PHYSICAL AND CHEMICAL CHARACTERISTICS OF NEEM OILS EXTRACTED FROM SEED, WHOLE FRUIT AND FLESH

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Abstract

This work aimed to study the chemical composition of fresh neem seed, whole fruit, and flesh and also their defatted meal. Also this study was carried out to investigate the physical and chemical properties (color, taste, odor, status, RI, FFA, PV, k232, IV, SV and unsap.), fatty acids composition, phenol and flavonoid compounds of neem oils extracted by solvent from seed, whole fruit and flesh. The results can be summarized as follows: Neem seed contained a high percentage of crude oil, protein and crude fiber followed by whole fruit then flesh and vice versa for moisture content. There is difference in oil color extracted from seed, whole fruit and flesh, were greenish-brown, greenish-yellow and golden yellow, respectively, while their taste and odor were bitter and unpleasant odor. Values of FFA, k232nm., IV, UNS and SV of neem oil extracted from flesh recorded a higher increased compared to other oils extracted from whole fruit and seed. Analysis of fatty acids by GC-capallary colum of these oils indicated that, high content in oleic acid for fruit and seed oils than that in flesh oil, but alph and gamma linolenic acids in the flesh oil recorded a higher content compared with oils obtained from whole fruit and seed. Results indicated that neem oils extracted from whole fruit and flesh contained high amount of total sterols (82.92 and 76.8%), respectively, while neem seed oil contained low amount of T. sterols and vice versa in amount of total hydrocarbons of these previous oils. Analysis of phenol and flavonoids compounds by HPLC of neem oils from whole fruit, seed and flesh reveal that it contained 22 and 11 phenolic and flavonoid compounds, respectively. Also analysis reveals neem fruit of oil contained a higher amount from all phenols compounds followed by flesh oil then seed oil. Also pyrogallol compound recorded a higher concentration compared to others phenol compounds in all neem oils under study.

Keywords: Neem seed, fruit and flesh oils, physical and chemical characteristics, unsaponifiable matter, fatty acid composition, phenol and flavonoid compounds of oils.

INTRODUCTION

Neem is an omnipotent tree and a sacred gift of nature. Neem tree is mainly cultivated in the Indian subcontinent. Neem is a member of the mahogany family,

Meliaceae. Today, it is known by the botanice name *Azadirachtaindica (A. indica) A. Juss*. Neem has been used extensively by humankind to treated various ailments before the availability of written records which recorded the beginning of history. (Venugopalan and Visweswaran. 2013).

Azadirachtaindica A. Juss (Meliaceae) , well known as the neem tree, is widely distributed in the tropical zones of Africa, south Asia and India. A. indica has been used as a traditional medicine for more than 2000 years in India, because of its valuable biological activities (anti- inflammatory , anti- ulcer, anti- malarial, anti-bacterial and anti- oxidant activities. (shin-ichiro *et al.,* 2014).

In the recent period, it was planted nearly 4,000neem tress in Egypt found in the Delta zone and South Sinai Governorate (Wikipedia,2014). The adult of neem tree produces about 350 kg of fruits and this amount is given about 30 kg of seeds. (Information unit–Central Administration for Agricultural Extension, 2015).

The neem oil yield that can be obtained from neem seed kernels also varies widely in literature from 25% to 45%. The oil can be obtained through pressing of the seed kernel. Neem oil can also be obtained by solvent extraction from seed, fruit and kernel (Wikipedia, 2014).

Seed of *Azadirachtaindica*, popularly known as neem, has 45% oil and is a minor of oil seed of considerable potential. Neem oil is usually bitter and non. edible. The oil contains 50% oleic and 15% linoleic and no usual fatty acids. The physic-chemical parameters are within the range of other edible oils. (Rukmimi,1987).

Neem kernels contain 30-50% of oil and many active ingredients (limonoids, mono-, di-sesqui-, and triterpenoids, coumarins, chromones, lignins, flavonoids and other phenols) having antifeedant, growth inhibiting, anti-oviposition and insecticidal activities. (Schmutterer, 1995).

