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EFFECT OF RADIATION AND SOME HEAT TREATMENTS ON THE PHYSICAL AND CHEMICAL CHARACTERISTICS OF IRAQ RAPE SEEDS OIL

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ABSTRACT: The effect of gamma radiation (4,6 and 10 kGy), heat treatments (roasting, boiling and microwave) and the combined treatment of heat and radiation of Iraq rape seeds had been investigated to find out the best treatment which improve the physical and chemical characteristics, fatty acids composition and oxidative stability of rape seed oil.

Change in colour, viscosity, free fatty acids, peroxide value, iodine value, unsaponifiable matters, and the absorption in u.v region is determine diene at 232 nm., and triene at 268nm were studied.

The results indicated that roasting for 1 hr. at 100 oC ; combined treatment of microwave for 2min. with radiation at dose level 4 KGy; and the heat treatment using the microwave for 2 min., caused a pronounced decrease in erucic acid (C22:1) from 51.81% to 43.05%, 45.26% and 44.35% for the above mentioned treatments, respectively. This fatty acid were found to be the most dominant fatty acid present in the Iraq rape seed oil, while the oleic acid (C18:1) content was increased to 17.41%, 15.92% and 14.44% compared with the control (11.46%) in the combined treatment of microwave for 2 min. with radiation; at dose level 4KGy, roasting at

100°C for 1 hr. and treated with radiation at 6KGy, respectively. Furthermore, the absorption at 232 nm. which reflects the presence of conjugated diene was decreased to 0.183, 0.218, 0.221, 0.250 and 0.270 when the seeds were irradiated at 10 and 4 KGy.; in the combined treatment of microwave for 2 min. with radiation at dose level 4KGy; boiling for 2 and 4 min., respectively as compared with the control (0.281). It should be noticed that the absorption at 268 n.m. (represents the conjugated triene) was also reduced with 4 and 10 KGy radiation treatments and the boiling for 2 min. to 0.122, 0.141 and 0.148, respectively when compared with the control (0.182). Roasting the seeds at 100 °C for 1 hours led to decrease the oil viscosity from 36.17 to 35.6 Cps. Furthermore, the oxidative stability at 100 °C of the rape seed oil extracted from the irradiated seeds at 6KGy was increased to 25.80 hrs compared with the control (24.oo hrs).

Further studies should be carried out to improve the quality of the rape seed derived oil especially because its consider as additional source of edible oil in Egypt.

Key words: Iraq rape seed oil, radiation, microwave, heat treatments and physical and chemical characteristics.

INTRODUCTION

The demand of lipid for human consumption or industry in Egypt increased annually. The governmental policy to meet the increasing demands of oils is to relay on winter oily seed plants beside the already present summer oily crops.

Rape seed is grown on a large scale not only in Europe and Canada but also in China and India, where varieties with high content of erucic are still growing (*Downey and Robbolen,1989*).

Several ways were conducted to produce low or even free erucic acid rape seed varieties such as half-seed technique (*Downey and Harvey 1963*).

In vegetables oils exposed to microwave energy, the higher the amount of polyunsaturated fatty acids in the oils, the greater was the rate of quality deterioration of the oils. The levels of free fatty acids also increases in vegetable oil heated in microwave oven (*Yoshida,et al, 1992*).

Free fatty acids, peroxide value and rancimat induction time of puff pastry were considerable changes, also linoleic acid content of this sample was decreased by microwave baking. (*Orhan Daglioglu, et al, 2000*).

Microwave heating caused some acceleration in oxidation of the oils, negatively affecting free acidity, peroxide values, and oxidative stability (*Yoshida et al, 1993 and Cossignani, et al, 1998*).

Compared to oil from untreated samples and oil recovered from microwave treated sample have a higher free falty acid levels and peroxide value. Oil from samples microwaved for up to 120sec., when stored at 27°C for 70 days, showed an increase in fatty acid levels, under the same storage conditions. Peroxide values of oil from samples microwaved for longer periods showed a greater increase of its value. While oil from samples microwaved for 180sec., had an undesirable dark color (*Ramesh, et al, 1995*).

Roasting treatment induced greatest effect on fatty acids composition of peanut before and after storage. Furthermore, roasted peanut as stored at ambient temperature for six months had considerable peroxidation than other stored samples e.g. raw and irradiated samples up to 10 KGY; (*EL-Niely, 2001*).

Irradiation process of peanut seed oil induced limited changes in the concentration of certain fatty acids where linoleic and linolenic acids content decreased slightly with the increasing in radiation dose, also free fatty acids, iodine value varied in limited range with increase in the radiation dose, (*EL-Niely, 2001*).

The physiochemical properties of soybean oil extracted from gamma irradiated soybean (0-10 KGY) revealed no significant changes in the fatty acids composition, acid value and peroxide value at those tested. (*Byun, et al.1995*). This could be attributed to oil seeds contain limited amount of water which could not be easily influenced to be radiolyzed by irradiation to produce enough free radical that could induce significant changes in gross composition of these materials.

