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Study on Some Avocado Fruits Varieties and Its Extracted Oil

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Abstract

This study aimed to evaluate the chemical composition and minerals content in defatted meal of different avocado fruits of Fuerte, Ettinger, Bacon, Hass and pinkerton vars.Also to determined their physical and chemical properties (Color , RI , Acidity , PV, K230 , and 270 nm, UNS , IV, and SV) , fatty acids and some natural antioxidant (total polyphenols , α-tocopherol and pigment contents (carotenoid and chlorophyll) of extracted oils from avocado fruits varieties . Sensory evaluation for external and internal fruit attributes in previous variety, was done obtained data observed that:-

All avocado fruits varieties rich in healthy and edible oil, especially Ettinger, Fuerte and Bacon vars. contained a high percentage of oil 13.67, 11.68 and 10.14 %, respectively. Defatted meals of all avocado fruit varieties contained a higher amount of K and Mg elements, which ranged from 3179.60 to 8857.85 ppm and 151.13 to 428.40ppm respectively.and they contained considerable amounts from other macro elements. but they contained a lower amount from micro elements (Zn , Mn , Fe and Se).

Produced oil from Fuerte var. had lowest values from acidity, PV, K230 and 270 nm. (0.63 %, 3.10 meqo_2/kg oil, 1.80 nm, 0.95 nm, respectively.) And it has a highest amount from UNS (5.60%) compared with other varieties .Total polyphenol of extracted oils from all avocado varieties recorded a higher values, which ranged from (1217.95 to 4280.05ppm). Bacon var. had a highest amounts from carotenoids and chlorophyll contents in extracted fruits oil 6.70 and 34.41 ppm, respectively, and vice versa in oil from Ettinger var. (1.56 and 2.64 ppm , respectively) . Extracted oil from Pinkerton, Hass and Ettinger vars. recorded a higher content of α-tocopherol compared with other varieties.

Oleic acid (omega -9) recorded a higher percentage of oil from Ettinger and Fuerte fruits vars. (54.60 and 51.36%, respectively) compared with other varieties. Obtained oils from all these varieties rich in omega 6 (linoleic acid) and also contained a considerable percentage from palmitoleic acid (C16:1).There was not any significant deference between varieties in all attribute parameters except for fruit size and flesh defect.

Keywords: Avocado fruit, sensory attributes, chemical composition, macro and micro minerals, physicochemical characteristics of oil fatty acid composition and natural antioxidant.

Introduction

The avocado tree (*Perseaamericana Mill*.) belongs to the family Lauraceae and is one of the few commercially significant members of the genus Persea. The fruit is called 'Ahuacatl' by the Aztecs and from there derived the term 'avocado', 'aguacate' (in Spanish), 'avocat' (in French) and 'abacate' (in Portuguese). The Aztecs considered avocados an aphrodisiac and called it huacatl ,meaning testicles, referring to the fruit's shape and the way they hang from the tree. The fruit also called 'palta' in Chile, Ecuador and Peru, and also has been referred to as alligator pear, vegetable butter, butter pear and mid shipman's butter ***(Yahia,. 2012.).***

There are over a hundred commercial cultivars of avocados grown globally and these can be classified into Guatemalan, Mexican, West Indian and hybrids .Popular commercial South African cultivars include Guatemalan 'Hass' and 'Reed', hybrids 'Fuerte', 'Ettinger', 'Pinkerton' 'and Ryan' and 'Zutano' (Mexican) ***(Hurtado-Fernandez, 2018).***

Most of the cultivars share similar features, with slight differences in size, color, flavor, shape and peak growing season. The 'Hass' is the predominant variety grown worldwide and is associated with a buttery, nutty flavor, and spherical shape that turns from bold green to dark purplish-black on ripening ***(Yahia, et al 2011and Mazhar, et al, 2015).***

Avocados are rich in nutrients and compounds that prevent chronic diseases, especially cardiovascular diseases, diabetes and some cancer forms. ***(Ana et al, 2019).***

Avocados may contribute to eye health since they contain a combination of MUFA and lutein/zeaxanthin and help improve carotenoid absorption from other fruits and vegetables ***(Unlu et al., 2005).***

Avocados are a good source of fiber and minerals, such as copper, phosphorus, magnesium, manganese, iron and zinc. Extracts of avocado oil are used for cosmetic facial and body lotions because of their immense regenerative and soothing properties. In the culinary space, avocados are used in making salads, sandwiches, savory dips, smoothies and a variety of other dishes ***(Karen, et al 2020).***

CV.Fuerte avocado fruits contains about 8.7 to 29.9% oil, Hass from 0.6 to 24% oil, Pinkerton from

7.9 to 17.5%, maluma from 3.8 to 21.9 %, carmen from 2.2 to 12.5 %, gem from 15.6 to 27.9 % (***Bezuidenhout , et al 2014).***

ELsorady et al , **(2016)** found that total content of moisture , lipid , protein , carbohydrates , ash , fiber and polyphenols in Hass and Fuerte avocado fruits were (70.23 and 72.15%) , (22 and 20.30%) , (0.74 and 1.01%) , (3.31 and 2.53%) , (0.62 and 0.71%) , (3.10 and 3.30%) and (1.7 and 1.2 mg⁄g,) respectively., also found that RI , FFA% , peroxide value , K 270 , IV , unsap and oxidative stability in Hass and Fuerte avocado fruit were (1.4651 and 1.4645) , (0.66 and 0.83%), (3.52 and 3.92 meqO_2 ⁄ kg oil) , (0.113 and 0.128nm) , (87.99 and 81.78 I_2⁄100g) , (1.65 and 1.42%) and (38.68 and 37.00hr. at 100˚C),respectively.

