

Original Research Paper

Effect of Gamma Radiation on Oil Quality of Dried Mint Leaves

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Abstract: The green mint crop is considered a medicinal and aromatic plant grown in most of Egypt's governors and it has multiple uses, whether it is used fresh or dried or mint oil is extracted from it and mint is also known as its medicinal importance as research has proven that it has many health benefits. This research was conducted to study the effect of gamma irradiation on the oil quality assessment of dried mint leaves. Dry mint leaves were treated by using doses of gamma radiation, 0.0, 5, 10, 15 and 20 kGy. The color properties as Chlorophyll a, Chlorophyll b and Carotenoids (mg/100g) were detected and also, the antioxidant activity, total phenols, total flavonoids and ascorbic acid of aqueous extract of mint leaves have been evaluated. The highest content of chlorophyll a, chlorophyll b, total chlorophyll and content of carotenoids in the dried mint leaves was observed in irradiated samples with 20 kGy. While, the highest content was in the irradiated sample with 5 kGy. The data demonstrated that the irradiated dried mint leaves at 5, 10, 15 KGy had lower phenolic, flavonoids, total antioxidant and ascorbic acid compounds than non-irradiated control in the mint extract. While, irradiated mint at 20 kGy had higher phenolic compounds. It was found significant differences in the content of chlorophyll (a), chlorophyll (b), phenol, flavonoids, antioxidants, ascorbic acid, while there was no significant difference in the carotene content. By using of irradiation with gamma rays of 20 kGy, the most influencing was the higher content of chlorophyll (a) and chlorophyll (b). While the use of the level of irradiation with gamma rays of 15 kGy had a greater impact on the high content of carotene, phenol, flavonoids. Also, the use of irradiation at 10 kGy levels had the best effect on the high content of antioxidant and ascorbic acid. This study indicated the Gamma irradiation of dried peppermint leaves may lead to improved quality of oil.

Keywords: *Mentha piperita* L, Gamma, Drying, Physical, Chemical Properties and Quality

Introduction

Some herbs or crops are consumed in their fresh state and may deteriorate within a few days after harvest. One way to preserve these plant products is to dry them in either by traditional sun/shade drying or microwave drying/oven drying. The area of the mint farm in Egypt is about 4312 Feddan (1 hectare = 2.4 Feddan) during the winter and summer seasons, with a rate of 6.2% of the total area of medicinal and aromatic plants, amounting to 69154 Feddan in 2018. ASEAS (2018). In terms of foreign trade, the value of Egyptian mint oil reached about an amount of exports amounting to about

291 tons in 2018 and the rate of export growth increased with a growth rate in the amount of exports of about 87% between 2014-2018 (UNMS, 2018).

Eliana *et al.* (2016) evaluated the effects of gamma irradiation on cytotoxicity and phenolic compounds of *Thymus vulgaris* L. and *Mentha piperita* L., used in traditional medicine. Thirteen and fourteen phenolic compounds were detected in *T. vulgaris* and *Mentha piperita*, respectively, none of which was affected by the irradiation dose used (10 kGy).

Amnah and Amal (2013) conducted to study the effect of gamma irradiation on the antioxidant activity,

quality assessment of microbial and sensory for fresh mint leaves. A high antioxidant activity when radioactive transactions gave a significant increase in the content of total phenols and total flavonoids compared to non-irradiated samples. Eric (2013) analyzed the effect of the drying methods on the nutritional characteristics of the spicy basil leave. Microwave-drying and oven drying were the methods that produced the best results for preserving most nutrients compared to the fresh herb, whereas ambient-air-drying, hot-air-drying and sun-drying brought about substantial losses in basil leave nutritional values.

Gavahian *et al.* (2015) used that Steam Distillation (SD) for extraction of essential oils from *Mentha piperita L.* (peppermint) and the results were compared with those of the Hydro Distillation (HD). The results showed that although extraction with HD started sooner, both methods had the extraction time of about 1 h.

Ghanooni *et al.* (2015) mentioned that the *Mentha piperita L.* Essential oils have different a bacterial activity. They investigated the effect of γ -irradiation on the bacterial activities of *Mentha piperita L.* Essential oils *in vitro* and *in vivo* systems. The aerial parts of peppermint were irradiated in a cobalt 60 source with 0, 10 and 25 kGy absorbed doses. The oil was effective in reducing CFU caused by sepsis-induced CLP operation.

Generally, these processes may cause negative attribute to the final food product, Phenolic compounds possess a wide spectrum of biological effects including antioxidant and free radical scavenging properties. Phenolic is classified into two groups such as *polyphenols* and simple phenols according to (Marinova *et al.*, 2005). Drying is the most common and effective method that increases the shelf life of spicy herbs by inhibiting the growth of microorganisms and preventing the onset of some biochemical reactions that may alter the organoleptic and nutritional characteristics of the dried leaf. However, drying must be performed carefully in order to preserve the aroma, appearance and nutritional characteristics of the raw herbs as much as possible (Crivelli *et al.*, 2002). Yousif *et al.* (1999) mentioned that during the long hours of drying heat was conducted from the surface to the interior of the leaves and the rate of evaporation of water on the surface of the leaves was faster than the rate of diffusion to the surface. However, all dried leaves achieved moisture content less than 20% wt.

Exposing food material to radiation has great advantages in contrast to the conventional methods of preservation such as cold storage, fumigation, salting and drying as it does not lead to loss of flavor, odor, texture or quality. In addition, irradiation is a direct, simple and efficient one-time process. Irradiation treatment combined with proper refrigeration for storage can prolong the shelf-life of these food items without affecting the flavor and texture (Shurong *et al.*, 2005).

Preserving food through radiation is considered a promising method to enhance the safety of the microbial quality of the food as it prolongs the period of validity.

Based on that, the radiation is considered a safe method of preserving food from microbial deterioration and consequently prolonging its marketing period (Haruvy and Deschenes, 2003). Boiling water extracted more polyphenols from dried plant materials than cool water, which means the heat of boiling water was the factor that led to higher total phenols being extracted from dried plant materials (Toor and Savage, 2004). Fatemi *et al.* (2010) showed that the γ -irradiation can be an effective way to treat problems in food supply pollution. The antibacterial activities of irradiated peppermint oil at two radiation doses of 10 kGy (the maximum permissible dose of radiation in food) and 25 kGy (sterile dose that all biological agents contaminating peppermint die) were studied to consider whether the γ -irradiation preserved the *in vivo* and *in vitro* antibacterial activities. Chlorophylls and carotenoids are frequent organic food components because they are naturally present in plants, giving them specific coloration. *In vivo*, these pigments play key roles in photosynthesis (Schoefs, 2002).

