MANSOURA JOURNAL OF PHYSICS
Official Journal of Faculty of Science, Mansoura University, Egypt
E-mail: scimag@mans.edu.eg ISSN: 2974-4954

UVC effect on growth, structure and bio-contents of *Foeniculum vulgare*

Hager Yuns[1], Abu Bakr El-Bediwi[*1], Hamed M El-Shora[2]

[1]Physics Department, Faculty of Science, Mansoura University, Egypt

[2]Botany Department, Faculty of Science, Mansoura University, Egypt

baker_elbediwi@yahoo.com

Received:6/6/2021
Accepted: 4/7/2021

Abstract: Morphological structures (growth, shape and weight), internal structure (order and position of chemical compound) and bio-contents (enzymes, vitamins and antioxidants for normal and irradiated *Foeniculum vulgare*) are studied. The growth of *Foeniculum vulgare* seeds are effected after exposure to UVC. The weight of *Foeniculum vulgare* seeds also decreased by exposure to UVC. Continuous increase in the *Foeniculum vulgare* enzyme activity, tocopherol content, vitamin C, total phenol content and antioxidant activity was observed by increasing the exposure time up to 3 hours then declined in the fourth hour.

keywords: Foeniculum vulgare, UVC, Molecular structure, Antioxidant activity, Phenol, Vitamins

1.Introduction

Foeniculum vulgare is a flowering plant species in the carrot family. *It* contains 6.3% of moisture, 9.5% protein, 10% fat, 13.4% minerals, 18.5% fibre and 42.3% carbohydrates. Ultraviolet (UV) constituted approximately 8- 9 % of total solar radiation and considers a part of non-ionizing rays of the electromagnetic spectrum region [1, 2]. Plants sensitive to UV can respond through accumulating some compounds in their outer tissue layers, which protect sensitive parts from damage by UV. The main enzymes involved in biosynthesis of these compounds are induced by UV irradiation via gene activation [3]. Higher UV radiation can inhibit plant growth and development of plants as well as reproduction and suppress photosynthesis [4, 5]. UV in the range 2800- 4000 Å as a small fraction of the solar radiation reaching the terrestrial ecosystems is an important modulator of plant physiology [6]. The physiological, biochemical processes, leaf chlorophyll, protein content, and peroxidase enzyme activity in plants can be affected by UVC [7, 8]. The effect of UVC on the germination percentage, germination rate, radicle length, and plumule length of maize and sugar beet seeds has been reported [9]. Also UVC increased the germination percentage of the groundnut [10]. Nonetheless that UVC radiation did not significantly affect the germination percentage of *Acacia ampliceps* [11]. The effect of UVC on growth, internal structure, free radical and enzymes of *Nigella Sativa* have been studied [12]. Furthermore, UVC effect on morphological characteristics and the content in *garden cress* studied and analyzed [13]. Internal structure and contents of *Ammi majus* changed by exposure to UVC for different time intervals and different distances [14]. The objective of the present research was to study the effect of ultra violet- C on morphological structure and medical contents such as enzymes, vitamins and antioxidant activity for *Foeniculum vulgare*.

The aim of this study is to investigate the morphological structures (growth, shape and weight), internal structure (order and position of chemical compound) and bio-contents (enzymes, vitamins and antioxidants for normal and irradiated *Foeniculum vulgare*).

Materials and experimental techniques

Seeds of *Foeniculum vulgare* are received from Egyptian ministry of agriculture. The irradiated used system consists of fluorescent lamp (Type-C with λ from 2000-2800 Å), its power equal to 15 watt. Also the system covered totally with aluminum foil to illuminate the sample from all sides. Internal structure of *Foeniculum vulgare* was studied by

PANalytical X`Pert PRO XRD device, using Cu K_α target with secondary monochromatic (where λ = 1.540 Å, the tube operated at 45 kV- 40 mA (Holland), the Bragg's angle (2θ) in the range of 5- 80°). Molecular structure of *Foeniculum vulgare* was studied by Nicolet™ iS™ 10 FT-IR Spectrometer from USA. Absorption of extracted *Foeniculum vulgare* was measured by UV- 2100 spectrophotometer.

