيط Intermediate Consumption	قيمة إنتاج المعاصر Olive Presses Output Value	تعويضات العاملين Compensation of Employees	كمية الزيت المستخرج Extracted Oil Quantity	كمية الزيتون المدروس Pressed Olive Quantity	عدد المعاصر العاملة No. of Operating Presses	المحافظة
Palestine	**8,799.4**	**2,011.2**	**10,810.6**	**919.3**	**20,134.9**	**84,147.6**	**274**	فلسطين
West Bank	**7,175.6**	**1,507.7**	**8,683.3**	**737.9**	**16,434.4**	**64,126.5**	**245**	الضفة الغربية
Jenin and Tubas*	1,600.1	353.3	1,953.4	291.2	5,035.6	20,400.2	59	جنين وطوباس*
Tulkarm	1,071.5	176.6	1,248.1	69.2	2,388.0	9,552.0	35	طولكرم
Nablus	626.3	256.2	882.4	118.5	2,015.7	7,168.5	40	نابلس
Qalqiliya	535.9	102.4	638.3	37.6	1,595.7	6,044.6	15	قلقيلية
Salfit	713.8	54.3	768.1	24.3	1,573.3	5,870.8	26	سلفيت
Ramallah and Al-Bireh	1,446.1	295.8	1,741.9	115.5	1,599.9	5,740.0	34	رام الله والبيرة
Jerusalem	308.9	41.2	350.0	27.7	261.0	930.4	4	القدس
Bethlehem	326.3	68.2	394.5	20.6	608.0	2,476.6	7	بيت لحم
Hebron	546.7	159.7	706.5	33.3	1,357.1	5,943.6	25	الخليل
Gaza Strip	**1,623.8**	**503.5**	**2,127.3**	**181.4**	**3,700.5**	**20,021.1**	**29**	قطاع غزة
Gaza & North Gaza*	324.7	118.3	443.0	52.0	760.0	4,605.3	10	غزة وشمال غزة*
Deir Al-Balah	862.6	232.7	1,095.3	74.2	1,780.3	9,210.7	9	دير البلح
Khan Yunis and Rafah*	436.5	152.5	589.0	55.2	1,160.2	6,205.2	10	خانيونس ورفح*
Traditional & Half Automatic Presses	**446.4**	**90.9**	**537.4**	**52.3**	**689.1**	**3,217.1**	**19**	معاصر قديمة ونصف أوتوماتيك
Full Automatic Presses	**8,353.0**	**1,920.2**	**10,273.2**	**867.1**	**19,445.7**	**80,930.5**	**255**	معاصر أوتوماتيك

* The Data of some Governorates were merged to maintain data confidentiality as stated in the General Statistics Law 2000.

1.5 Evolution of oil extraction:

1.5.1 Hand Press Extraction:

Documented oil extraction dates back to 1650 B.C. when ripened olives were pressed by hand in Egypt using wooden pestles and stone mortars. The extracted olive oil was filtered through goat hair filters and used as a lubricant. Sesame, linseed, and castor oils were recovered in Egypt by hand pressing as far back as 259 B.C (H. G. Kirschenbauer, 1994).

1.5.2 Early Mechanized Extraction:

By 184 B.C., the Romans developed more sophisticated technology such as edge-runner mills and screw and wedge presses. These technologies combined leverage and the use of animal power to aid in the milling and extraction of the oil. From Roman times until the eighteenth century, similar technology was used for oil extraction (H. G. Kirschenbauer, 1994) .

In the eighteenth century, wind and water power largely replaced animal power to assist in oil extraction. Large wind-driven stamper mills became popular in Europe. The wind turned a vane outside the oil mill, and the rotational energy was transmitted into the mill via shafts and gears, eventually rotating a horizontal cam shaft. The horizontal cam shaft had vertical stamper shafts connected to it. The initial stamper shafts were used as mortars to beat the oilseeds into a pulp inside a wooden pestle. The pulp was then transferred into filter bags woven from horse hair and placed vertically between opposing wedges. Additional stampers pounded the wedges together, squeezing the oil through the filter bags, where it could be collected. Hundreds of such oil mills sprung up across Europe (Anonymous, 1997).

1.5.3 Hydraulic Press Extraction:

In 1795, J. Bramah of England invented the hydraulic press for oil extraction . Oilseeds were milled, cooked, and wrapped in filters cloths woven from horse-hair. The oilseeds wrapped in filter cloths were manually loaded into perforated, horizontal boxes below the head block and above the ram of the press.

The boxes were pressed together using upward hydraulic pressure on the ram. The oil was pressed out through the filter cloths surrounding the oilseeds. The filter cloths and spent cake were manually removed from the hydraulic press. The residual oil in spent cake was approximately 10%. In 1801, the first cottonseed oil mill was constructed in the United States using hydraulic presses. By the 1870s, American technology in hydraulic pressing had outpaced European technology. Large hydraulic presses with up to 16 press boxes and up to 400 tons of force were being used (Anonymous, 1997) .

In 1874, Rose, Down, and Thompson of Hull, England, began marketing the American-designed hydraulic presses with the advantage of preforming the cakes to increase productivity. Facilities using this joint technology were commonly referred to as Anglo-American oil mills. In the late 1800s, German companies were producing hydraulic cage presses, with rams pressing the oilseeds inside of vertical slotted barrels that did not require filter cloths.

By the end of the nineteenth century, hydraulic press oil mills were the standard technology for oil extraction.

In 1900, Alfred French founded the French Oil Mill Machinery Company in Piqua, Ohio, for the purpose of advancing hydraulic press technology. He was awarded a patent for the automatic cake-trimming machine for automating the sizing of the cakes prior to pressing. He also developed and patented the ‘‘change valve’’ in 1905, which allowed the hydraulic press to change pressures near the end of the pressing cycle to squeeze additional oil. The continuous stacked cooker was patented in 1907 along with an innovative cake former. Two pass pressing was another of French’s developments, taking final residual oil in cake below 5% (Anonymous, 2000).

French hydraulic presses became the industry standard in the United States in the 1920s. Hydraulic press oil mills remained in use as late as the 1950s before the last of them were replaced with continuous screw presses and continuous solvent extraction plants, both of which required far less labor and could process at much higher rates. Figure 1.3 indicates a typical French hydraulic press.

The olive oil industry is the only oilseed industry still using hydraulic presses today. This is possible because of the price premium paid for virgin olive oil, processed without the use of heat or chemicals.

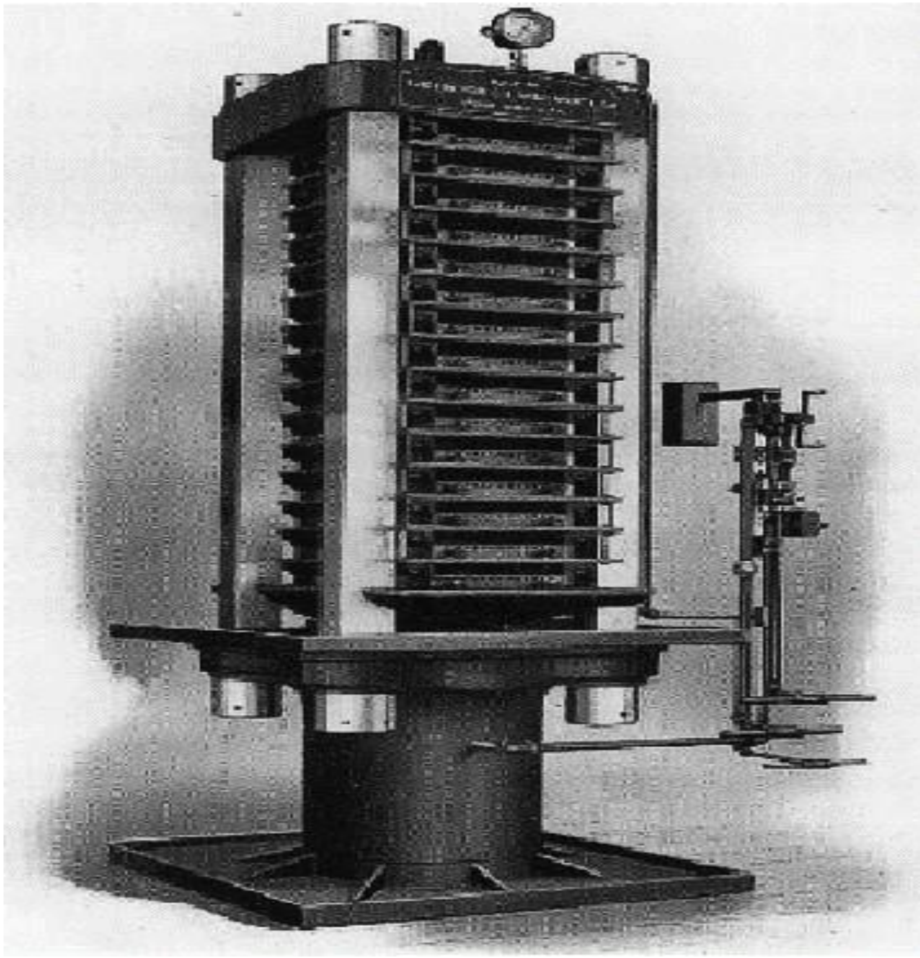


Figure 1.3 Hydraulic press. Courtesy of French Oil Mill Machinery Company (Anonymous, 2000).

1.5.4 Screw Press Extraction:

In 1900, Valerius D. Anderson invented the mechanical screw press in Cleveland, Ohio. He was awarded a U.S. patent for the apparatus . The mechanical screw press was a radical departure and significant technological advancement over the hydraulic presses being used at the time. The mechanical screw press used a vertical feeder and a horizontal screw with increasing body diameter to impart pressure on the oleaginous material as it proceeded along the length of the screw. The barrel surrounding the screw was slotted along its length, allowing the increasing internal pressure to first expel air and then expel the oil through the barrel. The expelled oil was collected in a trough under the screw, and the de-oiled cake was discharged at the end of the screw (V. D. Anderson, 1900) .

The primary advantage of the mechanical screw press was that it allowed continuous oil extraction and could process large quantities of oleaginous materials with minimal labor.

In the early 1900s, a number of European companies developed variations of the V. D. Anderson design concepts and began manufacturing mechanical screw presses. In the 1930s, after the U.S. patent had expired, other American firms did the same. These machines were able to replace large numbers of hydraulic presses.

In 1951, the V.D. Anderson Company was again the pioneer in mechanical screw pressing, being first to patent the process of using a mechanical screw press to continuously prepress oleaginous materials ahead of continuous solvent extraction plants (Anonynous, 2002).

In the past 100 years, the primary improvement in mechanical screw press design has been developing materials of construction that extend wearing part life. Screw and barrel parts that once lasted three months before requiring replacement may now last up to two years. Additionally, mechanical screw presses have been built to much larger scale, going from initial capacities of 5 tons per day up to present-day capacities of over 100 tons per day for full pressing and over 800 tons per day for prepressing applications.

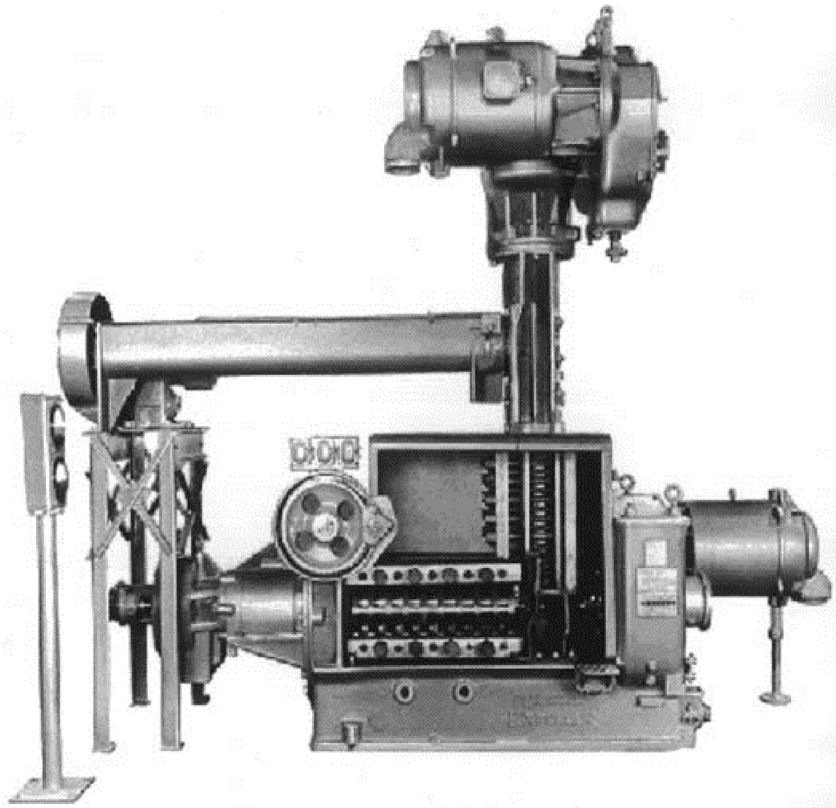


Figure 1.4: Illustration of an early Anderson Expeller (V. D. Anderson, 1900).

1.5.5 Solvent Extraction:

In 1855, Deiss of Marseilles, France, was the first to employ solvent extraction. He used carbon disulfide to dissolve olive oil retained in spent olive cakes.

This technology used batch solvent extraction, where the material was held in a common kettle for both the extraction process as well as the subsequent meal de solventizing process. Deiss obtained a patent for batch solvent extraction of olive oil in 1856(H. G. Kirschenbauer,1994).

Small batch solvent extraction plants were installed in France and Italy, and by 1870, small batch solvent extraction facilities had spread across Europe. Larger scale solvent extraction plants were supplied by Rose, Downs, and Thompson of Hull, England, starting in 1898 (P. J. Wan and P. J. Wakelyn,1997).

Between 1934 and 1937, the Hansa-Muhle Company of Germany supplied the first continuous solvent extraction plants to oilseed processors in the United States, using Hildebrant-type extractors. Leading German solvent extraction technology was set back due to World War II.The American company, French Oil Mill Machinery Company of Piqua, Ohio,developed continuous solvent extraction plants starting in 1939, using a multistage Bollman-type percolation extractor . (Anonynous, 2002).

In 1985, Mason of French Oil Mill Machinery Company developed a variation to the Schumacher DTDC design. The Mason design used a hollow stay-pipe type of perforated countercurrent tray design with clusters of perforations through a single plate at the top of the pipes. The DC also included the option of steam dryer trays prior to the air dryer trays, with the water vapor from the steam dryer trays being returned to the solvent extraction process for heat recovery. Another variation of the Schumacher DT was developed in 1997 and patented in 1999 by Kemper of the French Oil Mill Machinery Company and the Farmer of Bunge Corporation, which used a perforated countercurrent tray composed of a combination of indirect heating surface and slotted screen elements for more even distribution of countercurrent stripping steam (T. G. Kemper and R. D. Farmer, 1999) .

The latest extractor to be developed for mainstream oleaginous material extraction applications is a rotary-type extractor with fixed slotted floor and bevel gear drive trademarked as the Reflex Extractor. This extractor was developed by Kemper et al. of the French Oil Mill Machinery Company in 1995 and patented in 1997. The Reflex Extractor is an improvement on the Rotocel Extractor. One of these units installed at the Louis Dreyfus solvent extraction plant in Argentina has processed in excess of 9000 metric tons of soybeans per day, making it the world’s highest capacity extractor (T. G. Kemper, et al.,1998).

1.6 Application of olive oil and uses:

1.6.1 In Cosmetics:

The cosmetic use of vegetable oils can be complicated and in many cases there is a possibility of their acting as "attractives" that supposedly have surprising functions in cutaneous corrections. The cosmetic interest of these vegetable oils resides primarily in obtaining the unsaponifiable fraction, since in topical applications this fraction activates the cutaneous metabolism in the zone of application, producing an emollient, hydrating, dermoprotective, and photoprotective effect.

Olive oil considered officinal in most pharmacopoeias is a slightly yellow liquid with a characteristic odor that easily goes rancid. It comprises distinct acids, such as oleic (65-80%), palmitic (7-20%), Iinoleic (4%), estearic (2-4%), miristic (1 %) and occasionally lauric and arachidonic acids . Olive oil is employed in the fabrication of many pharmaceutical preparations and cosmetics due to its unsurpassable quality in soap, creams, skin oils, liniments, and sunscreens preparations . It is also used in the preparation of Salicylic Oil and Camphorated Oil. (V. Gallardo et al,. 1998).

1.6.2 In Soap:

Olive oil is one of the most common base oils used in soap making today. 100% olive oil soap, or “Castile” soap has been made for centuries – and today, soap makers of all types usually include at least some olive oil in their recipes. It makes a nice hard bar of soap, is mild, and in combination with other oils, makes a nice dense lather.

Olives are a type of fruit called a drupe which is basically a type of fleshy fruit that has one hard seed at the center. First, the olives are generally crushed and ground into a paste. Then, the oil is to be separated from the paste by various methods. The first oil that has come from the very first crush is the “virgin” olive oil. The paste that is left behind after the first extraction is called “pomace.”

Fatty acid composition of Olive oil:-

• Oleic 63-81%

• Palmitic 7-14%

• Linoleic 5-15%

• Stearic 3-5%

Olive oil contributes to soap hardness, stable lather, slippery feel, conditioning, moisturizing. Olive Oil attracts external moisture to your skin, helping to keep skin soft and supple. Pomace olive oil contains a larger proportion of unsaponifiable ingredients. This slightly affects its SAP value and imparts a greenish color to the oil and to soaps made with it. Pomace oil is preferred to grade A olive oil for soap making (Susmita Mishra, 1986) .

1.6.3 As Food:

Olive oil is known for its health benefits (Sala-Vila et al. 2016). Diet patterns with higher intakes of olive oil are associated with a reduced risk of death from all causes (Sala-Vila et al. 2016). The 2015–2020 Dietary Guidelines For Americans suggests an oil intake of about 5 teaspoons daily for a standard diet of about 2000 calories (USDHHS and USDA 2015).

There are three common types of olive oil, namely virgin olive oil, refined olive oil, and olive pomace oil. Each has its unique processing method, flavor characteristics, composition, and food applications. Virgin olive oil is produced by crushing fresh olives, followed by mechanical extraction of the oil. No heat or chemicals are used in this process. For the best quality olive oil, the fruit must be of high quality. Terms used to refer to the processing of olives for virgin olive oil include first-press, cold-pressed, or cold-extracted. This type of olive oil is the most flavorful and is potentially the most health-enhancing because it contains naturally occurring substances such as polyphenols (Buckland and Gonzalez 2015).

Refined olive oil is produced from low quality olive oil that undergoes are fining process that removes most of the free fatty acids, considered an undesirable component of oils, and other impurities in the oil. Potentially beneficial substances, such as polyphenols, are also removed during the refining process. The resulting oil is tasteless, colorless, and odorless, similar to commonly consumed refined vegetable oils (ISEO 2016).

1.7 Healthy Benefits of Olive Oil:

1.7.1 Cardiovascular Disease (CVD):-

Although higher intakes of fruits, vegetables, and legumes provide significant health benefits and protection from CVD, olive oil is independently protective (Grosso et al. 2015). In 2004, the Food and Drug Administration (FDA) approved a qualified health claim for olive oil.

Olive oil have a role in the prevention (Lopez et al. 2016) and treatment of hypertension (high blood pressure) (Fito et al. 2005). Virgin and refined olive oil were compared in men with coronary heart disease (Fito et al. 2005). Consuming virgin olive oil rich in phenolic compounds was shown to have antioxidant properties and reduce blood pressure in these patients.

Olive oil has also been shown to improve blood cholesterol. Refined olive oil was compared to butter in a recent study. Consuming olive oil decreased total and low-density lipoprotein (LDL) cholesterol compared to butter (Engel and Tholstrup 2015), which may decrease risk of a heart attack or stroke. Also, supplementation of extra-virgin olive oil (about 2 tablespoons per day) in adults over 50 years of age led to decreased total and LDL cholesterol within 6 weeks (Haban et al. 2004).

1.7.2 Diabetes and Metabolic Syndrome

Consuming olive oil may help prevent type 2 diabetes (T2D) (Guasch-Ferre 2015; Storniolo et al. 2015; Salas Salvado et al. 2014). Providing extra-virgin olive oil to adults at high risk for cardiovascular disease reduced the risk of T2D by 40% in only 4 years (Storniolo et al. 2015). A population study in Spain showed that those who consumed olive oil compared to sunflower oil had less risk of impaired glucose regulation (Soriguer et al. 2013), a condition which often leads to the development of T2D.

1.7.3 Cancer Prevention

There is some scientific evidence to support a link between olive oil intake and cancer prevention (Psaltopoulou et al. 2013). Specifically, people with the highest olive oil intake have less risk of any type of cancer compared to those with the lowest intake. Consuming olive oil may also decrease the risk of breast cancer (Xin et al. 2015) and cancers of the digestive system, such as oral, pharyngeal, and esophageal (throat), and it is slightly protective for colon cancer (Psal topoulou et al. 2013). There seems to be no link between olive oil intake and prostate, lung, or ovarian cancer risk, but there may be a protective effect of olive oil on laryngeal and stomach cancer risk (Psaltopoulou et al. 2013).

1.7.4 Inflammation

Inflammation is the body's beneficial response to tissue injury. However, chronic inflammation contributes to the development of many chronic diseases, such as cardio vascular disorders. A commonly used indicator of inflammation is C-reactive protein or CRP in the blood. In a review of 30 studies examining the effect of olive oil on markers of inflammation, olive oil showed a favorable effect on CRP levels (Schwingshackl, Christoph, and Hoffmann 2015). In patients with coronary heart disease, 3 tablespoons of extra virgin olive oil lowered levels of CRP compared to refined olive oil (Fito et al. 2008). Also, in persons with HIV, daily consumption of about 3 tablespoons of extra virgin olive oil lowered levels of CRP (Kozic et al. 2015).