Among these tea pigments, *pheophytins a and b* were abundant, followed by *chlorophylls a and b* and *carotenoids* such as β -carotene and lutein in lower concentrations. All these pigments exhibited significant antioxidant activities against hydroperoxide generation, in the order *chlorophyll a* > *lutein* > *pheophytin a* > *chlorophyll b* > β -carotene > *pheophytin b* (Loranty *et al.*, 2010). In particular, gamma irradiation was approved for disinfection and microbial control in various food products and supplements by the Food and Drug Administration (FDA), being a procedure technically and economically viable and physically safe with a powerful antimicrobial effect (Mizani *et al.*, 2009). They reported that sun drying of green leafy vegetables caused a significant increase in TPC, reducing property and free radical scavenging activity, even though there was a significant decrease in vitamin C content according to (Obloh *et al.*, 2009).

The aims of the current study were: (a) Drying of mint leaves using sun-drying method., (b) Select suitable dose of gamma radiation to irradiate dried mint leaves., (c) Studying some physical and chemical properties of extracting oil before and after irradiation and (d) Examine the influence of gamma radiations on oil mint quality.

Materials and Methods

Sample Preparation

The samples of fresh mint were purchased from a local market in Giza region, Egypt in July 2018. The leaves were carefully cleaned manually to remove dirt and damaged ones and were removed from the stalks. Then, the mint leaves were washed subjected to sun drying to achieve a percentage moisture content of < 20% at four days to dry in the Sun. Dried Mint leaves (moisture content < 20%), were sealed in low density polyethylene bags and stored at 4±1 °C until exposed to gamma radiation.

Moisture Content

The moisture content of the Mint leaves was determined by the method of the difference between weights before and after exposing to hot air oven at 70°C for 72 h is considered as moisture. The percentages of moisture were calculated as follows (Anonymous, 1990):

$$\text{Moisture content, \%} = W1 - W2 / W1 * 100 \quad (1)$$

Where:

W1 = Weight of the sample before drying, g

W2 = Weight of sample after drying, g

Gamma Irradiation Treatments

Dried Mint leaves divided into 5 groups and treated with ⁶⁰Co (Cobalt 60) gamma rays, at the National Center for Radiation Research and Technology (NCRRT), Egypt. Dried Mint leaves were exposed to different doses of γ- rays; 0 (control), 5, 10, 15 and 20 (Gy). The control and irradiated samples were stored in plastic containers at room temperature (28-30°C).

Preparing of Dry Mint Extract Samples

Dried mint leaves which exposed to radiation in various doses were extracted by mixing them with distill water and stirring and turning for 15 min, then separated in Centrifugal Concentrators for 10 min (1000×g). After filtering and extraction, a 110 mL were obtained and three replicates have been made after each test analysis (Pellegrini *et al.*, 2003).

Determination of Chlorophyll a, Chlorophyll b and Carotenoids

The extraction process was done in triplicate. The solution was analyzed for Chlorophyll *a* (Ch *a*), Chlorophyll *b* (Ch *b*) and carotenoid content by a spectrophotometer JENWAY 6300 at various wavelengths 470, 645 and 662 nm is using a glass cuvette. The equations used for the quantification are given in Table 1. Results were expressed as mg g⁻¹ of plant material.

The equations for calculation of chlorophyll *a*, chlorophyll *b* and the total carotenoid content (Sumanta *et al.*, 2014).

Parameter, units	Equations*
Chlorophyll <i>a</i> , mg ml ⁻¹	$1C_{cha} = 12.25 A_{662} - 279 A_{645}$
Chlorophyll <i>b</i> , mg ml ⁻¹	$C_{chb} = 24.5A_{645} - 5.1A_{662}$
Total chlorophyll, mg ml ⁻¹	$1C_{cht} = C_{cho} + C_{chb}$
Ratio between chlorophyll <i>a</i> and <i>b</i>	$= \frac{C_{cha}}{C_{chb}}$
Total carotenoids, mg ml ⁻¹	$C_{ca} = \frac{C_{cho} = 1000A_{470} - 1.82C_{cha} - 85.02C_{chb}}{198}$

*In column Equations following abbreviations are used:

C_{Cha} = Concentration of chlorophyll *a* in extract

C_{Chb} = Concentration of chlorophyll *b* in the extract

C_{Cht} = Concentration of total chlorophyll in extract

C_{Cca} = Concentration of carotenoids in extract

A662 = Absorbance of the extract at wavelength 662 nm

A645 = Absorbance of the extract at wavelength 645 nm

A470 = Absorbance of the extract at wavelength 470 nm

Total Antioxidant Assay

The antioxidant content has been estimated as an equivalent to Quercetin according to Meda *et al.* (2005).

Phenolic Analysis

The extracts obtained above were analyzed using an HPLC chromatograph (HewlettePackard 1100, Agilent Technologies, Santa Clara, CA, US) with a double online detection using a Diode Array Detector (DAD) with 280, 330 and 370 nm as preference wavelengths and a Mass Spectrometer (MS) equipped with an ESI source and a triple quadrupole-ion trap mass analyzer, which was connected to the HPLC system via the DAD cell outlet (Barros *et al.*, 2013).

Total flavonoids assay: this is accomplished by using the method used by (Meda *et al.*, 2005).

DPPH (2, 2-Diphenyl-1-Picrylhydrazyl) radical scavenging activity assay

Free radical scavenging activity against 2, 2-Diphenyl-1-Picrylhydrazyl (DPPH) radical was measured according to the modified method (Obok, 2005). Ascorbic acid was used as the standard; while the inhibition ratio of DPPH scavenging activity was calculated from the equation:

$$AA, \% = Ac - A_s / A_s * 100$$

Where:

AA = Ascorbic acid

Ac = Absorbance of control and

As = Absorbance of the test sample.

Statistical Analysis

One-way Analysis of Variance was used to analyze the data using the following mathematical model:

$$Y_{ij} = \mu_i + \epsilon_{ij}$$

where, $i = 1, 2, \dots, r$ and $n = 1, 2, \dots, n_1$.

Results and Discussion

Chlorophyll *a* and Chlorophyll *b* Contents

Data of Chlorophyll *a* and *b* were illustrated for all the tested mint samples in Table 1 and Fig 1 and 2. Other

scientists also reported that changes in the colour and the content of chlorophylls were related to the genotype but not to the growing conditions. The highest content of chlorophyll *a*, chlorophyll *b* and total chlorophyll in the mint leaves was observed 299.79, 289.72 and 589.511 mg/100 oil g in irradiated sample with 20 kGy, respectively. While, the lowest content of chlorophyll *a*, chlorophyll *b* and total chlorophyll in the mint leaves were observed 178.62, 162.95 and 341.57mg/100 oil g in irradiated sample with 5 kGy, respectively. These results were found, according to (Bekhradi *et al.*, 2015).

In the tested mint leaves a ratio between chlorophyll *a* and chlorophyll *b* ranged from 1.035-1.566, meaning that

chlorophyll *a* is the main form of chlorophyll in the leaves. These results were agreements with (Loranty *et al.*, 2010).