Preparation of plant extracts

Sample (1 gm) of *Foeniculum vulgare* is extracted in different solvents with 80 % ethanol, 80 % methanol, 80 % acetone, ethyle actate and distilled water with a ratio of 1: 10. The mixture was then centrifuged at 5000 rpm for 20 min and the supernatant was decanted into a 15 ml vial. The pellet was extracted under identical conditions. The supernatants are combined and used for meaning the antioxidant compounds and antioxidant activity. Vitamin C (ascorbate) content is determined by the method of Hodges *et al.* (1996) [15]. The absorbance was measured at 525 nm. The content of α-tocopherol (vitamin E) is estimated according to Hira *et al.* (2001) [16]. The absorbance was measured spectrophotometrically at 460 nm. Total phenolic content (TPC) in leaf extracts was determined by the method of Singleton and Rossi (1965) [17] using Folin-Ciocalteu colorimetric method and the absorbance was taken at 500 nm spectrophtometrically. SOD activity was measured according to Dhindsa and matowe (1981) [18]. The absorbance was measured at 560 nm. APX activity was determined following the method of Nakano and Asada (1981) [19], depending on measuring the rate of ascorbate oxidation at 290 nm. GR is assayed according to the method of Goldberg and S Pooner (1983) [20]. The GR activity in the sample was directly proportional to the change in the absorbance at 340 nm.

Results and discussions

X- Ray analysis

Figure 1 illustrates x- ray diffraction patterns of *Foeniculum vulgare* seeds before and after exposure to UVC for various time intervals at 5 cm. The analysis listed in Table 1 shows, started base line and area under the peak is changed after exposure to UVC for 1, 2, 3 and 4 hours at 5 cm distance. It means that, internal structure such as ordered and linked molecules of *Foeniculum vulgare* changed by exposure to UV radiation.