The total saturated fatty acids of the by- product of the rape seed oil as well as of other seeds (cotton and olive) were increased while the total unsaturated fatty acids were decreased when they were irradiated at 10, 25, 75 and 100

KGY. (*Abou- Bakr, 2000*).

Wada et al. (1998) showed that radiation induced increases in the activities of some antioxidative enzyme (peroxidase, catalase and super oxide dismutase) and changed isomye patterns.

Chiou et al. (1991) reported that oxidation of oil was not significantly changed by irradiation, while linoleic and linolenic acids, which decreased with increase radiation, depending on storage temperature.

Sokolov (1965) reported that irradiation of lipid with 10 KGy reduced the amount of trienoic fatty acids with triple bands while double bonds were correspondingly increased, therefore polyenoic acids were the main source of oxidative deterioration problems in fats. Many workers showed that peroxide values were increased in irradiated food with increasing doses. (*Kosaric et al, 1973, Shams El Din, 1984 and Emam, 1990*).

An evaluation of oils stability association with irradiation revealed that peroxide contents and TBA values were high in peanuts subjected to each higher level of irradiation. Conjugated diene and triene hydroperoxide content also increased with increase the irradiation doses as reported by *Chiou et al. (1990)*.

The World Health Organization (WHO), Food Agriculture Organization (FAO) and International Atomic Energy Agency (IAEA) permitted the use of gamma irradiation for treating different types of food stuffs up to 10 KGY and the food commodities so treated up to this absorbed irradiation dose considered safe and presents no toxicological hazards. At present, 37 countries have approved one or more food items for human consumption. Among the countries that have cleared irradiated foods are USA, UK, France, Canada, Holland, China, Japan, India, Indonesia and Pakistan. (*W. H. O., 1988*).

Therefore, the objective of this study is to determine the effects of heat treatment (microwave, boiling in water, roasteing), ionizing radiation and the combination of microwave or boiling in water or roasting with ionizing radiation on the physical and chemical properties, fatty acids composition and oxidative stability of Iraq rape seed oil.

MATERIALS AND METHODS

1- Materials:

Rape seeds (*Brassica Rapa*) were obtained from Agricultural Research Center, Giza, Egypt (farm form EL Kanater EL Khireya, Egypt, A during the season of 2001).

2- Ionizing radiation process:

Irradiation process was achieved at National Center for Radiation Research and Technology, Nasr City, Cairo, Egypt. The ionizing radiation used in this experiment was Cobalt-60 as a source of gamma rays. The facility used was Russian Gamma Cell (Issledovatel). The applied dose were 4, 6 and 10 KGY delivered at a dose rate of 1 mega/1.5 hrs.

3- Experimental design:

13 kilogram of Iraq rape seeds were handly cleaned and divided into six parts. They were subjected to the following treatments:

(1) The first portion of seeds were packed in sealed impermiseble gas of polyethylene bags 1 mm thickness under nitrogen gas with condition to serve as control.

(2) The seconed portion of seeds were soaked in a certain volume of distilled water to increase the moisture content from 6.5% to 14% at room temperature then, they were exposed to microwave for 2 min and another lot was exposed for 4 min. by using Samsung oven MX 145 28L of 2450 MHz at power level 70, then they were stand at room temperature according to (*Farag et al., 1994*).

(3) Seeds were dipped in boiling distilled water for 2 min. and another lot was boiled for 4 min. Both lots were air dried at room temperature

(4) Two seed lots were roasted at 80 and 100°C in the oven for 1 hr.

(5) Seeds were irradiated with 4, 6 and 10KGy after being packed in polyethylene bags, which were sealed under nitrogen gas condition.

(6) Another portion of the seeds which previuosly treated with either microwave for 2 min. or boiled for 2 min. or roasted at 80°C were exposed to radiation at dose level 4 KGy.

It should be noted that all the treated seeds lots were packed in sealed polyethylene bags under nitrogen gas condition.

4- Physical and chemical analysis:

Physical properties:

Color:

Color was determined by using Lovebond apparatus according to the method described in A.O.A.C. (1990).

Viscosity:

Viscosity was determined by using Brookfield DVIII programmable rheometer. The data was collected from the rheometer by means of software program "Rheocalc for windows" r.p.m from 1.0 to 5.0 Shear rate (S-1) from 7.5 to 37.5 temperature: 40°C The method as described by (*Lenk 1978*)

Chemical properties:

Acid value and Peroxide value: were determined according to the method described inA.O.A.C (1990).

Iodine value: was calculated from fatty acids percentage.

U.V. Spectroscopy characteristics:

Ultraviolet and visible spectra were conducted using a Pye Unicom double beam recording Spectrophotometer model SP 1600, as described by Kates (1972).

The sample was dissolved in freshly distilled Cyclohexane and the absorption were taken at 232 and 268n.m.