Percentage of decreasing or increasing of chlorophyll *a* and *b* differed between all the tested mint samples compared with control samples in Fig. 3 and 4. For chlorophyll *a*, it was noticed that negative percentage of -39.006, -35.203 and -25.634% for irradiated samples of 5, 10 and 15 kGy while at the irradiated sample with 20 kGy has a positive percentage of 2.370%

For chlorophyll *b*, it was found that negative percentage of -12.842 and -5.065% for irradiated samples of 5 and 10 kGy, while at irradiated samples with 15 and 20 kGy has a positive percentage of 1.150 and 54.964%.

Table 1: Chlorophyll a, chlorophyll b and carotenoids of Mint oil at different Gamma radiation doses

Color properties of Mint oil					
Gamma dose, kGy	Chlorophyll a (mg/100g)	Chlorophyll b (mg/100g)	Carotenoids (mg/100g)	Total chlorophyll	Ratio Chlorophyll a/Chlorophyll b
Control	292.85	186.96	106.45	479.81	1.566
5	178.62	162.95	96.56	341.57	1.096
10	229.97	177.49	99.96	407.46	1.296
15	233.90	189.11	103.11	423.01	1.237
20	299.79	289.72	110.33	589.51	1.035

Table 2: Chemical properties of Mint oil at different Gamma radiation doses

Chemical properties of Mint oil				
Gamma dose, kGy	Phenols (mg/100g)	Flavonoids (mg/100g)	Total Antioxidant (mg/100g)	Ascorbic acid (mg/100g)
Control	251.94	1.84	609.75	55.47
5	241.61	1.14	600.87	60.77
10	249.02	1.52	604.20	61.15
15	251.30	1.73	606.87	62.48
20	258.82	3.28	610.62	64.47

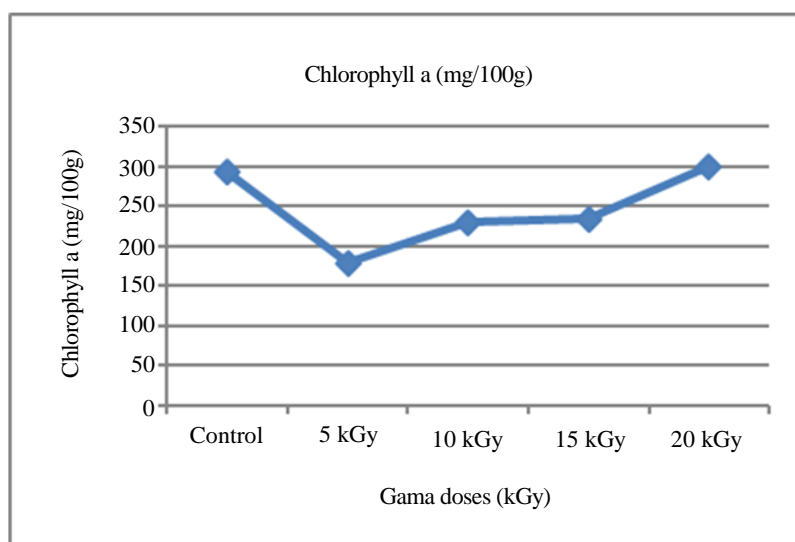


Fig. 1: Effect of gamma radiation doses on Chlorophyll a of Peppermint oil

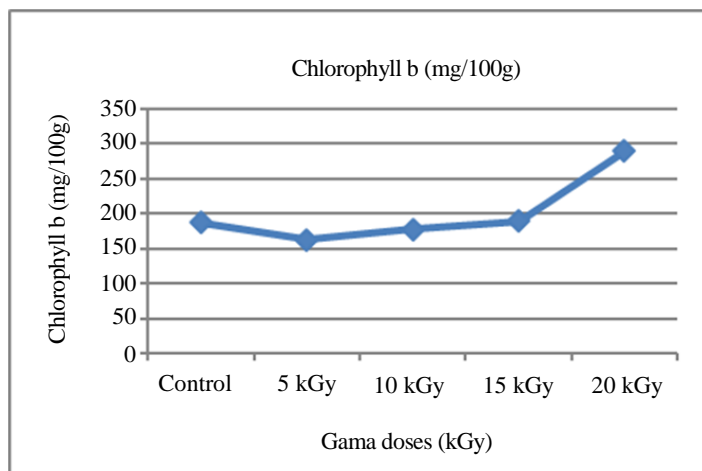


Fig. 2: Effect of gamma radiation doses on Chlorophyll b of Peppermint oil

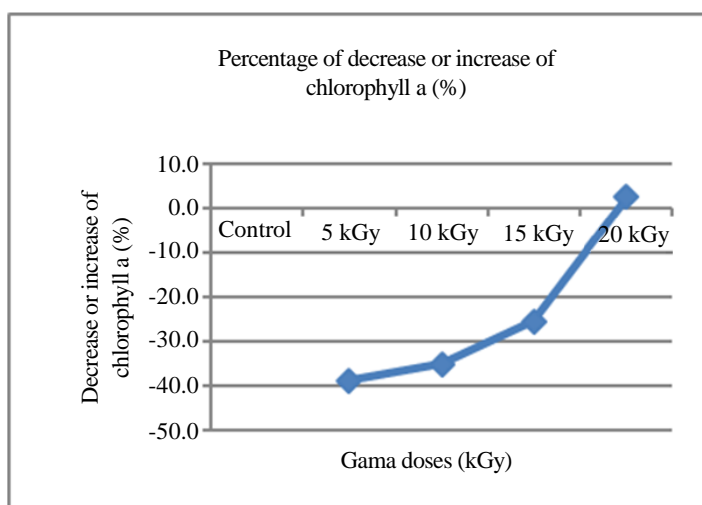


Fig. 3: Decrease or increase of chlorophyll a of peppermint oil at gamma radiation doses

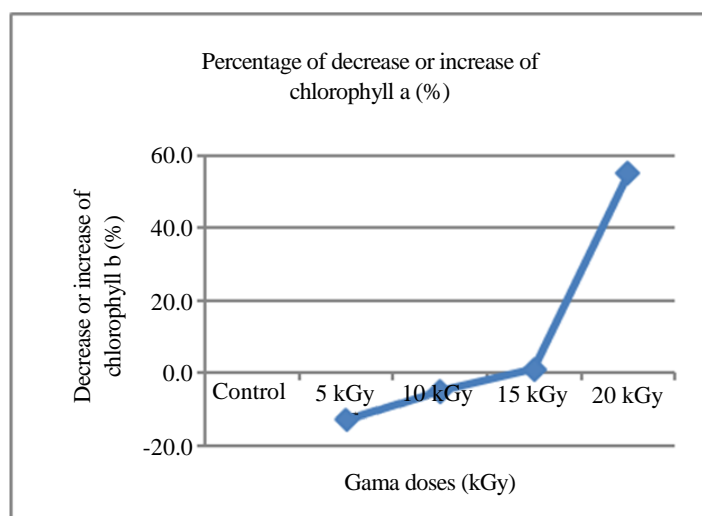


Fig. 4: Decrease or increase of chlorophyll b of peppermint oil at gamma radiation doses