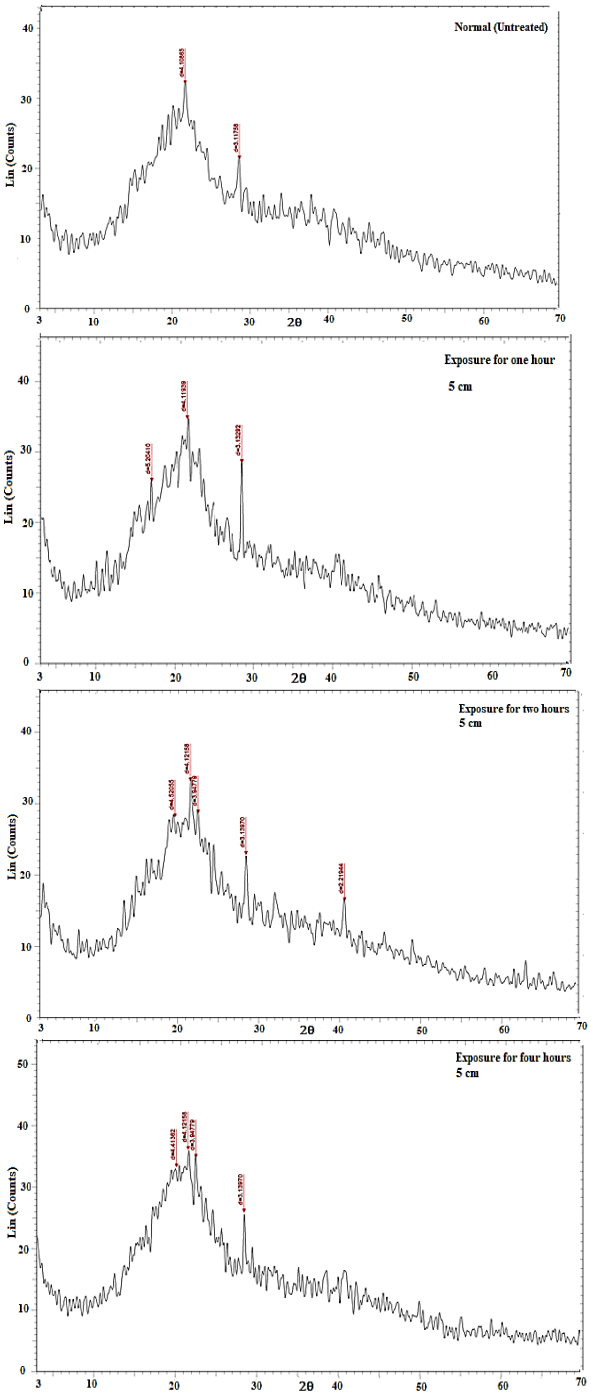


Figure 1:- x-ray diffraction patterns for *Foeniculum vulgare*

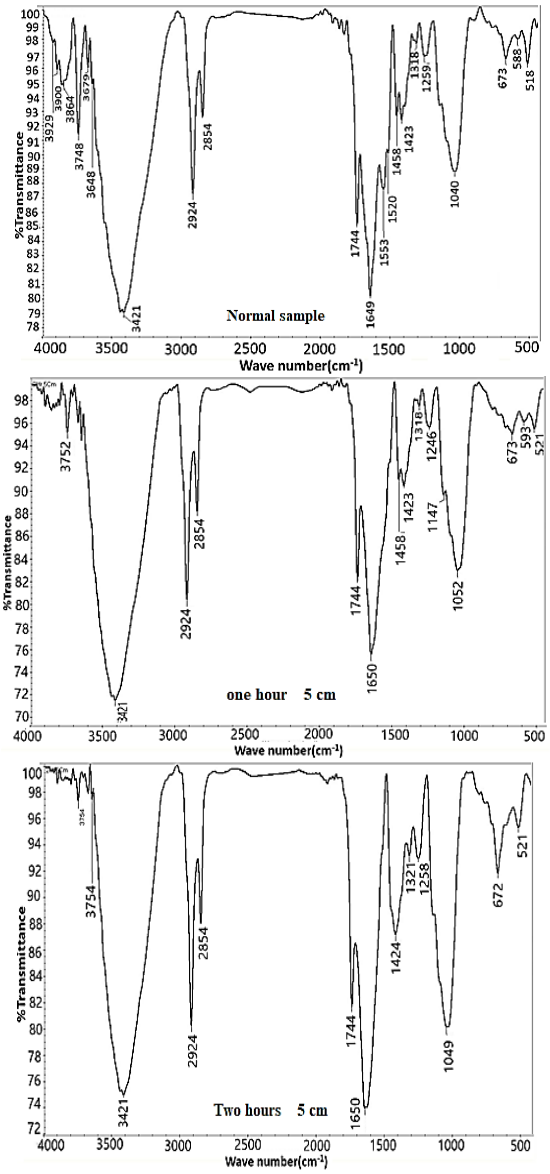
IR analysis

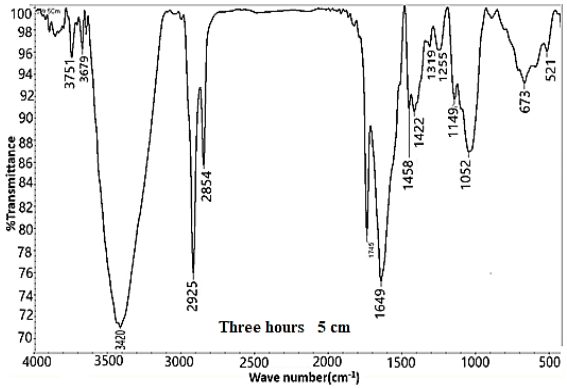
Figure 2 shows the relation between wave number (X- axis) and % transmittance (Y- axis) of normal and irradiated *Foeniculum vulgare* for 1, 2, 3 and 4 hours at 5 cm distance. IR spectrum analysis for *Foeniculum vulgare* shows that % transmittance at position ١٠٤٠, ١٦٤٩, ٢٩٢٤ and ٣٤٢١ cm^{-1} changed after exposure to UVC. From this, it was clear that,

molecular structure such as C- C bond at 1649 cm^{-1}, C-H bond at 2924 cm^{-1} and O- H bond at ~3421 cm^{-1} bonded of *Foeniculum vulgare* changed after exposure to UVC. These results reveled that these molecules absorb energy from UV which caused vibrated or break bonds linked it, produced its position, intensity and broad nesses change. These results agree with our previous studies [12- 14].

