IMPACT OF SUPPLYING SOME SAFE NATURAL HONEY BEE PRODUCTS ON THEPRODUCTION OF FENNEL PLANTS

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ABSTRACT

Honey bee products as propolis (Pp) and Royal jelly (RJ) are natural mixture and powerful source of safe nutrients that could be used in agriculture safely as substitution of poisonous and dangerous chemical fertilizers. The impact of using them either solely or in interaction as foliar application on some Fennel morphological traits, seed (fruit) yield, oil production and its main components and chemical constituents has been investigated in a field research during (2017/2018 and 2018/2019) at the Experimental farm in Faculty of agriculture, fayoum University. RJ and Pp were foliary sprayed at three rates 0.0, 0.2, 0.4% and 0, 3, 6 gL-1 respectively in sole and interaction treatments. All records assured that the application of both materials (RJ, Pp) have a positive useful impact on all traits studied either used individually or in interaction. The moderate concentrations of both materials individually or interaction (0.2 % RJ, 3 gL-1 Pp) gave the highest records of growth and yield characters and Anethole compared with other treatments with more superiority of Rj results over those of Pp in sole treatments even though Rj concentration is less than that of Pp especially in oil percentage and umbels number. On the other side, the highest concentration of either Rj (0.4%) or moderate one of Pp (3 gL-1) as sole treatment or in combination gave the highest records of most chemical composition. As well as 0.4% Rj with 6 gL-1 Pp produced the highest percentage of Estragole. Hence, fennel plants can be safely grown and highly produced by these safe natural materials without the help of the poisonous chemical fertilizers.

Keywords: *Foeniculum vulgare, Propolis, Royal Jelly, Foliar spray, Essential volatile oiland Anethole*

Fennel (*Foeniculum vulgare* Mill.) is a hardy, perennial, umbelliferous (Apiaceae) highly aromatic herb with a characteristic aniseed flavour and native to the Mediterranean areas that has become widely naturalized in many parts of the world (Barros *et al.,* 2010). It is considered also as the most important economic medicinal plant (Kandil, 2002). Fennel has the potential to be used in in food products as flavouring agents as in liqueurs, bread, cheese, pickles and pastries (Zoubiri *et al.,* 2014) as well as a constituent of cosmetics and pharmaceutical products (Telci *et al.,* 2009).Fennel is used traditionally in Europe and Mediterranean areas as antispasmodic, diuretic, anti-inflammatory, analgesic, secretomotor, secretolytic, and eye lotion (Gori *et al.,* 2012). Aswell as, it has been reported that fennel fruits have anticancer (Anand *et al.,* 2008) antioxidant and antimicrobial (Ruberto *et al.,* 2000), hepatoprotective (Ozbek *et al.,* 2004) and antihypertensive activities (Nyemba *et al.,* 1995 and Ono *et al.,* 1996). Moreover, effectiveness of fennel essential oil as acaricidal (Lee, 2004), antifungal (Singh et al., 2006), insecticidal and repellent against insects (Bertoli *et al.,* 2012) emmenagogue and galactagogue (Babu *et al.,* 2010) and in reducing infantile colic [Alexandrovich *et al.,* 2003] has been evaluated as well. All these marvelous attributes may turns back to its richness in carbohydrates, including sugars (Cataldi *et al.,* 1998),minerals (O¨zcan and Akbulut, 2007; O¨zcan, *et al.,* 2008) and essential fatty acids (Vardavas *et al.,* 2006), protein and fiber (Boori *et al.,* 2017). Also being considered as a spice could be due to terpenic compounds isolated from its fruit volatile oil (Abdallah *et al.,* 1978). The presence of phenolics, flavonoids, Vit. C and other natural active constituents may explain the antioxidant property of sweet fennel cultivars (Salama *et al.,* 2015). *F. vulgare* is precious for its essential oil which give it the characteristic anise odour that makes it an excellent flavouring agent. *F.vulgare* seed essential oil major components have been reported to be trans-anethole, fenchone, estragol (methyl chavicol), and a-phellandrene, (Rather *et al.,* 2016) of which their relative concentration varies considerably according to the phonological state and origin of the fennel (Diaaz- Maroto *et al.,* 2006). The method of extraction and geographical origin can alter the composition of *F. vulgare* essential oil as well (Rather *et al.,* 2016).