Fatty acids composition of oil:

The methyl esters were prepared using benzene: methanol : concentrated sulphuric acid (10: 86: 4) and methylation process was carried out for 1 hr. at 80-90°C according to Stahl (1967). The fatty acid methyl esters of Iraq rape seeds oil were analyzed by using Gas Liquid Chromatography/ hp 6890. Gas chromatography instrument with a flame ionizing detectors The following conditions were exploited to give the best resolution: innowax- cross linked polyethylene glycol column 30m.i.d.0.32 ml meter, 0.5 cm film thickness.Oven temperature programmed 150°C for 1 min. then elevated to 235°C with a rate of 17°C/min., then raised to 245°C with a rate of 1°C/ min. and hold at 245°C for 5 min., carrier gas: Nitrogen 1.5ml /min. Detector temperature was 275°C and injection temperature was 260°C.

A standard fatty acid methyl ester mixture was run in order to use retention times in identifying sample peaks. Fatty acid levels were estimated on the base of peak areas of known concentration of standard.

Measurement of oil stability by Racimate:

The stability of Iraq rape seed oil was determined by Rancimate method at 100°C with air flow rate at 20 L/ hr. according to the method described by *Mendez et al. (1997)*.

RESULTS AND DISCUSSION

1. Physical and chemical characteristics of the oil extracted from Iraq rape seeds, treated with ioniz-ing radiation:

Physical and chemical properties of Iraq rap seeds oils are shown in Table (1). The color of Iraq rape seeds oil extracted from the seeds irradiated at 4,6 and 10 KGy was decreased from 7.5 in control to 5.9, 4.9 and 5.3 as red unit, respectively. Also, the blue unit decreased from 0.2 to 0.1 in all the oil extracted from the irradiated seeds, % free fatty acid was also found to decrease from 0.54% in control sample to 0.31, 0.26 and 0.27of the seeds irradiated at 4, 6 and 10KGy, respectively, this may be due to negatively effect of radiation on the activity of the lipase enzyme.

Radiation seeds with 4, 6 and 10 KGy caused increase in viscosity from 36.17Cps (control sampls) to 40.60, 36.4 and 37.60 Cps, also peroxide value increased from 3.0 meq/Kg (control) to 6.58, 3.4 and 4.01 meq/kg, while iodine value decreased from 99.34 to 98.13, 99.28 and 95.75, respectively. The decrease in iodine value may be due to that radiated at the respective doses may have caused an increase in saturated fatty acids and a decrease in unsaturated fatty acid. (*Abu-baker, 2000 and EL-Niely, 2001*). The increase in peroxide value may be due to the radiation doses which may cause an acce-leration of hydroperoxide and peroxide formation, subsequently the formation of aldehydes .

On the other hand, the unsaponifiable matter percentage of samples treated by radiation doses 6 and10 kGy increased from 1.61% (control sample) to 1.95 and 1.86%.

UV absorbency measurement of different sample was measured at wavelength of 232n.m and 268n.m. as ultraviolet spectrophotometric analysis and results are tabulated in Table (1).

From these results it could be noticed that $E_{cm}^{1\%}$ at 232 n.m. and 268n.m.of the samples treated with 4 and 10 KGy decreased compared with the control (Table, 1).

2. Physical and chemical properties of the oil extracted from Iraq rape seeds treated with heat treatment (roasting, boiling and microwave):

The data obtained in Table (2) indicated that the treatment of Iraq rape seeds with roasting, boiling and microwave (heat treatments) had decreased in units color (Red and Blue) of Iraq rape seed oil, from 7.5 unit red in control sample to 6.2, 5.9, 4.00, 4.9, 6.9 and 5.00 unit red for samples roasted at 80°C and 100°C for 1 hour; boiled for 2 and 4 min. and microwave at 70 power level for 2 and 4 min., respectively.

Also, the results obtained in Table (2) indicated that the different heat treatments of Iraq rape seeds increased the viscosity (Cps) of its oil, from 36,17 in control sample to 40.2, 40.1, 40.2, 39.7 and 43.15 for samples roasted for 1 hour at 80°C, boiled for 2 and 4 min. and microwaved for 2 and 4 min. at power level 70, respectively. This increase in viscosity may be due to an increase in the polymers of these oils, which formed during the heat treatments.

Furthermore, the results in Table (2) showed that different heat treatments led to decrease in iodine values of Iraq rape seeds oil. The iodine values decreased from 99.34 in control sample to 94.54, 91.03, 99.24, 91.53, 95.72 and 98.41 for samples roasted for one hour at 80°C and 100°C, boiled for 2 and 4 min. and microwaved at power level 70 for 2 and 4 min., respectively. The decrease in iodine value may be due to the heat treatments, which may cause decrease in linoleic and linolenic acid (polyunsaturated fatty acids), under investigation. On the other hand, peroxide value of oil extracted from Iraq rape seeds treated with different heat treatments increased form 3.00 in the control sample to 3.97, 4.72, 6.33, 9.55, 10.45 and 13.92 meq/Kgm for samples roasted for one hour at 80°C and 100°C, boiled for 2 and 4 min. and microwaved at power level 70 for 2 and 4 min., respectively. This may be due to the obvious heat treatments, which accelerated the autoxidation and formation of peroxide compounds, and led to a direct increase in the peroxide values of these oils. Similar observation was reported by (*Rady et al., 1987)* about soya bean treated with dry heat treatments.