Table 1:- x-ray data for *Foeniculum vulgar*

	d Å	2θ	Intensity	Area	FWHM
Normal	4.10865	21.612	32.1	6.١	0.572
	3.11758	28.610	21.3	4.9	0.414
1 hr. at 5 cm	4.11939	21.555	34.7	356.8	11.21
	3.13292	28.467	28.5	2.4	0.187
2 hrs. at 5 cm	4.12158	21.543	33.2	125.٨	6.4٥
	3.13970	28.404	22.8	2.6٢	0.29
4 hrs. at 5 cm	4.12158	21.543	36.1	193.95	8.196
	3.13970	28.404	25.9	4.30	0.24





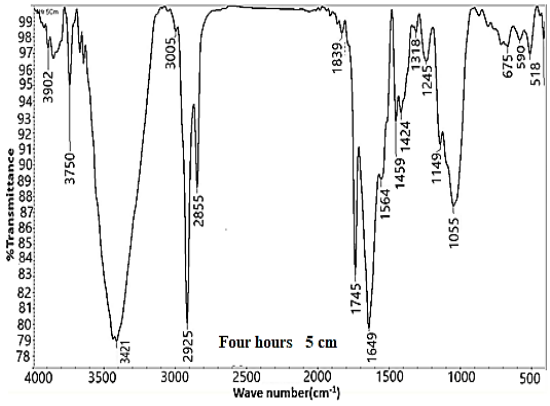


Figure 2: IR spectra for *Foeniculum vulgare*

Table 2: IR spectrum analysis of *Foeniculum vulgare.*

Exposure Time/ at 5 cm	Positioncm^{-1}	%Transmittance
Normal	10٤0	٨ز٨٨
	1649	80.15
	2925	87.28
	3421	79.002
One hour	1052	82.93
	1650	75.5
	2924	80.38
	1052	82.93
Two hours	1049	80.08
	16٥0	73.91
	2924	80.2
	3421	74.9
Four hours	1055	87.37
	1649	79.7
	2925	80.03
	3421	78.88

Antioxidant activity of methanol extract from *Foeniculum vulgare*

The antioxidant activity of methanolic and ethanol extracts from *Foeniculum vulgare* exposed to UVC at 5 cm for 1, 2, 3 and 4 hours presented in Figure 3 indicated continuous increase in the antioxidant activity throughout the four hours of exposure at each individual concentration of (20, 40, 60, 80 and 100 µg ml^{-1}). Also, it was found that, the increase in the antioxidant activity was continuous until the third hour, then decreased after the fourth hour.

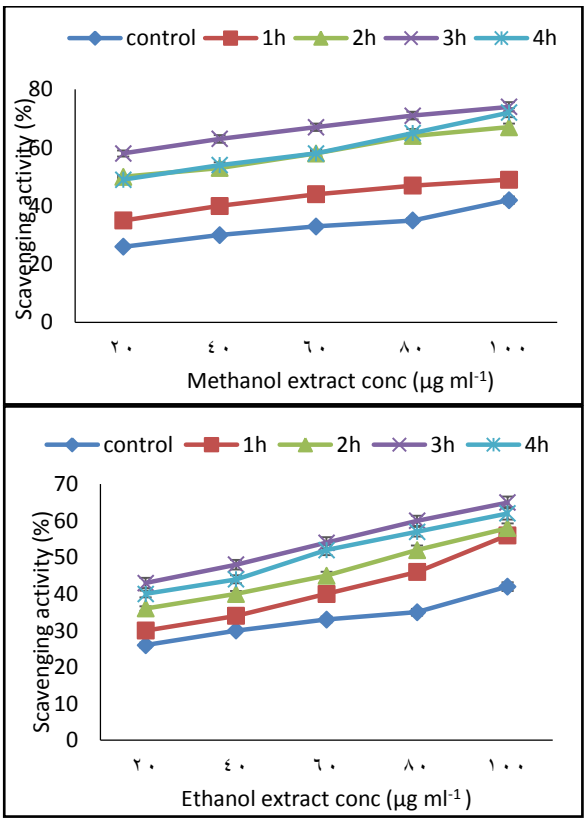


Figure 3: antioxidant activity of methanol and ethanol extracts from *Foeniculum vulgare*