The fats in avocados, like other plant foods, are mostly healthy monounsaturated fats. As well as providing fat-soluble vitamins, the monounsaturated fats in avocados help to control cholesterol production and may reduce the risk of cardiovascular disease. ***(Noorul et al., 2016).***

The avocado (*Perseaamericana Mill*.) is an important sub-tropical climacteric fruit characterized by a green peel and a creamy, buttery pulp. Fresh avocado oil (11%–19%) is comprised of monounsaturated fatty acids (71%), saturated fatty acids (16%) and polyunsaturated fatty acids (13%). These oils regulate bad cholesterol (Low density lipoprotein,) levels in blood with good cholesterol (High density lipoprotein), and improve the bioavailability of fat-soluble vitamins and phytochemicals ***(Dreher, et al 2013).***

Analysis of avocado fruits oil indicate that the linolenic oil content of the 'Hass' avocado averages just over 21%, only the content of the mono unsaturated fat oleic acid was higher. ***(Gupta,et al 2018).***

Avocados contain a number of bioactive phytochemicals including carotenoids, phenols, and that have been reported to have anti-carcinogenic properties **(*Ding et al., 2009)*.** Avocado fruit quality is based on size, shape, skin color (in black-skinned cultivars), absence of external and internal defects, texture and flavor, which are determined by physical, chemical and sensory analyses, since sensory attributes play an important role in consumer satisfaction. ***(Cañete et al., 2015).***

Minerals are important micronutrients; so called trace elements are essential for life. This act as co-factor of enzymes and as organizers of the molecular structure of the cell and its membrane in excess amount they can be toxic and their in sufficiency may lead to metabolic disorders ***(Jones ; 1992).***

The aim of these study, comparative chemical composition and mineral contents of some avocado fruits varieties and evaluated physicochemical properties, fatty acid composition and natural antioxidant of their oils.

Materials and methods

Materials:-

Avocado (*persea Americana cvs.*) fruits varieties; Fuerte, Ettinger, Bacon, Hass and Pinkerton vars (harvested in October 2019) were obtained from horticulture research station in Al-Qanater Charitable, Horticultural Research Institute, Agricultural Research Center, Giza,Egypt.

Chemicals:-

All chemicals (hexan, cyclohexan, chloroform, acitic acid, ethanol, methanol, toluene, pottasiom hydroxide and sodium salphate anhydride used on this study (analytical grades) were obtained from fat and oil Dep. Food Tech. Inst. Agric. Res. Center, Giza-Egypt. Reagents and standards: folin – ciocateu reagent were Folin – ciocateu reagent and 2,2-diprydail were obtained from Gerbsaure Chemical Co. Ltd. Germany, caffeic acid and tocopherol standards were purchased from Sigma Chemical Co. (St. Louis, Mo).

Methods:

Proximate analysis of avocado fruits:

The moisture, fat, protein, ash and crude fiber contents of all avocado fruits vars. were determined as described by **AOAC *(2012).***

Available carbohydrate was estimated by difference according to the following equation Available carbohydrate = 100 - (moisture + fat + protein + ash + fiber contents).

Minerals: (N , P , K , Na , Mg , Ca , Zn , Fe , Mn and Se) were analyzed separately , using an atomic absorption spectrophotometer (Agilent technologies 4210 MP-AES) .according to **AOAC *(2012).***

Avocado oil extraction:-

Samples of avocado fruit for each variety were washed, air dried and cut into very small pieces and were dried at 40˚C. overnight in oven ***(Satriana et al., 2019).***The dried samples were ground using grinder model (MFIO mierofime grinder), then soaked in pure n-hexane for 24h. The miscella for each variety collected and filtered. This process was repeated three times using fresh solvent each time. The solvent was evaporator at 40˚C, the moisture in oil was removed by over anhydrous sodium sulfate, filtered (whatman NO.1) and stored in brown bottles and then kept at 5˚C until analysis **A.O.C.S (1998).**

Physical and chemical Properties of oil:

The refractive index of extracted oil was measured according to **AOAC (2012)** using Abbe refractometer at 25˚C.

The color measurement: The method described by ***Lee et al., (2004)*** was applied for measuring color. The absorbance of 5% (w/v) solutions of oil in chloroform was measured at 420 nm. using “Spectronic 20” Spectrophotometer (Bauch& Lamb).

Acidity, peroxide value and unsaponifiable matters were determined according to the methods of **AOAC (2012).**

UV absorbance at 230 and 270 nm. Diene and Triene (K 230 and K 270 nm.) of oil were determined according to the **EEC (1991)** of the extracted oil.

Fatty acids composition: The fatty acid methyl esters of oils were prepared using trans-esterification with cold methanolic solution of potassium hydroxide. The fatty acid methyl esters were identified by GC-capillary column according to the method of **IOOC (2001).**

Iodine and saponification values of avocado fruits oil were calculated from fatty acids percentage by equation according to **Nelson (1995).**

Bioactive compounds of avocado oil:

The total polyphenols (ppm) was determined according to the method of ***Gutfinger (1981).***

Total tocopherols as a α- Tocopherols (ppm) were determined according to the method described by ***Wong et al. (1988).***

Chlorophyll and carotenoid contents (ppm) were estimated according to ***Isabel Minguez-Mosquera, et al. (1991)*** method.

- Sensory evaluation of avocado fruits:-

- A sensorial analysis was performed by a group of 10 trained panelists selected among the members of the staff of HRI, ARC, Egypt. for the work. This panel carried out the sensory analysis in five varieties (one for each harvest date). For each variety, samples of 20 fruits were randomly presented to panelists in a controlled environment laboratory. Panelists used the whole sample for visual evaluation while one/two representative fruits from the samples were used for external and internal fruit attributes.
- The sensory attributes evaluated were fruit size, color, shape, firmness in fingers, skin and flesh defects, hardness in mouth, creamy, grassy and nutty flavor, and eating quality. (Obenland et al., 2012). (Table 1). A five-point hedonic scale was used for each attribute, where 1 is the worst, and 5 the best value (Table 1). As described by Canete et al .,(2018).

Table 1. Organoleptic attributes scored by sensory evaluation panel in 'Hass' avocado.

Quality attributes	**Scale 1-5**	
	Value = 1	**value = 5**
External attributes		
Size	Small	Large
Skin color	Green	Black
Shape	Not pyriform	Pyriform
Skin defect	Very much	Non
Firmness(in finger)	Hard	Soft
Global performance	Bad	Excellent
Internal attributes		
Flesh defects	Very much	None
Texture:		
Hardness(in mouth)	Hard	Soft
Creamy	None	Very much
Flavor:		
Grassy	Very much	None
Nutty	None	Very much
Eating quality	Bad	Excellent
Global performance	Bad	Excellent

(Canet et al, 2015).

Statistical analysis:

A) The obtained data were statistically analyzed by the least significant (L.S.D) at the 5% level of probability procedure according to ***Snedecor and Cochran (1980)*** using version of costat 6.451.

B) Data of sensory evaluation were analyzed by the analysis of variances and differences between mean of median values using the General Linear Model (GLM) procedure within a package program of statistical analysis system (Copyright 1987).