Carotenoid Content

The basic pigments of green plants are chlorophylls, always accompanied by carotenoids. The highest content of carotenoids was observed in *Mentha spicata* leaves, 110.33 mg 100 oil g in irradiated sample with 20 kGy. While, the lowest content of carotenoids was observed in *Mentha spicata* leaves, 96.56 mg 100 oil g in irradiated sample with 5 kGy Table 1 and Fig. 5. Carotenoid content in other herbs like dills is significantly higher 30.3 mg 100 g⁻¹ (Lisiewska *et al.*, 2004). Percentage of decreasing or increasing of carotenoids differed between all the tested mint samples compared with control samples in Fig. 6. For carotenoids, it was noticed that negative percentage of -9.291, -6.097 and -3.138% of irradiated samples of 5, 10 and 15 kGy, while at the irradiated sample with 20 kGy has a positive percentage of 3.645%.

The Effects of γ -Irradiation and the Total Phenols and Total Flavonoids

The effects of γ -irradiation and the total phenols and total flavonoids are shown in Table 2 and Fig. 7 and 8.

The data demonstrated that the irradiated mint at 5, 10, 15 KGy had lower phenolic compounds than non-irradiated control in the mint extract. While, irradiated mint at 20 KGy had higher phenolic compounds. The significant decreases in the phenolic contents were 241.61, 249.02 and 251.30 mg/100g for samples irradiated at 5, 10 and 15 kGy, respectively, compared to the content in case of non-irradiated control (251.94 mg/100g). While, the increases in the phenolic contents were 258.82 mg/100g for sample irradiated at 20 kGy, compared to the content in case of non-irradiated (control)