1.8 Differences between Oil Extraction Methods:

1.8.1 Olive oil extraction systems:

Different extraction technologies, such as pressure and centrifugation and selective filtration (i.e. "surface tension" or "percolation") enabling the separation of oily must from the olive paste can be used (Boskou, 1996; Di Giovacchino et al., 1994, 1995).

1.8.2 Pressure extraction system:

Pressing is one of the oldest methods of oil extraction and has evolved considerably over the centuries. In olive oil mills equipped with this system the press separation of the oil from the paste is currently carried out using open hydraulic presses. From a theoretical point of view, this system guarantees intrinsic oil quality.

However, its use presents a few problems, mainly due not only to its low working capacity per hour, in which case the storage of olives lengthens, but also to the proper use of the filter mats and to the types of materials used to build the equipment. The critical aspects of the process regarding the use of the press, which impacts on the quality of the oil, are concerned with both the proper management of the filter mats and the use of construction materials made of stainless steel. As regards the filter mats, it is important to point out that they can represent a source of contamination, due to the fact that they may introduce fermentation and an oxidation defect into the oil, causing sensorial defects (Angerosa et al., 2004).

This effect can arise both from the contamination with oils obtained from poor batches of olives and from fermentation processes of the vegetation water and pomace fragments, which remain in the filter mats, when they are kept in storage during the different processing stages. The latter problem occurs particularly when the oil harvest is interrupted by bad climatic conditions and it is impossible to work continuously.

In order to minimize the risk of defects developing in the VOO, it would be desirable to work in a continuous cycle to change the stacked filter mats frequently during the process and to clean them periodically using a pressure washer to store the aforementioned filter mats at a low temperature (0 - 5 °C) to avoid fermentative processes during breaks in the oil processing.

The materials used to construct the press, all the metallic parts which come into contact with the product must be made of, or at least covered with stainless steel to avoid the transfer of metals, especially those metals which can speed up the oil oxidation, to the oil during the extraction process.

1.8.3 Extraction by centrifugation:

The majority of VOO is currently extracted by centrifugation in Mediterranean countries. The idea of exploiting direct centrifugation of the malaxed paste to extract the oil dates back to the late nineteenth century, In the olive oil sector, this idea determined technological innovations in the VOO mechanical extraction process, which were opposed to the traditional press (Servili et al., 1999).

The first operating patents, including the patent by Corteggiani, date back to 1956, followed by new companies producing olive oil machines in the early sixties. This machine, called a decanter, consists of a drum containing a cylindrical and a conical part with a horizontal axis, inside which an additional cylinder worm is placed, which acts as a screw conveyor. which allow the oil to be separated both from the vegetation water and from the pomace .

The evolution of this technology has led to the production of decanters with low water consumption. By using these new systems, the extracted oils feature a higher phenolic concentration than those extracted by means of the traditional centrifugation process, because the loss of these hydrophilic phenolic compounds in the vegetation water is reduced. it is important to point out these new extraction systems, which enable high quality VOOs to be obtained. (Ranalli & Angerosa, 1996; Servili et al., 1999; Stefanoudakii et al., 1999; Di Giovacchino et al., 2001).

The main problem, when using the systems, is not only a decrease in oil quality, but also the high humidity level of the pomaces (50% - 60%). This last aspect implies two disadvantages where to store by-products of the extraction process; how to transport to the pomace oil factory and their subsequent use for residual oil recovery by solvent extraction.

The pomaces produced by system are generally employed for the production of compost or for spreading to improve agriculture soil, because they allow a quality of oil to be obtained oils they produce a certain amount of vegetation waters, which imply water draining procedures which comply with the regulations of the law.

1.9 Objectives of the study:

The main objective of this work is to exposure of the grind olives at various stages of electricity HVDC (High voltage direct current), (DC :- is electrical current which comes from a battery which supplies a constant flow of electricity in one direction) from 1000 volt – 20000 volt for variant incidence time and determination of quantity and quality oil tests (yield, acidity, peroxide value, and K_{232}, K_{270}) because of problem in the presence of a large loss of oil during extraction and in the case of olive oil, this loss is too high because it is converted from extra virgin oil to oil dried and therefore there is a significant loss in the quantity and price of oil . Figure 1.5: direct current.

Advantage of Direct Current:-

1. Reactance : DC system does not introduce a reactance in the line.

2. Power : In DC system, the power is just the real component.

3. Frequency : In DC system, the frequency is zero, thus no frequency variation to monitor.

4. Analysis : Analysis of AC system always involved complex numbers, while DC is only a real number, thus simplifying the analysis.

5. NO skin effect. The DC system has no skin effect so we can utilize entire cross section area of line conductor.

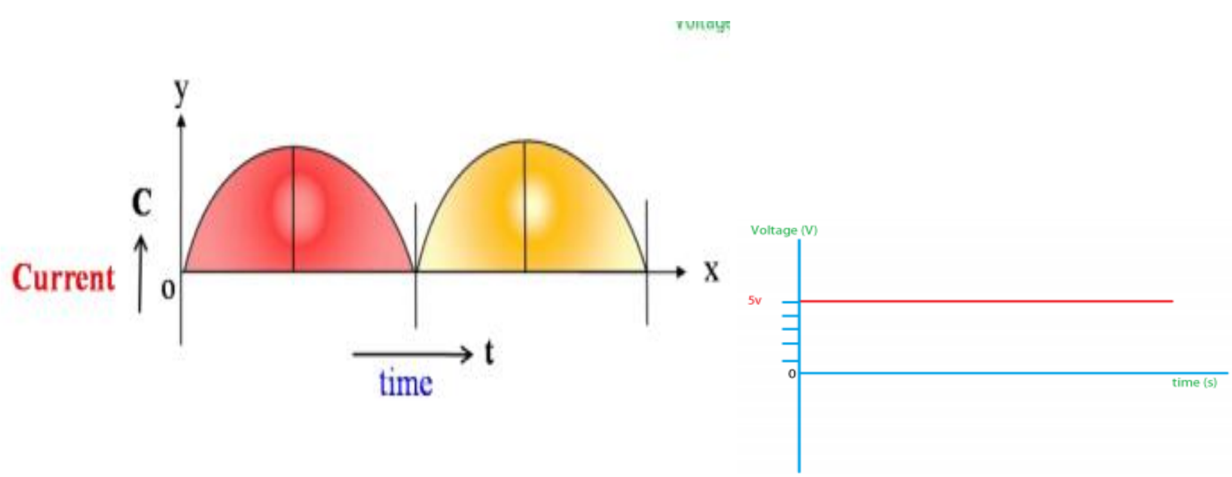


Figure 1.5: Direct current illustration

This goal will be achieved by the following objectives :-

1- Amount of oil produced

2- class of oil obtained

3- sensorial evaluation of oil

1.10 The importance of the study :

The importance of this study is the increase the yield of olive oil extraction to about 45%, decrease the energy consumption during the olive presses, and disposal of the pollution that produce from waste of the oil (solid and liquid waste).

There are two predominant olive oil processing waste products produced in the press , the solid material (pomace), that is relatively dry, and the fruit water, often referred to as water of vegetation. The system produces one waste product that is a mixture of the water and solid material. In countries where significant production occurs, the pomace is often sold for further oil extraction with solvents.

The water of vegetation (fruit water) can be a significant pollutant because of its high organic load. If added to natural ground water the high biological oxygen demand (BOD) causes damage to aquatic life. Both the solid and liquid portions of the process are composed of the same organic materials organic compounds (mainly phenols, polyphenols and tannins) and inorganic elements (such as potassium salts and phosphates) as most fruits, leaves, or other organic material left in the field to decompose naturally. Because of the small particle size, however, it is difficult to filter out the pure water from dissolved organic substances.

If these substances decompose anaerobically, disagreeable odors are produced. Incorporation with dry solid materials in order to create aerobic conditions produces compost that can be spread back onto the land. Each city and or county government regulates the disposal of processing plant waste products. Compost facilities are regulated to minimize odors and leachate runoff. Municipal discharge to sewage systems is expensive (Vossen, P.M,. 1997).

2. Literature Review

2.1 Introduction:

Heavy search took place to find same field researches or any other related studies. Scientific journals and text books were scanned enable to gather as many information as possible for the effect of electrical current on the olive oil quality and quantity.

Unfortunately, no such work was done on this field except of couple of publication were invested the effect of AC current on olive oil yield.

Therefore, the literature review accomplished in this investigation was concentrated and focused more on the ability of physical or even chemical agents to affect olive oil yield.

Moreover it has been found very helpful to study methods applied for olive oil extraction. This somehow helped in covering some weakness on understanding the role of the applications that helped in extracting more oil content.

However, major factors affecting olive oil quality and quantities will be discussed in these chapters which are going to add an insight and tremendous understanding for the extraction process.

2.2 Extraction of olive oil:

2.2.1 Pressing and screw extraction

Yusuf, K.A et al., (2017). studied the performance evaluation of a screw press to determine the effects of moisture content of the seed before pressing and the heating temperature of the sample during pressing on the extraction efficiency of the screw press using cashew kernels and groundnut seeds. The study was considered as a 4×3×3 factorial experiment with four levels of heating temperatures (80,90,100 and 110°C), three levels of moisture content (7,8,and 9% moisture content) and in three replications using a Randomized Complete Block Design (RCBD) with moisture content as a blocking factor. The results of the evaluation shows that extraction efficiency increases with increase in temperature but tends to decrease as the temperature is increased beyond 100°C in both samples. Also, the higher the moisture content of cashew kernel, the higher the extraction efficiency. But in the case of groundnut seed, extraction efficiency of the screw press decreases with increase in moisture content. The optimum extraction efficiency of 82.00% (at 9% moisture content) and 81.53 % (at 7% moisture content) was obtained for cashew kernels and groundnut seeds extraction with a corresponding heating temperature of 100°C respectively.

Different techniques of oil extraction are applied, including traditional press, two- and three-phase systems. (Adnan I. Khdair et al., 2015). studied olive oil quality obtained from different pressing systems in terms of free acidity, ultraviolet absorption, peroxide value, polyphenol content, organoleptic assessment and overall quality index. Olive oils obtained from the two-phase mills were classified as extra virgin olive oil. While, olive oils obtained from the three-phase mill were ranged from extra to ordinary virgin olive oil. In the contrary olive oils obtained from the three conventional mills were classified as lampante virgin olive oil. The two-phase decanters produce high quality olive oils with higher contents of total polyphenols which makes them more resistant to oxidation during storage. These decanters, also having an advantage of saving on waste water disposal costs because they produce only a small amount of such waste.

Mariana Ionescu et al., (2014). reported the influence and impact of the main variable on the pressing of oil seed material. vegetable oil, one of the most important component for both food and non-food industry, is contained by the oleaginous plants in seeds, pulp, stone fruits, in the tubers or sprouts. Depending on the nature of material and their oil content, various methods can be used for oil extraction from oleaginous material. Mechanical continuous presses are the most commonly used machines for the pressing of oleaginous materials in oil industry. These presses have the following advantages: continuous working, high working capacity, operating without major shocks and vibrations, easy adjustment of the working pressures, etc. The request for the vegetable oil increases as a result of the increasing number of applications that it can have. Thus, to satisfy the vegetable oil demand, it is necessary that the oil extraction methods to be faster and more efficient. Processes and phenomena that occur during the pressing process of the oleaginous materials are very complex. For optimizing the pressing process it is useful to know the main variables affecting the oil recovery and oil quality. This study aims to summarize the influence and impact of the main variables on the pressing of oil seed materials.

The recent upsurge of interest in the demand for oils from soybean has prompted the development of more efficient mechanical screw press. The performance evaluation test was conducted to investigate the expelling efficiency of the machine, the effect of kneading temperature on the oil yield and the extraction losses of the machine. The literature put soybean oil content as between 18-20% of the whole soybean. The moisture content of the soybean used for the experiment was 10.7% (w.b). The mean oil yield, expelling efficiency and extraction losses ranged between 6.61 and 14.22%, 32.26±0.39% (50°C) and 68.13±2.27% (90°C), and 5.39% and 9.90% respectively. The optimum kneading temperature that corresponded to the highest expelling efficiency was (69.13±2.27%) at 90°C. The differences among the mass flow rate values of the paste at the different temperature levels were statistically different ($P<0.05$). The machine competed favorably with other expelling machines. The operation of the machine is simple, minimize the drudgery and labor intensities that are involved in the traditional manual operation, (Davies Moses et al., 2014).

Harun Dıraman and Hamdi., 2014. using lipid profiles for the characterization of Turkish monocultiver olive oil produced by different system . The olive oils were extracted by classic hydraulic pressing ,three phase continuous system, Abencor oil method at laboratory scale, and foot oil process from monocultivar Turkish olives, including Ayvalik, Memecik, Nizip Yaglik, Gemlik, Domat, and Uslu. Total phenolics, ortho-diphenols, oxidative stability, and total chlorophylls of the oils differed by location. The cis-trans fatty acids, triacylglycerols, and the actual versus theoretical equivalent carbon number of 42 (ECN 42) triglycerol content (ECN42) were within national and international averages. Oil samples from the three phase continuous system had higher total phenolic contents than those of the hydraulic pressure system. Turkish mono cultivar virgin olive oil samples were classified by biochemical profiles using the principal component and hierarchical cluster analyses multivariate statistical methods. Clustering analysis defined groups according to growing location. Triacylglycerols and fatty acid profiles can be used for identification of monocultivar olive oils with regard to authenticity and classification.

In the traditional press method for olive oil production, olives are crushed and malaxed into a paste, which is spread on mats. Pressure is applied to squeeze out the oil and wastewater, leaving a material on the mats called pomace. The oil and wastewater are then separated by gravity. (Goldsmith, C.D et al., 2013). The fate of the olive phenolic compounds, including oleuropein, and antioxidant activity was investigated at each stage of the process and the waste products (pomace and waste water) were evaluated as potential sources of valuable phenolic compounds and antioxidant activity. The largest loss of phenolic compounds was seen at the crushing stage (60% of phenolic compounds, 70% of oleuropein) but only 21% of antioxidant activity was lost. Malaxation did not cause significant losses of phenolic compounds but the antioxidant activity was affected (43% loss). Pomace retained 26% of the phenolic compounds, 21% of the oleuropein and 33% of the antioxidant activity. When dried, the phenolic compounds and oleuropein were 3.5-fold concentrated in the wastewater and it exhibited a 2.7-fold increase in antioxidant activity compared to whole olives. The olive waste products from the traditional press method, pomace and wastewater, are good sources of valuable phenolic compounds and antioxidant activity.

2.2.2 Solvent extraction

Mladen Brncic et al., 2012. The effect of extraction solvents (30, 50 and 70 % aqueous solutions of ethanol and acetone, and 100 % distilled water), extraction temperature (60 and 90 °C) and extraction time (30, 60 and 90 min) on the composition and mass fraction of polyphenolic compounds in Dalmatian wild sage (Salvia officinalis L.) extracts has been investigated. The total poly phenolic content of sage extracts was determined spectrophotometrically using Folin-Ciocalteu method, whereas the individual polyphenols were determined by HPLC UV/PDA method. Results indicated that the main polyphenols in sage extracts were vanillic, caffeic, syringic, salvianolic K and salvianolic I acids, methyl rosmarinate, 6-hydroxyluteolin-7-glucoside, luteolin-7-glucuronide, luteolin-7-glucoside, apigenin-7-glucunoride, apigenin-7-glucoside,with rosmarinic acid and luteolin-3-glucuronide as predominant compounds. The mass fractions of total and individual polyphenols significantly depend on the type of extraction solvent, solvent composition and extraction temperature. The results showed that binary solvent systems are more efficient than mono-solvent systems in the extraction of poly phenolic compounds in regard to their relative polarity. The aqueous solutions of ethanol or acetone (30 %), extraction temperature of 60 °C and extraction time of 30 min were the most efficient for the extraction of polyphenols from dry sage leaves.

Oil extraction by ethanol from partially defatted prepressed sunflower seeds in pulsed and nonpulsed extractors was compared. The oil yield was increased by 8.7% after short extraction periods (up to 6.06 residence times) with a pulsing flow, which was probably due to reduction in the axial dispersion that induces a greater concentration gradient between the miscella surrounding the solid and the bulk (miscella, J. Sineiro et al., 1998).

2.2.3 Influence of enzyme on the oil extraction

The methods of oil aqueous extraction process (AEP) assisted by enzymes are, over the last 50 years, an alternative designed to replace traditional methods of extraction using organic solvents. Guillaume and Lionel., 2010, found that to extract the oil using an AEP, the use of specific enzymes, able to hydrolyze some or all components of seeds, can significantly increase the yields of extraction. Hydrolyzing the different constituents of cell walls (cellulose, hemicellulose, pectins, proteins, etc.), enzymes are able to enhance the liberation of the oil. A number of physico-chemical parameters must also be considered for the better expression of the enzymatic mixture, while maintaining the quality of oils and meals.

Rakesh Sharma, and P C Sharma., 2006. Enzymatic pretreatments to enhance oil recovery in olive oil extraction process were investigated. The laboratory scale mechanical method consisting of crushing of olive fruits in fruit mill, malaxation in oil press for 60 min followed by pressing in hydraulic press at 15 ton/m^2 for 30 min and finally centrifugation of oil-water mixture (5000 rpm for 20 min) to separate oil was optimized.

Combination of pectinase + cellulase 0.05% resulted in maximum oil recovery and minimum loss of oil in cake compared to individual enzymes (pectinase, cellulase and pectinase CCM) even at higher concentrations.

The oils obtained with enzymatic treatments had relatively higher natural antioxidants (total phenols), slightly higher oil clarity, and lower free fatty acids and peroxides.

All the quality parameters of olive oil extracted with or without enzymes were well within the specifications of Indian Food Laws and Codex Alimentarius. Enzymatic pretreatments significantly improved oil recovery and did not exert any adverse effect on the nutritional and pharmaceutical quality of the oil.

2.3 The effect of pulsed electric field:

2.3.1 used as preservation method of the oil

The electric field is a suitable method to preserve the oil composition with minimal modifications without the synthetic antioxidant addition, (Jose Alberto et al., 2016). studied the effect of an electric field treatment (voltage: 3 kV cm-1, frequency: 60 Hz and time: of 5 and 25 min) on the stability of unsaturated fatty acids in virgin olive oil. Unsaturated fatty acid oxidation in the virgin olive oil was analyzed by Fourier transform infrared spectroscopy in the mid infrared region, and by quality parameters (acidity, peroxide and iodine).

Likewise evaluate the stability of mono- and polyunsaturated fatty acids in crude chia (Salvia hispanica L.) oil samples subjected to an electric field (voltage: 9 KV cm-1; frequency: 720 Hertz; treatment time: 3 min). Fatty acid composition was analyzed by gas chromatography, and oil deterioration grade was assessed by quality parameters (acidity, peroxide, and iodine). (José Alberto et al., 2016). Electric field is considered a suitable method to preserve oil quality and preventing trans fatty acids (TFA) formation, was found that the application of an electric field does not cause changes on the concentration of unsaturated fatty acids, in its quality and information of TFA in the crude chia oil.

Similarly, José Alberto et al., 2015studied the effect of an electric field application “EF” (voltage 9 kV cm-1, frequency 720 Hz and time 3 min) as an alternative method of preservation of crude avocado oil., Two strategies were utilized: 1) EF on avocado oil (oil 1) and 2) EF on avocado pulp, then the oil was extracted (oil 2). The stability of the unsaturated fatty acids in crude avocado oil was analyzed by gas chromatography and by quality parameters (acidity, peroxide and iodine). The EF caused minimal changes on unsaturated fatty acid composition. The results reported here could be helpful to widen the applicability of an electric field processing as an oil preservation method.

2.3.2 Improve the quality and yield of the oil

The application of pulsed electric field (PEF) as one of the non thermal intensification methods has been proposed to increase oil yield extraction from sunflower seeds. Ivan Shorstkii et al., (2017). PEF treatments have been carried out under various electrical parameters such as electric field, pulsed frequency, pulse width, time of treatment and sample conductivity. 55 fractional factorial design has been used for the analysis of the impact of PEF parameters on oil yield, and oil yield square model parameters have been investigated. The oil yield was found to increase by 9.1% after treatment of sunflower seeds by variation of PEF parameters: 30 s under an electric field of 7.0 kV/cm having frequency of 15 Hz, solvent content of 40 wt% and pulse width of 30 μs.

Likewise, application of pulsed electric field (PEF) has been proposed to increase oil extraction yield from sunflower seeds. Ivan Shorstkii et al., (2014). PEF treatments have been carried out under various parameters such as electric field, frequency, pulse width, time of treatment and solvent amount in samples. 55 fractional factorial design has been used for optimization of process parameters and impact of the PEF factors on the square model parameters has been investigated. The oil yield was found to increase by 9.1 % after PEF treatment of sunflower seeds for 90 sec under an electric field of 7.0 kVcm-1 having frequency of 1.5 Hz and pulse width of 30 μs. The obtained results used to scale up non-thermal food processing technologies for oil extraction from sunflower seeds.

Eduardo Puertolas et al., (2014), studied the impact of the use of pulsed electric field (PEF) technology on Arroniz olive oil production in terms of extraction yield and chemical and sensory quality has been studied at pilot scale in an industrial oil mill. The application of a PEF treatment (2 kV/cm; 11.25 kJ/kg) to the olive paste significantly increased the extraction yield by 13.3%, with respect to a control. Furthermore, olive oil obtained by PEF showed total phenolic content, total phytosterols and total tocopherols significantly higher than the control (11.5%, 9.9% and 15.0%, respectively). The use of PEF had no negative effects on general chemical and sensory characteristics of the olive oil, maintaining the highest quality according to EU legal standards (EVOO; extra virgin olive oil). Therefore, PEF could be an appropriate technology to improve olive oil yield and produce EVOO enriched in human-health-related compounds, such as polyphenols, phytosterols and tocopherols.