Specific differences between samples were determined by LSD test for each attribute. Results were test of degree of significant level at $p< 0.05$.

Results and Discussion

Chemical composition of avocado fruits:-

Data in Table (2) show the chemical composition of some avocado fruits varieties such as: Fuerte, Ettinger, Bacon, Hass and Pinkerton (moisture content, total lipid, crude protein, available carbohydrate, crude fiber and ash contents) as a shown in the same table. CV. Ettinger avocado fruits had the highest content of total lipid (13.67%) and lowest content of moisture (75.36%), while oil content in CV. Hass avocado fruit was the lowest value (3.91%) and moisture content was the highest amount (86.64%) compared with other varieties under investigation. The oil content of CV. Fuerte (11.68%) was greater than that in CV. Bacon

(10.14%) and in CV. Pinkerton (5.83%). These results agreed with those of (***Ozdermir and Topus 2004).***

Protein content of Fuerte, Ettinger and Bacon varieties recorded a higher values (2.45, 2.51 and 1.86%, respectively) compared with its in Hass and Pinkerton vars. (0.73 and 0.62 %, respectively). Protein values of Fuerte, Ettinger and Bacon varieties are comparable to the protein values of avocado fruits 1.96 and 1.72 %, which obtained by ***USDA (2011) and FAO (1989)*** respectively, while protein values of Hass and Pinkerton varieties agreed with ***Elsorady et al, (2016)*** .With regarding the results. CV. Pinkerton fruits had the highest content of available carbohydrates (9.38%) followed by CV. Fuerte (7.23%), CV. Hass (6.82%) then CV. Ettinger (5.98%) and CV. Bacon (4.77%). These values are high as a compared to the values of 3.31 and 2.53 % in Hass and Fuerte avocado fruits which obtained by ***ELsorady et al., (2016)***. Also data in the same table observed that all varieties of avocado fruits had close results in fiber content, which contained 1.42, 1.84, 1.38, 1.56 and 1.75 % in Fuerte, Ettinger, Bacon, Hass and Pinkerton varieties respectively. These results of fiber content were not agree with ***Elsorady et al., (2016).***The residue remaining ash content after all the moisture and organic materials have been of Fuerte , Ettinger , Bacon , Hass , Pinkerton avocado varieties were 0.47 , 0.64 , 1.10 , 0.34 and 0.29 % respectively . This values of ash content of samples fall within the range (0.4 –1.68%) reported by ***FAO (1989).***for Fuerte avocado. These results are in agreement with these obtained by ***Bora et al. (2001)***. Differences in previous results of proximate analysis of various varieties of avocado fruits may be due to agricultural treatments, maturity degree and climate factor.

Table 2. Chemical composition of some avocado fruit varieties (g/100g on wet weight basis):-

Components (%)	Fuerte	Ettinger	Bacon	Hass	pinkerton	**LSD**
Moisture	76.75^{c}±0.37	75.36^{c}±0.87	80.75^{b}±1.63	86.64^{a}±1.49	82.13^{b}±0.34	**1.97**
Oils	11.68^{b}±0.3	13.67^{a}±0.39	10.14^{c}±0.13	3.91^{e}±0.14	5.83^{d}±0.08	**0.43**
Crude protein	2.45^{a}±0.28	2.51^{a}±0.12	1.86^{b}±0.33	0.73^{c}±0.07	0.62^{c}±0.03	**0.37**
available carbohydrate	7.23^{ab}±1.03	5.98^{b}±1.48	4.65^{b}±1.97	6.82^{b}±1.78	9.83^{a}±0.26	**2.61**
Crude fiber	1.42^{c}±0.05	1.84^{a}±0.07	1.38^{c}±0.05	1.56^{b}±0.05	1.75^{a}±0.07	**0.10**
Ash content	0.47^{c}±0.03	0.64^{b}±0.03	1.10^{a}±0.02	0.34^{d}±0.03	0.29^{d}±0.04	**0.05**

- Values are means ± standard deviation of three determination.
- Mean values in the same column with different letters are significantly different ($P \leq 0.05$).

Minerals content of defatted meals of various avocado fruits varieties:-

The roles played by the micronutrients in biological systems are important and essential for human metabolism. Avocado fruits meal is a good source of minerals. The minerals content of defatted meals of avocado fruits varieties (DMAF) are shown in Table (3). From the results it could be observed that, the DMAF of all varieties had potassium (K) as the predominate mineral followed by magnesium (Mg), phosphorus (P). Calcium (Ca) and sodium (Na) as macro elements , were (3179.60 , 151.13 , 72.13 , 64.31 and 37.71 ppm, respectively.) .in CV. Fuerte , (8857.85, 284.69 , 99.64 , 68.67 and 79.43 ppm, respectively.) in CV. Ettinger , (8635.65 , 299.59 , 103.29 , 84.54 and 34.59ppm,respectively.) in CV. Bacon , (6800.48 , 329.92 , 112.11 , 106.80 and 66.70ppm,respectively.) in CV. Hass and (7380.12 , 428.40 , 106.19 , 94.27 and 54.57 ppm, respectively.) in CV Pinkerton . Also from the results in the same table, it could be noticed that , DMAF of Fuerte , Ettinger , Bacon , Hass and Pinkerton vars. contain a considerable amount of micro elements ; Zin(Zn) , iron , (Fe) , manganese (Mn) and Selenium (Se). were (11.89,6.90,7.93,7.25 and 8.12 ppm) , (2.65 , 3.81 , 4.11 , 2.71 and 2.32ppm) , (1.05 , 2.47 , 3.18, 1.92 , 2.74 ppm) and (1.13 , 2.20 , 0.34 , 2.74 and 2.55 ppm.), respectively.

The variation in defatted meals of different avocado fruits may be due to make up genetic and agronomic practices especially fertilization process for each variety.