Neem oil fatty acids comprise oleic, stearic, palmitic and linoleic acids. The fatty acids composition of the neem oil may vary from tree to tree because of genetic make-up, (Faye, 2010).

The predominant fatty acids in A. indica seed oil were oleic (43.5%) , linoleic (18.7%) , palmitic (17.8%) and stearic (17.9%) acids (Djenontin*et al.,* 2012 and Gosse *et al*., 2005).

Djenontin *et al.,* 2012 found differences in sterol composition of neem oils from Ivory coast and India. The major sterol is β-sitosterol (7.77 mg/100g) in neem seed oil, also it contains 1.2% total unsaponifiable matter, 30.8, 62.3 and 6.9 ppm for α , γ and σ tocopherols respectively, while β - tocopherol not detected.

Protein and ash contents in neem seed cake were 31.4 and 5.3%, respectively (Djenontin *et al.,* 2012).

This study demonstrates the differences between physicochemical properties, fatty acids composition, total tocopherols ,soluble fat vitamins , phenol and flavonoid compounds and unsaponifiable matters of neem oils extracted from neem seed,whole fruit and flesh.

MATERIALS AND METHODS

Materials:

Neem fruit : were obtained from Al-Kanater experimental station, Horticultural Research Institute, Agricultural Research Center, El-Giza Governorate, Egypt. The fruits were harvested from trees in season 2014.

Neem seed and flesh: The seeds were manually separated from neem fruit, then cleaned from any adhering flesh furthermore the decorticated flesh from fruit collected alone and cleaned.

All chemicals :were come from Sigma Chemical Co. (St. Louis, MO, USA). The stock standard solutions were prepared by dissolving the standard phenolic compounds and flavonoids in the appropriate volume of 50% aqueous methanol to produce a final concentration of 1 mg/ml. Stock from standards solutions were stored in the dark at -18º C.

Methods:

1- **Extraction of oil from neem seed, whole fruit and flesh**:

Neem seed, fruit and flesh were dried at 40℃ overnight in oven. The dried seed, fruit and flesh were ground using grinder model (MFIO micro fine grinder drive) , soaked in pure n- hexan for 24 h. The miscella were collected and filtered. This process was repeated three times using fresh solvent each time. The solvent was evaporated under vacuum in rotary evaporator at 40℃, the moisture in oil was removed over anhydrous sodium sulfate, filtered (whatman No 1) and stored in brown bottles and then kept at 5℃ until analysis A.O.C.S.(1981).

2- **Chemical composition of fresh neem seed, whole fruit and flesh and their deffated meals:**

- Moisture, crude oil, protein, crude fiber and ash contents were determined according to the methods of A.O.A.C. (2000).
- Total carbohydrates were estimated by deference.

3- **Physical and chemical characteriestics of neem seed, whole fruit and flesh oils**:

- Color, taste, odor and status of neem oils were carried out by ten volunteered staff members at Food Technology Research Institute whom are working in the field of food science and technology for several years.

- Refractive index (RI) : RI of neem oils was determined at 25 ℃ according to A.O.A.C. (2000) by using refractometer (NXRL-3 poland).
- Free fatty acids (FFA) and peroxide value (Meq.O_2/kg oil) were determined according to the methods of the A.O.A.C. (1995).
- Iodine and saponification values of neem oils were calculated from fatty acids percentage by equation according to Susana Nelson (1995).
- Absorbency in ultravioletat 232 and 270 nm. :
  Ultraviolet and visible spectra were conducted using a pye unicum double beam recording spectrophotometer Model SP 1600, as described by Kates (1972). The oil samples were dissolved in freshly distilled cyclohexane and the absorption were measured at 232 and 270 nm.

4- Fatty acids composition:

The fatty acids methyl esters were prepared using trans- esterification with cold methanolic solution of potassium hydroxide. The fatty acids methyl esters were identified by GC- capillary column according to the methods of IOOC (2001).