The effect of the application of pulsed electric field (PEF) treatments of different intensities (0–2 kV/cm) on Arbequina olive paste in reference to olive oil extraction at different malaxation times on (0, 15, and 30 min) and temperatures (15 and 26 °C) was investigated. The extraction yield improved by 54 % when the olive paste was treated with PEF (2 kV/cm) without malaxation. When the olive paste was malaxated at 26 °C, the application of a PEF treatment did not increase the extraction yield as compared with the control. However, at 15 °C, a PEF treatment of 2 kV/cm improved the extraction yield by 14.1 %, which corresponded with an enhancement of 1.7 kg of oil per 100 kg of olive fruits. The application of a PEF treatment could permit reduction of the malaxation temperature from 26 to 15 °C without impairing the extraction yield. Parameters legally established (acidity, peroxide value, K_{232}, and K_{270}) to measure the level of quality of the virgin olive oil were not affected by the PEF treatments. A sensory analysis revealed that the application of a PEF treatment did not generate any bad flavor or taste in the oil, (M. Abenoza et al., 2013).

Sukardi et al., 2013. studied the effect of PEF (pulsed electric field) treatment on opening or damages on the cell wall of glandular trichome of fresh patchouli leaves and the quality of patchouli oil. Patchouli plant varieties of Sidikalang (Aceh) resulted by tissue culture in the Laboratory of Biology-Brawijaya University, after acclimatization planted in field trials. After 7 months age of plant, the fresh leaves (more than one leaves) were taken to observe the GT cell structure using light microscopy and SEM. Subsequently another leaf was treated with PEF at field strengths (E) between 50-150 V/Cm with a time of 2-3 seconds, and observed using SEM. Before distillation, 150 g of patchouli dry leaves were treated with PEF at 150 V/Cm and 15 seconds. The results showed that the PEF with field strength (E=100 V/Cm) and 2 seconds treatment, the GT cell walls were broken down (rupture). PEF treatment also increases the oil yield by 35% and improve the proportion compound of patchouli oil.

The effect of high electric field pulses (HELP) as a non-thermal novel technique on cell disintegration and oil extraction of palm fruit mesocarp was investigated by K. Paoplook and M.N. Eshtiaghi., 2013. The process parameters (pulse number 5 to 30 pulses, Field strength 1 to 5 kV/cm, capacity of capacitors 0.49 to 1.98μF) showed a direct effect on cell disintegration.

Increasing the field strength increased the cell disintegration. Up to 97% cell disintegration was achieved after high electric field pulse treatment at 5 kV/cm and 30 pulses. In addition increasing the pulse number from 5 to 30 pulses (at constant field strength of 4kV/cm) increased the cell disintegration. Furthermore, increasing the capacity of capacitors up to 1.98 µF showed positive effect on cell disintegration of palm fruit mesocarp. The energy consumption and process time during cell disintegration using HELP was distinctly lower (about 12 kJ/kg, less than 30 sec.) compared to thermal treatment (at 80 °C, 2h, about 210 kJ/kg). Pressing of palm fruit mesocarp have indicated that the remaining pulp after pressing for high electric field pulse pretreated samples (at 4 and 6kV/cm) was distinctly lower (about 20 and 18.6% respectively) compared to thermally treated samples (21.5%). The measurement of oil yield showed positive effect of HELP pre-treatment. Increasing the field strength increased the oil yield. The peroxide value of crude oil pretreated with HELP was slightly higher compared to untreated or thermally treated samples.

Joes Alberto et al., 2013, evaluated the temporal effects of electric field (EF) application on avocado oil samples, based on the idea of inactivation of Polyphenol-Oxidase Enzyme (POE) in avocado pulp. In that work, EF treatments (9 kVcm-1, frequency 720 Hz and time of 3 min) and two strategies were utilized: EF on avocado oil (oil 1) and EF on avocado pulp, then the oil was extracted (oil 2) were evaluated to assess their effect on the fatty acid profile in avocado pulp. The effect of EF treatment on chemical values of the oils: acidity, peroxide and iodine were also determined. After EF treatment, non significant changes in the contents of saturated fatty acids, monounsaturated and polyunsaturated fatty acids were observed, with the chemical values determined in avocado oil crude presented deterioration, but changes were statistically not significant.

Impact of pulsed electric fields (PEF) on maize, olives and soybeans for enhanced and gentle recovery of functional food ingredients through induction of stress reactions. M. Guderjan et al., 2005. a modified process scheme for the production of maize germ oil with increased amounts of phytosterols (up to 32.4%) at simultaneous by higher oil yield (up to 88.4%) was developed. Phytosterols are secondary plant substances and essential metabolites of plant membranes, reducing the serum level of low-density lipoprotein (LDL) cholesterol in humans, associated with atherosclerosis. By using hull fractions during the extraction additionally to a mild application of PEF (0.6 kV/cm) on maize germs, the yield of phytosterols increased by 32.4%. In addition the oil yield of fresh olives increased by 6.5–7.4% depending on the field strength and the amount of the isoflavonoids genistein and daidzein in soybeans increased by 20–21% in comparison to the reference sample.

The effect of high pressure on olive oil oxidation in emulsified model systems and in oil tomato food systems were compared with an equivalent heat treatment. The high pressure treatment reduced both early and final Maillard reaction products as well as lipid oxidation in the emulsified model systems. (C. Severini, A. baiano, P. roverei, G. dall AGlioi and R. Massina., 2002). Similar results were obtained in the oil tomato food system although to a different degree, probably because of the influence of lycopene and ascorbic acid in the tomato-sauce and of the complexity of the food matrix.

2.4 The factors on yield of olive oil

A.Y. Aydar et al., (2017). studied the effects of different extraction parameters including ultrasound time, temperature and malaxation time on olive oil quality. The extraction variables ultrasound initial temperature (20–50 °C), ultrasound time (2–10 min) and malaxation time (30–50 min) were studied to obtain ideal conditions of ultrasonic treatment on the olive paste for obtaining a greater yield in the extraction of oil, while maintaining a maximum level of commercial quality. To evaluate the level of commercial quality, absorbance in the UV region, peroxide (PV) and free acidity values (AV), the total chlorophyll, carotenoid, phenol contents, total antioxidant activity and sensory analysis of EVOOs extracted from Edremit cultivar were determined. The optimum conditions were found to be 50 °C, 2 min and 43.23 min for ultrasound initial temperature, sonication time and malaxation time, respectively. This optimal condition gave an extraction yield of 8.25 % and the acidity value of 0.24 mg oleic acid/100 g olive oil.

The malaxation of olive paste is an essential olive oil production step which allows not only satisfactory yields of oil extraction. During malaxation, changes of oil composition also occur because of the partition phenomena among oil, water and solid phase and the activity of fruit enzymes released during crushing. (Valerija Germek et al., 2012). Quality and quantity of extracted oil can be influenced by varying the conditions of this operation (such as time, temperature, addition of technological coadjuvants). Different malaxation times (30, 45 and 60 min) were applied to olive paste of Buza cultivar which was previously enriched with the phenolic extract obtained from the freeze-dried olive pulp of Istarska Bjelica cultivar. Olive paste was phenol enriched at the level of 38% (w/w) in order to improve the phenolic content in resulting oils and to check the influence on volatile compounds. Phenols in olive pastes and corresponding olive oils were determined by RP HPLC with UV-DAD detection, whereas volatile compounds in oils were analyzed by SPME-GC-MS. An addition of phenolic extract to olive paste mostly affected the amounts of dialdehydic form of oleuropein aglycone and apigenin which increased by 47.3% and 90% in Buza paste, and the major phenolic compound in olive paste was dialdehydic form of decarboxymethyloleuropein aglycone, as well as in the oil. By increasing the malaxation time, the decrease of free hydroxytirosol, tyrosol and verbascoside in enriched olive paste was observed. The similar was observed for oil samples, except for vanillin which increased (by 31%) along with the malaxation time. Among volatile compounds responsible for positive odour notes, the prolonged malaxation time had a significant negative effect (Tukey's test, $p<0.05$) on hexanal, hexan-1-ol and Z-3-hexenyl acetate. Longer malaxation time (60 min) of olive paste enriched with the phenolic extract showed more pronounced effect on phenols than on volatile compounds.

Deli, S et al., (2011). studied the effects of physical parameters of a screw press machine on oil yield of N. sativa seeds using a Komet Screw Oil Expeller. Different nozzle size (6, 10, and 12 mm), extraction speed (21, 54, 65 and 98 rpm) and diameter of shaft screw (8 and 11 mm) were applied in this study. Different nozzle size, diameter of shaft screw and rotational speed do effects the percentage of oil yield. By using shaft screw with diameter of 8 mm had resulted to the decrease of oil yield with the increase of nozzle size and rotational speed. While, by using the shaft screw with diameter of 11 mm had recorded the highest percentage of oil yield at 65 rpm when using nozzle with the size of 6 and 10 mm. However, when using nozzle with the size of 12 mm, the percentage of yield had recorded the same result pattern with the result of using shaft screw with diameter of 8 mm which is; the decreased of percentage of oil yield with the increase of rotational speed. The highest percentage of oil yield recorded was at the combination of shaft screw with diameter of 8 mm, rotational speed at 21 rpm and nozzle size of 6 mm. There was significant difference ($p<0.05$) between oil yield with heat temperatures. The oil yield was higher at 50°C (22.68%) and lower at 100°C (15.21%). Most of the results obtained (percentage of oil yield of N. sativa seeds recorded) were significantly different ($p<0.05$) in relation with the effect of physical parameters of machine screw press on the oil yield.

2.5 The factors affecting quality of olive oil

Blending of oil has been expected as one of the most important solution in producing vegetable oil with good storage stabilities. The study conducted by (Muhammad Siddiq and Hamid Ullah Shah., 2016) aimed to identify the best oil blend in terms of physicochemical properties between olive and palm oils.. They studied the effect of stress conditions on the quality and stability of olive and palm oil blends at Nuclear Institute for Food and Agriculture (NIFA) Tarnab Peshawar and The University of Agriculture Peshawar KP-Pakistan during 2015. Olive: palm oils treated in sole or mixture at various ratios were kept at different stress conditions for three months. Data was recorded on peroxide value (PV), free fatty acid (FFA), anisidine value (AV), iodine value (IV), color index (CI) and beta carotene (BC) value of the oils. The results showed considerable variations in all the studied parameters tested in different blends under various stress conditions. Maximum PV (10.76%), FFA (2.44%), AV (2.29), IV (77.09) and CI (0.609) were recorded in sole olive oil, while minimum PV (9.69%), FFA (0.65%), AV (0.88), IV (53.40) and CI (0.146) were noted in sole palm oil. The samples kept in sunlight showed maximum PV (12.82%), FFA (1.32%) and AV (1.39), while maximum IV (63.10), CI (0.371) and BC (11.30) value were observed in samples stored at ambient temperature. Storage conditions increased PV from 218 to 27.82, FFA from 0.88 to 1.47, AV from 1.02 to 1.56, while decreased IV from 63.38 to 58.05, CI from 0.392 to 0.337 and BC from 27.87 to 3.46. It was concluded that olive: palm oils mixed at a level of 10:90% and 20:80% ratios have the best quality stricture, which are more acceptable and better than other blends when mixed together that will achieve better strength as well as financial system phase.

Evaluation of the Olive Mills Efficiency and studying Olive Oil Quality in the West Bank for the Years 2012/2013, was done by (Orwa Houshia et al., 2014). Investigation of efficiency not only on olive growing farms but also olive oil manufacturing firms may provide valuable insights into potential improvement of productivity. Another aim was to create a Database which we proceed to develop strategies and systems for the management and organization of operation of the mills. Oil testing was carried out to study quality of oil for those seasons. The Peroxide value (PV) is related to storage of the oil and measures chemical products that are produced through reaction with oxygen to ultimately cause rancidity. The IOC standard is < 20 meq O2 /kg of oil for the peroxide value. The IOC acidity test standard for free fatty acids in extra virgin olive oil is a maximum of 0.8, in agreement with most of our results that ranged from 0.8- 3.3% for the acidity, and 6.77 to 46.09 for the peroxide value.

With high competition pressure and a saturated market, food quality has become an increasingly important means of competition on the market. Quality concept focuses on customer needs and expectations. A powerful and indispensable tool to understand the intrinsic quality of foods and to translate customer needs into product is sensory analysis. Margherita Pagliuca and Debora Scarpato., (2011) have chosen to focus the analysis on olive oil, given its importance in the present competitive scenario and also for the renewed and growing interest that this product has in nutrition. The aims of this work were twofold: firstly, to see whether the consumers have an adequate knowledge of the specific qualities of olive oil and also the perceived quality in regard to origin; and secondly, to analyze consumer preferences in order to identify sensory characteristics most important to the acceptability of five olive oil products.

All the seeds examined of extraction and characterization shown to contain varying levels of oils, mainly in the range of 26-42%, with the exception of Detarium microcarpum which contains about 7% of oils. Characterization of the oils by standard techniques suggest that they contain high levels of saturated fatly acids, judging by their low iodine values (IV) which did not exceed 88 in all cases. They are, hence, not suitable as alkyd resins for paint formulation but may, however, be used for soap production judging by their high saponification values (SV) in the range of 199-261. Lophira lanceolata showed considerable reduction in IV and increase in PV over a period of one month under storage conditions of light , darkness and refrigeration. In light, the IV value of 65 dropped by 50% at the end of one month, while under the same conditions the PV increased by almost tenfold. Less profound changes in both IV and PV were observed for oil stored in darkness and under refrigeration. The observed profound changes were explained as arising from oxidative rancidity of the oils. The nutritional non-oil residue of Lophira lanceolata may be suitable as animal feed judging by the balance of its nutrient composition, M.Z. Kyari et al., (2008).

A. ranalli, A. malfatti, And P. cabras., (2001). Virgin olive oils extracted with an enzyme complex were characterized with respect to the control oils by:- higher contents of major individual phenols (free 1 aglycons), o-diphenols, total phenols, tocopherols, pleasant volatiles (including those from lipoxygenase pathway), green (chlorophylls and pheophytins) and yellow (carotenoids) lipochromes, higher aliphatic and triterpene alcohols, phytol, citrostadienol, triterpene dialcohols, and steroids; lower contents of unpleasant volatiles and waxes; higher values of chroma, integral color index, and 1,2-diglycerides/1,3-diglycerides ratio; higher sensory, bitter, spicy, and green fruit scorings; and lower values of lightness and turbidity. The organophosphorus pesticide residues were usually not detected in the oils produced with or without enzyme.

Franca Angerosa et al., (2000) studied the influence of operative conditions adopted during the malaxation of pastes on the quality of resulting oils, we compared sensory characteristics, secoiridoid compounds and the volatile composition of oils extracted from homogeneous batches of olive fruits from Coratina and Frantoio cultivars by using different malaxation times and temperatures. Malaxation time, and especially temperature, negatively affected the intensity of sensory attributes and the content of secoiridoid compounds, modified the composition of metabolites arising from lipoxygenase (LOX) pathways, reducing volatile compounds displaying pleasant sensations and increasing those giving less attractive perceptions, and also elevated the production of 2-methyl butanal and 3-methyl butanal through amino acid conversion. Low temperatures and times, ranging between 30 and 45 min, according to the rheology of the olive pastes, were the optimal operative conditions for the malaxation.

3. Materials and Methods

3.1 Introduction:

This chapter introduces an insight and knowledge for the investigation process applied. The total materials used and the method implemented will be described in details. The materials used and methods applied have been the tools to fulfill the methodology designed for investigating the effect of electrical current on the olive oil yield and quality.

However, since this project was genuine, a descriptive type of experiments were designed to evaluate the ability of the electrical current to affect olive oil yield and quality. As well, evaluation of the degree of electrical current impact was measured.

Since the electrical current is a vector of time, the incidence time of electrical current with the sample needed to be studied and evaluated. Another major research factor found to be the amount of sample exposed to electrical current, as it is well known that the organic materials are reacting with electrical field and current in proportional mater of amount. Thus the amount of sample exist has been studied as well.

However, this chapter will discuss the materials used, the method applied at all levels and stages, and the methodology invented to verify the purpose of this investigation which is limited to the idea titled; does electrical current enhance the yield of olive oil extraction.

3.2 Materials:

The materials used in this investigation included materials and equipment, as followings:

Materials and equipment for processing and preparing the samples

Materials and equipment for analysis

3.2.1 Materials and equipment used in Processing:

Materials were limited to the investigated sample, which was olive fruit type Surry cultivar. Olive fruit were collected one time from local farm in Tulkarem city. Around 350kg were brought in by open boxes with sieved walls.

Equipment: As the investigation based on extracting olive oil simulating the industrial mills. The following equipment and utensils were gathered to form a lab scale processing line, as follow:

Table: Made from granite (locally made).

Sieves: bought from local shop

Big pot: Made from stainless steel, with capacity of 50L (local).

Grinder: Triple phase electrical grinder with coarse die. (Franko, Italy)

Glass container: with adjustable wall at following distances 2.5, 5, 10, 15, 20 cm

Electrical source of DC current: provide electrical current from 2000V to 25000V. German made (model).

Dough mixer: stainless steel pot with different speed. (universal model, china)

Olive press: locally made with oil piston of 5 ton power.

Centrifugation device: with adjustable speed up to 3500RPM.

Calculator device: Scientific model (Sony, Japan)

The following procedure was applied:

The above devices were used at daily basis through the project work, as follow:

The manpower was used to collect olive fruits from Tulkarem city,

Sieve were used to remove olive leaves from olives,

Potable water was used to rinse olives,

Meat grinder to mill olives and get the paste,

Stainless steel mixing container for malaxation from food processing lab, Device of electrical current used to treat of the paste from physical lab,

Hydraulic press for oil extraction was designed and made by Dr. Ibrahim Afaneh,

Centrifuge device to allow separation of the solid, water, and oil phases

3.2.2 Chemical analysis for olive oil quality:

Chemical and analytical analysis were tested in term of: free acidity (% of oleic acid), peroxide value (meq O_2 / kg), k_{270} and k_{232}.

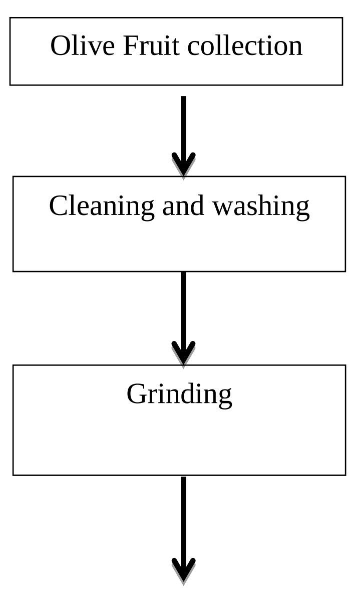
Absorption measurements for purity determination were made at 232, and 270 nm, Lambda Xls from analytical lab (model).

Therefore, to compare the oil yield as well as the general quality obtained as a functional of different process conditions adopted.

3.3 Methods

3.3.1 Methods of processing:

The processing steps is granted by following the flow chart which been adopted for the whole project, as shown in Figure 3.1



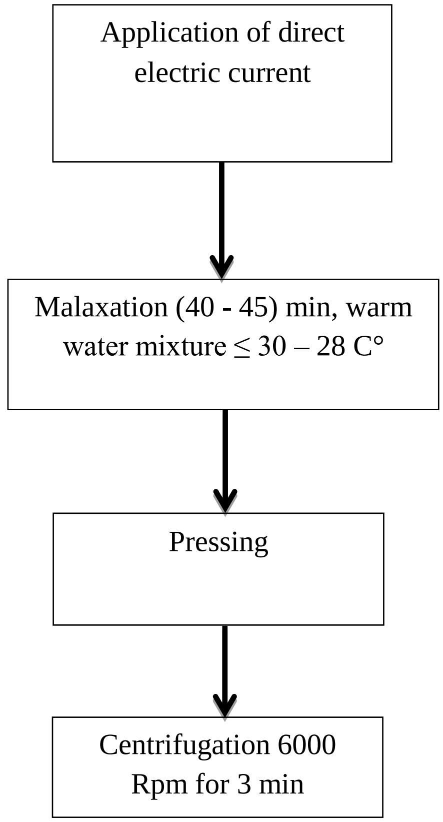


Figure 3.1 Flow chart for olive oil extraction method

3.3.1.1 Olive fruit collection:

Olives samples were obtained from the cultivars (Surry) in Tulkarem _ Palestine. The collection was directly from the trees in the first day of November 2017.

3.3.1.2 Cleaning and washing :

Cleaning the olives samples and removing the leaves and stones using the sieve and then rinsing with water, The purpose of preliminary washing is to remove any foreign material that could damage machinery or contaminate the oil. Only olives that have been collected from the soil or require removal of copper, sprays, etc. need to be washed. If olives are crushed in a hammer mills, the extra moisture from the wash water can cause extractability problems because an emulsion forms between the oil and water.

Polyphenol content is lower in washed olives; there can be as high as a 49% loss in oil stability. Oil sensory ratings for washed olives is usually affected negatively and washed olives generally have a lower bitterness rating, lower "Piquant" rating, and a less fruity flavor. Wash water is often dirty and has a good chance of passing flavors into the oil.

It is important that no fruit remains stuck in the bins and hoppers at the processing plant as it can ferment and ruin the oil. Olives should be stored for as short a period as possible and at cool temperatures (4.4 – 7.2° C). use centrifuge temperatures above 10° C can cause problems. Wet fruit is also much more likely to ferment than dry fruit.

Small quantities of leaves are not detrimental to the oil and sometimes leaves are added to produce a chlorophyll (green) color and flavor in the oil. Branches and wood) material are however very detrimental to olive oil flavor producing a woody taste.

3.3.1.3 Grinding:

Olive fruit is made up of approximately 1/3 solid material, 1/3 water, and 1/3 oil. The objective of the first true step of olive oil production, crushing the olives, is to produce a paste with easily extracted oil droplets. the type of machines was used to grind olives samples is stainless steel mill (meat grinder).

Generally consist of a metal body that rotates at high speed, hurling the olives against a metal grate. The major advantage of metal crushers is their speed and continuous operation, which translate into high output, compact size, and this improves the breakup of the oil cells.

3.3.1.4 Application of direct electric current:

After grinding, the olive paste was DEC treated. The DEC treatment involved high voltage from 1000 volt to 20000 volt, at different distances from 2.5 cm to 10 cm, and different time from 1min to 10 min. Figure 3.1 showed the device of electrical current.