Data in Table (2) shows that roasting and boiling treatments led

to decrease the free fatty acids percentages of Iraq rape seed oil from 0.54 in control sample to 0.27, 0.39, 0.33 and 0.36 for samples roasted for one hour at 80°C and 100°C and boiled for 2 and 4 min., while, free fatty acids percentages of the microwave treated samples for 2 and 4 min. was increased from 0.54 in control sample to 1.36 and 1.36 respectively. Similar data was reported by *Yoshida (1992)*, who found that the levels of free fatty acids increased in vegetabale oils heated in microwave oven, also these, data are in agreement with those reported by *Orhan, et al., (2000)*.

This increase in peroxide value and free fatty acids by microwave heating may be due to microwave heating did which caused some acceleration in the oxidation of oils, negetively effect in free fatty acids, peroxide value and oxidative stability (*Yoshida et al., 1993 and Cossignani et al., 1998*).

From the results in Table (2) it could be noticed that the increase in unsaponifiable matter percentages of oil extracted from Iraq rape seed as the *result* of roasting and boiling treatments, it increased from 1.61 in control sample to 1.69, 1.80, 3.37 and 3.4 for samples roasted for one hour at 80°C and 100°C and boiled for 2 and 4 min., respectively. On the contrary, it was decreased as a result of microwave treatment to 1.59 and 1.23 for samples microwaved at power level 70 for 2 and 4 min., respectively.

From the data in the same Table (2) it could be observed that $E^{1\%}_{1cm}$ of the sample at 232 n.m. increased by roasting and microwave compared with the control sample but it decreased by boiling treatment, whereas the $E^{1\%}_{1cm}$ of the samples at 268 n.m., treated with different heat treatments result in the presence of triene at level lower in roasting at 80°C for one hour, boiling for 2 and 4 min.and microwave for 4 min., compared with the control (Table, 2).

3. Physical and chemical propertis of Iraq rape seed oil treated with a combination:

Color unit (red), was decreased from 7.5 unit in control sample to 5.2, 3.5 and 5.9 units red for samples treated with combined roasting at 80°C or boiling, for 2 min or microwave for 2 min. and radiated at 4 KGy, respectively.

Meanwhile, viscosity (C_{ps}) and peroxide value were increased from

36.17; (C_{ps}) and 3.00 (meq/Kgm) in control samples to 40.15, 37.09 and 38.99 (C_{ps}); 10.00, 6.60 and 10.60 (meq/Kgm); respectively, while, idoine value decrease from 99.34 in control sample to 97.34, 97.07 and 96.13 for samples combinated roasting or boiling or microwave with radiation, recpectively. Roasting at 80°C for 1 hr. or boiling for 2 min. or microwave at power level 70 for 2 min. with radiation at 4 KGy ; respectively.

On the other hand, combination of boiling for 2 min. or microwave for 2 min. and radiation at 4 KGy induced an increase in free fatty acids presentages of Iraq rape seeds oil from 0.54 in control sample to 0.55 and 1.42, respectively. On the contrary combination of roasti-ng at 80°C with radiation at 4 KGy caused decrease in free fatty acid percentages reached to 0.39%.

Unsaponifiable matter percentage was decreased as a result of combination of roasting at 80°C for one hour or microwave for 2 min. with radiation at level dose 4kGy, were 1.26 and 1.36 respectively, compared with control sample 1.61, but it increased to 3.26 by combination between boiling for 2min. and radiation at 4kGy. This decrease in unsaponifiable matters percentage by combination of roasting or microwave with radiation may be due to breakdown the unsaponifiable matter to other compoundeds by heat treatments (rost and microwave)

Absorbance of samples at 232nm. was increased as the result of combination between roasting at 80°C for one hour or boiling for 2 min. with radiation at 4kGy, (0.428 and 0.366, respectively) compared with control sample (0.281), but it decreased to 0.221 by combination of microwave for 2 min. with radiation at 4kGy. On the other hand absorbance of sample at 268 n.m. increased as a result of combnation boiling for 2 min. or microwave for 2 min. with radiation at 4kGy (0.250 and 0.227), respecively, compared with control sample (0.182), but it was decreased to 0.116 by combination between roasting at 80°C for one hour with radiation at 4kGy.

4. Fatty acids composition of Iraq rape seeds oil treated with ionizing radiation:

The results in Table (4) showed that the predominant saturated fatty acids (palmitic acid, $C_{16:0}$) in control sample inecreased to 4.7, 5.64 and 5.31% for samples treated by radiation at 4, 6 and 10kGy, respectively, compared with control sample (3.80%). Oleic acid ($C_{18:1}$) was increased to 12.82, 14.44 and 13.17% as a result treatments of radiation at 4, 6 and 10kGy, respectively, compared with the control sample; 11.46%.