5- Identification of unsaponifiable matter by GC:

The unsaponifiable matter was separated from the oils at room temperature according to the method of **A.O.A.C. (2000).** Identification of hydrocarbons and sterols content of the unsaponifiable matter was carried out.

6- Determination of bioactive in crude neem seed, whole fruit and flesh oils :

- **Determination of total tocopherols:**
  The total tocopherols and was determined according to the methods of Wong *et al.*, (1988).
- **Determination of vitamins (A,D and K) :**
  Vitamins A, D and K were determined according to the methods of Perez-Ruiz *et al.*,(2007), Nöll (1996) and Wittiy *et al.,* (2013), respectively.

7- Identification of phenolic and flavonoid compounds :

Phenolic and flavonoid compounds were identified by HPLC according to the methods of Goupy*et al.*, (1999).

8- Statistical analysis: The obtained data were exposed analysis of variance. Duncan's Multiple range tests at ($p \leq 0.05$) level was used to compare between means. The analysis was carried out using the PRO-ANOVA procedure of Statistical Analysis System (SAS, 1996).

RESULTS AND DISCUSSION

1-Chemical composition of fresh neem :

Table (1) shows the percentage of moisture, protein, crude fat, fiber, ash and total carbohydrates in fresh neem seed, whole fruit and flesh. There are a significant

differences between the concentration of these contents. The highest percentages of the protein, crude oil and fiber belong to neem seed and the lowest concentration belong to neem flesh and vice versa in moisture content. With regarding the tabulated data in Table (2), total carbohydrates and ash contents of defatted meal of flesh recorded a higher increament compared to them in defatted meal of seed and fruit. On the other hand, the highest content of protein and crude fiber was found in neem seed meal compared with whole fruit and flesh meal.

Table 1. Chemical composition of fresh neem (%) :

Item / Samples	Moisture	Protein	Crude oil	Crude fiber	Ash	*Carbohydrate
Seed	57.89^{C}	4.35^{A}	19.85^{A}	7.26^{A}	1.61^{C}	9.04^{C}
Whole fruit	63.93^{B}	1.6^{C}	13.26^{B}	4.5^{B}	1.63^{A}	15.08^{A}
Flesh	72.87^{A}	1.33^{C}	10.03^{C}	1.85^{C}	1.52^{B}	12.4^{B}

* Calculated by deference Data are mean (n = 3, P < 0.05). Means with the same letter are not significantly different

Table 2. Chemical composition of defatted neem meals (%) :

Item / Samples	Protein	Crude fiber	Ash	*Carbohydrate
Seed	17.93^{A}	29.92^{A}	6.62^{C}	45.53^{C}
Whole fruit	7.05^{C}	19.81^{B}	7.18^{B}	65.96^{B}
Flesh	7.97^{B}	10.82^{C}	8.89^{A}	72.32^{A}

*Calculated by deference Data are mean (n = 3, P < 0.05). Means with the same letter are not significantly different

2 –Physical and chemical characteristics of crude neem oils:

Table (3) gives the physical and chemical properties of neem oils. From the results presented in Table (3), it could be observed that the neem oils extracted from seed, whole fruit and flesh varies in color, were greenish- brown, greenish- yellow and golden-yellow, respectively, while all neem oils were bitter and unpleasant odor. The bitter taste of neem oils may be due to the content of many triterpenoid compound. Also the unpleasant odor is due to presence of nimbidinic acid, which contains sulphur (Rukmini, 1987). The status of oils at room temperature was liquid for oils from seed and whole fruit but it was solid for oil extracted from flesh, this may be due to phospholipids inside found unsaponifiable matter (13.46%) of flesh oil. Regarding to data in the same table it could be noticed that the refractive index (RI at 25℃) of neem oils extracted from neem seed and whole fruit recorded 1.4760 and 1.4770, respectively while it was not detected in oil obtained from neem flesh. Also data in the same table, shown that the values of FFA, UV. absorbance at 232 nm.(K232nm.) and iodine value (IV) of neem oil extracted from flesh recorded the highest values as compared to neem oils extracted from seed and fruit. This increase in the FFA and