Physical and chemical characteristic of oil extracted from avocado fruits:-

Table (4) show physical and chemical properties of oil extracted from avocado fruits varieties ; Fuerte , Ettinger , Bacon , Hass and pinkerton .((color at 420 nm., Refractive index at 25˚C (RI) , free fatty acid (FFA) , peroxide values (PV) , K230 and 270 nm . Iodine value and saponification values (IV and SV), and unsaponifiable matters (UNS)). Color is one of the primary variables in analyzing the quality of edible oils. Photometric color index value of extracted oil from various avocado fruits vars. , were 1.4 , 1.21 , 2.01 , 1.82 and 1.85 for Fuerte , Ettinger , Bacon , Hass and Pinkerton vars., respectively . The RI of fats and oils depends to some extension their unsaturation. The RI of fruits oil was 1.4676, 1.4674, 1.4686, 1.4678 and 1.4664 for Fuerte, Ettinger, Bacon, Hass and pinkerton vars. respectively Values of RI all varieties fall within the range of values

reported for some seed oil 1.47 for soybean oil and 1.47 for corn oil **(Sodeke, 2005).**

The free fatty acids (FFA) found as a results of hydrolysis reaction of triglyceride to glycerol and FFA by lipase activity, the FFA of the oils of avocado fruits varieties were estimated and was found to be 0.63, 0.85, 1.49, 1.12 and 1.05 % in Fuerte, Ettinger, Bacon, Hass and Pinkerton vars., respectively. The lower of FFA is an important variable in considering the quality of oil because the lower of FFA, the better quality of the oil (***Ikhuoria and maliki 2007***).reported a value of 0.37 for avocado oil and added that the lower the free fatty acid, the more its edibility. The PV is an indication of unsaturation of fats or oils. The PV values of the produced oil from different varieties of avocado fruits were 3.1 , 1.5 , 5.1 , 3.22 and 2.45 ($MeqO_2$ / Kg oil) for Fuerte , Ettinger , Bacon , Hass and Pinkerton vars. ,respectively .These results are agree with those obtained by (***Werman and Neeman 1986)*** reported and initial peroxide content of 5.85 Meq O_2 / Kg oil) measured in crude oil of avocado fruits . These values of the PV of the avocado fruits oil under investigation related to contain fair amount of unsaturated acids. Higher values of PV indicate the presence of final secondary products such as primary and diene and trienes or unsaturated carbonyl compounds that account for the characteristic flavor of an oxidized oil ***(Gertz and Klostormann, 2000).*** Diene and triene at 230 and 270 nm. (K230 and 270) reveal the oxidative stability and purity of oil.The K230 and 270 nm.were (1.80 and 0.95nm), (4.97 and 2.25nm), (6.36 and 3.18nm), (2.10 and 1.11nm) and (5.14 and 2.92nm) .For oils of Fuerte, Ettinger, Bacon, Hass and Pinkerton vars. respectively.

Table 3. - Minerals content of defatted meals of various avocado fruits varieties (ppm):-

Minerals (ppm) Macro element:	Fuerte	Ettinger	Bacon	Hass	pinkerton
N	3.39	3.82	3.48	2.97	3.18
P	72.13	99.46	103.29	112.11	106.19
K	3179.60	8857.85	8635.65	6800.48	7380.12
Na	37.71	79.43	34.59	66.70	54.57
Mg	151.13	284.69	299.59	329.92	428.40
Ca	64.31	68.67	84.54	106.80	94.27
Micro element:					
Zn	11.89	6.90	7.93	7.25	8.12
Fe	2.65	3.81	4.11	2.71	2.32
Mn	1.05	2.47	3.18	1.92	2.74
Se	1.13	2.20	0.34	2.74	2.55

Table 4. Physical and chemical characteristics of extracted oil from avocado fruit varieties:-

Physical and chemical properties of oil	**Fuerte**	**Ettinger**	**Bacon**	**Hass**	**Pinkerton**	**LSD**
Physical properties:- Color	1.40^{c}±0.01	1.21^{d}±0.02	2.01^{a}±0.07	1.82^{b}±0.02	1.85^{b}±0.02	0.04
RI	1.4676^{bc}±0.0003	1.4674^{c}±0.0004	1.4686^{a}±0.0004	1.4678^{b}±0.0004	1.4664^{d}±0.0004	0.0002
Chemical properties :-						
Free fatty acid (%)	0.63^{e} ±0.03	0.85^{d}±0.03	1.49^{a}±0.01	1.12^{b}±0.03	1.05^{c}±0.02	0.04
Peroxide value (meqo2/kg oil)	3.10^{b}±0.14	1.50^{d}±0.4	5.10^{a}±0.04	3.22^{b}±0.05	2.45^{c}±0.06	0.3
(K_{230} nm.)	1.80^{e}±0.02	4.97^{c}±0.02	6.36^{a}±0.04	2.10^{d}±0.04	5.14^{b}±0.03	0.05
(K_{270} nm.)	0.95^{e}±0.01	2.25^{c}±0.01	3.18^{a}±0.02	1.11^{d}±0.02	2.92^{b}±0.01	0.02
Unsaponifiable matters (%)	5.60^{b}±0.03	3.83^{c}±0.01	5.80^{a}±0.02	3.20^{d}±0.03	2.80^{e}±0.07	0.06
Iodine value I_2/100g oil	84.87	90.93	91.17	93.87	84.06	-----
Saponification value 100g oil/KOH/(Mg	204.69	203.62	205.85	195.14	207.07	----

- Values are means ± standard deviation of three determination
- Mean values in the same column with different letters are significantly different (P≤ 0.05).
- Iodine and saponifical values calculated from fatty acids . *Nelson Susana (1995).*

Saponificarion value (SV) is inversely proportional to the average molecular weight are chain length of the fatty acids present in the fats or oil the shorter the average chain length in fatty acids , the higher is the saponification value (***Jain1995).***

The amount of SV of oils of avocado fruits oil was found to be 204.69 , 203.62 , 205.85 , 195.14 and 207.07mg KOH/100 g oil for Fuerte, Ettinger, Bacon, Hass and Pinkerton vars ., respectively., IV of oils for the same above mention varieties were 84.87 , 90.93 , 91.17, 93.87 and 84.06 I_2 / 100gm oil., respectively . Higher the IV is indicator to the more degree of unsaturation in fats and oils ***Dutta, (1991).***With regarding the results , it could be noticed that ,the Fuerte, Ettinger, Bacon, Hass and Pinkerton vars. of avocado fruits oil contained a higher amount from unsaponifiable matters as clear that, 5.6, 3.83, 5.80, 3.20 and 2.80 %., respectively. The higher values of UNS are an important variable in considering the quality and healthy of the oil.