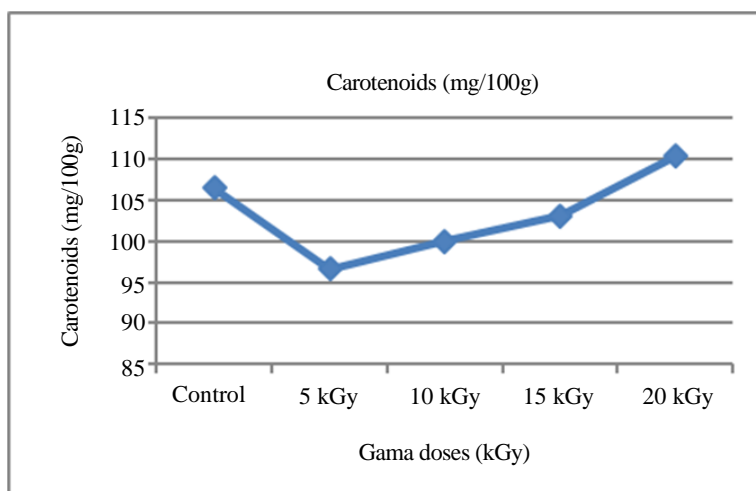


Fig. 5: Effect of gamma radiation doses on carotenoids of peppermint oil

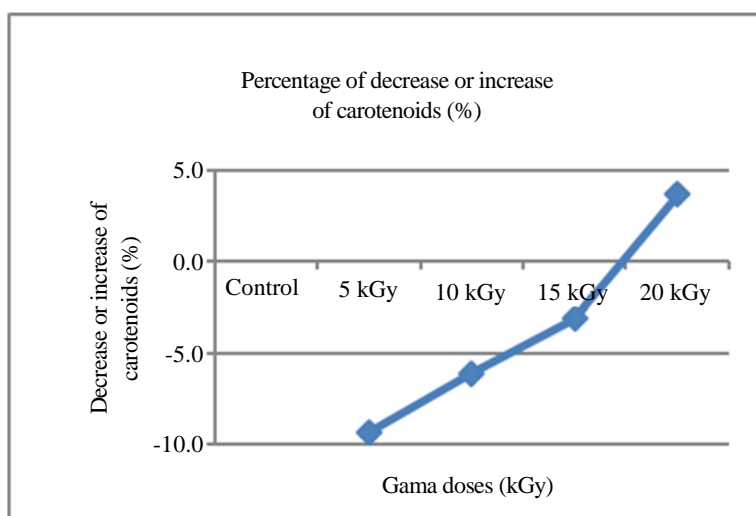


Fig. 6: Decrease or increase of carotenoids of peppermint oil at gamma radiation

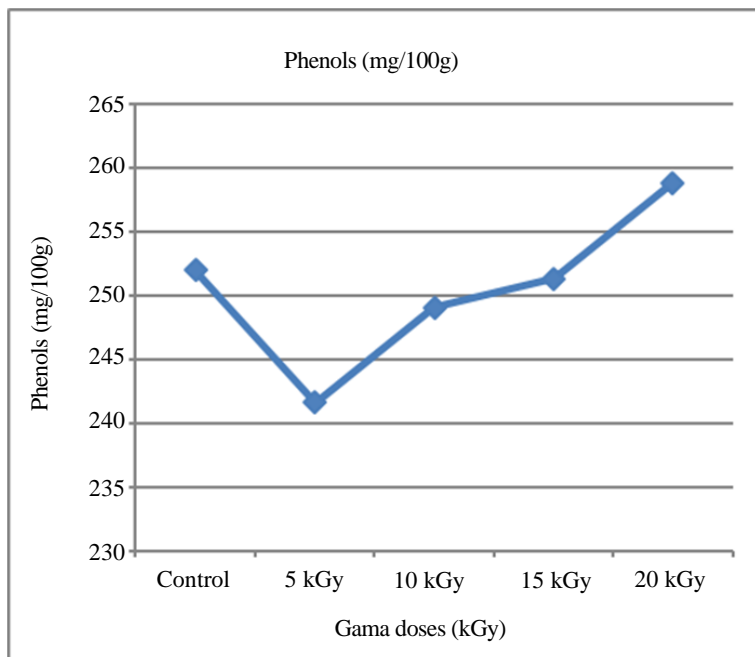


Fig. 7: Effect of gamma radiation doses on phenols of peppermint oil

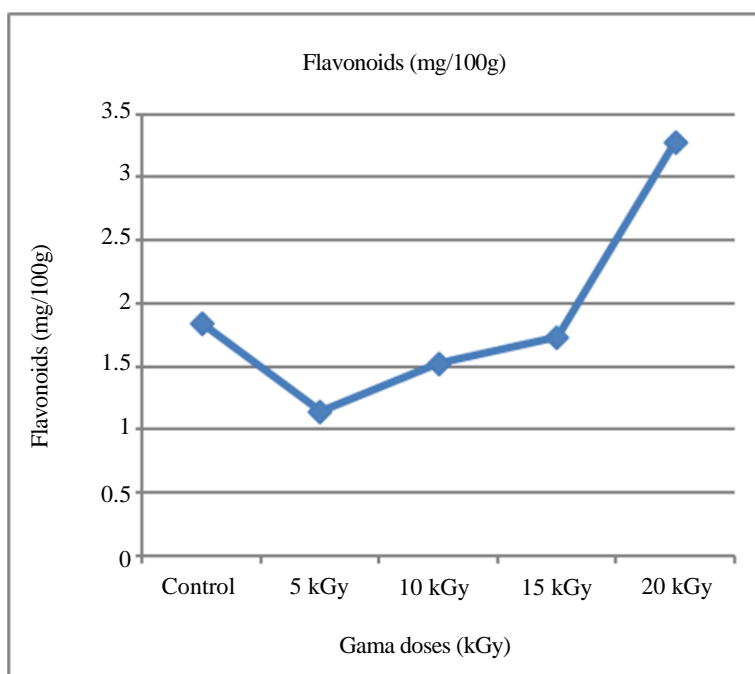


Fig. 8: Effect of gamma radiation doses on flavonoids of peppermint oil

The data demonstrated that the irradiated mint at 5, 10, 15 KGy had lower flavonoids, compounds than non-irradiated control in the mint extract. While, irradiated mint at 20 KGy had higher flavonoids compounds.

The significant decreases in the flavonoids contents were 1.14, 1.52 and 1.73 mg/100g for samples irradiated at 5, 10 and 15 kGy, respectively, compared to the

content in case of non-irradiated control (1.84 mg/100g). While, the increases in in the phenolic contents were 3.28 mg/100g for sample irradiated at 20 kGy, compared to the content in case of non-irradiated (control). The maximum increase was obtained at 20 kGy dose.

Phenols are found in food either freely or as glycosides. There are more than 8000 kinds of natural

phenols that are known to be in plants. Phenols exist in food are divided into two main divisions, aromatic phenols and flavonoids (Kim and Lee, 2004).

Percentage of decreasing or increasing of phenolic differed between all the tested mint samples compared with control samples in Fig. 9. For phenolic, it was noticed that negative percentage of -4.100, -1.159 and -0.254%, for irradiated samples of 5, 10 and 15 kGy, compared to non-irradiated sample (control), while at the irradiated sample

with 20 kGy has positive percentage of 2.731%, compared to non-irradiated sample (control).

Percentage of decreasing or increasing of flavonoids differed between all the tested mint samples compared with control samples in Fig. 10. For flavonoids, it was noticed that negative percentage of -38.133, -17.511 and -6.114%, for irradiated samples of 5, 10 and 15 kGy, compared to non-irradiated sample (control). While, at the irradiated sample with 20 kGy has a positive percentage of 78.003%, compared to non-irradiated sample (control).

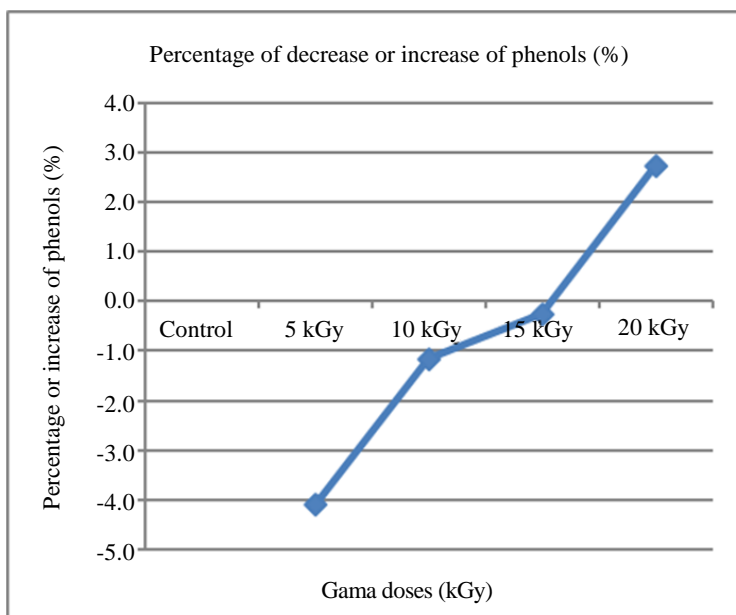


Fig. 9: Percentage of decrease or increase of phenols of peppermint oil at gamma radiation

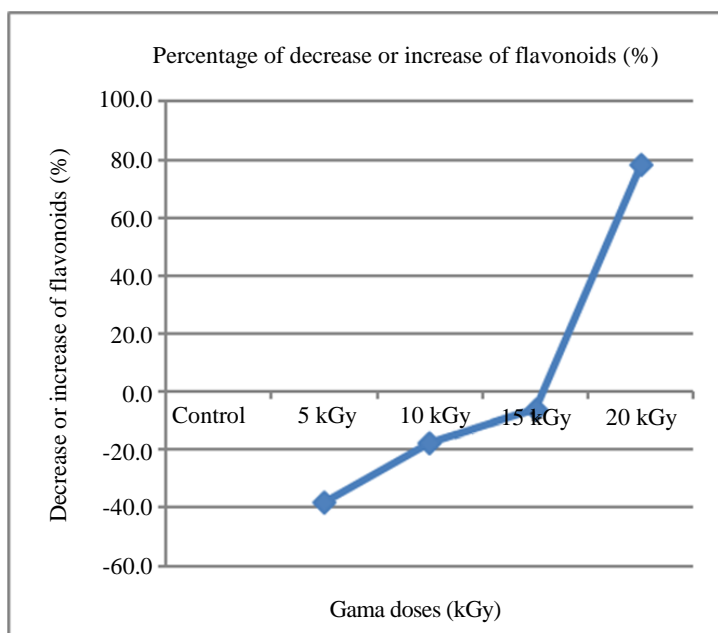


Fig. 10: Percentage of decrease or increase of flavonoids of peppermint oil at gamma radiation

Flavonoids are vegetable dyes spread in different parts of the plants. They are divided into several various divisions that include Flavones. More precisely, Flavones are considered to be compounds that their color range varies from colorless to light yellow and can be found in citrus, cumin and mint (Alessandro *et al.*, 2003).

The Effects of γ -Irradiation and the Total Antioxidant and Ascorbic Acid

The effects of γ -irradiation and the total antioxidant and ascorbic acid are shown in Table 3 and Fig. 11 and 12.