K232 nm. may be due to the degradation and hydrolysis of oil by increasing the moisture content in flesh (72.87%) which caused increase in the previous parameters compared with that in the seed and fruit (57.89 and 63.93 %). Also, the increase in IV of oil extracted from flesh may be due to it contains a higher amount of poly unsaturated fatty acid (C18: 3n3, 12.3%) compared with oils extracted from seed and fruit (0.99 and 1.09 %, respectively). From the same table it could be noticed that the highest saponification value (SV) and unsaponifiable matter % (UNS) was found for flesh oil (202.97 and 13.46%) compared with seed and fruit oils (196.96 and 2.89%) , (196.69 and 5.45%) respectively.

On the other hand , the highest values of (PV) and K270 nm. Were found for seed oil followed by whole fruit and flesh oil. This increase in PV and K270nm. may be due to oxidative degradation in oils from seed and fruit compared with flesh oil. Genrally the physical and chemical properties are within the range of other vegetable oils. This results coincide with that mentioned by Rukmimi (1987).

Table 3. Physical and chemical characteriestics of crude neem oils:

Item	Crude neem oils extracted from		
	Seed	Whole fruit	Flesh
Color	Greenish-brown	Greenish-yellow	Golden-yellow
Taste	Bitter	Bitter	Bitter
Odor	Combine the odors of peanet and garlic	Combine the odors of peanet and garlic	Combine the odors of peanet and garlic
Status	Liquid	Liquid	Soild
Refractive index (RI at 25℃)	1.4760^{A}	1.4770^{A}	Nd
Free fatty acid %	1.44^{B}	1.42^{B}	5.27^{A}
Peroxide value (Meq.O_2/kg oil)	15.29^{A}	11.33^{AB}	9.18^{B}
Conjugated diene at 232nm.	25.53^{B}	28.2^{AB}	28.78^{A}
Conjugatedtriene at 270nm.	4.58^{A}	3.27^{B}	3.16^{B}
Iodine value (I_2/100g oil)	75.52^{B}	74.98^{B}	91.75^{A}
Saponification value (mg KOH/g oil)	196.96^{B}	196.69^{B}	202.97^{A}
Unsaponifiable matter (unsap)%	2.89^{C}	5.45^{B}	13.46^{A}

Data are mean (n = 3, P < 0.05). Means with the same letter are not significantly different Nd. means not determined

3-Fatty acids composition of crude neem oils:

Separation and determination of fatty acids methyl esters were carried out by GC-Capillary column chromatography to identify their types and amounts. From the results in Table (4), it could be noticed that, the predominant saturated fatty acids of extracted oil from neem flesh was palmitic acid (19.17 %), while stearic acid was major in oils from seed and whole fruit (15.86 and 17.5% , respectively). Also the major unsaturated fatty acid was oleic acid in seed, fruit and flesh oil (43.6 ,45.3 and 30.6%,respectively), followed by linoleic acid (18.95 ,18.34 and 16.25%, respectively). The highest α -linolenic and γ – linoleneic acids were found in flesh oil

(12.31% and 1.51%, respectively). On the other hand, the percentages of total saturated fatty acid of neem seed, whole fruit and flesh oils, were 32.07,32.26 and 34.86 % and total unsaturated fatty acids were 65.94,65.88 and 64.22 %, respectively. Generally, there is no significant differences in the percentage of total saturated fatty acid of seed and whole fruit oils (32.07 and 32.26%, respectively), meanwhile the highest TSFA was found in flesh oil (34.86%). Concerning TUNSFA there is no significant differences between seed and whole fruit oils (65.94, 65.88% respectively) , meanwhile the lowest TUSFA was observed in flesh oil (64.22%). These results are in agreement with those obtained by Djenontin *et al.*, (2012) and Gosse *et al.*, (2005). Finally neem seed, whole fruit and flesh oils contained a high amount of essential fatty acid C18:1 (ω9), C18:2 (ω6) and C18:3 n3 (ω3) and also C18:3 n6 (Gamma linolenic acid), which increased the nutritional properties of investigated oils after some treatments (debitterization, refining, bleaching and deodorization process). Generally, these fatty acids composition of neem seed and whole fruit oil are close to finding by Djenontin *et al.*, (2012) and Faye (2010). But there are no reference literature data about fatty acids composition of neem flesh oil.