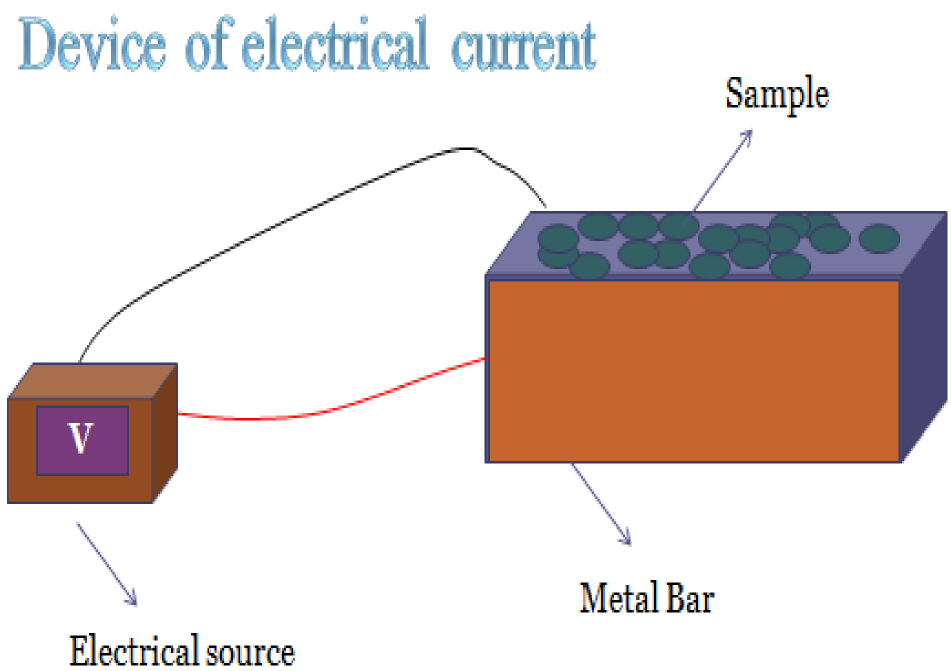


Figure 3.2 device of direct electric current

3.3.1.5 Malaxation:

The mixing of olive paste for 40-45 min with warm water (28-30 °C) It should be warm to improve the viscosity of the oil and improve extractability. Malaxation causes the breakdown of water-oil emulsion, allowing oil droplets to form larger droplets, which separate easily from the aqueous phase during the solid-liquid and liquid-liquid separation processes.

3.3.1.6 Pressing:

In this stage using hydraulic presses of the olive oil mills, with this system the press separation of the oil from the paste.

3.3.1.7 Centrifuge:

After the stage of the pressing then using vertical centrifuges spin that it at two times the velocity of a decanter and provides four times the separation force for the solid, water, and oil phases. They provide an additional separation of the three phases to further remove solid particles and water from the oil.

3.3.2 Analysis method of the oil quality:

3.3.2.1 Determination of peroxide value (PV):

Quantity of those substances in the sample, expressed in terms of active oxygen, which oxidize potassium iodide under the conditions specified in this International Standard, divided by the mass of the test portion. Add 25 ml of acetic acid/isooctane solution to 10g of oil in conical flask and replace the stopper. Swirl the flask until the sample has dissolved. Using a suitable volumetric pipette, add 1 ml of saturated potassium iodide solution and replace the stopper. Allow the solution to react for 1 min, thoroughly shaking it at least three times during this period, then immediately add 65 ml of distilled water. Titrate the solution with sodium thiosulfate solution, adding it gradually and with constant, vigorous agitation, until the yellow iodine color has almost disappeared. Add about 1 ml of starch solution and continue the titration with constant agitation, especially near the endpoint, to liberate all of the iodine from the solvent layer, adding the sodium thiosulfate solution drop by drop until the blue color just disappears.

was determined as follows: $PV = \frac{S * N * 100}{W}$

Where:-

S :- ml of $Na_2S_2O_3$.

N :- normality of Na_2S_2O.

W :- weight of oil sample (g).

3.3.2.2 Determination of acidity value :

Weigh into a flask a sufficient mass of the test sample, according to the color and expected acid value. NOTE: The mass of the test portion and the concentration of the titrate should be such that the titrate does not exceed 10 ml.

Heat to boiling 35 ml of the ethanol containing 1 ml of the phenolphthalein indicator in a second flask. Whilst the temperature of the ethanol is still over 70℃, neutralize it carefully with a solution of 0.1 mol/1 sodium hydroxide. The endpoint of the titration is reached when the addition of a single drop of alkali produces a slight but definite color change persisting for at least 15 seconds. Add the neutralized ethanol to the test portion in the first flask and mix thoroughly. Bring the contents to the boil and titrate with the sodium hydroxide solution, agitating the flask contents vigorously during the titration .

Was calculated as: $acidity = V*C*M10*W$

V :- the volume of titrated potassium hydroxide solution used, in milliliters.

C :- the exact concentration in moles per liter of the titrated solution of potassium hydroxide used.

M :- the molar weight in grams per mole of the acid used to express the result (oleic acid = 282).

W :- the weight in grams of the sample.

3.3.2.3 Determinations of ultraviolet (K_{232}, K_{270}) spectrophotometric :

Spectrophotometric (model) examination in the ultraviolet region can provide information on the quality of a fat, its state of preservation and fat changes from technological processes. The absorption at the wavelengths specified in the method is due to the presence of conjugated diene and triene systems (EC, 1991). The fat is dissolved in the required solvent and the absorbance of the solution is then determined at the specified wavelengths (UV region) with reference to pure solvent. The absorptivity of 1 % solution of the fat in the specified solvent were calculated from the spectrophotometer readings based on a standard method (EC, 1991, IOOC, 2003).

Clear and well settled virgin olive oil (0.25 g) was accurately weighed, dissolved and filled to the mark with spectro-grade cyclohexane in a volumetric flask (25 mL). The virgin olive oil solution was homogenized and where opalescence or turbidity was observed, the solution was discarded and a fresh perfectly clear solution was prepared. Virgin olive oil solution was filled in rectangular quartz cuvettes (optical length = 1 cm) and the absorbances were measured with a spectrophotometer (Cary 50 Conc UV-VIS Spectrophotometer, Varian, Melbourne, Australia) at appropriate wavelengths (232, and 270 nm), using the spectro-grade cyclohexane as a reference. Spectrophotometric analysis of olive oil in accordance with the International Olive Oil Council (IOOC) and the European Union (EU) regulations (IOOC, 2003, EC, 1991) specifies determination of the absorptivity at wavelengths of 232 and 270 nm .

Was determined as :- $K_{\lambda} = \frac{E_{\lambda}}{C*S}$

Where :-

K_{λ} :- absorptivity at λ equal to 232 or 270 nm.

E_{λ} :- absorbance measured at λ equal 232 or 270 nm.

C :- concentration (g/100 mL) of the virgin olive oil solution.

3.4 Methodology:

The approach of studying the effect of electrical current on olive oil yield and quality is highly dependent on a fact that the electrical current would affect the constituent of olive fruit without introducing heat. Several steps were taken into consideration enable to perform such research. The approach of the investigation was carried out in following steps in order;

Step No. One: The electrical current need to be checked if it has an effect on the yield, thus random pre-investigation testing were carried out. The results of this step will help in considering the major factors to be studied and to design these major factors characteristics (intervals, power, and quantities).

Step No. Two: designing the investigation matrix to cover all needed attempts. This matrix was covering the whole project that comes in accordance with the first step results. The matrix of the experiment was shown in Table 3.1.

Step No. Three: studying the effect of each factor investigated on olive oil yield. These factors were:

electrical power (KV) and its intervals

Time incidence between sample and electrical treatment (min)

Amount of materials subjected to electrical treatment. This factor is been called distance which refer to the predetermined distance between the two walls of the glass chamber. The distances determined are: 2.5, 5, and 10cm. thus the amount of olive fruit held at 2.5cm distance were much lower than those held at 5cm distance and so on.

Step No. Four: calculating the yield for the resulted oil for all attempts.

Step No. Five: studying the effect of investigated factors on olive oil quality which included:

chemical tests: studied through acidity of olive oil and Peroxide value of olive oil

analytical analysis: studied though investigating the K factors both: K_{232} and K_{270}

However, the major process was through extracting olive oil from olive fruit subjected to many forms of treatment and compared the results with the standard sample that are produced without any treatment. Therefore, enable to decrease the non-controlled mistakes and to perform a unique procedure in same manor and condition all over the project time life, the following procedure will be adopted:

1Kg of olive was taken and the leaves were removed and washed shown in Figure 3.1 then once olives had been mechanically crushed (3000 rpm; 3 mm sieve), by used Meat grinder to mill olives and get the paste shown in Figure 3.2, after milling operation directly applied direct electrical current treatment for variable parameters such as high voltage, time, and distance as following of the table (3.1) shown in Figure 3.3, then the obtained paste was malaxated at ≤ 30 – 28 C° for 40-45 min in Stainless steel container shown in Figure 3.4, following the malaxation step, olive paste immediately to hydraulic pressure With a strength of 5 ton for separation of the oil from paste shown in Figure 3.5, subsequently, to the vertical centrifuge (6000 rpm) shown in Figure 3.6. in this step, olive oil was physically separated from the olive pomace and then was stored in the plastic bottle envelope with aluminum foil.

All steps above are applied one more time on the samples of olive oil but without direct electrical current treatment, this sample is called standard. So that we can compare the sample that have been applied direct electrical current treatment with the samples that have not been applied direct electrical current treatment.

Figure 3.3: Leaves removal, cleaning and washing.

Figure 3.4: Meat grinding to mill olive.

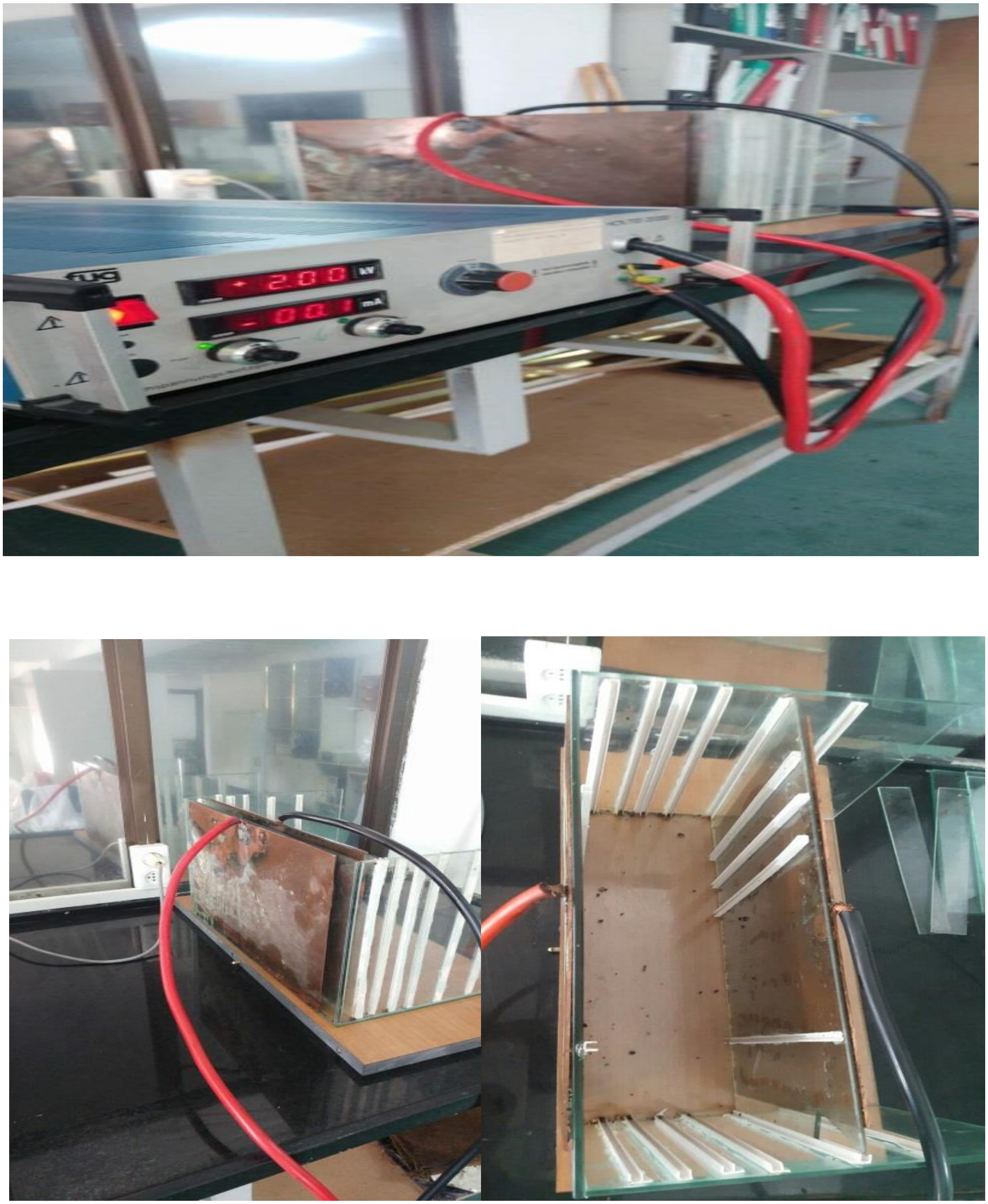


Figure 3.5: The device of direct electrical current (High voltage) .

Figure 3.6: show stainless steel container (mixer).

Figure 3.7: Hydraulic pressure With a strength of 5 ton for separation of the oil.

Figure 3.8: The vertical centrifuge (6000 rpm).

Table 3.1: All attempts that have been used.

Sample (No)	Voltage (Kv)	Time (Min)	Distance (Cm)
Standard	–	–	–
1	2	10	2.5
2	4	10	2.5
3	6	10	2.5
4	8	10	2.5
5	10	10	2.5
6	12	10	2.5
7	14	10	2.5
8	16	10	2.5
9	18	10	2.5
10	20	10	2.5
Sample (No)	Voltage (Kv)	Time (Min)	Distance (Cm)
Standard	–	–	–
11	2	1	2.5
12	10	1	2.5
13	16	1	2.5
Standard	–	–	–
14	2	5	2.5
15	10	5	2.5
16	16	5	2.5
Standard	–	–	–
17	2	1	5
18	10	1	5
19	16	1	5
20	20	1	5
Standard	–	–	–
21	2	5	5
22	10	5	5

23	16	5	5
24	20	5	5
Standard	–	–	–
25	2	10	5
26	10	10	5
27	16	10	5
Standard	–	–	–
28	16	1	10
29	16	5	10
30	16	10	10

3.4.1 Determination of oil quality:

After finishing olive oil extraction the quality tests such as: peroxide value, acidity value, k_{232}, k_{270}, and sensory characteristic are conducted

3.4.1.1 Determination of peroxide value:

According to the procedure (manual of fat and oil lab):

Filled the burette with standardized sodium thiosulphate solution.

Taked 250 ml Erlenmeyer flask with ground neck and stopper, wash it very well and dry.

Weigh accurately about 10g oil in the flask (take the weight by difference).

Added 25 ml of acetic acid chloroform mixture using graduated cylinder. stir until complete dissolving.

Added 1ml of saturated potassium iodide solution then quickly insert the stopper and shake vigorously for 1min.

Put the flask in a dark place for 5 min.

Un stopper then rinse the stopper into the flask with about 10 ml DW.

Added 1 ml of starch solution.

Added 65 ml DW and mix well.

Titrated the liberated iodine with standardized sodium thiosulphate solution.

Carry out another determination on the sample.

Carry out simultaneously a blank test.

3.4.1.2 Determination of acidity value:

The acidity value is measured according to the procedure (manual of fat and oil lab):

1. Filled the burette with standardized sodium hydroxide soln.

2. Weigh about 10 g sample in a clean Erlenmeyer flask.

3. Preparation of neutralized solvent: using GC, transfer 35 ml of ethanol 95% to an Erlenmeyer flask, add three drops of 1% phenolphthalein soln. warm on a hot plate then neutralize with sodium hydroxide soln until the appearance of faint pink color.

4. Added the neutralized solvent to the sample, shake and warm on hot plate.

5. Titrate the sample with standardized sodium hydroxide soln. until the appearance of faint pink color which must persist for at least 30s.

3.4.1.3 Determination of K_{232}, and K_{270}:

Olive oil samples were diluted in iso-octane (2,2,4- trimethylpentane). All samples were measured in matched, synthetic fused silica cuvettes (10 mm is the recommended path length) running a solvent blank as a reference. Absorption measurements for purity determination were made at 232, and 270 nm.

4. Result and Discussion

4.1 Introduction:

This part of the thesis is discussing the results obtained during the investigation. The results were discussed , interpreted, and compared with cited results in the literature and reaching the most probable explanation for the variation if existed.

This chapter exhibited the results obtained during the investigation into main streams, namely;

Those factors affected the yield of olive oil extracted: the amount of olive oil extracted were calculated for the following factors:

Amount of voltage applied. Refers to it by “Power” (KV).

The duration time of applying the current. Refers to it by “Time” (min).

The amount of olives exposed to current. Refers to it by “Distance” (cm).

Those factors affecting the quality of olive oil extracted: the oil obtained from the above treatment were tested for quality tests, including:

Acidity

Peroxide value

K-Factors: K232 and K270

Results were presented in the form of curves, columns, and tables and those discussed in scientific way. It is worth mentioning that results of this investigation were very hard to be compared with results cited in the literature since the idea of this project is genuine.

However, this chapter will start showing the results obtained for random testing to assure the effect of power, time, and distance are solely affecting the yield. This “Pre-Investigation Stage” was highly recommended to confirm the degree of effect for those factors affecting yield without discussion.

4.2 Pre-Investigation Stage:

This stage of investigation included exposing the crushed olive fruits to random selected intervals of the followings:

Voltage: the following voltages were used; 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20 KV.

Time: the following time were used: 1, 5, and 10 min

Distance: the following distance were used: 2.5, 5, and 10 cm.

4.2.1 Inspecting the effect of Voltage:

Olive fruit samples were exposed to different amount of voltage showed a high effect on yield. In comparing results obtained with standard sample showed an increase in olive oil extracted as appeared in figure 4.1. It is obvious from the curve that as power increased the oil yield increased.

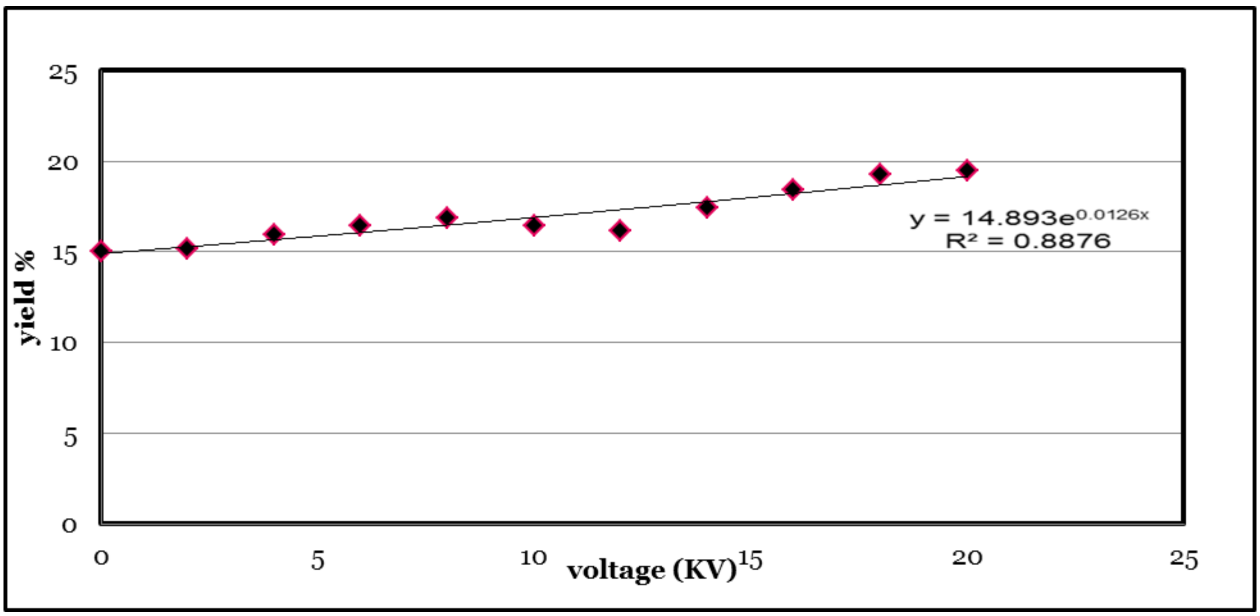


Figure 4.1 Effect of voltage on olive oil yield

4.2.2 Inspecting the effect of Time:

Figure 4.2 showed the effect of time on olive oil extraction for olive fruit exposed to fixed amount of power for different time duration. A remarkable increase of olive oil yield was revealed for 1min duration over the other two times investigated which are; 5 and 10 min.