On the other hand, treatments of rape seed by radiation at 4,6 and 10 kGy caused a decrease in lenoleic acid ($C_{18:2}$) precentage. It decreased from 15.09% (control sample) to 14.3%, 14.8% and 13.72% respectively,. Also lenolenic acid ($C_{18:3}$) was decreased at the same doses to 5.62%, 5.37% and 4.95% respectively compared with the control sample (5.65%). While Erucic acid ($C_{22:1}$) which was the most predominant fatty acid present in the Iraq rape seed oil recorded a slight decrease to 50.77%, 50.18%, and 50.95%, as a results of radiation at 4,6 and 10kGy, respectively compared with the cont-rol sample (51.81)%.

Total saturated fatty acids of Iraq rape seeds oil treated by radiation at 4,6 and 10kGy, recorded increase to 6.90%, 6.90% and 6.93%, respectively compared with control sample (6.83). On the contrary, total unsaturated fatty acids decreased as a result of treatment by the same doses level of radiation (Table, 4) to 93.10%, 93.10% and 93.07% respectively, compared with the control sample (93.17%). Similar that are in agreement with *Abobaker (2000) and EL-Nily (2001)*.

5. Fatty acids composition of rape seed oil treated with heat treatments:

Data obtaind in Table (5), showed the influence of heat treatments (roasting at 80°C and 100°C for one hour, boiling at 100°C for 2 and 4 min. and microwave at power level 70 for 2 and 4 min.) on Iraq rape seeds oil; Pervious treatments led to increase in palmitic acid from 3.8% (control sample) to 5.1, 5.9, 5.65, 5.98, 6.01 and 5.48%, recpectively.

Also, oleic acid increased from 11.46% in control sample to 13.40, 15.92, 14.41, 13.29, 14.30 and 14.81%, recpectively.

Linoleic and linolenic acids were decreased in all previous treatments compared with control samples. These are in agreement with those obtained by (*Orhan et. al., 2000*) who found that prounounced decrease in linoleic acid content of the samples microwaved baking. These reducation in unsaturated fatty acids (linoleic and linolenic acids) may be due to oxidation occurred during heat treatments. While, increase of palmitic and oleic acid was relatively increased as a result decrease in linoleic and linolenic acids under investigation.

On the other hand, erucic acid ($C_{22:1}$) recored a higher decrease as a result of treatment by roasting at 100°C and microwaving for 2 min.; 43.05% and 45.26%, respectively, compared with the control sample (51.81%) and also it recorded a slight decrease in samples roasted at 80°C, boiled for 4 min. and microwaved for 2 and 4 min., were 49.41%, 49.92%, 48.57% and 49.57%, respectively, total saturated fatty acids increased from 6.83% in control sample to 8.45, 10.07, 6.99, 10.28, 9.40 and 6.97% in all previuos treatments respectively. On the contrary total unsaturated fatty acids decreased from 93.17% in control sample to 91.55, 89.93, 93.31, 89.72, 90.60 and 93.03% in all previous treatments respectively.

6. Fatty acids composition of rape seed oil treated with combination:

Data obtained in Table (6) showed that combination between heat treatments (roasting at 80°C or boiling for 2 min. or microwave for 2 min.) and radiation at 4kGy coused; some change in fatty acids composition of Iraq rape seed oil.

Palmitic acid ($C_{16:0}$) increased from 3.8% (control sample) to 5.10%, 5.03% and 6.02% as the effect of interaction between roasting or boiling or microwave and radiation, respectively.

Interaction between roasting, or boiling and radiation related to appeard palmitoleic acid ($C_{16:1}$) 0.52% and 0.38%, respectively.

Stearic acid (C18:0) increased to 1.42% and 1.79%, respectively, by interaction between roasting or microwave and radiation, but it was decreased by combination of boiling and radiation to 1.28% compared with the control sample (1.38%).

Interaction between roasting or boiling or microwave and radiation led to decrease in linoleic acid (C18:2) to 14.49%, 14.19% and 14.47%, respectively, compared with the control sample (15.09%), also, it reflected on resulted decrease in linolenic acid (C18:3) to 5.51%, 5.51% and 5.38%, respectively, compared with the control sample (5.65%), while, it caused an increase in oleic acid ($C_{18:1}$) from 11.46% in control sample to 13.25%, 15.91% and 17.41%, respectively.

The results in the same Table (6) showed that, erucic acid (C22:1) was recorded a higher decrease by the interaction between microwave for 2min.. and radiation at 4KGy. to 44.35% compared with the control sample (51.81%), also, it decreased to 49.51% and 46.42% by interaction between roasting or boiling with radiation, respectively.

Combination of microwave and radiation led to disappear lignoceric acid (C24:0), while roasting and radiation it increased to 0.69%, but boiling and radiation treatment decreased it to 0.51% compared with the control sample (0.59%).