Total phenol content of methanol extract from *Foeniculum vulgare*

Figure 4 shows the continuous increase in total phenol content in the methanol extract throughout the first three hours. However, after the fourth hour the total phenol content declined. The total phenol content value of the ethanol extract from *Foeniculum vulgare* exposed to UVC at 5 cm also increased in the same manner recorded for methanol extract.

Vitamin C content of ethanol and methanol extract from *Foeniculum vulgare*

Vitamin C content of methanol and ethanol extracts from *Foeniculum vulgare* illustrated in Figure 5 indicated continuous increase in vitamin C in *Foeniculum vulgare* by exposure to UVC at 5 cm for 1, 2 and 3 hours but after the fourth hour the vitamin C content decreased.

Tocopherol content of methanol and ethanol extracts from *Foeniculum vulgare*

Figure 6 shows the tocopherol contents in methanol and ethanol extracts from *Foeniculum vulgare* increased by exposed to UVC at 5 cm and the exposure intervals 1h, 2h, and 3h whereas exposure for 4 h resulted in reduction of tocopherol.

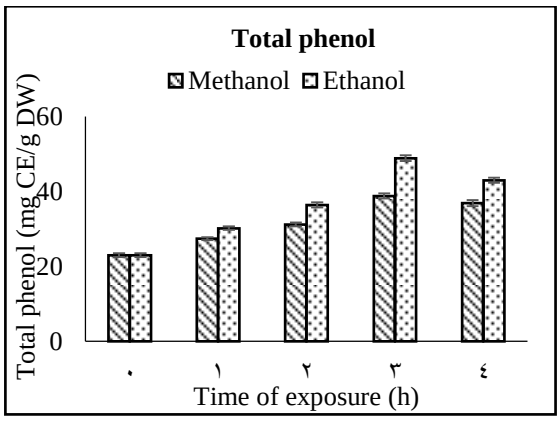


Figure 4: Total phenol content of methanol and ethanol extracts from *Foeniculum vulgare*

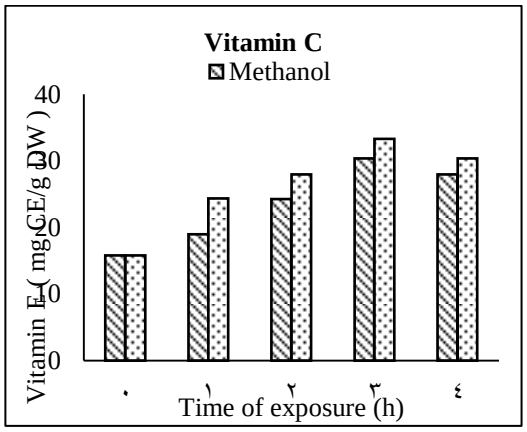


Figure 5: Vitamin C content of methanol and ethanol extracts from *Foeniculum vulgare*

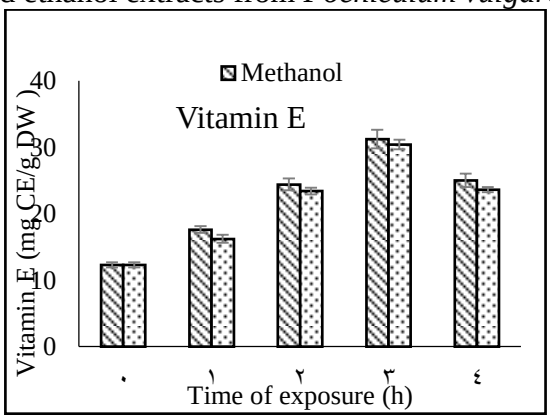


Figure 6: Vitamin E content of methanol and ethanol extracts from *Foeniculum vulgare*

Antioxidant enzymes in *Foeniculum vulgare*

Superoxide dismutase (SOD)

The activity of SOD was estimated in extract prepared from *Foeniculum vulgare* and the results shown in Figure 7 indicate continuous increase in the enzyme activities after exposure to UVC for 1, 2 and 3 hours after which it declined by exposure for 4 hours.