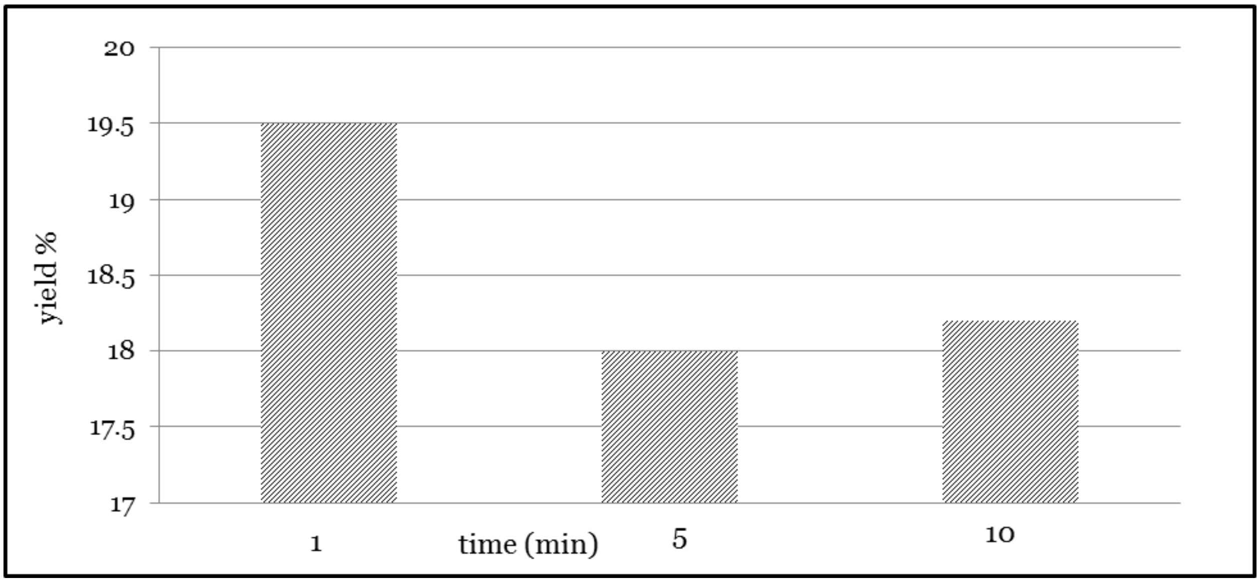


Figure 4.2 Effect of Time on olive oil yield

4.2.3 Inspecting the effect of Distance:

Results obtained were plotted in Figure 4.3. As shown, the effect of distance was found to be critical. The results showed high effect for 2.5 cm distance, while 5 and 10 cm showed limited increase in yield in comparison with standard sample extracted without treatment.

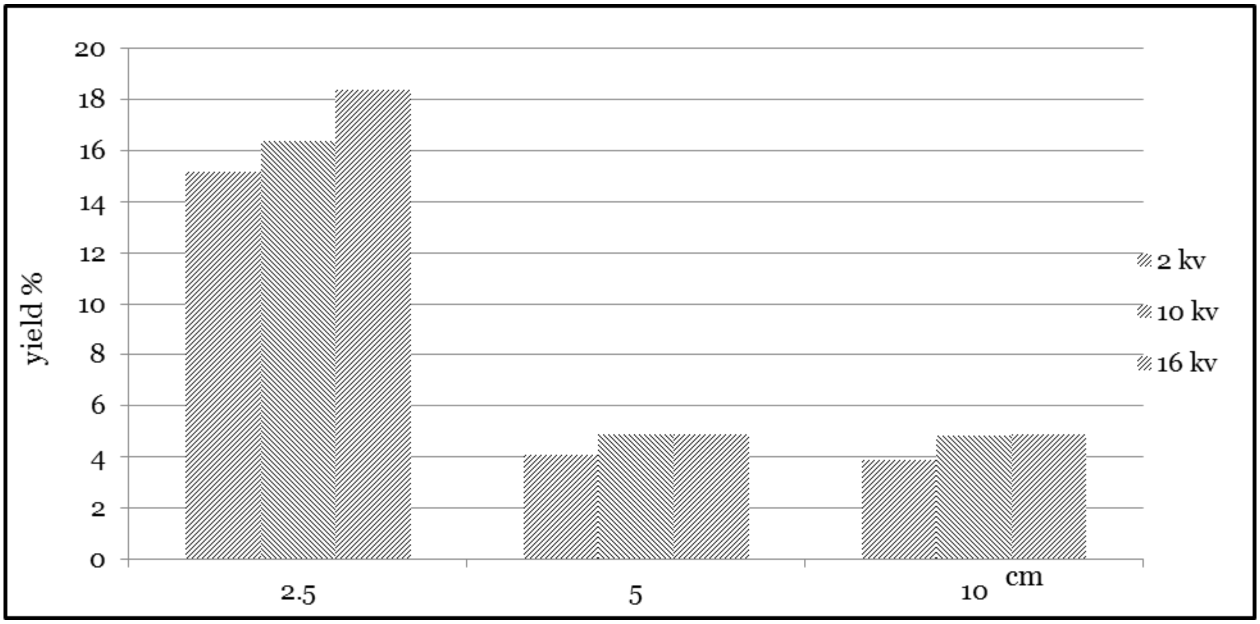


Figure 4.3 Effect of Distance on olive oil yield

4.3 Factors Affecting Yield:

Results shown in this part will focus on the yield of olive oil obtained during exposing olive fruits to a pre-determined factors prior to extraction; namely; voltage, time, and distance.

4.3.1 Effect of Voltage:

Several applications using different ranges of voltage has been used. An intervals of 2KV was used to construct the following application: 2, 4, 6, 8, 10, 12, 14, 16, 18, and 20KV .

Results obtained and plotted in Figure 4.4, showed that the effect of power used was very clear. An increase in yield with increasing the voltage applied were revealed in the whole Figure when samples placed at 2.5cm distance and treated for 10min. However, this increase was shown to be in straight line correlation.

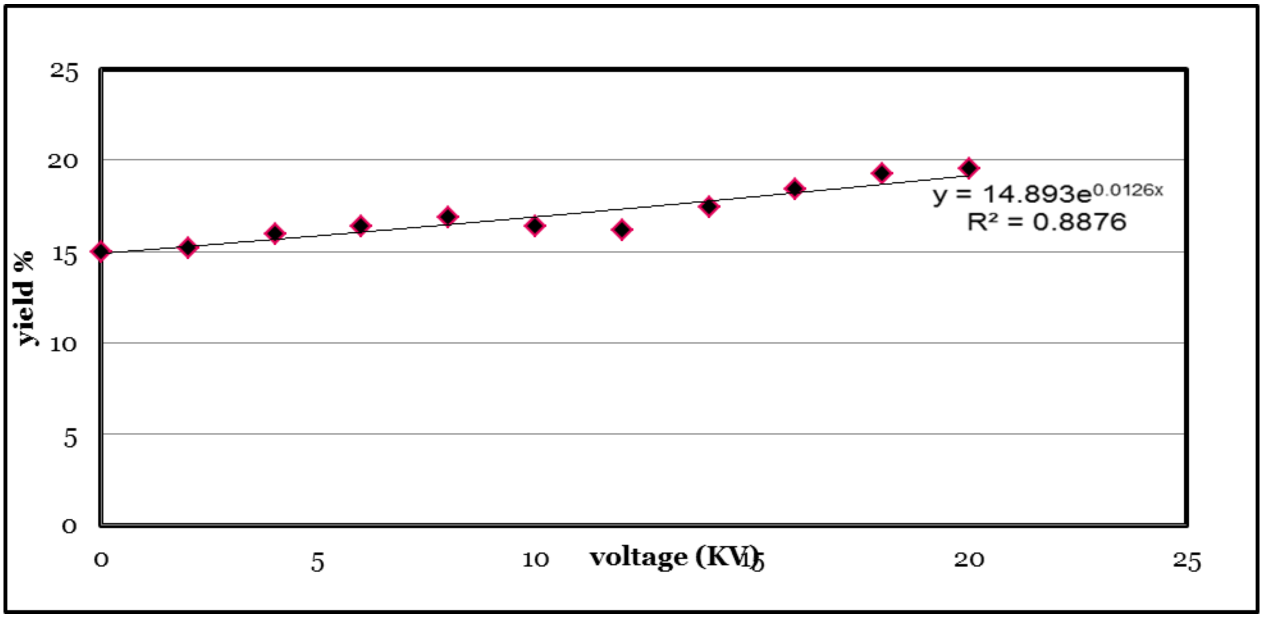


Figure 4.4 Effect of different voltage application using fixed value of time (10min) and fixed distance (2.5cm).

Figure 4.4 also showed that the minimum increase in yield was for samples treated with minimum amount of power, i.e. 2KV, while the maximum increase was for samples treated with highest power used which was the 20KV. This huge increase in yield was remarkable in comparison with the standard sample. Although the samples treated with minimum power showed very limited increase in yield in comparing with standard sample but the highest power used showed an elevation in olive oil yield with around 30% extra.

This was due to higher effect of voltage on oil sacks within the olive fruit. The effect of electrical current on cell membrane helped in dropping off more oil amount. Another possible explanation was due the partial net charging took place for fatty acids which in turn allowed the oil to lose its electrical charge that helped oil to facilitate certain amount of stability within the oil sacks. Thus fatty acids gathered in the center of those sacks and was easily rendered from the matrix.

This finding was reported by Eduardo Puertolas et al, (2015), who studied the effect of AC current on olive oil yield and found to be increased with increasing the power used.

The effect of different power used was studied as well with another duration time and same distance. Different power investigated for samples placed at 2.5cm distance and treated with 5 min duration time. The results showed an increase in the yield with increasing the voltage value applied, in straight line correlation. A higher effect on yield for samples treated with 20KV more than 18 KV at the same time. This is due to higher effect of voltage on oil sacks within the olive fruit. The effect of electrical current on cell membrane helped in increasing dropping off more oil amount.

Same finding were reported by M. Benito et al, (2013) and Eduardo Puertolas et al, (2015), who studied the effect of AC current on olive oil yield and found to be increased with increasing the power used.

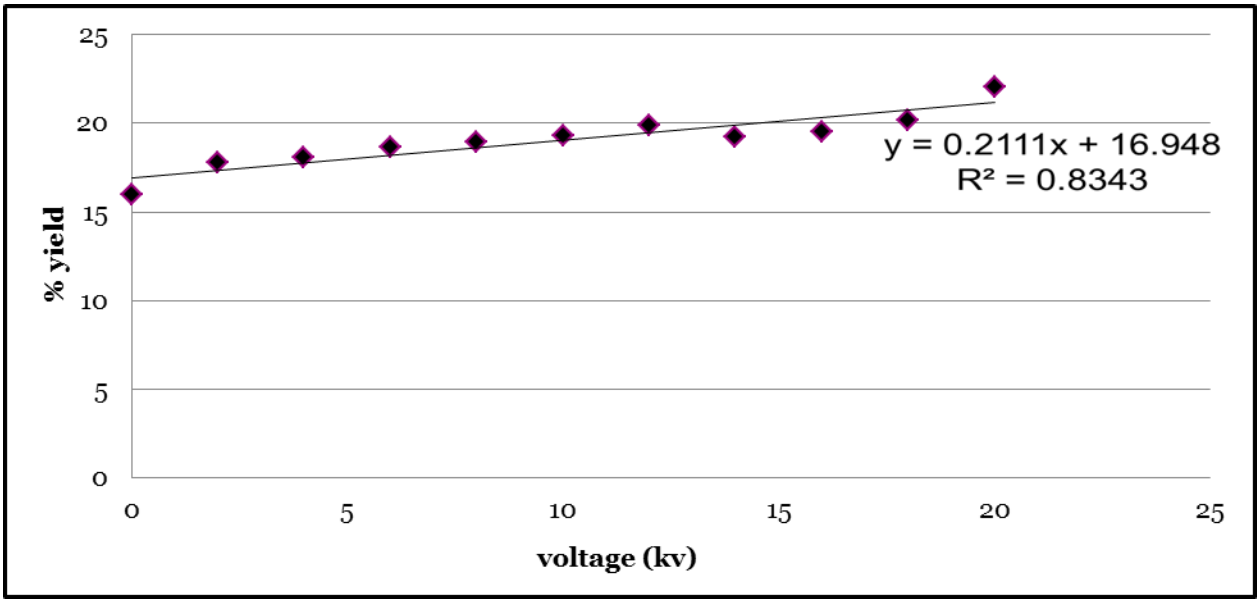


Figure 4.5 Effect of different voltage application using fixed value of time (5min) and fixed distance (2.5cm).

Following up with the same investigation's factor, different voltage powers were tested under same distance (2.5cm) but only for 1min duration time, as shown in Figure 4.6

Results obtained for this trial showed an increase in yield with increasing the voltage value applied, in straight line correlation (Figure 4.6).

Higher effect on yield for samples treated with 20KV was more than all other powers used. At the same time each power applied showed an increase in yield gradually as the power increased.

This is due to higher effect of voltage on rapturing the oil sacks membrane within the olive fruit. The effect of electrical current on cell membrane helped in increasing the dropping off more oil amount from one side and from other side the net charge almost became neutral which helped to increase the oil extraction.

Same finding were reported by M. Benito et al, (2013) and Eduardo Puertolas et al, (2015), who studied the effect of AC current on olive oil yield and found to be increased with increasing the power used.

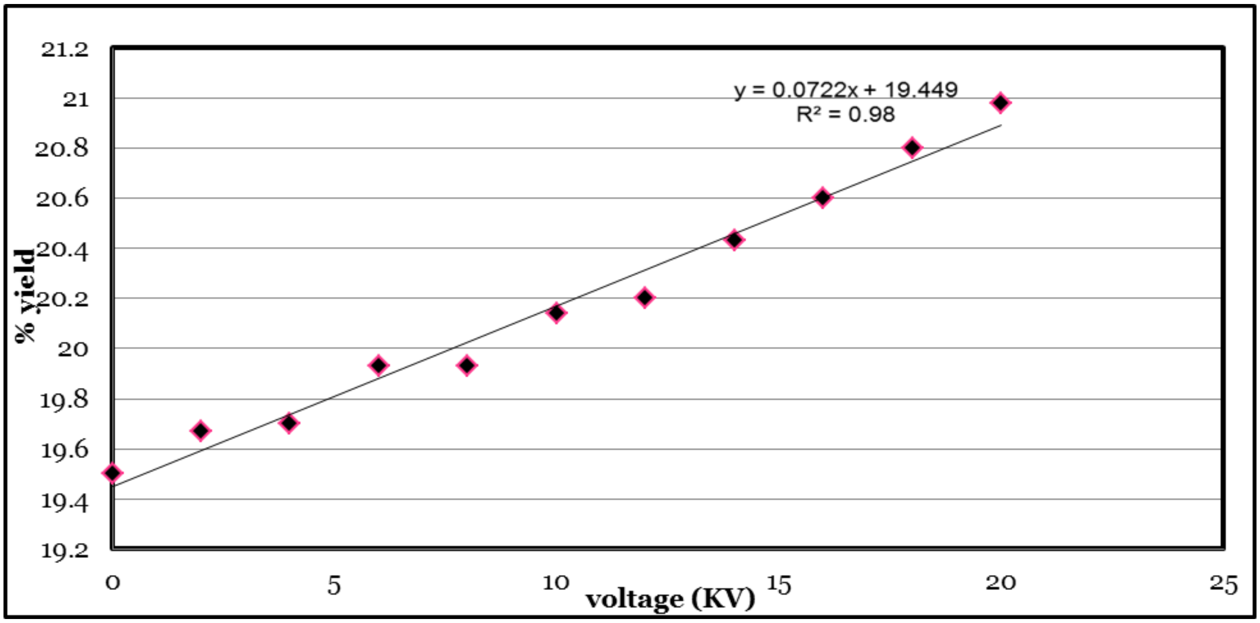


Figure 4.6 The effect of different voltage application applied for fixed time (1min) and fixed distance (2.5cm).

The above mentioned results showed proportional increase for olive oil yield with increasing electrical power used. The effect of each electrical power vary according to time used and the distance that olive fruits were placed in. Therefore, comparison of each treatment is   recorded in Table 4.1.

From Table 4.1 it is obvious that the effect of electrical current used for olive fruit samples placed at 2.5cm distance was higher at 1min duration time than the other two time intervals. The possible explanation of such finding is showing the effect of electrical current on oil sacks as well as the net charge of fatty oil is correlated with limited incidence time. This finding clearing up the fact that the time duration used is critical and could somehow produce an opposite effect.

Table 4.1 Comparison between olive oil yields extracted at different duration time from olive fruits placed at 2.5cm distance and treated with different electrical power.

Voltage used (KV)	Yield at 1min duration time	Yield at 5min duration time	Yield at 10min duration time
0	19.51	15.98	15.01
2	19.67	18.91	15.18
4	19.72	18.89	15.93
6	19.93	18.95	16.41
8	19.93	19.06	16.84
10	20.14	19.22	16.42
12	20.2	19.18	16.15
14	20.43	19.25	17.41
16	20.60	19.33	18.42
18	20.82	19.41	19.24
20	20.98	19.49	19.51

To verify the trend effect of power in correlation with other factors, in particular, time and distance, samples were subjected to different voltage power using new distance (5cm) for different time.

Figure 4.7 shows the olive oil extracted from different samples subjected to different power for 10min duration time placed at 5cm distance. The increase in olive oil yield is correlated with an increase in the power used. This gradual increase was again evident.

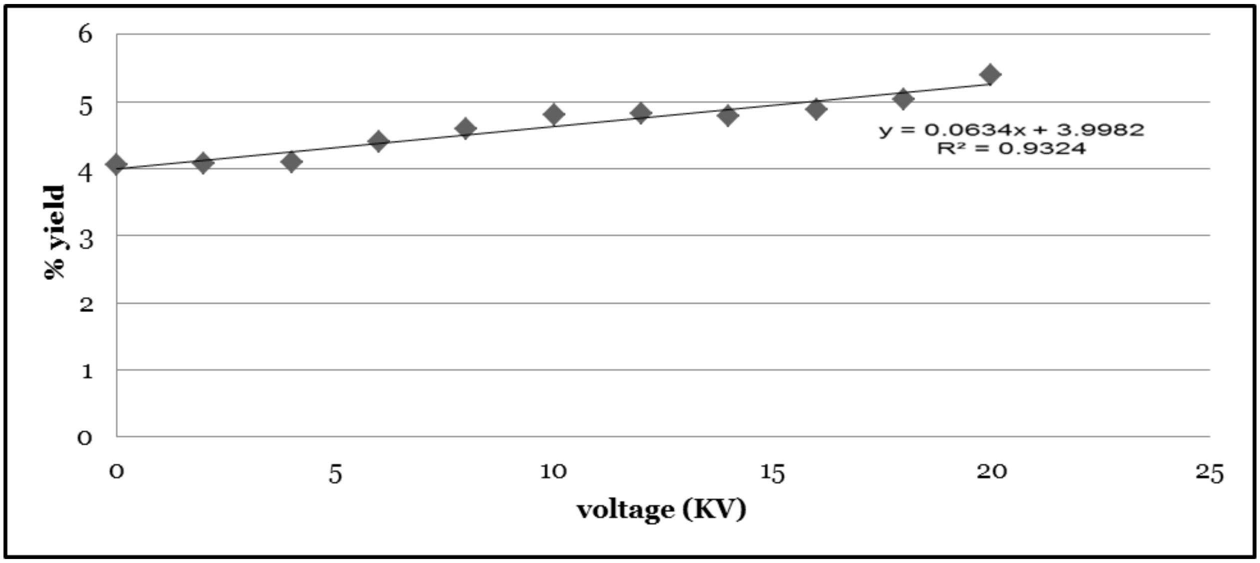


Figure 4.7 Effect of different voltage application using fixed value of time (10 min) and fixed distance (5 cm).

The results showed an increase in the yield with increasing the voltage value applied, in straight line correlation. The minimum amount of olive oil yield was around 4% when the olive fruits treated with minimum power, which was 2KV. This amount of yield was increased gradually as the power used to treat olive fruit increased until it reached 5.4% for samples subjected to electrical current of 20KV.

This is due to the potential of electrical current to induce a remarkable effect on oil sacks within the olive fruit. The effect of electrical current on cell membrane helped in increasing the dropping off more oil amount.

The other possible causes of this effect could be generated from the ability of electrical current to net charging fatty acids and became neutral, thus oily part lost one mean of bounding with the fruit, which in turn facilitate oil dropping off.

Same finding were reported to olive oil extracted from fruits exposed to different power placed at 5cm distance for 5min and 1min as shown in Figure 4.8 and Figure 4.9, respectively.

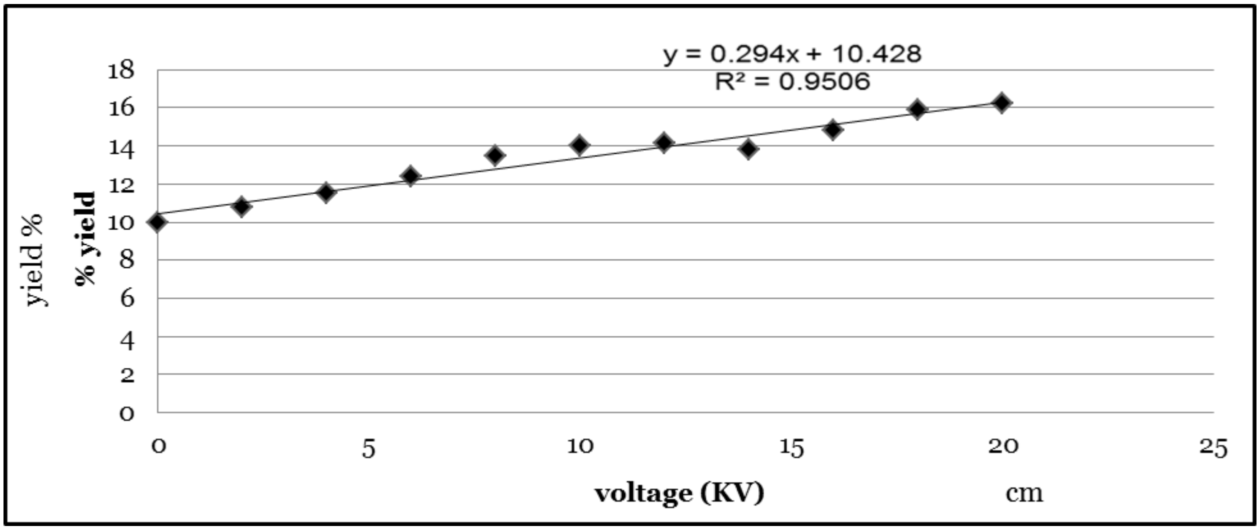


Figure 4.8 The effect of different voltage application using fixed value of time (5min) and fixed distance (5cm).