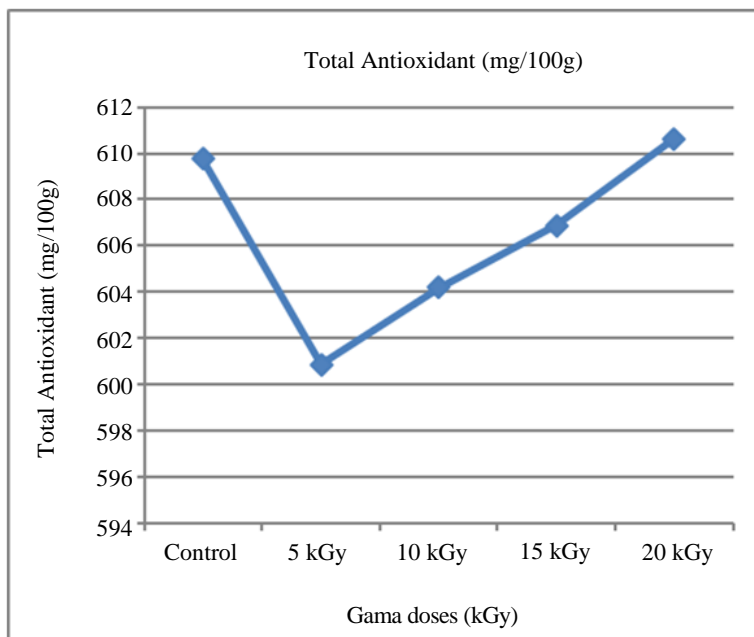


Fig. 11: Effect of gamma radiation doses on Total Antioxidant of Peppermint oil

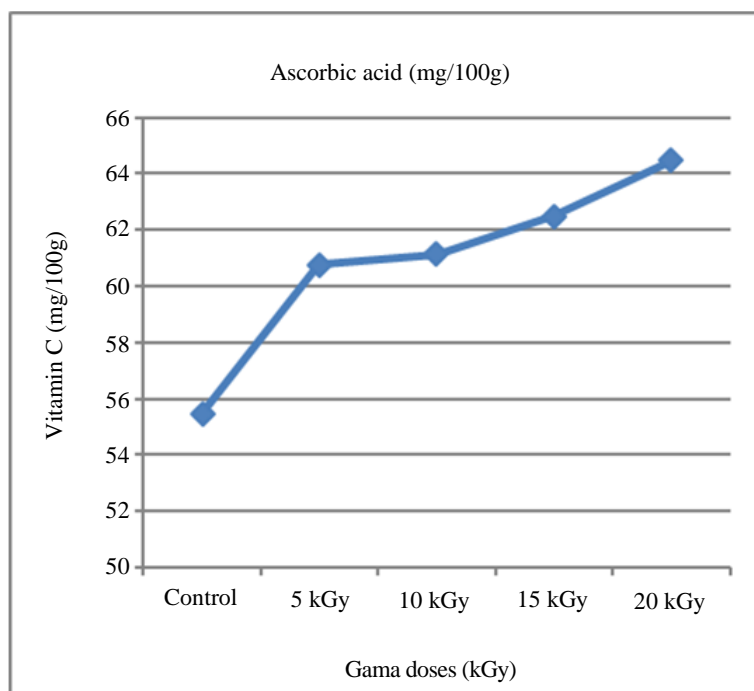


Fig. 12: Effect of gamma radiation doses on Ascorbic acid of Peppermint oil

The data demonstrated that the irradiated mint at 5, 10, 15 KGy had lower Total Antioxidant compounds than non-irradiated control in the mint extract. While, irradiated mint at 20 KGy had higher total Antioxidant compounds. The significant decreases in the Total Antioxidant contents were 600.87, 604.20 and 606.87 mg/100g for samples irradiated at 5, 10 and 15 kGy, respectively, compared to the content in case of non-irradiated control (609.75 mg/100g). While, the increases in the Total Antioxidant contents were 610.62 mg/100g for sample irradiated at 20 kGy, compared to the content in case of non-irradiated (control).

The data demonstrated that the irradiated mint at 5, 10, 15 KGy had lower Ascorbic acid compounds than non-irradiated control in the mint extract. While, irradiated mint at 20 KGy had higher Ascorbic acid compounds. The significant increase in the Ascorbic acid contents were 60.77, 61.15, 62.48 and 64.47 mg/100g for samples irradiated at 5, 10, 15 and 20 kGy, respectively, compared to the content in case of non-irradiated control (55.47 mg/100g). So, the lowest value of the Ascorbic acid contents was 55.47 mg/100g for sample non-irradiated. While, the highest value of the Ascorbic acid contents was 64.47 mg/100g for sample irradiated was obtained at 20 kGy dose. It was obvious that 20 kGy irradiation dose led to the highest increase in the total antioxidant.

The present findings are in good agreement with that of Taipina *et al.* (2009) who reported that there was no loss of the antioxidant content of pecan nuts as a result of gamma. While Huang and Mau (2006) found that the antioxidant content of the methanolic extract of *Agaricusblazei* was 45 mg/100g and this amount was increased to 106 mg/100g after 20 kGy of γ -irradiation.

Percentage of decreasing or increasing of total Antioxidants differed between all the tested mint samples compared with control samples in Fig. 13. For total Antioxidants, it was noticed that negative percentage of -1.456, - 0.910 and - 0.472% for irradiated samples of 5, 10 and 15 kGy, compared to non-irradiated sample (control), while at the irradiated sample with 20 kGy has a positive percentage of 0.143%, compared to non-irradiated sample (control).

Percentage of decreasing or increasing of Ascorbic acid differed between all the tested mint samples compared with control samples in Fig. 14. For Ascorbic acid, it was noticed that positive percentage of 9.555, 10.240, 12.637 and 16.225% for irradiated samples of 5, 10 and 15 kGy, compared to non-irradiated sample (control). So, the lowest increase was 9.555% in the irradiated sample with 5 kGy. While, the highest increase was 16.225% at the irradiated sample with 20 kGy.

Intense and/or prolonged thermal treatment may be responsible for a significant loss of natural antioxidants, as most of these compounds are relatively unstable. Yet in some cases, drying process causes little or no change to the content and activity of naturally occurring antioxidants, such as carotenoids and vitamin C (e.g., lycopene) according to Nicoli *et al.* (1999).

Statical Analysis

The economic benefit of using gamma irradiation with different radiation levels on the quality characteristics of dried mint oil.

Table 1 showed that the use of irradiation with gamma rays at different radiation levels, which are 5, 10, 15 and 20 kGy, led to the effect on the quality specifications of oil extracted from dried mint leaves where the results showed that the highest percentage of chlorophyll A, chlorophyll B, the total chlorophyll, carotenoids in dried mint leaves were at a dose of irradiation of 20 kGy, as it was found that the highest value of phenolic compounds was at a dose of irradiation of 20 kGy.

By performing a variance analysis of the quality characteristics of the oil extracted from dried mint leaves and measured with the content of every 100 g of oil extracted from chlorophyll A, chlorophyll B, carotene, phenol, flavonoids, antioxidant compounds, ascorbic acid by mass at different irradiation levels 5, 10, 15, 20 kGy and it was found from the results shown in Table 3 that there were significant differences in the content of chlorophyll (A), chlorophyll (B), phenol, flavonoids, antioxidants, ascorbic acid, where the calculated value of F was about 459.881, 17606.373, 632.746, 14.806, 88,844 and 4,666, respectively. While there was no significant difference in carotene content as the calculated F value reached 1.383.