Fatty acid composition of oil extracted from different avocado fruits varieties:-

Fatty acid profiles and their percentage in the oils obtained from ; Fuerte , Ettinger , Bacon Hass and Pinkerton avocado fruits varieties are shown in Table (5).Palmitic (C16:0) ,palmitolic (C16:1), oleic (C18:1), linoleic (C18:2), and lenolenic (C18:3) acids were found to be major fatty acids in their oils . The C16:0 fatty acids content in the extracted oils ranged from 16.43 to 28.20 % , with the highest values observed for Pinkerton var. (28.20%) followed by Hass and Bacon vars. (24.54 and 23.95 % respectively), Then Fuerte var. (20.5%) and Ettinger (16.43%). C16:1 was found to be the highest value in Pinkerton (11.62%) followed by Bacon (9.21%), Fuerte (7.97%), Then Ettinger (6.60%) and Hass (5.51%).

On the other hand , Ettinger fruits oil had the highest percentage from C18:1 (54.60%) ,while olic acid in Fuerte oil recorded a slight decreased (51.36 %) compared with it in Ettinger oil , but it was recorded a higher decreased (38.13,36.79 and 35.59%), in produced oil from Bacon , Hass and Pinkerton varieties respectively. On the other side the highest content of C18:2 was found to be in oil from Hass fruit oil (28.70%) and the lowest content in Fuerte fruits oil (17.57%) also Hass fruits oil contained the highest amount from C18:3 (2.76%) and the lowest value from it in oil of CV. Fuerte fruit oil (1.00%) .

Table 5. Fatty acids composition of extracted from avocado fruits oil:-

Fatty acids composition (%)	Fuerte	Ettinger	Bacon	Hass	Pinkerton
C 14:0	**0.09**	**0.06**	**0.11**	**0.15**	**0.12**
C 16:0	**20.50**	**16.43**	**23.93**	**24.54**	**28.20**
C 16:1	**7.97**	**6.60**	**9.21**	**5.51**	**11.61**
C 17:0	**0.08**	**0.08**	**0.16**	**0.18**	**0.14**
C 17:1	**0.13**	**0.1**	**0.08**	**0.16**	**0.08**
C 18:0	**1.01**	**0.85**	**0.81**	**0.95**	**0.67**
C 18:1 ω -9	**51.36**	**54.60**	**38.13**	**36.79**	**35.59**
C 18:2 ω-6	**17.57**	**19.70**	**24.80**	**28.70**	**21.09**
C18:3 ω - 3	**1.00**	**1.34**	**2.53**	**2.76**	**2.24**
C 20:0	**0.12**	**0.09**	**0.09**	**0.08**	**0.10**
C 20:1	**0.13**	**0.12**	**0.11**	**0.12**	**0.09**
C 22:0	**0.04**	**0.03**	**0.04**	**0.01**	**0.01**
TSFA	**21.84**	**17.54**	**25.14**	**25.91**	**29.24**
TUSFA	**78.16**	**82.46**	**74.86**	**74.04**	**70.70**
MUSFA	**59.59**	**61.42**	**47.53**	**42.58**	**47.37**
PUFA	**18.57**	**21.04**	**27.33**	**31.46**	**23.33**
PUFA/M	**3.21**	**2.91**	**1.74**	**1.35**	**2.03**
TU/TS	**0.28**	**0.21**	**0.33**	**0.61**	**0.41**

TSFA: Total saturated fatty acid. TUSFA: Total unsaturated fatty acid.

MUSFA: Mono unsaturated fatty acid. PUFA: Poly unsaturated fatty acid.M/PUFA: Mono unsaturated fatty acid/Poly unsaturated fatty acid. TS/ TU: Total saturated fatty acid / Total unsaturated fatty acid.

Generally oils extracted from avocado fruits varieties contained a higher amount of ω -9 (C18:1) and a considerable amounts from palmitolic acid (C16:1), which they are decreasing risk of cardiovascular disease because these fatty acids preserve levels of HDL (high – density lipoproteins) and act as antioxidants ***(lopez et al ., 1996),*** Also these oil contained a higher amounts from ω -6 (C18:2) and lower amounts from ω – 3 (C18:3) .Total saturated fatty acid⁄Total unsaturated fatty acids present in high values in extracted oil of Bacon ,Pinkerton and Hass fruit oil. 0.36 , 0.41 and 0.61, respectively., while present in low amounts in oils of Ettinger and Fuerte vars. (0.21 and 0.28% respectively). Mono ⁄ poly unsaturated fatty acids ratio (M⁄PUFA) recorded a higher present in Fuerte oil. (3.21%) followed by in Ettinger oil (2.91%), Pinkerton oil (2.03%) then Bacon oil (1.74%) and in Hass oil. (1.35%). the high percentage of M ⁄ PUFA ratio in oils is an important for stability and quality. Also the higher of M ⁄ PUFA ratio is a necessary variable in considering the healthy of oil because the higher of the same previous ratio meaning that the higher C18:2 which they are decreasing risk of cardiovascular disease. These results are in agreement with those reported by several authors ***(Stavroula.et al., 2004)***.

The variation in fatty acids content of extracted oil from different varieties of avocado fruits may be due to make up genetic of avocado plant for each variety, and also may be related to vary the characteristic and structure of produced oil from avocado fruits for each variety.

Natural antioxidant of extracted oil from avocado fruits:-

Natural antioxidants; total tocopherols as a α-tocophero, pigments (carotenoids and chlorophyll contents) and total polyphenols of extracted oil from avocado fruits (Fuerte , Ettinger , Bacon , Hass and pinkerton vars.) are shown in Table (6). From the results. There was high variation in amount of most natural antioxidant of extracted oil from avocado fruits. Natural antioxidants of avocado fruits oil revealed that the Pinkerton fruits oil contained a higher amount of α- tocopherol (79.26 ppm) followed by Ettinger (71.81ppm) and Hass var. (68.67ppm) , and also it was determined to be 54.30 and 54.45 ppm in the Fuerte and Bacon respectively.

On the other hand. The highest content of carotenoid and chlorophyll were found to be in extracted Bacon oil (6.70 and 34.41 ppm, respectively) and the lowest contents were found in Ettinger oil (1.56 and 2.64 ppm, respectively). The total polyphenol of extracted oil from avocado fruits recorded a higher amounts in all samples , whereas concentration of total polyphenols in oils of Fuerte , Ettinger , Bacon , Hass and Pinkerton vars. oil was 1276.14 , 1324.49 , 1217.95 , 3463.27 and 4280.01 ppm., respectively . These values are in agreement with those obtained by of (***Soong and Barlow 2004), (Elsorady et al., 2016) and (Shehata and Soltan 2013)*** . Differences in values of natural antioxidant may be due to differences in harvesting time immaturity degree, agricultural practices and climatic factor.