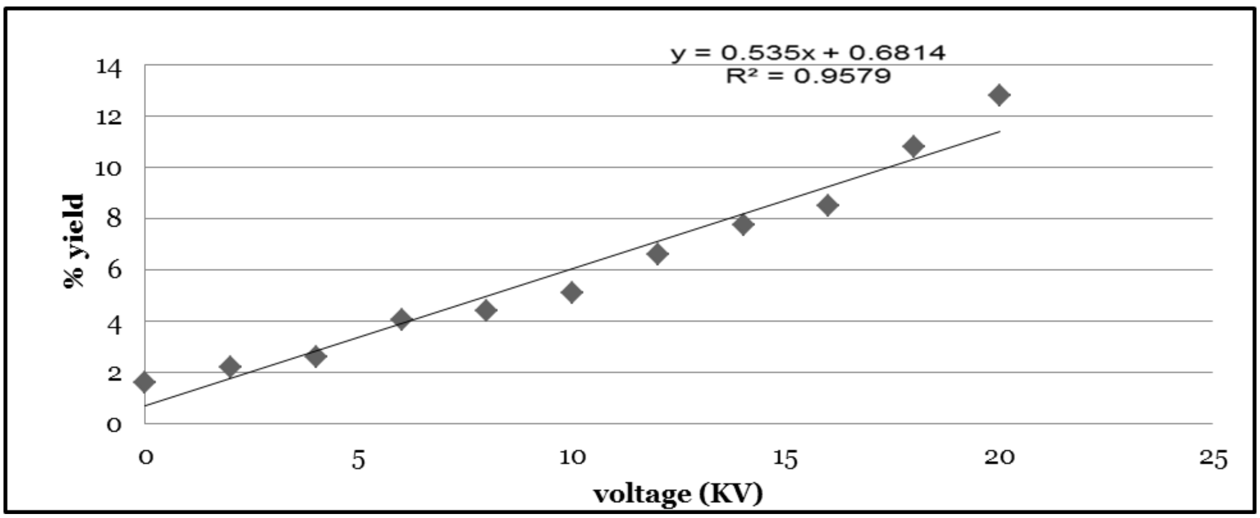


Figure 4.9 The effect of different voltage application using fixed value of time (1 min) and fixed distance (5cm).

To figure out the degree effect of these treatment on olive oil yield, Table 4.1 exploit the yield resulted for each electrical treatment for different time.

As revealed in the previous results when olive oil placed at 2.5cm distance, same trend were reported for samples treated at 5cm distance. And again the 1min time treatment duration found to exhibit the best values among time intervals investigated. This remarkable increase in yield for samples being treated for 1min creating critical finding and building up more emphasis on

The role of the 1min electrical treatment and to solidify the fact that the effect of electrical current is time bounded.

Table 4.2 Comparison between olive oil yields extracted at different duration times from olive fruits placed at 5cm distance and treated with different electrical power

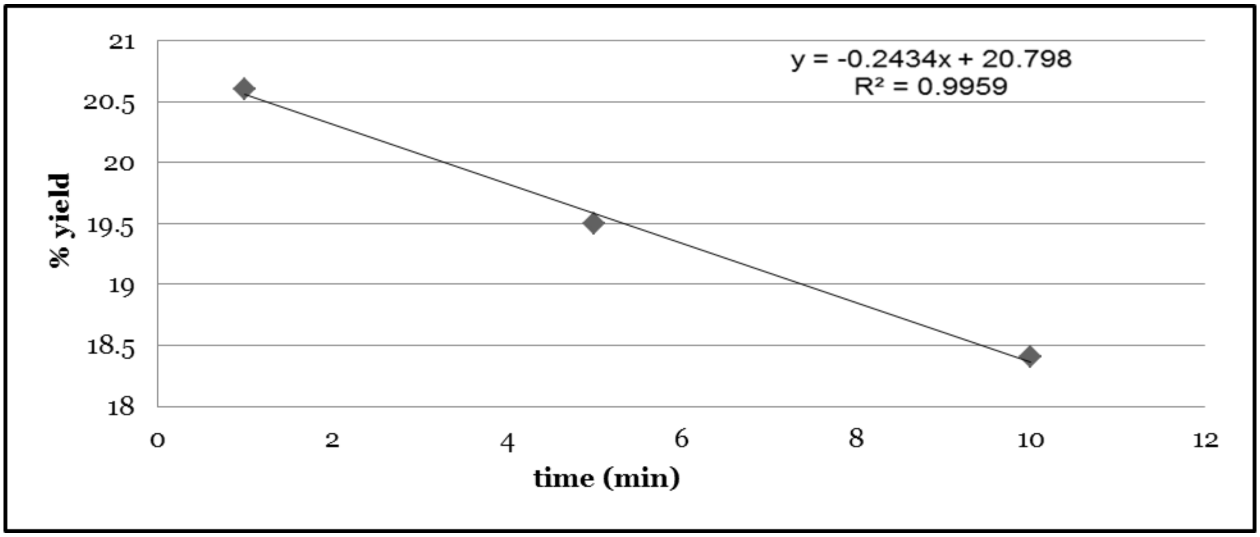
Voltage used (KV)	Yield at 1min duration time	Yield at 5min duration time	Yield at 10min duration time
0	1.62	10.00	4.05
2	2.21	10.81	4.07
4	2.63	11.51	4.10
6	4.02	12.42	4.41
8	4.40	13.50	4.62
10	5.12	14.03	4.81
12	6.59	14.13	4.83
14	7.74	13.81	4.79
16	8.51	14.82	4.88
18	10.79	15.89	5.03
20	12.84	16.21	5.40

4.3.2 Effect of time (fixed voltage and distance) :

Several applications using different range of time being used. To verify the effect of time the following time application were used: 1, 5, and 10min were investigated in the whole study by using three major electrical values, namely; 2, 10, and 16 KV.

Figure 4.10 shows the obvious difference of the yield resulted among 1, 5, and 10 min treatment with using one electrical current of 16KV.

The curve plotted in Figure 4.10 shows a remarkable increase for samples treated at 1 min in comparison to 5 and 10min duration time of treatment.



This finding is supporting the previous finding showed that the best treatment time was obtained when the duration was 1min. several explanation could be highlighted due to this finding and main reason was derived from the effect of electrical current on oil sacks and its effect on neutralizing the charge of the fatty acids.

Figure 4.10 shows the effect of different time application using fixed value of voltage (16 KV) and fixed distance (2.5cm). Same finding was obtained when samples treated at 10 and 2 KV, as appeared in Figure 4.11 and Figure 4.12, respectively.

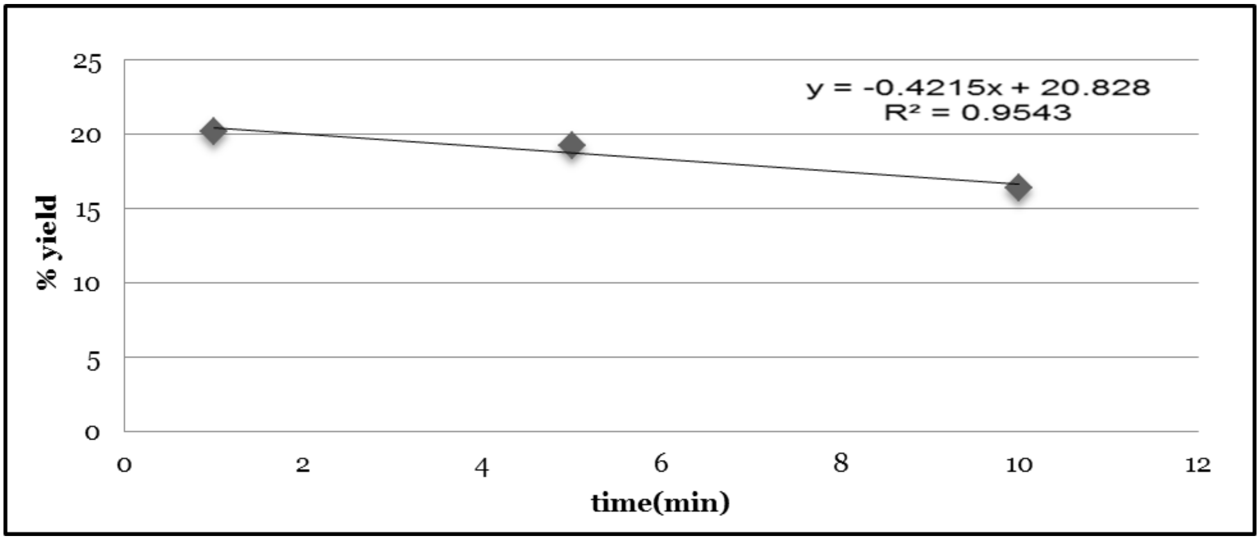


Figure 4.11 The effect of different time application using fixed value of voltage (10 KV) and fixed distance (2.5cm).

The results showed an increase in the yield with decreasing the time value applied, in straight line correlation. A higher effect on yield for samples treated with 1 min more than 10 min at different voltages. This is due to higher effect of time on oil sacks within the olive fruit. The effect of little time on cell membrane helped in increasing the dropping off more oil amount.

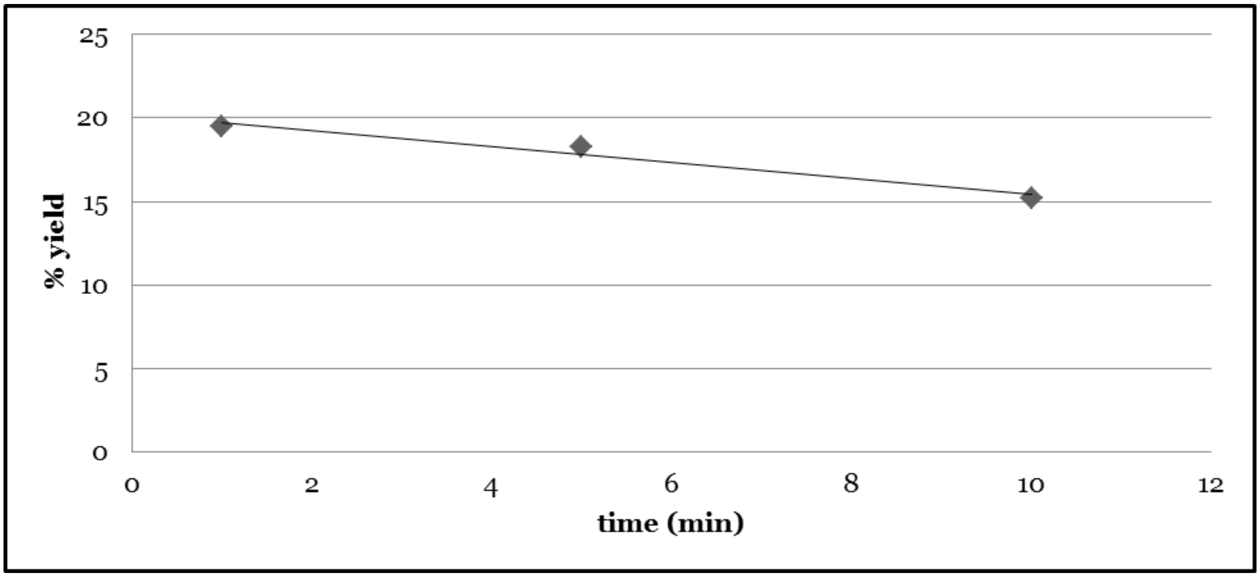


Figure 4.12 The effect of different time application using fixed value of voltage (2 KV) and fixed distance (2.5cm).

The higher effect of treating samples at 2.5cm distance found to be in direct proportional correlation with voltage value used and as well affected by duration time used inversely, as shown in Table 4.3

Table 4.3 Comparison between olive oil yields extracted at different duration time from olive fruits placed at 2.5cm distance and treated with different electrical power.

Voltage used (KV)	Yield at 1min duration time	Yield at 5min duration time	Yield at 10min duration time
2	19.5	18.3	15.18
10	20.14	19.2	16.4
16	20.6	19.5	18.4

Different findings were found for samples placed at 5cm distance. Figure 4.13 shows the result of fruit samples treated by 16KV electrical current for 1,5, and 10 min. The curve shows an increase in yield while the time increase. It is obvious that placing samples at 5cm distance had shown higher impact for the distance to a level that promoted lower effect of the 1min treatment over other treatment. The huge difference between samples treated for 1 min and the other two elevated times giving evidences that time was critical to determine the efficiency of the electrical current application.

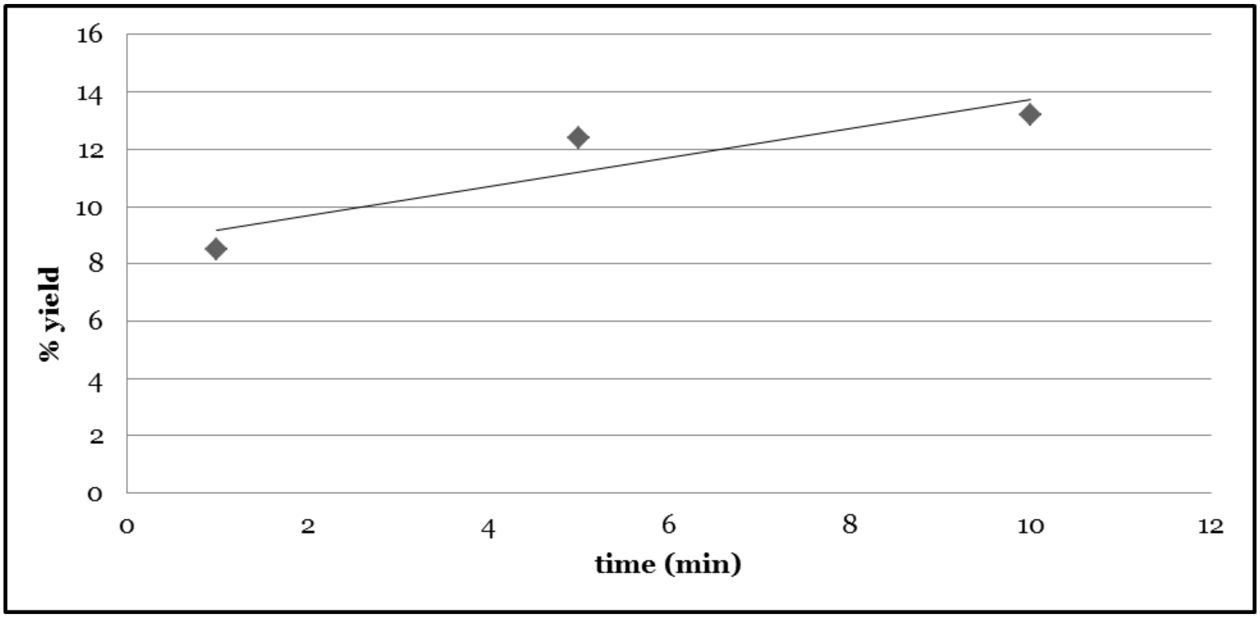


Figure 4.13 The effect of different time application using fixed value of voltage (16 KV) and fixed distance (5cm).

Figure 4.14 and Figure 4.15 exhibit a complete different trend for the olive oil yielded by applying 10 and 2KV, respectively. The highest value was for the samples exposed to the electrical current for 5min. This finding also puts more emphasis on the role of yield as correlated highly with the time of exposure.

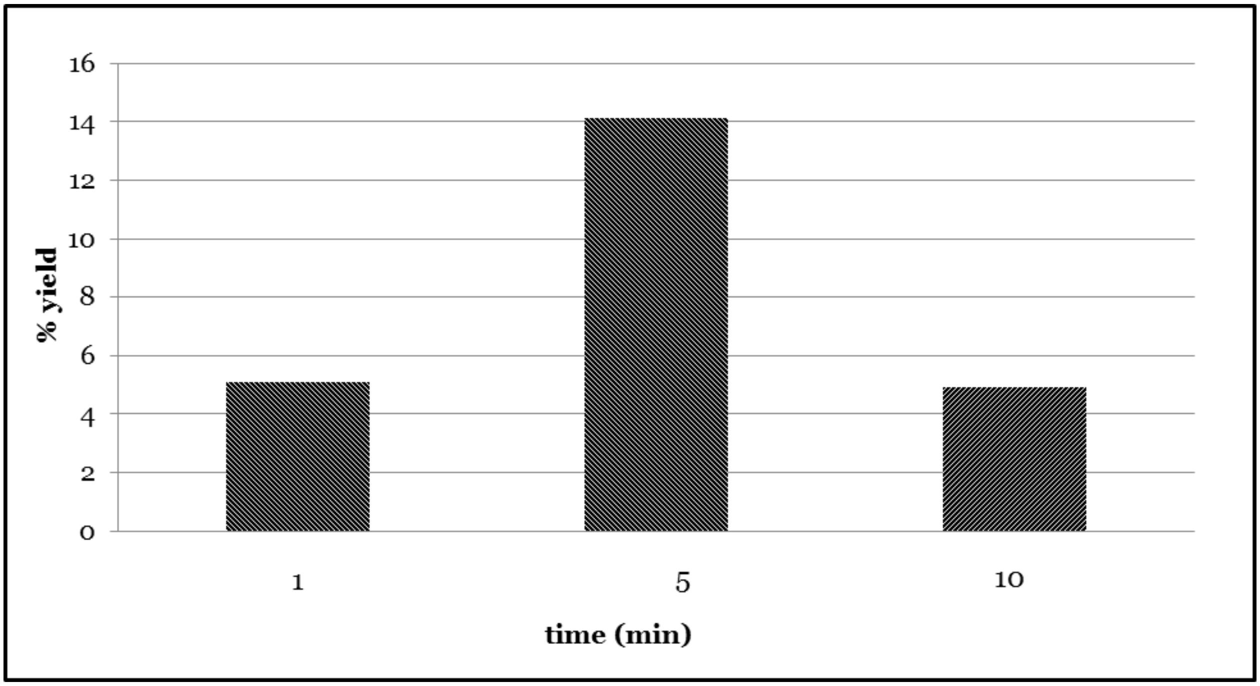


Figure 4.14 The effect of different time application using fixed value of voltage (10 KV) and fixed distance (5cm).

The results showed an increase in the yield with decreasing the time value applied, in straight line correlation. A higher effect on yield for samples treated with 5 min more than 10 and 1 min at the same voltage and distance. This is due to higher effect of time on oil sacks within the olive fruit. The effect of little time on cell membrane helped in increasing the dropping off more oil amount.

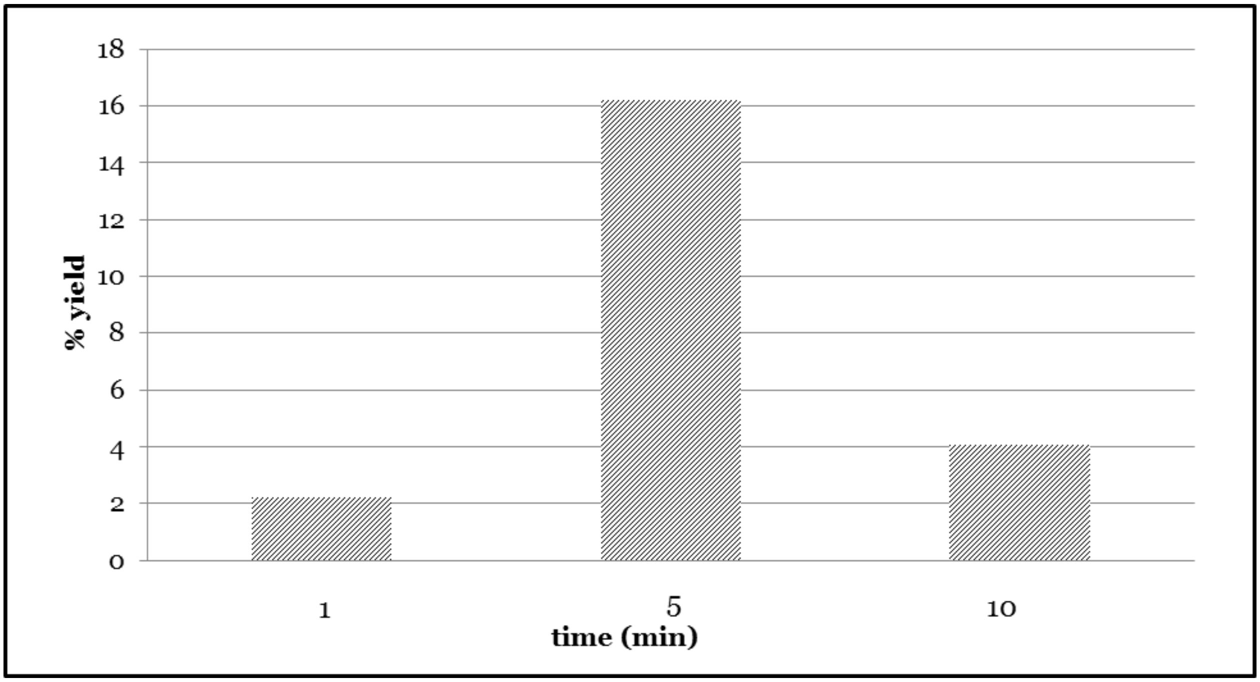


Figure 4.15 The effect of different time application using fixed value of voltage (2 KV) and fixed distance (5cm).

4.4 Correlations Affecting Yield:

The above and previous results showed the effect of the studied factors in single term. It is very important to study the effect of combined factors.

4.4. 1 Correlation of time to Voltage with fixed Distance:

Several applications using different ranges of time being used. An intervals of 1, 5, and 10 min were investigated in the whole project.

The results in Figure 4.16 showed an increase in the yield with decreasing the time value applied, in straight line correlation. A higher effect on yield for samples treated with 1 min more than 10 min at the same voltage and distance. This is due to higher effect of time on oil sacks within the olive fruit. The effect of little time on cell membrane helped in increasing the dropping off more oil amount.