Table 4. Fatty acids composition of crude neem oils (%)

Fatty acids	Crude neem oil extracted from		
	Seed	Whole fruit	Flesh
Myristic acidC14:0	0.41^{B}	0.12^{B}	2.34^{A}
Palmitic acid C16:0	11.25^{B}	11.56^{B}	19.17^{A}
Palmitoleic acidC16:1(ω7)	0.88^{AB}	0.50^{B}	1.28^{A}
Margarinic acid C17:0	0.23^{B}	0.29^{B}	1.87^{A}
Heptadecenoic acid C17:1	0.17^{B}	0.17^{B}	1.05^{A}
Stearic acid C18:0	15.86^{B}	17.5^{A}	9.7^{C}
Oleic acid C18:1(ω9)	43.6^{A}	45.3^{A}	30.6^{B}
Linoleic acid C18:2 (ω6)	18.95^{A}	18.34^{B}	16.25^{C}
γ - linolenic acid C18:3n6 (ω6)	0.95^{B}	0.48^{C}	1.51^{A}
α - linolenic acid C18:3n3 (ω3)	0.99^{B}	1.09^{B}	12.3^{A}
Arachidic acid C20:0	3.89^{A}	2.59^{A}	1.58^{A}
Eicosenoic acid C20:1 (ω9)	0.399^{B}	--	1.23^{A}
Unknown	1.031^{A}	0.66^{B}	--
Behenic acid C22:0	0.26^{A}	0.3^{A}	0.199^{A}
Unknown	0.96^{A}	1.2^{B}	0.921^{A}
Ligoceric acid C24:0	0.163^{A}	0.2^{A}	--
TSFA.	32.07^{B}	32.26^{B}	34.86^{A}
TUNSFA.	65.94^{A}	65.88^{A}	64.22^{B}
TSFA./TUNSFA.	0.48^{B}	0.49^{B}	0.54^{A}

Data are mean (n = 3, $P < 0.05$). Means with the same letter are not significantly different

4 -The relative percentages of unsaponifiable matter components of crude neem oils:

Unsaponifiable matters of neem seed, whole fruit and flesh oils were fractionated by GC technique and the obtained results are shown in Table (5). From the results

presented in Table (5) it could be observed that C_{21}(31.07%) was the major hydrocarbon followed by C_{20} (22.32%) in neem seed oil, while it were (3.98 and 1.7%) and (5.61 and 0.82%) in neem fruit and flesh oils ,respectively. Also C_{21} considerable the major hydrocarbon for the neem oil extracted from flesh. As the sterols β-sitosterol was the main sterols in neem seed and whole fruit, which it was 11.56 and 16.24% , respectively, but it showed decrease in flesh oil (8.51%), while campesteral was the major sterols in neem oils extracted from flesh (24.72%) followed by whole fruit oil (16.2%) , while it was recorded a higher decrease in neem seed oil (1.92%). On the other hand, campestenol recorded the highest value in flesh oil followed by whole fruit and seed oil. And also from these data it could be stated that the amount of total sterols of whole fruit oil was the highest amount (82.92%) followed by oils from flesh (76.80%) then seed oil (36.78 %). Finally, these sterol composition of all neem oils under study are close to sterol of neem seed oil reported by Djenontin*et al*., (2012), Faye (2010)and Gosse *et al*., (2005).