Interaction between roasting or boiling or microwave with radiation resulted an increase in total saturated fatty acid, but it caused a decrease in total unsaturated fatty acids compared with the control sample, Table (6).

7. Stability of Iraq rape seed oil treated with radiation, heat and combination:

From the results summarized in Table (7), it could be seen that oxidative stability of oils extracted from the control sample and the samples treated by radiation dose 4, 6 and 10kGy were 24.00, 20.00, 25.80 and 23.40 hr. respectively.

The heat treatments (roasting at 80°C and 100°C for one hour, boiling for 2 and 4 min. and microwave at power level 70 for 2 and 4 min.) caused a higher decrease in the stability of these oils which extracted from previously treatm-ents, it were 18.56, 17.30, 18.96, 17.38, 10.36 and 10.30 (hr.), respectively compared with the control sample; 24.00 (hr.).

Similar observation was reported by (*Orhan et. al., 2000*) who found that the stability of puff pastry decreased by microwave during thawing and microwave baking.

The decrease in the stability of oil extracted from Iraq rape seeds treated with heat treatments may be due to lipoxygenase activity in heat treatments. The increase in the stability of sample treated by radiation at 6kGy may be due to Lipoxygenase activity which was inhi-bited in oil seed by gamma radiation treatments. (*Hafez et al., 1989*). This increased in the stability by radiation at 6 KGy agree with *Byun et. al., (1995)* who found that the stability of soybeen oil extracted from δ-irradiation soybeens (0-10 KGy) were a tendency toward increased induction period was obseved as irridiation dose increased.

Stability of oils extracted from seed *treated* by roasting at 80°C or boiling for 2 min. or microwave for 2 min. with radiation at 4kGy were decreased to 16.60, 20.20 and 9.30 hr., respectively. The decrease in the stability of these samples may be due to the breakdown of natural antioxidant phenol contents. (*Youniss, 1997*).

In conclusion, the results of this study indecated a decrease in the linoleic, linolienic and erucic acids and an increase in the oleic acid of oils extracted from radiated and heated (roast, boil and microwave) Iraq rape seeds, all the previous treatments improved the red colour of these oils and the effect of irradiation at 6 KGy increased the oxidative stability of oil compared with the control samples.

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Table (1): Physical and chemical characteristics of oil extracted from Iraq rape seeds treated with ionizing radiation .

Physical and chemical properties	Control	Dose levels (KGy) *		
		4	6	10
Colour:				
- Yellow	35	35	35	35
- Red	7.5	5.9	4.9	5.3
- Blue	0.2	0.1	0.1	0.1
Viscosity (at 40° C) C_{Ps} **	36.17	40.60	36.40	37.60
Free fatty acids (%)	0.54	0.31	0.26	0.27
Peroxide value (meq / kgm)	3.00	6.58	3.40	4.01
Iodine value	99.34	98.13	99.28	95.75
Unsaponifiable matters (%)	1.61	1.24	1.95	1.86
Diene at 232 nm.	0.281	0.218	0.363	0.183
Triene at 268 nm.	0.182	0.122	0.205	0.141

* KGy : Kilo gray
** CPs : centipoise

Table (2) : Physical and chemical characteristics of oil extracted from Iraq rape seeds treated with heat treatments.

Physical and Chemical properties	Control	Heat treatments					
		Roasting for 1 hr.		Boiling at 100°C for		Microwave at power level 70 for	
		80° C	100° C	2 min	4 min	2 min.	4 min.
Colours :							
- Yellow	35	35	35	35	35	35	35
- Red	7.50	6.2	5.9	4.0	4.9	6.9	5.0
- Blue	0.20	0.1	0.1	0.3	0.1	0.1	0.1
Viscosity at 40° C (C_{PS})*	36.17	40.2	35.6	40.1	40.2	39.7	43.15
Free fatty acids (%)	0.54	0.27	0.39	0.33	0.36	1.36	1.36
Peroxide value (meq. / kgm)	3.00	3.97	4.72	6.33	9.55	10.45	13.92
Iodine Value	99.34	94.54	91.03	99.24	91.53	95.72	98.41
Unsaponifiable matters (%)	1.61	1.69	1.80	3.37	3.40	1.59	1.23
Diene at 232 nm.	0.281	0.299	0.378	0.250	0.270	0.421	0.783
Triene at 268 nm.	0.182	0.174	0.206	0.148	0.181	0.213	0.153

* C_{PS} : Centipoise

Table (3): Physical and chemical characteristics of oil extracted from Iraq rape seeds treated with a combination of heat treatment and radiation.