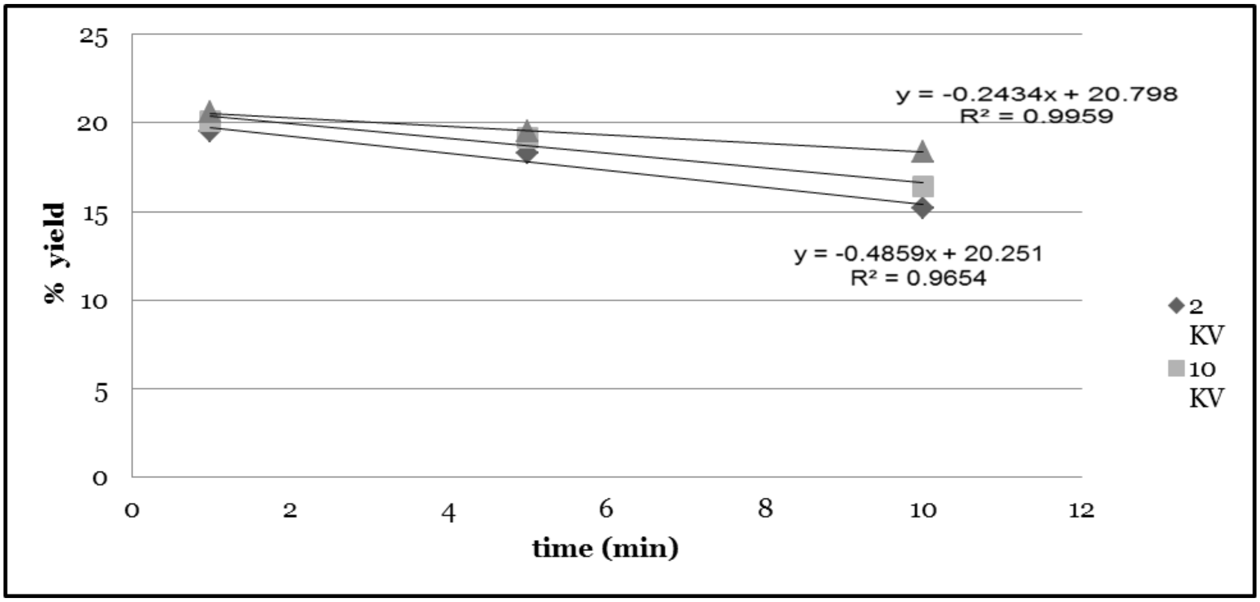


Figure 4.16 The effect of different time application using different value of voltage (2,10, and 16 KV), different time (1,5, and 10 min), and fixed distance (2.5cm).

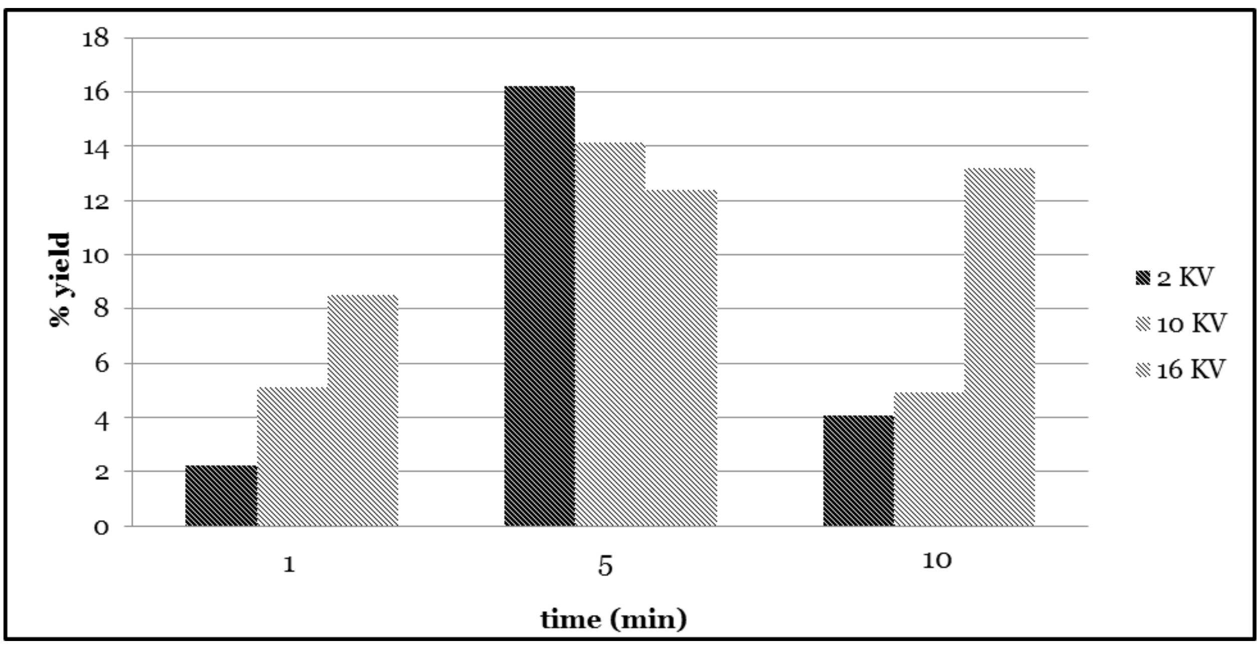


Figure 4.17 The effect of different time application using different value of voltage (2,10 , and 16 KV), different time (1,5, and 10 min), and fixed distance (5cm).

The results showed an increase in the yield with decreasing the time value applied, in straight line correlation. A higher effect on yield for samples treated with 5 min more than 10 and 1 min at the same voltage and distance. This is due to higher effect of time on oil sacks within the olive fruit. The effect of little time on cell membrane helped in increasing the dropping off more oil amount.

4.4.2 Correlation of Distance to Voltage with fixed Time:

Several applications using different ranges of distance been used. An interval of 2.5 cm was used to construct the following application: 2.5 and 5 cm were investigated in the whole project.

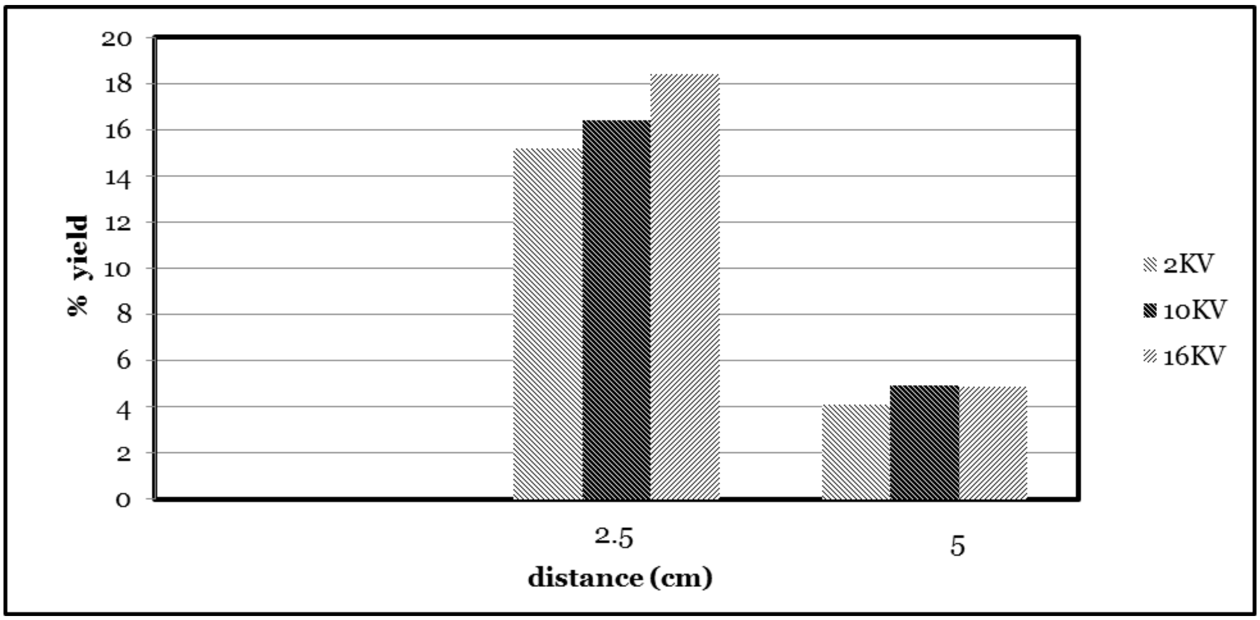


Figure 4.18 The effect of same time application using different value of voltage (2, 10, 16 KV) and different distance (2.5 and 5cm).

The results showed an increase in the yield with increasing the voltage value applied, and decreasing distance value applied. A higher effect on yield for samples treated with 16 KV and 2.5 cm more than 2 KV and 5 cm at the same time (10 min). This is due to higher effect of distance on oil sacks within the olive fruit. The effect of little distance on cell membrane helped in increasing the dropping off more oil amount.

These results are in accordance with the finding reported by A. C. Sanchez-Gimeno et al, (2013).

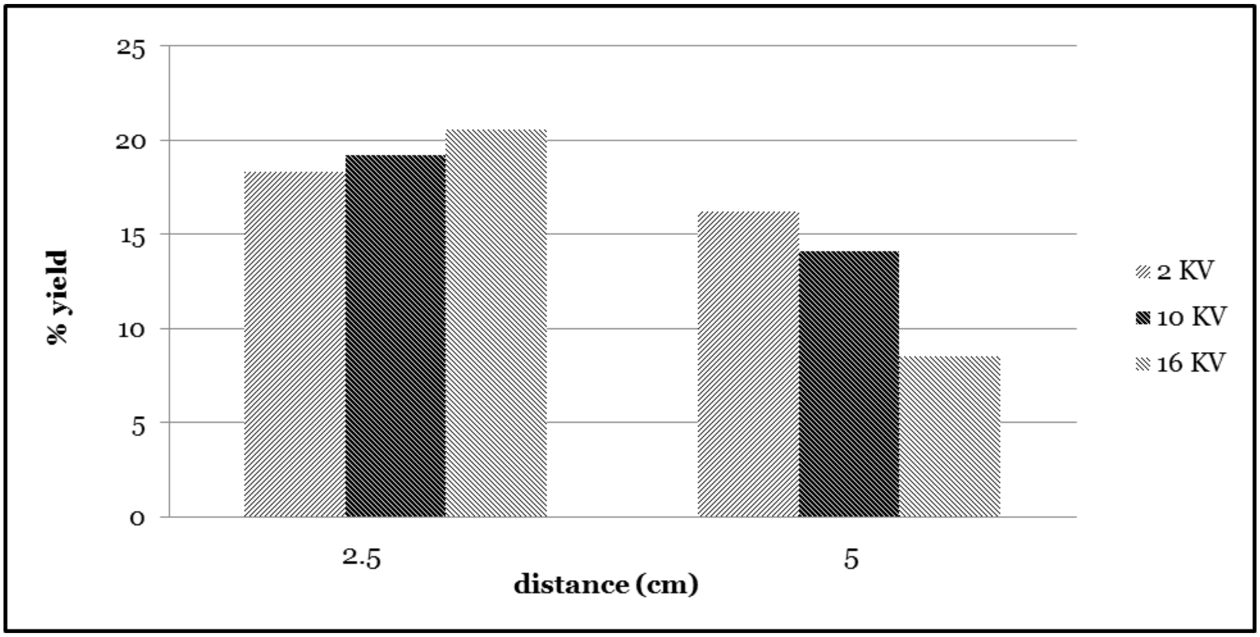


Figure 4.19 The effect of different distance (2.5, 5 cm) application using different value of voltage (2, 10, 16 KV) and fixed time (5min).

The results showed an increase in the yield with increasing the voltage value applied, and decreasing distance value applied. A higher effect on yield for samples treated with 16 KV and 2.5 cm more than 2 KV and 5 cm at the same time (10 min). This is due to higher effect of distance on oil sacks within the olive fruit. The effect of little distance on cell membrane helped in increasing the dropping off more oil amount.

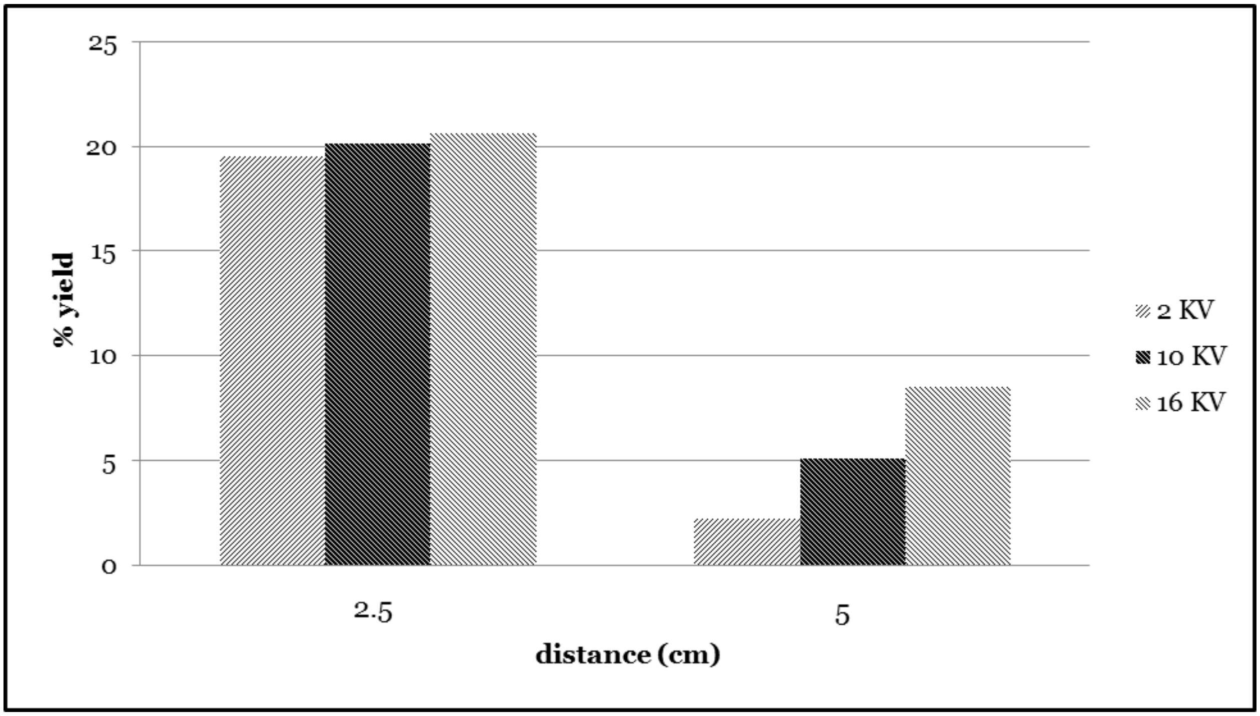


Figure 4.20 The effect of different distance (2.5, 5 cm) application using different value of voltage (2, 10, 16 KV) and fixed time (1min).

The results showed an increase in the yield with increasing the voltage value applied, and decreasing distance value applied. A higher effect on yield for samples treated with 16 KV and 2.5 cm more than 2 KV and 5 cm at the same time (10 min). This is due to higher effect of distance on oil sacks within the olive fruit. The effect of little distance on cell membrane helped in increasing the dropping off more oil amount.

4.5. Effect of Electrical Treatment on Olive Oil Quality:

The pre-determined olive oil quality tests were used to evaluate the effect of electrical current on oil quality. Different legitimate test for olive oil quality could be applied. However, chemical test in terms of acidity and peroxide value as well as with analytical test in terms of K_{232} and K_{270} will be investigated

4.5.1 Chemical Tests:

Olive oil obtained after several treatments were subjected to chemical tests, namely; free acidity and peroxide value.

Results obtained provided an insight for the effect relativeness of electrical treatment conditions in three major olive fruit treatment conditions, as following:

Different electrical power with moderate distance and time duration.

Different electrical power with small distance and large time duration.

Different time duration with high electrical power and large distance.

The acidity and peroxide value will be investigated for olive oil produced under these three suggested conditions.

4.5.1.1 Acidity Test:

4.5.1.1.1 Free Acidity during Modest Treatment Condition:

Different electrical power with moderate distance and time duration was used in this investigation. Table 4.4 shows the effect of olive oil extracted from the electrical treatment expressed a quite better results of the acidity condition in comparison to untreated olive oil. These very limited development in controlling better results for olive oil acidity was an important issue for considering the efficiency of electrical treatment being chosen. The variation among acidity for samples resulted from different electrical power application were not big. It was found that under moderate electrical treatment condition, there was no significant variation among finite electrical power used, which was 2KV, or elevated power used (16KV). However, the modest differences among the treated and untreated samples, indicating that the effect of electrical current used on olive oil acidity was a dependent factor on other treatment condition.

Table 4.4: Free acidity at different values of voltage, time and distance.

Sample treated with: power, distance, duration time	free acidity
Standard	0.91%
2kv, 5cm, 5min	0.83%
10kv, 5cm, 5min	0.90%
16kv, 5cm, 5min	0.82%
20kv, 5cm, 5min	0.80%

4.5.1.1.2. Free Acidity During Sever Treatment Condition:

Different electrical power with small distance and large time duration were used to carry on this part of the investigation.

A remarkable diversion of the electrical current effect on acidity was shown for samples treated with elevated time duration. Huge difference between the treated olive oil samples with the standard one, as appeared in Table 4.5.

This remarkable difference was shown for all samples regardless the electrical power used. This condition of treatment represent sever condition were directed to olive fruit, as the distance is small and the time duration is high. Studying the provided table promote an idea of this increase in acidity was in direct proportional trend, as increasing electrical power led to increase olive oil resulted acidity, under sever treatment condition (small distance and large time). However, this result is highlighting the critical effect of time on olive oil quality chemical test in term of acidity.

The increase in olive oil acidity due to this treatment was due to the ability of olive oil exposed to the electrical current for long time to create a noticeable changes in olive oil fatty acids which became more susceptible for breaking the triglycerides-fatty acid skeletal structure. Which in turn helped in removing these fatty acids from its bound and became free fatty acids. This cleavage caused the olive oil acidity elevation.

Table 4.5: The difference between the treated olive oil samples with the standard one.

Sample treated with: power, distance, duration time	free acidity
Standard	0.94%
14kv, 2.5cm, 10min	1.2%
16kv, 2.5cm, 10min	1.3%
18kv, 2.5cm, 10min	0.99%
20kv, 2.5cm, 10min	1.5%

4.5.1.1.3 Free acidity during fixed electrical current treatment:

Different time duration with high electrical power and large distance was used to investigate multi disciplining treatment conditions.

This condition of electrical treatment was found to be the most to preserving olive oil acidity. As shown in results in Table 4.6 a noticeable difference between standard sample acidity and other treated samples.

Although the application was through treated olive fruit with high electrical power but the acidity developed for the resulted olive oil was much better and kept below the standard sample. This finding was regardless the time used because the distance that used to place olive fruits in was very high. This, in turn, decreased the limited harsh effect of electrical current on skeletal structure of triglycerides. Therefore, the fatty acids exist in this structure kept its bounds with the structure and even more it became stronger. This positive effect of electrical current on strengthening the bond between fatty acids and triglycerides was possible through altering the net-charge of these fatty acids. Another explanation could be through the ability of electrical current to modify a shrinking case within the bounds between fatty acids and triglycerides. This effect on the shrinking ability of fatty acid should be sensitive and most likely to be in trend of bell shape.

Table 4.6: The difference between standard sample acidity and other treated samples.

Sample treated with: power, distance, duration time	free acidity
Standard	0.92%
16kv, 10cm, 1min	0.59%
16kv, 10cm, 5min	0.71%
16kv, 10cm, 10min	0.76%

4.5.1.2 Peroxide Test:

4.5.1.2.1 Peroxide Value During Modest Treatment Condition:

Different electrical power with moderate distance and time duration was used in this investigation. Table 4.7 shows the effect on olive oil peroxide value extracted from the electrical treatment. This tremendous decrease in peroxide value showed the positive effect of electrical current treatment on adding more stability on skeletal body structure of triglycerides of the olive oil.

Table 4.7: Results of peroxide value

Sample treated with: power, distance, duration time	peroxide value
Standard	19.17
2kv, 5cm, 5min	8.13
10kv, 5cm, 5min	10.06
16kv, 5cm, 5min	10.90
20kv, 5cm, 5min	8.78

4.5.1.2.2 Peroxide Value During Sever Treatment Condition:

Different electrical power with small distance and large time duration were used to carry on this part of the investigation. In general, almost no effect was seen for the effect of electrical current used to treat olive fruit prior to extraction. Small increase in peroxidation was illustrated by very high electrical power. This state of no effect was due to the ability of electrical current to ceasing its effect during long term application. This case could be possible if the hydroxyl group was demonstrating an isoelectric behavior, i.e. double affect with electrical current which in turn the more produce less.

Table 4.8: Results of peroxide value

Sample treated with: power, distance, duration time	peroxide value
Standard	11.02
14kv, 2.5cm, 10min	11.42
16kv, 2.5cm, 10min	11.89
18kv, 2.5cm, 10min	11.24
20kv, 2.5cm, 10min	12.42

4.5.1.2.3 Peroxide Value During fixed electrical current treatment:

Different time duration with high electrical power and large distance was used to investigate multi disciplining treatment conditions.

It is obvious from Table 4.9 that the effect of time was clearly seen. Samples resulted from minimum time duration treatment showed a decent reduction in peroxide value in comparison to the standard sample (no electrical treatment applied). This value was gradually increased as the time applied increase until the samples produced with highest time duration showed peroxide results proceeding toward the value of the standard sample.

It is clear from this result that the effect of time on the chemical quality of olive oil peroxide value was very critical.

Table 4.9: The results of peroxide value

Sample treated with: power, distance, duration time	Peroxide Value
Standard	15.04
16kv, 10cm, 1min	10.1
16kv, 10cm, 5min	13.6
16kv, 10cm, 10min	14.5

4.5.2. Analytical Test:

Olive oil resulted from olive fruit treated with electrical current under different condition of extraction were subjected for K factor investigation, both the K_{232} and K_{270}.

4.5.2.1 K factors Value During Modest Treatment Condition:

Different electrical power with moderate distance and time duration was used in this investigation. Table 4.10 shows the effect on olive oil extracted from the electrical treatment on K factors value were expressed a noticeable increase in olive oil stability status up to 16KV. These values associated with modest treatment and electrical power value up to 16KV helped in developing low values of both K factors. This obvious lower values in comparison to that one in standard sample developing the idea of the role of electrical power used would promote a stabilizing status for triglycerides and its constituents.