By conducting LSD test to measure the least significant difference between the control sample and the radiation irradiated samples with gamma rays to know the fundamental differences between the different averages and to know the level of irradiation due to the greater impact on the quality specifications of peppermint oil, it was found from the results shown in Table 4 that the use of irradiation with gamma rays At 20 kGy, the most influencing was the higher content of chlorophyll (a) and chlorophyll (b). While the use of the level of irradiation with gamma rays at the level of 15 kGy had a greater impact on the high content of carotene, phenol, flavonoids. Also, the use of irradiation at 10 kGy level had the best effect on the high content of antioxidant and ascorbic acid.

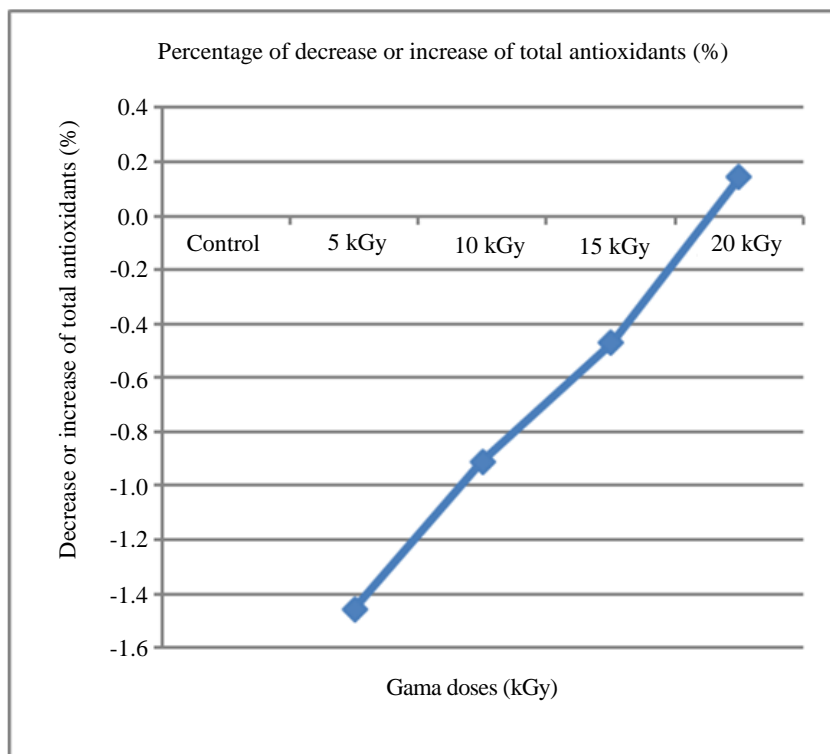


Fig. 13: Percentage of decrease or increase of total antioxidants of peppermint oil at gamma radiation

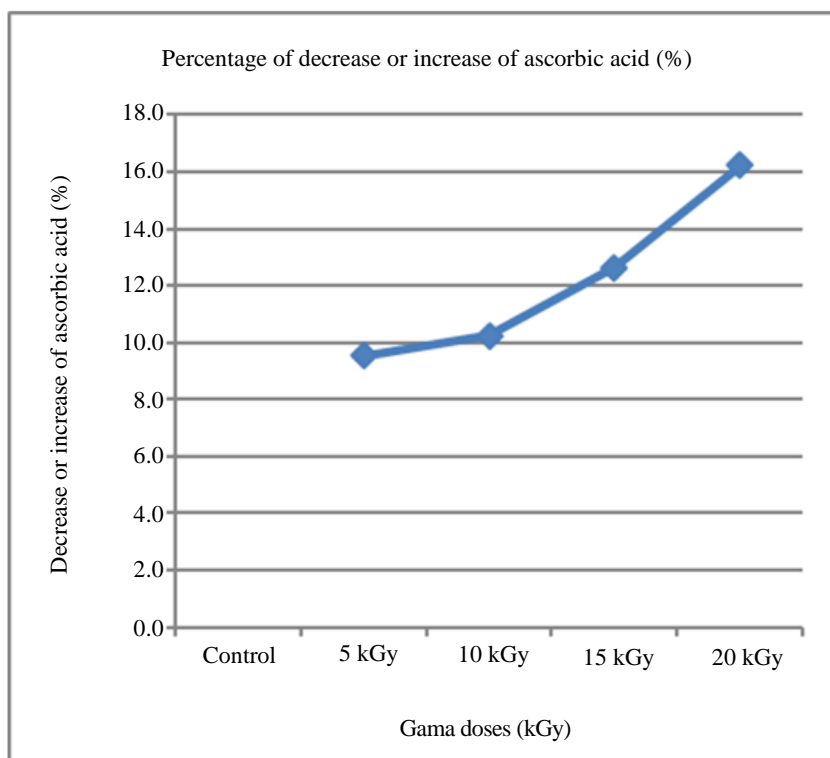


Fig. 14: Percentage of decrease or increase of ascorbic acid of peppermint oil at gamma radiation

Table 3: Analysis of variance of quality characteristics of oil extracted from dried mint leaves at different irradiation doses

Properties of Oil Mint		Sum of Squares	DF	Mean Square	F	Sig.
Chlorophyll a (mg/100g)	Between Groups	34048.254	4	8512.064	459.881	0.000
	Within Groups	185.093	10	18.509		
	Total	34233.347	14			
Chlorophyll b (mg/100g)	Between Groups	109523.987	4	27380.997	17606.373	0.000
	Within Groups	15.552	10	1.555		
	Total	109539.538	14			
Carotenoids (mg/100g)	Between Groups	259.461	4	64.865	1.383	0.308
	Within Groups	469.048	10	46.905		
	Total	728.509	14			
Phenols (mg/100g)	Between Groups	457.267	4	114.317	632.746	0.000
	Within Groups	1.807	10	0.181		
	Total	459.074	14			
Flavonoids (mg/100g)	Between Groups	13.638	4	3.41	14.806	0.000
	Within Groups	2.303	10	0.23		
	Total	15.941	14			
Total Antioxidant (mg/100g)	Between Groups	125.169	4	31.292	88.844	0.000
	Within Groups	3.522	10	0.352		
	Total	128.691	14			
Ascorbic acid (mg/100g)	Between Groups	145.812	4	36.453	4.666	0.022
	Within Groups	78.124	10	7.812		
	Total	223.936	14			