Physical and Chemical properties	Control	Treatments		
		Ro. + R.	B. + R.	M. + R.
Colours :				
- Yellow	35	35	35	35
- Red	7.5	5.2	3.5	5.9
- Blue	0.2	0.0	0.3	0.3
Viscosity at 40° C (C_{PS})*	36.17	40.15	37.09	38.99
Free fatty acids (%)	0.54	0.39	0.55	1.42
Peroxide value (meq. / kgm)	3.00	10.00	6.60	10.60
Iodine value	99.34	97.34	97.09	96.13
Unsaponifiable matters (%)	1.61	1.26	3.26	1.36
Diene at 232 nm.	0.281	0.428	0.366	0.221
Triene at 268 nm.	0.182	0.116	0.250	0.227

Where as:
Ro. : Roasting at 80° C for / 1 hour
R. : Radiation at 4 KGy.
B. : Boiling in water at 100°C for 2 min.
M. : Microwave for 2 min.
* (CPS) : Centipoise

Table (4): Fatty acids composition of oil extracted from Iraq rape seeds treated with ionizing radiation .

Fatty acids composition (%)	Control	Dose Levels (K.Gy)		
		4	6	10
Palmitic acid (C 16 : 0)	3.80	4.70	5.64	5.31
Stearic acid (C 18 : 0)	1.38	1.14	1.26	1.51
Oleic acid (C 18 : 1)	11.46	12.82	14.44	13.17
Lenoleic acid (C 18 : 2)	15.09	14.30	14.80	13.72
Lenolenic acid (C 18 : 3)	5.65	5.62	5.37	4.95
Arachidic acid (C 20 : 0)	1.06	0.89		0.92
Eicosenoic acid (C 20 : 1)	9.65	8.70	8.31	8.38
Behenic acid (C 22 : 0)		0.51		1.01
Erucic acid (C 22 : 1)	51.81	50.77	50.18	50.95
Lignoceric (C 24 : 0)	0.59	0.55		
Total S.F.A *	6.83	6.90	6.90	6.93
Total U.S.F.A **	93.17	93.10	93.10	93.07

* Total saturated fatty acids

** Total unsaturated fatty acids

Table (5): Fatty acids composition of oil extracted from Iraq rape seeds treated with different heat treatment.

Fatty acids composition (%)	Control	Heat treatments					
		Roasting for 1 hour at		Boiling at 100°C for		Microwave at power level 70 % for	
		80° C	100° C	2 min.	4 min.	2 min.	4 min.
Palmitic acid (C 16 : 0)	3.80	5.10	5.90	5.65	5.98	6.01	5.48
Palmitoleic acid (C 16 : 1)			1.37			1.54	
Stearic acid (C 18 : 0)	1.38	1.36	1.68	1.04	1.87	1.57	1.49
Oleic acid (C 18 : 1)	11.46	13.40	15.92	14.41	13.29	14.30	14.41
Linoleic acid (C 18 : 2)	15.09	14.48	14.20	14.94	13.85	14.94	14.38
Linolenic acid (C 18 : 3)	5.65	5.27	5.35	5.36	5.16	5.57	5.41
Arachidic acid (C 20 : 0)	1.06	0.98	1.30		1.24	1.82	
Eicosenoic acid (C 20 : 1)	9.65	8.99	10.04	8.70	8.85	8.99	8.86
Behenic acid (C 22 : 0)		1.01	1.19		1.19		
Erucic acid (C 22 : 1)	51.81	49.41	43.05	49.92	48.57	45.26	49.57
Lignoceric C 24 : 0	0.59						
TSFA *	6.83	8.45	10.07	6.99	10.28	9.40	6.97
TUSFA **	93.17	91.55	89.93	93.01	89.72	90.60	93.03

TSFA* : Total saturated fatty acids
TUSFA** : Total unsaturated fatty acids

Table (6): Fatty acids composition of oil extracted from Iraq rape seeds treated with a combination of heat treatments and radiation at dose level 4 KGy

Fatty acids composition (%)	Control	Combination of heat treatment and radiation at 4 KGy		
		Ro. at 80°C + R.	B. for 2 min. + R.	M. for 2 min. + R.
Palmitic acid (C 16 : 0)	3.80	5.10	5.03	5.05
Palmitoleic acid (C 16 : 1)		0.52	0.38	
Stearic acid (C 18 : 0)	1.38	1.42	1.28	1.79
Oleic acid (C 18 : 1)	11.46	13.25	15.91	17.41
Linoleic acid (C 18 : 2)	15.09	14.49	14.19	14.47
Linolenic acid (C 18 : 3)	5.65	5.51	5.51	5.38
Arachidic acid (C 20 : 0)	1.06	0.97	0.58	
Eicosenoic acid (C 20 : 1)	9.65	8.93	9.75	10.55
Behenic acid (C 22 : 0)			0.50	
Erucic acid (C 22 : 1)	51.81	49.51	46.42	44.35
Lignoceric (C 24 : 0)	0.59	0.69	0.51	
TSFA *	6.83	8.18	7.90	7.84
TUSFA **	93.17	91.82	92.10	92.10

Ro. : Roasting at 80 c for 1 hour .
R. : Radiation by Gamma rays at a dose level 4 KGy .
B. : Boiling at 100°C for 2 minutes .
M. : Microwave at power level 70 % for 2 minutes .
TSFA* : Total saturated fatty acids. **TUSFA **** : Total unsaturated fatty acids .