Table 4.10 also showed a remarkable increase in K factors above the standard sample especially for K_{270} which demonstrated huge increase for samples treated with 20KV in comparison with both the other lower electrical power used and the standard sample.

Table 4.10: The results of k_{232}, k_{270}

Sample treated with: power, distance, duration time	K_{232}	K_{270}
standard	3.14	0.28
2 kv, 5 cm, 5 min	1.94	0.18
10 kv, 5 cm, 5 min	2.14	0.19
16 kv, 5 cm, 5 min	2.17	0.19
20 kv, 5 cm, 5 min	3.61	0.40

4.5.2.2. K factors During Sever Treatment Condition:

Different electrical power with small distance and large time duration were used to carry on this part of the investigation.

Table 4.11 showed that the K factors value for olive fruits treated with given condition was increased with increasing duration time. The maximum time increased was able to produce very acceptable values of K_{232} while slight increase in K_{270} was demonstrated by 10min duration time in comparison with standard sample.

Another worth mentioning result driven from Table 4.11 is that the lower time duration used showed remarkable decrease in K factors both the K_{232} and K_{270}.

Table4.11 The results of K_{232} and K_{270} at different voltage, distance and time.

Sample subjected to: Voltage, distance from electrical source, time duration	K_{232}	K_{270}
Standard	2.24	0.18
16KV, 10 cm, 1 min	1.04	0.08
16 KV, 10 cm, 5 min	1.08	0.09
16 KV, 10 cm, 10 min	1.65	0.21

4.5.2.3 K factors During fixed electrical current treatment:

Different time duration with high electrical power and large distance was used to investigate multi disciplining treatment conditions.

As shown in Table 4.12, the K_{232} was increased as the electrical current power was applied for all samples in comparison to standard sample. This effect of electrical current was cooperated with high time duration used with olive fruit. This remarkable increase in K_{232} indicate the effect of electrical current on olive oil stability was negative. At the same time gradual increase of K_{232} by increasing voltage power was slightly low. The remarkable effect was for the time more than the electrical current.

Table 4.12, The K_{232} and K_{270} at different values of power, distance and time.

Sample treated with: power, distance, duration time	K_{232}	K_{270}
Standard	1.54	0.21
14 kv, 2.5 cm, 10 min	2.02	0.22
16 kv, 2.5 cm, 10 min	2.55	0.18
18 kv, 2.5 cm, 10 min	2.80	0.23
20 kv, 2.5 cm, 10 min	2.86	0.29

Table 4.12 also showed that the effect of such treatment on K270 was very limited and marginal. Finite limited increase in K_{270} can’t be seen as an effect of such treatment on K_{270}. This limited effect was probably due to the nature of the constituents of the triglycerides were not altered or affected by such electrical current applied.

4.6 Quality assuring testing:

This investigation is highly dependent on the fraction resulted for each run and the comparison took place after word. Thus this fraction played a major role to distinguish between one treatment to another. Even more, these values were the key element to determine whether the application studied was effective or not. Therefore, it was highly recommended to verify the accuracy of these experiments through calculating the error value as shown in Table 4.13.

As shown in the provided Table the values of the error for each run was very low. These limited figures reveals the fact that the mistaken took place during the investigation among each run was very small, thus the values of the resulted olive oil yield considered to be highly trusted.

Table 4.13: show the values of the error for different experiments.

Sample treated with: power, distance, duration time	Values error
Standard	±1.17
2kv, 2.5cm, 10min	±1.17
3kv, 2.5cm, 10min	±1.18
Standard	±1.12
4kv, 2.5cm, 10min	±1.18
6kv, 2.5cm, 10min	±1.18
8kv, 2.5cm, 10min	±1.17
Standard	±1.18
10kv, 2.5cm, 10min	±1.17
12kv, 2.5cm, 10min	±1.18
Standard	±1.17
14kv, 2.5cm, 10min	±1.17
16kv, 2.5cm, 10min	±1.18

5. Conclusion and Future Work

5.1 Introduction:

Results obtained in this investigation helped a lot to shape better the understanding for the effect of electrical current on olive oil extraction yield. This understanding wasn't able without studying different factors and different conditions.

At the same time the importance of having more yield consist one application while the other not less importance is the quality of the oil obtained. It is common sense undertaking that factors could be helpful in one side while they could have negative effect on other sides.

Therefore, it is very important to highlight the major and solid conclusions drawn from this investigation and to suggest the form of future research needed to build up more understanding and to facilitate showing more evidences and details.

5.2 Conclusions:

Through understanding and analyzing the results obtained in this investigation, the main conclusions were:

Electrical current of DC type has a remarkable increase on oil extraction yield.

Olive oil yield is sensitive to the electrical power used.

The electrical power induced a remarkable increase on oil yield extraction in corporation with time duration applied and amount of olive fruit exposed to electrical treatment.

Time duration was found to be very critical in promoting better extraction of oil.

The more time used, the more oil obtained.

Olive oil quality was remarkably affected by electrical treatment.

Olive oil acidity and peroxide were found to be positively developed for olive oil extracted from electrically treated olive fruit.

k factors were noticeably affected by electrical treatment.

5.3 Future Work:

From the results obtained in this research several missing information were considered to be very important for analyzing the data. At the same time several aspects of other factors can be investigated and would help in solidifying and supporting the idea of this new technique used. However, it is very important in the future to study more close intervals in term of voltage used, and time intervals.

Different condition of electrical treatment in terms of humidity, ambient temperature and air availability need to be investigated.

References:

Abenoza M., Benito M., Saldana G., Alvarez I., Raso J., Sanchez-Gimeno A. C., Effects of Pulsed Electric Field on Yield Extraction and Quality of Olive Oil, DOI 10.1007/s11947-012-0817-6, 2012.

Akcar H., Gumuskesen S., Sensory Evaluation Of Flavored Extra Virgin Olive Oil, GIDA 36 (5): (249-253) 2011.

Anderson V. D., U.S. Patent 637,354, 1900.

Angerosa F., Servili M., Selvaggini R., Taticchi A., Esposto S., Montedoro GF., Volatile compounds in virgin olive oil: occurrence and their relationship with the quality, JChromatogr.A.(1054): 17-31, 2004.

Angerosa F., Lanza B., Marsilio V., Biogenesis of fusty defect in virgin olive oils. Grasas Aceites. (47):142-150, 1996.

Angerosa F., Mostallino R., Vito C., Influence of malaxation temperature and time on the quality of virgin olive oils, Food Chemistry 72 (19_28), 2001.

Anonymous, in Chronology, 2000.

Anonymous, in The Extraction of Oil from Seeds and Nuts, 1997.

Anonynous. Anderson International Crop. Available:

http://www.andersonintl.com/history.html, 2002.

Aydar AY., Bagdatlıoglu N., Koseoglu O., Effect of ultrasound on olive oil extraction and optimization of ultrasound- assisted extraction of extra virgin olive oil by response surface methodology (RSM), http://dx.doi.org/10.3989/gya.1057162, 2017.

Beceiro J., Artiaga R., Gracia C., Saavedra J., Naya S., Mier J., Comparison of olive, corn, soybean and sunflower oils by PDSC. Journal of Thermal Analysis and Calorimetry, DOI: 10.1007/s10973-010-1165-2, 2011.

Ben-Hassine K ., Taamalli A., Ferchichi S., Mlaouah A., Benincasa C., Romano E., Flamini G., Lazzez A., Grati-kamoun N., Perri E., Malouche D., Hammami M.,Physicochemical and sensory characteristics of virgin olive oils in relation to cultivar, extraction system and storage conditions, FRIN-04819; No of Pages 11, 2013.

Bongartz A., and Oberg D. G., Sensory Evaluation of Extra Virgin Olive Oil (EVOO) Extended to Include the Quality Factor, Journal of Agricultural Science and Technology A 1 (422-435), 2011.

Bonos, E., Christaki, E. and Florou-Paneri, P. 2011.

Boskou D., Olive oil composition. Olive oil chemistry and technology. Boskou, D. (Ed), AOC Press, Champaign, Illinois, USA. pp. 52-83, 1996.

Boussetta N., Turka M., De Taeye C., Larondelle Y., Lanoiselle J.L., Vorobiev E., Effect of high voltage electrical discharges, heating and ethanol concentration on the extraction of total polyphenols and lignans from flaxseed cake, 2013.

Çakraj R., Prifti D., Boci I., Borova N., Evaluation of the Sensory Quality of Extra Virgin Olive Oil in the Albanian Market, International Refereed Journal of Engineering and Science, Volume 3, PP. 01-07, 2014.

Cerqueira, P. S., Souza A., and Marques M. R. C., Effects Of Direct And Alternating Current On The Treatment Of Oily Water In An Electro Flocculation Process, Brazilian Journal Of Chemical Engineering, doi.org/10.1590/0104-6632.20140313s00002363, Vol. 31, No. 03, pp. 693 - 701, 2014.

Deli S., Masturah F., Tajul Aris M., and Wan Nadiah Y., The Effects of physical parameters of the screw press oil expeller on oil yield from Nigella sativa L seeds, International Food Research Journal 18(4): (1367-1373), 2011.

Demurin, Y., Skoric, D. and Karlovic D., Genetic variability of tocopherol composition in sunflower seeds as a basis of breeding for improved oil quality. Plant Breed. 115,33–36, 1996.

Dent M., Uzelac V., Peni M., Brni M., Bosiljkov T., and Levaj B., The Effect of Extraction Solvents, Temperature and Time on the Composition and Mass Fraction of Polyphenols in Dalmatian Wild Sage Extracts, Food Technol. Biotechnol. 51 (1) 84–91 , 2013.

Di Giovacchino L., Costantini N., Serraiocco A., Surricchio G., Basti C., Natural antioxidants and volatile compounds of virgin olive oils obtained by two or three phases centrifugal decanters. Eur. J. Lipid Sci. Technol. (103) :279-285, 2001.

Dinnella C., Masi C., Zoboli G., Monteleone E., Sensory functionality of extra-virgin olive oil in vegetable foods assessed by Temporal Dominance of Sensations and Descriptive Analysis, Food Quality and Preference 26 (141-150), 2015.

Dıraman H., and Dibeklioglu H., Using Lipid Profiles For The Characterization Of Turkish Monocultivar Olive Oils Produced By Different Systems, International Journal of Food Properties, 17 (1013–1033), DOI: 10.1080/10942912.2012.685675, 2014.

Eduardo Puertolas , Inigo Martinez de Maranon, Olive oil pilot-production assisted by pulsed electric field: Impact on extraction yield, chemical parameters and sensory properties, food chemistry 167 (497-502), 2015.

Evon, P., Vandenbossche, V., Pontalier, P.Y. and Rigal, L., Direct extraction of oil from sunflower seeds by twin-screw extruder according to an aqueous extraction process: Feasibility study and influence of operating conditions. Ind. Crops Prod. 26, 351–359, 2007.

Fantozzi P,. Introduction to the Problem of Evaluating Olive Oil Quality. Acta Horticultura 356, 1994.

Frank D. Gunstone, Vegetable Oils In Food Technology: Composition, Properties and Uses, University of St Andrews and Honorary Research Professor Scottish Crop Research Institute Dundee, 2002.

Germek V., Koprivnjak O., Butinar B., Pizzale L., iklavciMc M., Conte L. S., Influence of malaxation time on phenols and volatile compounds of virgin olive oil obtained from phenol enriched olive paste, 2011.

Goldsmith C.D., Stathopoulos C. E., Golding J. B., and Roach P. D., Fate of the phenolic compounds during olive oil production with the traditional press method, International Food Research Journal 21(1): 101-109, 2014.

Guderjan M., Topfl S., Angersbach A., Knorr D., Impact of pulsed electric field treatment on the recovery and quality of plant oils, Journal of Food Engineering 67 (281–287), 2005.

Gunstone, F.D., Soybeans dominate global oilseed. Inform, 12, 737–740, 2001.

Hamatschek J,. Application of decanters for the production of juices and edible oils. Food Tech. Europe, Dec. 1994/Jan. 1995, pp. 21–23, 1995.

Houshia O., Abueid M., Abu Amshah R., Obaid R., Arafat D., Qadri M., Qadry M., Jaber M., Hammad O., Assessment of Olive Oil Mills Efficiency and Olive Oil Quality in the West Bank for the Years 2012/2013, Arab American University, DOI:10.5923/j.env.20140404.04, 2014 .

http://aooa.com.au/quality-standards/olive-oil-grading/

International Olive Oil Council, Organoleptic Assessment of Virgin Olive Oil. COI/T.20/Doc: No 15/Rev. 1-20, 1996.

Ionescu M., Voicu G., Biriş S., Covaliu C., Dinca M., Ungureanu N., Parameters Influencing The Screw Pressing Process Of Oil Seed Materials, University Politehnica of Bucharest, 2014.

J. Sineiroa, H. Dominguezb, M.J. Nuneza, and J.M. Lemaa, Ethanolic Extraction of Sunflower Oil in a Pulsing Extractor, AOCS 75, 753–754 (1998).

Kemper T. G and Farmer R. D., U.S. Patent 5,992,050, 1999.

Kemper T. G., U.S. Patent 5,705,133, 1998.

Khdair A., Ayoub S and Abu-Rumman G., Effect of Pressing Techniques on Olive Oil Quality, American Journal of Food Technology 10 (4): 176-183, DOI: 10.3923/ajft.2015.176.183, 2015.

Kiritsakis A,. Olive Oil, Food and Nutrition Press, Inc., Trunbull, Con, 1998.

Kirschenbauer H. G., Fats and Oils, Reinhold Publishing, New York, pp. 122–123, 1944.

Kyari M.Z., Extraction and characterization of seed oils, International Agrophysics, 2008.

Lewin S, Displacement of water and its control of biochemical reactions. Academic London, 1974.

Luck WAP, Structures of water in aqueous systems. In: Water activity: influences on food quality 1981.

Maza A., Process for the recovery of corn oil from corn germ. US Patent 6,201,142, 2001.

Morales M.T. and Aparicio R., Effect of Extraction Conditions on Sensory Quality of Virgin Olive Oil, AOCS, Vol. 76, no. 3, 1999.

Moses D., Performance evaluation of continuous screw press for extraction soybean oil, American Journal of Science and Technology, 2014.

O'Brian, R.D. Characterization of Fats and Oils, in Fats and Oils: Formulating and Processing for Applications, second edition. CRC Press, Boca Raton, p.8, 2004.

Olive Oil: Conditions of Competition between U.S. and Major Foreign Supplier Industries, United States International Trade Commission, 2013.

Ortega J., Cassellis M., and Reyes J., and Edith Cortés Rodríguez, Study of an electric field application as an alternative of method of preservation on crude avocado oil, Mex. J. Mat. Sci. Eng. 2 (45-51), 2015.

Ortega J., Lopez M, Torre R., Effect Of Electric Field Treatment On Avocado Oil, Nov. Vol. 1, International Journal of Research In Agriculture and Food Sciences, 2013.

Ortega J., Lopez M., Cansino N., Cabrera G., Molina T., and Torre R., Preliminary study on the application of an electric field as a method of preservation for virgin olive oil ,p. 291-294, Doi: 10.4025/actascitechnol.v38i3.28020, 2016.

Ortega J., Reyes J., Moran L., Cassellis M., Suarez S., Hernández M., Effect of an electric field treatment on unsaturated fatty acid composition in crude chia oil, American Journal of Research Communication: Vol 4(9) , 2016.

Pagliuca M., Scarpato D., Food Quality, Consumer Perception And Preferencese: An Analysis On Olive Oil, Electronic Journal of Applied Statistical Analysis, Vol. 4, Issue 2, 215 – 226, DOI 10.1285/i20705948v4n2p215, 2011.

Paoplook K., and Eshtiaghi M.N., Impact of High Electric Field Pulses on Cell Disintegration and Oil Extraction from Palm Fruit Mesocarp, International Journal of Agriculture Innovations and Research, Volume 2, 2319-1473, 2013.

Qutub., Characterisation of the Main Palestinian Olive Cultivars and Olive Oil. EU/AFD, 2010.

Ranalli A & Angerosa F., Integral centrifuges for olive oil extraction. The qualitative characteristics of products. J. Am. Oil Chem. Soc. (73): 417-422, 1996.

Ranalli A., Malfatti A., And Cabras P., Composition and Quality of Pressed Virgin Olive Oils Extracted with a New Enzyme Processing Aid, Institute of Food Technologists, Vol. 66, No. 2, 2001.

RICOCHON G., and MUNIGLIA L., Influence of enzymes on the oil extraction processes in aqueous media, doi: 10.1684/ocl.2010.0337, 2010.

Ronyai E., Simandi B., Tomoskozi S., Deak A., Vigh, L. and Weinbrenner., Z. Supercritical fluid extraction of corn germ with carbon dioxide ethyl alcohol mixture. J. Supercrit. Fluids, 14, 75–81, 1998.

Santis D., Frangipane M., Sensory Perceptions of Virgin Olive Oil: New Panel Evaluation Method and the Chemical Compounds Responsible, Natural Science, 3, 132-142, 2015.

Servili M., Baldioli M., Selvaggini R., Macchioni A., Montedoro GF., Phenolic compounds of olive fruit: one- and two-dimensional Nuclear Magnetic Resonance characterization of nüzhenide and its distribution in the constitutive parts of fruit. J. Agric. Food Chem. (47): 12-18, 1999.

Servili M., De Stefano G., Piacquadio P., Di Giovacchino L., Sciancalepore V. Effect of extraction systems on the phenolic composition of virgin olive oils. Eur.Journal Lip. Sci. Technol. (101): 328-332, 1999.

Severini C., Baiano A., Rovere P., Dall Aglio G. and Massini R., Effect Of High Pressure On Olive Oil Oxidation And The Maillard Reaction In Model And Food Systems, Ital. J. Food Sci. n. 3, vol. 14, 2002.

Sharma R., and Sharma P C., Optimization of enzymatic pretreatments for maximizing olive oil recovery , Journal of Scientific & Industrial Research , Vol. 66, January, pp. 52-55, 2007.

Shorstkii I., Mirshekarloom., and Koshevoi E., Application Of Pulsed Electric Field For Oil Extraction From Sunflower Seeds , Kuban State University of Technology, doi:10.1111/jfpe.122812015 .

Shorstkiia I., Mirshekarloo M., Koshevoi E., Application of pulsed electric field for oil extraction from sunflower seeds, Kuban State University of Technology.

SiddiqM., and Hamid Ullah Shah, Effect of Stress Conditions on the Quality and Stability of Olive and Palm Oil Blends, arhad Journal of Agriculture, 32(3): 134-141, 2016.

Stefanoudakii E., Koutsaftakis A., Kotsifaki F., Angerosa F., Di Girolamo, M., Quality characteristics of olive oils dual-phases, three-phases decanters and laboratory mill. Acta Hort. (474): 705-708, 1999.

Sukardi A., Soeparman S., Argo B ., and Irawan Y., The Effect Of Pulsed Electric Field (PEF) On Glandular Trichome And Compound Of Patchouli Oil`, Journal of Natural Sciences Research , Vol.3, No.15, 2013.

United Nations Development Programme, World Food Programme, UN Office for the Coordination of Humanitarian Affairs, The World Bank, 2008 .

Vossen P.M,. Italian Olive Oil Production. California Olive Oil Council Publication, 1992.

Vossen P.M., Spanish Olive Oil Production. California Olive Oil Council Publication, 1997.

Wan P. J. and Wakelyn P. J., Technology and Solvents for Extracting Oilseeds and Nonpetroleum Oils, AOCS Press, Champaign, Illinois, pp. 14–18, 1997.

Wang, T., Hammond, E.G. and Fehr, Neutral and polar lipid phase transition of soybeans with altered saturated fatty acid contents. J. Am. Oil Chem. Soc., 78, 1139–1144, 2001.

Wijayaa C., Wijayab W and Mehtac B., General Properties of Major Food Components, DOI: 10.1007/978-3-642-41609-5_35-1, 2015.

Woerfel, J.B., Extraction, in Practical Handbook of Soybean Processing and Utilization (ed D.R. Erickson), AOCS Press, Champaign, IL, pp. 65–92, 1995.

Yusuf K.A., Akhigbe A.E and Izuagie F.I., Performance Evaluation of a Screw Press for Extraction of Groundnut Seeds and Cashew Kernel, International Journal of Engineering and Information Systems, Vol. 1 Issue 5, Pages: 1-8, 2017.

استخلاص زيت الزيتون باستخدام التيار الكهربائي المستمر للتحسين العائد بنسبة 45%

اسم الطالبة :- براءة زياد خليل

اسم المشرف :- د. ابراهيم عبد الله عفانة

الملخص:

الأهداف الرئيسية للدراسة الحالية هي دراسة تأثير التيار الكهربائي على تحسين إنتاجية محصول زيت الزيتون، وتأثير الجهد ، وتأثير الزمن ، وتأثير المسافة ، وتحديد نوعية زيت الزيتون.

تم الحصول على عينات من الزيتون من نوع شجرة (صري) في طولكرم _ فلسطين. كانت المجموعة مباشرة من الأشجار في اليوم الأول من نوفمبر 2017. تم تطبيق عدة مراحل على عينات مثل (تنظيف وغسل الأسنان) ، ثم تطبيق التيار الكهربائي المباشر. أظهرت النتائج أن أعلى معدل استخراج زيت زيتون حوالي 45٪ ، تأثير أعلى على المحصول للعينات المعالجة بـ KV 20 ، 1دقيقة ، 2.5 سم.

زيت الزيتون ، الذي تم استخلاصه باستخدام تطبيق التيار الكهربائي المباشر ، تم إجراء اختبارات نوعية الزيت لتحديد جودته، تأثير DEC على القيم الكيميائية للزيت: الحموضة ، قيمة البيروكسيد وعواملK232 ، K270 ، وكان معظم زيت الزيتون في مرحلة الزيت البكر الإضافية وفقا للمعايير القانونية للاتحاد الأوروبي. (EVOO) ؛ زيت الزيتون البكر الممتاز.