Table 6. Natural antioxidants of extracted oil from avocado fruits:-

Natural antioxidants of oils (ppm)	Fuerte	Ettinger	Bacon	Hass	Pinkertons	**LSD**
Total tocoopherol (as α-tocopherol)	**54.30^{d}±0.02**	**71.81^{a}±0.24**	**54.45^{d}±0.01**	**68.67^{c}±0.06**	**79.26^{a}±0.01**	**0.06**
Pigment contents:- Cartooned	**5.21^{d}±0.16**	**1.56^{e}±0.06**	**6.70^{a}±0.01**	**5.54^{c}±0.04**	**5.70^{b}± 0.02**	**0.14**
Chlorophyll	**9.29^{d}±0.02**	**2.64^{e}±0.07**	**34.41^{a}±0.03**	**15.61^{c}±0.02**	**17.54^{b}±0.01**	**0.06**
Total polyphenols	**1276.14^{d}±4.11**	**1324.49 ^{c}±6.02**	**1217.95 ^{e}±2.92**	**3463.27^{b}±6.07**	**4280.01^{a}±0.66**	**8.11**

- **Values are means ± standard deviation of three determination**
- **Mean values in the same column with different letters are significantly different (P≤ 0.05).**

Sensory attributes of avocado fruits varieties:-

Sensory attributes play an important role in consumer satisfaction ***(Canet et al, 2015).*** With avocado , as with many others fruits , parameters related to appearance and texture (based on touch in hand) are important in consumer acceptance and purchase decision and eating quality determined consumer satisfaction and repeat purchases ***(Kader, 2002).*** Fruit flavor (taste plus aroma) and texture are the main components of eating quality ***(Tan, 2000).***

The sensory evaluation scores for external and internal of avocado fruit attributes fruits; Fuerte,Ettinger,bacon,Hass and Pinkerton vars. are shown in Table (7). Fruit size, color, shape, firmness in finger and skin defect (External fruit attributes) and flesh defects , hardness in mouth, creamy,grassy,nutty flavor and eating quality (internal fruit attributes) Table (7).were evaluated. The paneltests did not any significant deference between varieties in all parameters of external and internal fruit attributes except for fruit size was (5-2) and also flesh defect was (5-2). This due to the fact that all fruits from different varieties were evaluated at the same stage of ripeness.

Table 7. Sensory attributes scores of different avocado fruits:

Sensory attributes	Values		Avocado fruits varieties					LSD
External fruit attributes:-			**Fuerte**	**Ettinger**	**Bacon**	**Hass**	**Pinkerton**	
Siza	**Large**	**5**	**5 ^{a}±0.5**	**4 ^{b}±0.5**	**2 ^{d} ±0.5**	**3 ^{c} ±0.5**	**3.5 ^{bc} ±0.1**	**0.81**
	Small	**1**						
Skin color	**Green**	**1**	**1.3 ^{a} ±0.35**	**1.3 ^{a} ±0.35**	**1.3 ^{a} ±0.35**	**1.3 ^{a} ±0.35**	**1.3 ^{a}±0.35**	**0.63**
	Black	**5**						
Shape	**Not pyriform**	**5**	**3.3 ^{a} ±0.49**	**3.3 ^{a} ±0.49**	**3.3 ^{a} ±0.49**	**3.3 ^{a} ±0.49**	**3.3 ^{a} ±0.49**	**0.89**
	Pyriform	**1**						
Skin defects	**Very much**	**5**	**1.3 ^{a} ±0.30**	**1.3 ^{a} ±0.30**	**1.6 ^{a} ±0.11**	**1.3 ^{a} ±0.30**	**1.3 ^{a} ±0.30**	**0.49**
	None	**1**						
Firmness (in fingers)	**Hard**	**1**	**2.3 ^{a} ±0.41**	**2.3 ^{a} ±0.41**	**2.3 ^{a} ±0.41**	**2.3 ^{a} ±0.41**	**2.3 ^{a}±0.41**	**0.75**
	Soft	**5**						
Internal fruit attributes:-								
	Very much	**5**	**4.66 ^{a} ±0.4**	**4 ^{ab}±0.83**	**1.3 ^{d} ±0.76**	**3 ^{c} ±0.5**	**3.5 ^{bc}±0.1**	**0.92**
Flesh defect	**None**	**1**						
Hardness (in mouth)	**Hard**	**1**	**1.3 ^{a} ±0.41**	**1.3 ^{a} ±0.41**	**1.3 ^{a} ±0.41**	**1.3 ^{a} ±0.41**	**1.3 ^{a}±0.41**	**0.75**
	Soft	**5**						
Creamy	**None**	**1**	**1 ^{a}±0.5**	**1 ^{a}±0.5**	**1 ^{a} ±0.5**	**1 ^{a} ±0.5**	**1 ^{a}±0.5**	**0.90**
	Very much	**5**						
Grassy	**Very much**	**5**	**5 ^{a} ±0.3**	**5 ^{a} ±0.3**	**5 ^{a} ±0.2**	**5 ^{a} ±0.3**	**5 ^{a}±0.8**	**0.75**
	None	**1**						
Nutty	**None**	**1**	**1 ^{a}±0.5**	**1 ^{a}±0.5**	**1 ^{a} ±0.5**	**1 ^{a} ±0.5**	**1 ^{a}±0.5**	**0.90**
	Very much	**5**						
Eating quality	**Bad**	**1**	**1 ^{a} ±0.4**	**1 ^{a} ±0.4**	**1 ^{a} ±0.4**	**1 ^{a} ±0.4**	**1 ^{a}±0.4**	**0.72**
	Excellent	**5**						

- **values are means ± standard deviation of three determination.**
- **Values are means ± standard deviation of three determination**
- **Mean values in the same column with different letters are significantly different (P≤ 0.05).**

Conclusion:-

The results cited above revealed that, different variety of avocado fruit was source of edible and healthy oil . and also their meals rich in macro and micro elements .

The extracted oils from the above mentioned different avocado fruit varieties contained higher amounts from ω -9, ω-6, total poly phenols, total tocopherols, chlorophyll and carotenoid contents which they are important for human nutrition .