Table 5. Identification of unsaponifiable matter of crude neem oils (%)

Unsaponifiable matter % Components	Crude neem oils extracted from		
	Seed	Whole fruit	Flesh
Hydrocarbons:			
C16	0.24	---	---
C17	0.29	---	---
C18	0.47^{A}	0.27^{C}	0.43^{B}
C19	0.59^{A}	0.44^{B}	0.6^{A}
C20	22.32^{A}	1.7^{B}	0.82^{C}
C21	31.07^{A}	3.48^{C}	5.61^{B}
C22	3.52^{A}	1.66^{B}	0.68^{C}
C23	0.57^{B}	0.54^{C}	0.60^{A}
C24	0.79^{C}	3.71^{A}	4.07^{A}
C25	2.02^{C}	2.88^{A}	2.47^{B}
Squalene	0.29^{C}	0.61^{B}	0.7^{A}
C28	1.05^{C}	1.79^{A}	1.22^{B}
Sterols:			
β- Estradiol	2.81^{B}	3.31^{A}	0.88^{C}
Unknown	2.84^{C}	9.54^{B}	11.91^{A}
Cholesterol	3.72^{A}	1.31^{B}	---
Brassicasterol	2.97^{A}	0.89^{B}	---
Campesterol	1.92^{C}	16.2^{B}	24.72^{A}
Campestenol	3.99^{C}	9.14^{B}	10.59^{A}
Unknown	----	10.01^{A}	5.04^{B}
Stigmasterol	1.63^{B}	2.43^{A}	1.4^{C}
β- Sitosterol	11.56^{B}	16.24^{A}	8.51^{C}
Sitostanol	3.1^{B}	5.67^{A}	2.09^{C}
Δ5-avenasterol	2.24^{C}	5.31^{A}	3.98^{B}
Δ5,24 stigmasterial	---	3.02^{A}	2.89^{B}
Gramisterol	---	---	2.12
Δ7-avenasterol	---	---	2.67
T.Hydrocarbons	63.22^{A}	17.08^{C}	23.2^{B}
T.Sterols	36.78^{C}	82.92^{A}	76.80^{B}

Data are mean (n = 3, $P < 0.05$). Means with the same letter are not significantly different

5-Fat soluble vitamins in crude neem oils:

From the data in Table (6) it could be noticed that, vitamin K recorded the highest content compared with other vitamins in all oils from seed, whole fruit and flesh. On the other hand, there is a higher difference in a mount of tocopherol of neem oils extracted from seed, whole fruit and flesh by the way concentration of total tocopherols in neem oil of whole fruit (82.6 ppm) was higher than that of oils from seed and flesh (48.1 and 34.5 ppm), respectively. This finding are agreement with previously published results by Djenontin *et al.*, (2012).

Table 6.The content of fat soluble vitamins in crude neem oils (ppm) .

Vitamins	Crude neem oil extracted from		
	Seed	Whole fruit	Flesh
Vitamin A	15.7^{B}	26.9^{A}	13.2^{C}
Vitamin D	9.85^{A}	6.83^{B}	3.02^{C}
Vitamin K	721^{A}	344.3^{C}	376.3^{B}
Total tocopherol	48.1^{B}	82.6^{A}	34.5^{C}

Data are mean (n = 3, P < 0.05). Means with the same letter are not significantly different

6-Phenolic compounds in crude neem oils:

Table (7) shows the amount of phenolic compounds in crude neem oils extracted from seed, whole fruit and flesh. From the results in this table it could be observed that, the phenolic compounds in all previous samples of oil found to be twenty two compounds (gallic, pyrogallol, 3- hydroxytyrosol, protocatchoic, chlorogenic, catechol, catechin, caffeine, P- OH benzoic, vanillic, ferulic, iso-ferulic, stolleuropein, reversetrol, E- vanillic, ellagic, alpha- coumaric, salycillic, 3,4,5 methoxycinnamic, coumarin, p-coumaric and cinnamic). Also from the results, there is a significant difference between the concentration of all previous phenolic compounds in neem oils extracted from whole fruit, seed and flesh, the lowest content of all phenolic compounds presence in neem seed oil and the highest amount belong to whole fruit oil, but flesh oil contains intermediate amount from these compounds. On the other hand, pyrogallol compound recorded the highest content in all the previous samples of crude neem oil compared to the other phenolic compounds, while cinnamic compound recorded the lowest amount in all oils.