Due to people awareness and eagerness towards healthy products, the use of alternate natural materials as honey bee products in agriculture has paid the attention lately. Honey bee products like propolis and Royal jelly (RJ) are natural mixture and powerful source of safe nutrients that could be used safely in dispense of poisonous and dangerous chemical fertilizers. Propolis or bee glue is a natural resinous hive product which bees collect from plants, particularly from flowers and leaf buds (Babaei *et al.,* 2016) to seal and save the hive from intruders and natural phenomena (Souza and Palma, 2009). The potential importance and efficacy of propolis is due to its variable chemical compounds as poly-phenols

(flavonoid aglycones, phenolic acids and their esters, phenolic aldehydes, alcohols, and ketones), terpenoids, steroids, amino acids and inorganic compounds (Salatino *et al.,* 2005 and Bankova, 2005). Chemical composition of Propolis depends on its floral origin with constituents varying widely due to climate and geographical conditions (Kosalec *et al.,* 2004; Seidel *et al.,* 2008). Such composition may stand behind the various biological properties propolis possesses such as antibacterial, antifungal, antiviral, antioxidant, hepatoprotective and immuno-stimulating activities (Piccinelli *et al.,* 2011 and Bankova, 2005)

Because of its exceptional biological properties attributed to it, royal jelly (RJ) has considerable commercial appeal and is now utilized in many sectors; pharmaceutical and food industries and the cosmetic and manufacturing sectors. As a result, this led to large-scale importation of this product in countries where production is insufficient to meet domestic demand. RJ is whitish substance with a gelatinous consistency, often not homogenous due to the presence of undissolved granules of varying size and has a distinctively sharp odour and taste (Sabatini *et al.,* 2009).

Being one of the honey bee products, so the main constituents of RJ reported are proteins,carbohydrates and lipids (Takenaka and Echigo, 1980; Garcia-Amoedo and Almeida- Muradian, 2007). It is manufactured from pollens, water and honey mixed with saliva, hormones and vitamins (Nassef and El-Aref 2016). Hence, it contains variable amounts of minerals, vitamins particularly B vitamin and pheromones (Gene Bruno 2005)

This exclusive nourishment for bee queen, (RJ), has been used since ancient times for care and human health and it still has importance in traditional and folkloristic medicine, especially in Asia within the apitherapy. RJ and its derived compounds show a highest activity especially against Gram positive bacteria (Fratinia *et al.,* 2016). As well as, anti- inflammatory, immunomodulatory, neuromodulatory, metabolic syndrome preventing,anti-aging activities (Cornara *et al.,* 2017) antioxidant properties (Guo *et al.,* 2008) antibacterial, antifungal and antiviral (Viuda-Martos *et al.,* 2008 and Barnutiu *et al.,* 2011) were also reported.

MATERIALS AND METHODS

Plant material and growing conditions

The present investigation was carried out at the Experimental Farm in Faculty of Agriculture, Fayoum University, during two successive seasons of (2017/2018 and 2018/2019). This investigation aimed to study the effect of Royal jelly queens (RJ) and Propolis (Pp) aqueous extract as individual and interaction effect on the growth, seed (fruit) yield, oil production and its main components and chemical constituents of Fennel (*Foeniculum vulgare*, Mill,) plants.

The local seeds of Fennel were kindly obtained from Medicinal and Aromatic Plants Research Department NRC, Dokky, Giza, Egypt. Seeds were sown on 9th and 8th ofOct. (for two seasons, respectively). Five seeds were sown in each hill at 35cm apart and then were thinned (at the age of 30 days) to two plants. Plants received the normal agricultural practices as needed.

The layout of the experiment used was "factorial experimental" in complete randomized block design system with three replicates. Each replicate contained 3 plots each plot contained four rows. The plot area was (2.8 × 2.4) = 6.72 m^2 and included 4 rows each row was 60 cm apart and 2.8m in length.

In addition, received uniform treatments of manure 25 m^3/Fad., irrigation and fertilization at the field according to recommended practices, i.e. fennel plants fertilized with NPK fertilization at (200: 200: 100) kg/fed/season. The sources of NPK chemical fertilizer were ammonium sulphate (20.6% N), calcium super/ phosphate (15.5% P_2O_5) and potassium sulphate (48% K_2O) according to (Mohamed, 2009). Application of calcium superphosphate was added as one dose during the preparation of the soil. Half of the N. and K. rates were added after 50 days after sowing and the second addition was done after 30 days from the first one. Prior to any practices, a composite soil sample was taken from the soil surface (0-30 cm) of the experimental site. Physical and chemical analyses of the experimental soil were determined according to (Jackson, 1973) and (Black *et al.,* 1982), respectively. The obtained results of soil analyses are presented in Table (a).