Ascorbate peroxidase (APX)

The APX activity was measured in *Foeniculum vulgare* after exposure to UVC for

1, 2, 3 and 4 hours and the results presented in Figure 7 revealed an increase in the enzyme activity by exposure to UVC until the third hour but after the fourth hour the activity declined.

Glutathione reductase (GR)

The activity of glutathione reductase in extract prepared from *Foeniculum vulgare* was measured and shown in Figure 7. The result indicated continuous increase in the enzyme activity by increasing the exposure time to 3 hours then declined during the fourth hour.

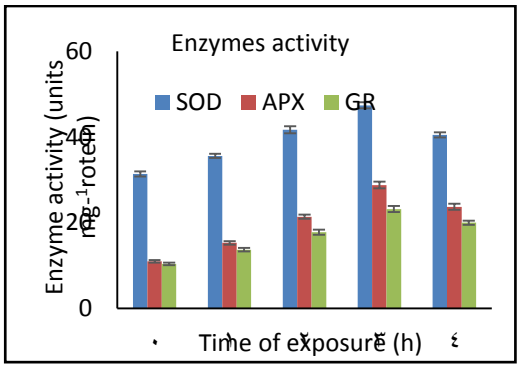


Figure 7: Enzymes activity in *Foeniculum vulgare*

Seeds growth (morphological structure)

Figure 8 shows *Foeniculum vulgare* seeds growth before and after exposure to UVC for different interval times (1, 2, 3 and 4 hours) at distance 5 cm. The growth such as plant shape, straightness of branch growth, greenness, and number of grown seeds was affected by exposure to UVC. It means that UVC effected on the internal structure of seeds as proved before in x-ray and IR analysis.

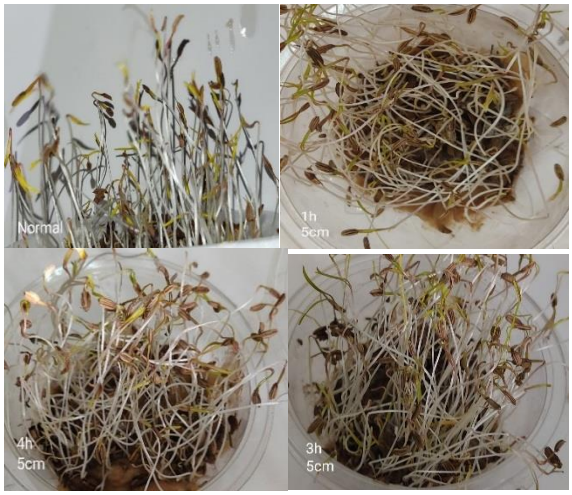


Figure 8: seeds growth before and after exposure to UVC

Seeds weight (volumetrically change)

The weight of *Foeniculum vulgare* seeds decreased after exposure to UVC for time intervals (1, 2, 3 and 4 hours) at distance 5 cm as seen in Table 3. It means that UVC effected the seed's geometrical structure

Table 3: seeds weight (g) before and after exposure to UVC

Time	Plant seeds weight (g)
Normal	5
1hour	4.85
2hour	4.84
3hour	4.79
4hour	4.77

Conclusion

The growth criteria of *Foeniculum vulgare* affected after exposure to UVC. Thus, UVC radiation effected on the internal structure of seeds as proved before by x-ray and IR analysis. The seeds weight decreased by exposure to UVC. It means UVC effected the geometrical structure of seeds. *Foeniculum vulgare* enzyme activity, tocopherol content, vitamin C, total phenol content and antioxidant activity values increased by increasing the exposure time to 3 hours then declined during the fourth hour. The increase of these contents during the first three hours of exposure may be due to induction of the enzymes involved in biosynthesis of these components. However, this decline may be due to inactivation of these enzymes at prolonged time of UVC exposure.

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