Table 7. The content of phenolic compounds found in crude neem oils (mg/100g) .

Phenolic compounds	Phenolic compounds content of neem oils extracted from		
	Seed	Whole fruit	Flesh
Gallic	0.85^{C}	3.71^{A}	2.86^{B}
Pyrogallol	58.1^{C}	172.7^{A}	114.6^{B}
3- hydroxytyrosol	1.21^{C}	26.3^{A}	25.09^{B}
Protocatchoic	1.11^{C}	5.74^{A}	4.63^{B}
Chlorogenic	$I.07^{C}$	14.05^{A}	13.02^{B}
Catechol	2.16^{C}	16.08^{A}	14.08^{B}
Catechin	0.57^{C}	23.1^{A}	22.53^{B}
Caffeine	0.083^{C}	3.85^{A}	3.15^{B}
P- OH benzoic	1.09^{C}	6.15^{A}	5.05^{B}
Vanillic	6.71^{B}	7.41^{A}	0.70^{C}
Ferulic	1.24^{C}	8.33^{A}	7.1^{B}
Iso-ferulic	0.35^{C}	4.79^{A}	4.4^{B}
Stolleuropein	11.42^{C}	28.68^{A}	17.3^{B}
Reversetrol	1.71^{C}	5.15^{A}	2.2^{B}
E- vanillic	3.82^{C}	58.13^{A}	54.13^{B}
Ellagic	0.91^{C}	9.1^{A}	8.1^{B}
Alpha- coumaric	0.23^{C}	3.54^{A}	3.3^{B}
Salycillic	2.13^{C}	13.62^{A}	11.5^{B}
3,4,5 Methoxycinnamic	4.96^{B}	7.78^{A}	2.82^{C}
Coumarin	0.38^{C}	6.63^{A}	6.2^{B}
p- Coumaric	2.24^{C}	6.66^{A}	4.5^{C}
Cinnamic	0.68^{C}	2.06^{A}	1.38^{B}

Data are mean (n = 3, P < 0.05). Means with the same letter are not significantly different

7-Flavonoid compounds in crude neem oils:

From the data found in Table (8), it could be concluded that, neem oils produced from seed, whole fruit and flesh contained eleven flavonoid compounds (naringin, rutin, hesperidin, rosmarinic, quercetrin, quercetin, naringinin, kaempferal, hespertin, apegenin and 7- hydroxyl-flavone). Also, it is clear from the data presented in this table, that there is a significant difference between the amount of the flavonoids in all previous crude neem oils, the highest amount of all these flavonoids is related to neem whole fruit oil, followed by flesh oil then neem seed oil. Commonlly, there no reference literature data about vitamins, phenolic and flavonoid compounds.

Table 8. The content of flavonoid compounds found in crude neem oils (mg/100g) .

Flavonoids	Flavonoid compounds content of neem oils extracted from		
	Seed	Whole fruit	Flesh
Naringin	2.13^{A}	2.21^{A}	0.08^{B}
Rutin	0.59^{C}	2.09^{A}	1.50^{B}
Hesperidin	0.61^{C}	1.57^{A}	0.96^{B}
Rosmarinic	0.13^{C}	1.36^{A}	1.23^{B}
Quercetrin	0.99^{C}	3.24^{A}	2.25^{B}
Quercetin	0.27^{C}	1.46^{A}	1.2^{B}
Naringinin	0.23^{C}	1.86^{A}	1.63^{B}
Kaempferal	0.74^{C}	2.31^{A}	1.6^{B}
Hespertin	1.39^{B}	2.94^{A}	1.5^{B}
Apegenin	0.11^{C}	1.38^{A}	1.27^{B}
7- Hydroxyl-flavone	0.08^{B}	1.45^{A}	1.40^{A}

Data are mean (n = 3, P < 0.05). Means with the same letter are not significantly different

CONCLUSION

The aforementioned results declared that the seed , whole fruit and flesh are a good source of oil and high content of natural antioxidants (phenolic and flavonoid compounds and unsaponifiable matter) to rise the efficiency of oxidative stability in some oils (poor oxidative stability) and also their meals are rich in protein and carbohydrates content, whilst the odor and bitter taste of these oils are undesirable that further studied should be carried out on the debitterization, refining, bleaching and deodorization and their effects on neem oil quality .