Reference

Ana L. Ramos-Aguilar,, Ornelas-Paz, J., Tapia-Vargas, L. M., Ruiz-Cruz, S., Gardea-Béjar, A. A., Yahia, E. M., and Ibarra-Junquera, V. (2019). The importance of the bioactive compounds of avocado fruit (*Persea americana Mill*) on human health. *Biotecnia*, *21*(3), 154-162.

AOAC. (2012). Official methods of analysis of AOAC International 19th Ed. Association of Official Analytical Chemists, Gaithorsburg Maryland.

AOCS.(1998). America oil Chemists society. Official and Tentative methods of American Oil Chemists' Society. 5th ed., 35 East waker drive,Chieago, illinos,USA.

Bezuidenhout, C., and Bezuidenhout, J. (2014). Oil content of the commercial avocado varieties and the relationship with moisture and ripening pattern. *South African Avocado Growers' Association Yearbook*, *37*:62-64.

Bora, P. S., Narain, N., Rocha, R. V., and Paulo, M. Q. (2001). Characterization of the oils from the pulp and seeds of avocado (cultivar: Fuerte) fruits. *Grasas y aceites*, *52*(3-4): 171-174.

Cañete, M. L., Hueso, J. J., Pinillos, V., and Cuevas, J. (2015). Ripening degree at harvest affects bruising susceptibility and fruit sensorial traits of loquat (*Eriobotrya japonica Lindl*.). *Scientia Horticulturae*, *187*:102-107.

Cañete, M. L., Pérez de los Cobos, R., and Hueso, J. J. (2016, June). Influence of harvest date on sensory quality attributes of avocado 'Hass'. In *VIII International Postharvest Symposium: Enhancing Supply Chain and Consumer Benefits-Ethical and Technological Issues 1194* (pp. 1127-1132).

Ding, H., Han, C., Guo, D., Chin, Y. W., Ding, Y., Kinghorn, A. D., and D'Ambrosio, S. M. (2009). Selective induction of apoptosis of human oral cancer cell lines by avocado extracts via a ROS-mediated mechanism. *Nutrition and cancer*, *61*(3): 348-356.

Dreher, M. L.,and Davenport, A. J. (2013). Hass avocado composition and potential health effects. *Critical reviews in food science and nutrition*, *53*(7):738-750.

Dutta, P. K. (1991). *Physico-chemical and microbiological investigation of the lipid in Puntius gonionotus* (Doctoral dissertation, M SC Thesis, Dept. of Applied Chemistry, University of Rajshahi.PP.93.

EEC, E. R. (1991). 2568/91 on the characteristics of olive and olive pomace oils and their analytical methods. *Off. J. Eur. Communities L*, *248*, 1À82.

Elsorady, M., Khalil, I., and Abd Elkarim, H. (2016). Use of Avocado Oil fruits as fat replacer in some food products. *Journal of Productivity and Development*, *21*(2): 187-201.

FAO, (1989). *Some medicinal plants of Africa and Latin America*. FAO Forestry Paper, 67. Rome.

Gertz, C., and Klostermann, S. (2000). A new analytical procedure to differentiate virgin or non-refined from refined vegetable fats and oils. European journal of lipid science and technology, 102(5), 329-336.

Gupta, S. K., Singhal, P., Singh, A., Chauhan, R., and Kumar, B. (2018). Nutritional and pharmaceutical benefits of avocado plant .*Journal of Advanced Scientific Research*, *9*(2):04-11.

Gutfinger, T. (1981). Polyphenols in olive oils. *Journal of the American Oil Chemists' Society*, *58*(11), 966-968.

Hurtado-Fernández, E., Fernández-Gutiérrez, A., and Carrasco-Pancorbo, A. (2018). Avocado fruit Persea american. In *Exotic fruits* (pp. 37-48). Academic Press.

Ikhuoria, E. U., and Maliki, M. (2007). Characterization of avocado pear (*Perseaamericana*) and African pear (Dacryodes edulis) extracts. *African Journal of Biotechnology*, *6*(7):950-952.

IOOC. 2001. Method of analysis of the International olive oil Council preparation of the fatty acid methyl esters from olive oil and olive pomace oil. Co, T. 20:24.

Isabel Minguez-Mosquera, M., Rejano-Navarro, L., Gandul-Rojas, B., SanchezGomez, A. H., and Garrido-Fernandez, J. (1991). Color-pigment correlation in virgin olive oil. *Journal of the American Oil Chemists' Society*, *68*(5), 332-336.

Jain J L (1995) Fundamentals of Biochemistry,s.chand.and Co.Ltd,New delhi , India , 5th ed. P115.

Jones, D. P., Coates; R. J., Flagg;E. W; Eley; J. W; Block; G; Greenberg, R. S., and Jackson, B. (1992). Glutathione in foods listed in history food frequency questionnaire17 (1): 57–75.

Kader, A.A.(2002). Fruits in the global market. In fruits quality and its biological basis, M. knee, ed.(uk:Sheffield academic press), p.1-16.

Karen M., Semakaleng ,Pai and dharinisivakumar (2020): extension of avocado fruit postharvest quality using non- chemical treatments. Agronomy 10(2):212.

Lee, Y. C., Oh, S. W., Chang, J., & Kim, I. H. (2004). Chemical composition and oxidative stability of safflower oil prepared from safflower seed roasted with different temperatures. *Food chemistry*, *84*(1):1-6.

Lopez ledesma,R,FratiMunari,A.,Hernandez Dominguez,B.,Cervantes Montavlo , S., Hernandez Luna ,M.and Juarez,C. (1996). Monounsaturated fatty acid (avocado) rich diet for mild hypercholesterolemia. *Archives of Medical research*, *27*(4), 519-523.

Nelson, S. (1995). Food analysis fat characterization (Oscar, A. pike), chapter 14.

Noorul, H., Nesar, A., Zafar, K., Khalid, M., Zeeshan, A., and Vartika, S. (2016). Health benefits and pharmacology of Persea americana mill. (Avocado). *Int. J. Res. Pharmacol. Pharmacother*, *5*:132-141.

Obenland, D., Collin, S., Sievert, J., Negm, F., and Arpaia, M. L. (2012). Influence of maturity and ripening on aroma volatiles and flavor in 'Hass' avocado. *Postharvest biology and technology*, *71*: 41-50.