Table (7): Stability at 100°C (hr.) of oil extracted from Iraq rape seeds treated with radiation, heat treatments and combination of heat treatment with radiation at dose level 4 KGy .

control	Treatments					
	Radiation at dose levels (KGy)					
	4		6		10	
24.00	20.00		25.80		23.40	
	Heat treatments					
	Roasting at		Boiling for		Microwave for	
	80° C	100° C	2 min.	4 min.	2 min.	4 min.
24.00	18.56	17.30	18.96	17.38	10.36	10.30
	Combination of heat treatment and radiation					
	Ro. at 80° C + R.		B. for 2 min. + R.		M. for 2 min. + R.	
24.00	16.60		20.20		9.30	

Where as

KGy : kilo gray.
Ro. : Roasting at 80° C for 1 hour .
R. : Radiation by using Gamma rays at a dose level 4 KGy .
B. : Boiling at 100°C for 2 minutes .
M. : Microwave at power level 70 % for 2 minutes .

تأثير الإشعاع و بعض المعاملات الحرارية على الخواص الطبيعية والكيماوية لزيت بذور الشلجم العراقي

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** المركز القومي لبحوث و تكنولوجيا الإشعاع – هيئة الطاقة الذرية- ص.ب ٢٩ مدينة نصر- القاهرة- مصر.

تم دراسة تأثير إشعة جاما و بعض المعاملات الحرارية (تحميص- غليان- ميكروويف) والتداخل بين المعاملات الحرارية و بين إشعة جاما على بذور الشلجم العراقي لإيجاد أفضل معاملة لتحسين الخواص الطبيعية والكيميائية وتركيب الأحماض الدهنية وثبات الزيت. وتمت دراسة التقديرات المختلفة ،اللون ، اللزوجة ، الأحماض الدهنية الحرة ، رقم البيروكسيد، الرقم اليودي، والمواد غير القابلة للتصبن وقياس الامتصاص في منطقة U.V. لتقدير الدايين عند ٢٣٢ نانوميتر والترايين عند ٢٦٨ نانو ميتر. وقد أشارت النتائج إلى أن التحميص لمدة ساعة على درجة ١٠٠°م والمعاملة بالميكروويف لمدة دقيقتين وأيضا التداخل ما بين المعاملة بالميكروويف لمدة دقيقتين مع التشعيع بجرعة ٤ كيلو جراي أدت إلى نقص في محتوى حمض الأيروسيك (ك٢٢: ١) إلى٤٣,٠٥% و ٤٥,٢٦% و٤٤,٣٥ بالمقارنة بالكنترول (٥١،٨١%) على التوالي. وهذا الحمض يعتبر الحمض السائد في زيت بذور الشلجم العراقي بينما محتوى حمض الأوليك (ك١٨: ١) زاد إلى ١٧,٤١% و١٥,٩٢ % و١٤,٤٤% مقارنة بالكنترول (١١،٤٦%) وذلك في التداخل ما بين المعاملة بالميكروويف لمدة دقيقتين مع التشعيع جرعة ٤ك يلو جراى و التحميص لمدة ساعة على ١٠٠°م والمعاملة فقط بالتشعيع بجرعة ٦ كيلو جراي على التوالي، بالإضافة إلى أن الامتصاص عند ٢٣٢ نانوميتر نقص إلى ٠,١٨٣، ٠,٢١٨، ٠,٠٢٥،٠,٢٢١، ٠,٢٧٠ وذلك في المعاملة بالإشعاع على ١٠،٤ كيلو جراي والمعاملة المتداخلة بين الميكروويف لمدة دقيقتين والتشعيع بجرعة ٤ كيلو جراى والغلي لمدة ٢،٤ دقائق على التوالي بالمقارنة

بالكنـــترول (٠,٢٨١)، وأدت المعاملـــة بالإشـــعاع بجرعة ٤،١٠ كيلو جراى والغلي لمدة دقيقتيـــن إلـــى نقص الامتصاص على ٢٦٨ نانوميتر إلى ٠,١٢٢، ٠,١٤١، ٠,١٤٨ على التوالـــي بالمقارنـــة بالكنترول (٠,١٨٢) كما أدى التحميص على ١٠٠م لمدة ساعتين إلى نقص في لزوجة الزيت من ٣٦,١٧ إلى ٣٥,٦ سنتيبواز، بينما زاد ثبات الزيت على ١٠٠° م الـــى ٢٥,٨ ساعة في المعاملة بالاشعاع بجرعة ٦ كيلو جراي بالمقارنة بالكنترول (٢٤ ســـاعة) ولذلك لا بد من عمل دراسات مستقبلية لتحسين نوعية الزيت المستخلص من بذرة الشلجم وخصوصاًعند استخدام هذه البذور كمصدر جديد لزيت الأكل فى مصر.