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الخواص الطبيعية و الكيميائية لزيوت النيم المستخلصة من البذوروالثمرة الكاملة و لحم الثمرة

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أجريت هذة الدراسة لتقييم التركيب الكيميائى لثمار النيم الكاملة و البذور و لحم الثمارالطازجة و ايضا لكسبتهم منزوعة الدهن ، كما أجريت هذة الدراسة لتقيم الخواص الطبيعية و الكيميائية (من حيث اللون– الطعم – الرائحة – القوام – معامل الانكسار – الاحماض الدهنية الحرة – قيمة البيروكسيد – الرقم اليودى – المواد المتصبنة و الغير متصبنة) و تركيب الاحماض الدهنية و ايضا المركبات الفينولية، الفلافونويد و الفيتامينات لزيوت النيم المستخلصة بالمذيب العضوى من الثمار الكاملة و البذور ولحم الثمار ونتائج الدراسة يمكن توضيحها كالاتى :

أظهرت دراسة التركيب الكيميائى لبذور النيم الطازجة أنها تحتوى على نسبة عالية من الزيت و البروتين و الالياف تليها الثمار الكاملة ثم لحم الثمار و العكس بالعكس فى نسية الرطوبة .

وأوضحت الدراسة أن هناك اختلاف فى لون الزيوت المستخلصة من الثمار الكاملة و البذور و لحم الثمار فكان اللون بنى مخضر و اصفر مخضر و اصفر ذهبى على التوالى اما بالنسبة للطعم فكان مر و الرائحة غير مرغوبة للثلاث زيوت موضع الدراسة و كان قوام الزيت المستخلص من الثمار الكاملة و البذور سائل بينما زيت لحم الثمار كان صلب على درجة حرارة الغرفة.

كما سجلت قيم الحموضة و القياس على طول موجى 232 نانوميتر و الرقم اليودى والمواد الغير قابلة للتصبن رقم التصبن زيادة كبيرة لزيت لحم الثمار مقارنة بالزيوت الاخرى المستخلصة من الثمار الكاملة و البذور.

كما أشارت نتائج تحليل الاحماض الدهنية لهذة الزيوت بواسطة جهاز التحليل الكروماتوجرافى الغازى أن هناك زيادة كبيرة لحمض الاوليك فى زيت الثمار الكاملة و البذور عن تلك الموجودة فى زيت لحم الثمار و لكن سجلت أحماض الالفا و الجاما لينولينك زيادة كبيرة فى زيت لحم الثمار بالمقارنة بالزيت المستخلص من الثمار الكاملة و البذور.

و تشير النتائج ايضا الى احتواء زيوت النيم المستخلصة من الثمار الكاملة و لحم الثمار على كمية كبيرة من الاستيرولات الكلية 82.92 و 76.8% على التوالى بينما أوضحت النتائج أحتواء زيت بذور النيم على كمية قليلة من الاستيرولات و بالعكس فى كمية الهيدروكربونات الكلية لهذة الزيوت سالفة الذكر.

كما أظهر تحليل المركبات الفينولية و الفلافونويد بواسطة جهاز التحليل الكروماتوجرافى السائل لزيت النيم المستخلص من الثمار الكاملة و البذور و لحم الثمار أنها تحتوى على 22 مركب فينولى و 11 مركب فلافونويد وعلى أية حال أظهر التحليل أن زيت الثمار و لحمها يحتوى على كمية أكبر من المركبات الفينولية و الفلافونويد مقارنة بزيت البذور. كما سجل المركب الفينولى البيروجالول أعلى تركيز بالمقارنة بالمركبات الفينولية الاخرى فى كل زيوت النيم موضع الدراسة.