Ozdemir, F. and Topuz, A. (2004). Changes in dry matter, oil content and fatty acids composition of avocado during harvesting time and post-harvesting ripening period. *Food Chemistry*, *86*(1): 79-83.

Satriana, S., Supardan, M. D., Arpi, N., and Wan Mustapha, W. A. (2019). Development of methods used in the extraction of avocado oil. *European Journal of Lipid Science and Technology*, *121*(1): 1800210.

Shehata, M. M., and Soltan, S. S. (2013). Effects of bioactive component of kiwi fruit and avocado (fruit and seed) on hypercholesterolemic rats. *World Journal of Dairy & Food Sciences*, *8*(1): 82-93.

Snedecor, G. W., and Cochran, W. G. (1980). Statistical Methods Iowa State University Press, Ames. *Statistical methods, 7th ed.The Iowa State University Press, Ames*.

Sodeke, V. A. (2005). Extraction of oil from water melon seed and analysis. *Quarterly Research Service*, 25-30.

Soong, Y. Y., and Barlow, P. J. (2004). Antioxidant activity and phenolic content of selected fruit seeds. *Food chemistry*, *88*(3): 411-417.

Stavroula.A.Vekiari. Papadopoulou, P. P., Lionakis, S., and Krystallis, A. (2004). Variation in the composition of Cretan avocado cultivars during ripening. Journal of the Science of Food and Agriculture, 84(5):485-492.

Tan, S. C. (2000). Determinants of eating quality in fruit and vegetables. In *Proceedings-Nutrition Society of Australia* (Vol. 24, pp. 183-190). Nutrition Society of Australia; 1998.

Unlu, N. Z., Bohn, T., Clinton, S. K., and Schwartz, S. J. (2005). Carotenoid absorption from salad and salsa by humans is enhanced by the addition of avocado or avocado oil. *The Journal of nutrition*, *135*(3): 431-436.

USDA (US Department of Agriculture). (2011). Avocado, almond, pistachio and walnut Composition.nutrient data laboratory USDA National nutrient database for standard , Reference , release 24, U.S. Department of agriculture , Washington,DC.

Werman, M. J., and Neeman, I. (1986). Oxidative stability of avocado oil. *Journal of the American Oil Chemists' Society*, *63*(3): 355-360.

Wong, M. L., Timms, R. E., and Goh, E. M. (1988). Colorimetric determination of total tocopherols in palm oil, olein and stearin. *Journal of the American oil chemist society*, *65*(2): 258.

Yahia, E. M. (2012). Avocado. *Crop Post-Harvest: Science and Technology: Perishables*, 159-186.

Yahia, E.M.and Woolf, A.B. (2011): Avocado (Perseaamericana Mill.). In Postharvest Biology and Technology of Tropical and Subtropical Fruits; Woodhead Publishing Limited: Cambridge, UK; pp. 125–185.

دراسة على ثمار بعض أصناف الافوكادو والزيوت المستخلصة منها

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تهدف هذه الدراسة الى تقييم التركيب الكيميائي ومكونات المعادن في الكسب منزوع الدهن لأصناف مختلفة من ثمار الافوكادو (فيورت وايتينجر وبيكون وهاس وبنكرتون) وللتقييم الحسى لصفات الثمار الخارجية والداخلية للثمار وايضا لتقدير الخواص الطبيعية والكيميائية (لون – معامل انكسار – حموضة –رقم البيروكسيد –الامتصاص الضوئى في منطقة ال UVعلى طول موجى 230 و270 نانوميتر ونسبة المواد الغير قابلة للتصبن والرقم اليودى ورقم التصبن وتركيب الاحماض الدهنية ومضادات الاكسدة الطبيعية (الفينولات الكلية و الفا توكوفيرول ومكونات الصبغة من الكاروتينات والكلوروفيل) للزيت المستخلص من ثمار هذه الاصناف المشار اليها

وقد اظهرت النتائج :-

لا يوجد أي اختلاف معنوي بين الاصناف في كل القياسات الحسية فيما عدا حجم الثمرة وعيوب اللحم

تعتبر كل اصناف الافوكادو مصدر غنى بزيت غذائي صحى خصوصا اصناف ايتنجروفيورت وبيكون حيث احتوت على نسبة عالية من الزيت 13.62 و 11.66 و 10.74 % على التوالي

احتوات الكسبة منزوعة الدهن لكل ثمار اصناف الافوكادو على محتوى عالى من عنصري البوتاسيوم والماغنسيوم حيث تراوحت نسبتهم من (3179.6 الى 8857.85 جزء في المليون) و (151.13 الى428.40 جزء في المليون)على التوالي كما احتوت هذه الكسبة ايضا على كميات معقولة من العناصر الكبرى الاخرى ولكنها احتوت على كميات منخفضة من العناصر المعدنية الصغرى (الزنك والمنجنيز والحديد والسلينيوم)

احتوى الزيت المستخلص من صنف فيورت يحتوى على أقل أرقام من الحموضة والبيروكسيد وk230وk270K(0.63% و 3.10 و 1.80 نانوميتر و 0.95 نانوميتر) وكانت اعلى نسبة من المواد الغير قابلة للتصبن من صنف بيكون (5.80%) مقارنة بالأصناف الاخرى

سجلت الفينولات الكلية للزيت المستخلص من كل أصناف الافوكادو قيم عالية حيث وجدت بنسبة تتراوح بين 464.22 الى 4280.05 جزء في المليون.

احتوى الزيت المستخلص من صنف بيكون على كميات عالية من الكاروتينات والكلوروفيل (6.70 ، 34.41 جزء في المليون على التوالي) والعكس وجد ان في الزيت المستخلص الصنف ايتينجر فقد احتوى على اقل نسبة منهم 1.56 ، 2.62 جزء في المليون على التوالي.

احتوى الزيت المستخلص من اصناف بينكرتون وهاس وايتينجر على محتوى عالى من مركب الالفا توكوفيرول في مقارنة بالصنفين الاخرين كما كان محتوى حمض الاوليك عالى في زيت ثمار صنف (ايتينجروفيورت 54.53 ، 51.21 % على التوالي) مقارنة بالصنفين الاخرين.

يعتبر الزيت المتحصل عليه من الاصناف تحت الدراسة مصدر غنى بأوميجا (6) (حمض اللينوليك) وايضا تحتوى زيوت ثمار هذه الاصناف على نسب معقولة من حمض البالميتوليك (C16:1).