Source: According to Tables 1 and 2

Table 4: LSD test results

Properties of Oil Mint	Control (I)	Treatments (J)	Mean Difference (I-J)	Sig.
Chlorophyll a	Zero Gama level	Gama dose		
Chlorophyll a	0%	5%	75.651	0.000
		10%	72.315333	0.000
		15%	128.002333	0.000
Chlorophyll b	0%	20%	7.227333	0.067
		5%	107.285333	0.000
		10%	95.433	0.000
Carotenoids	0%	15%	120.997333	0.000
		20%	-104.300667	0.000
		5%	4.375333	0.452
Phenols	0%	10%	7.492667	0.21
		15%	11.711333	0.063
		20%	9.932833	0.106
Flavonoids	0%	5%	17.116333	0.000
		10%	7.242	0.000
		15%	6.836	0.000
Total Antioxidant	0%	20%	9.9044	0.000
		5%	0.590667	0.163
		10%	-0.296	0.467
Ascorbic acid	0%	15%	-2.224	0.000
		20%	-0.139667	0.729
		5%	8.888667	0.000
Ascorbic acid	0%	10%	3.263667	0.000
		15%	5.361333	0.000
		20%	4.416667	0.000
Ascorbic acid	0%	5%	-7.838	0.006
		10%	-8.843333	0.003
		15%	-6.439333	0.018
Ascorbic acid	0%	20%	-4.585667	0.072

Source: According to Tables 1 and 2

Conclusion

The highest content of chlorophyll *a*, chlorophyll *b*, total chlorophyll and content of carotenoids in the dried mint leaves were observed in irradiated samples with 20 kGy. While, the highest content was in the irradiated sample with 5 kGy.

The irradiated dried mint leaves at 5, 10, 15 KGy had lower phenolic, flavonoids, Total antioxidant and Ascorbic acid compounds than non-irradiated control in the mint extract. While, irradiated mint at 20 KGy had higher phenolic compounds.

It was found significant differences in the content of chlorophyll (A), chlorophyll (B), phenol, flavonoids, antioxidants, ascorbic acid, while there was no significant difference in the carotene content.

By using of irradiation with gamma rays of 20 kGy, the most influencing was the higher content of chlorophyll (a) and chlorophyll (b). While the use of the level of irradiation with gamma rays of 15 kGy had a greater impact on the high content of carotene, phenol, flavonoids. Also, the use of irradiation at 10 kGy level had the best effect on the high content of antioxidant and ascorbic acid.

Therefore, the results indicate that the use of irradiation is a suitable method for dried mint leaf preservation,

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Author's Contributions

Abd El-Rahman Abd El-Raouf Ahmed: Designed the research plan.

Gamal Kamal Arafa: Participated in experiment.

Helmy El-Sayed Hassan: Participated in experiment.

Hend Nabil Mohamed: Coordinated the data analysis.

Ethics

This article is original and contains unpublished material. The corresponding author confirms that all of the other authors have read and approved the manuscript and no ethical issues involved.

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المستخلص العربي

تأثير أشعة جاما على جودة زيت أوراق النعناع المجففة
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يعتبر النعناع الأخضر من النباتات الطبية والعطرية ويزرع في معظم محافظات مصر وله استخدامات متعددة ، سواء كان يستخدم طازجا أو مجففاً أو يتم استخراج زيت النعناع منه ، كما يُعرف أيضاً بأهميته الطبية ، ولقد أثبتت الابحاث أن النعناع يحتوي على العديد من الفوائد الصحية. تم إجراء هذا البحث لدراسة تأثير التشعيع بأشعة جاما على تقييم جودة الزيت المستخلص من أوراق النعناع المجففة. حيث تم تعريض أوراق النعناع المجففة لخمس جرعات من أشعة جاما ، 0.0 ، 5 ، 10 ، 15 و 20

كيلوجراى. وقد تم الكشف عن خصائص اللون مثل الكلوروفيل (أ) ، والكلوروفيل (ب) والكاروتينات ، وكذلك تم تقييم نشاط مضادات الأكسدة والفينول الكلي والفلافونويد الكلي وحمض الأسكوربيك المستخلص المائي لأوراق النعناع. أهم النتائج المتحصل عليها كانت كالتالى: لوحظت أعلى نسبة من الكلوروفيل (أ) ، الكلوروفيل (ب) ، الكلوروفيل الكلي ومحتوى الكاروتينات في أوراق النعناع المجففة في عينات مشبعة مع 20 كيلوجراى. بينما ، كان أقل محتوى في العينة المشبعة مع 5 كيلوجراى. كما أظهرت البيانات أن أوراق النعناع المجففة والمشبعة بجرعات 5 ، 10 ، 15 كيلوجراى كانت تحتوي على مركبات الفينول والفلافونيدات ومركبات مضادات الأكسدة الكلية وحمض الأسكوربيك أقل من العينة الغير المشبعة من زيت النعناع. بينما كانت العينة المشبعة بجرعة 20 كيلوجراى تحتوي على مركبات فينولية أعلى.. المردود الاقتصادى لاستخدام التشعيع بأشعة جاما بمستويات اشعاع مختلفة المستخرج من اوراق النعناع المجففة: على صفات الجودة زيت النعناع لاثر One Way ANOVA وكانت نتيجة تحليل التباين فى اتجاه واحد استخدام التشعيع بأشعة جاما على صفات الجودة للزيت المستخلص من اوراق النعناع المجففة من اوراق النعناع المجفف من كلوروفيل أ ، كلوروفيل ب ، الكاروتين ، الفينول ، الفلافونويدز ، مركبات مضادات

الأكسدة ، حمض الاسكوربيك بالجم عند مستويات التشعيع المختلفة 5 ، 10 ، 15 ، 20 كيلو جراى فقد تبين وجود فروق معنوية فى محتوى الكلوروفيل (أ) ، كلوروفيل (ب) ، الفينول ، الفلافونيد ، الانتياوكسيدن ، 459.881 المحسوبة نحو F حمض الاسكوربيك ، حيث بلغت قيمة على الترتيب. 4.666 ، 88.844 ، 14.806 ، 632.746 ، 17606.373 ، F بينما لا يوجد فروق معنوية فى محتوى الكاروتين حيث بلغت قيمة 1.383 المحسوبة لقياس اقل فرق معنوى بين عينة الكنترول والعينات LSD وباجراء اختبار المعالجة بالتشعيع بأشعة جاما لمعرفة الفروق الجوهرية بين المتوسطات المختلفة ومعرفة مستوى التشعيع الذى يرجع له التأثير الأكبر على مواصفات الجودة لزيت النعناع تبين من النتائج أن استخدام التشعيع بأشعة جاما عند مستوى 20% كان الاكبر تأثيرا على ارتفاع محتوى الكلوروفيل (أ) ، الكلوروفيل (ب). بينما استخدام مستوى التشعيع بأشعة جاما عند مستوى 15% كان له تأثيرا أكبر على ارتفاع محتوى الكاروتين ، الفينول ، الفلافونويد. كما كان استخدام التشعيع عند مستوى 10% أفضل تأثيرا على ارتفاع محتوى الانتياوكسيدن وحمض الاسكوربيك....وبالتالى وجد من خلال هذه الدراسة أن تشعيع أوراق النعناع المجفف بأشعة جاما قد يؤدي إلى تحسين جودة الزيت.