Table (a). *Some initial physic- chemical characteristics of the studied soils*

Years	Mechanical analysis				Hydraulic conductivity (cm3/hr)						
	Sand %	Silt %	Clay %	Texture class							
2017	10	20	70	clay	0.028						
2018	9	21	70	clay	0.029						
Years	Chemical properties										
	Mg Kg^{-1} soil							EC dSm^{-1}	pH	CaCo3 %	Organic matter%
	N	P	K	Fe	Zn	Mg	Mn				
2017	17.57	37332	69939	3.73	0.89	0.37	8.73	1.91	7.52	3382	1.11
2018	18.67	97738	79239	3.66	0.87	0.39	8.78	1.89	7.49	3393	1.15

Preparation and analysis of chemical constituents of RJ and Pp

(RJ) extract and (Pp) were added as foliar application at 0.0, 0.2, 0.4% and 0, 3, 6gL^{-1} respectively. Triton B was added to the spray solution to serve at 0.1 % as a wetting agent was used. These applications were added three times /season. The first one was sprayed after 50 days from sowing, followed by the second and the third ones after 3 and 6 weeks from the first one, respectively.

(RJ) treatments were obtained from the Experimental farm apiary (bee yard) in the Faculty of Agriculture, Fayoum Univ. on March 2017\18 and stored in the freezer till it was applied as foliar application.

The chemical composition of (RJ) assessed by GC–MS are presented in Table (b).

Chemical analysis	**Content**	**Chemical analysis**	**Content**
Moisture %	60.84	pH	3.4
Ash %	1.02	Total Phenolics (µg as gallic acid / mg sample)	22.4
Protein %	12.57	Total Flavonoids (µg as rutin / mg sample)	1.51
Fat %	9.85	Total carbohydrate %	15.72

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	RJ		
IC50=	**0.32**		

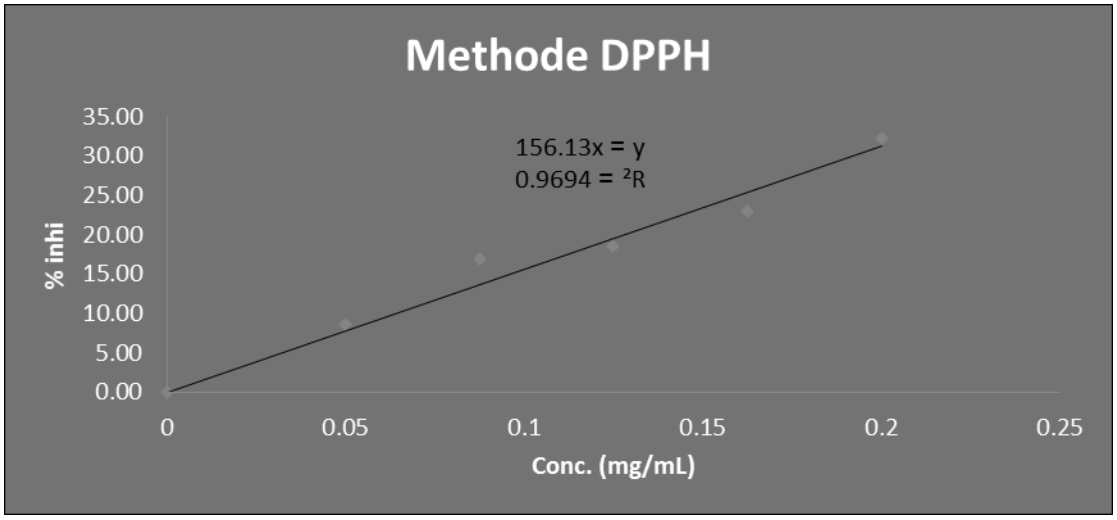
TEAC (µmol Trolox/g)			**Vit C(µmol Vit C/g)**	**Vit E (µmol Vit E/g)**
RJ	271.17		256.55	226.01
TEAC (gTrolox/g)			**Vit C(g Vit C/g)**	**Vit E (g Vit E/g)**
RJ	0.0679		0.0452	0.0973
Antioxidant capacity				
	EC50			**ARP**
RJ	0.32			3.125
	RJ			
IC50=	**0.16**			

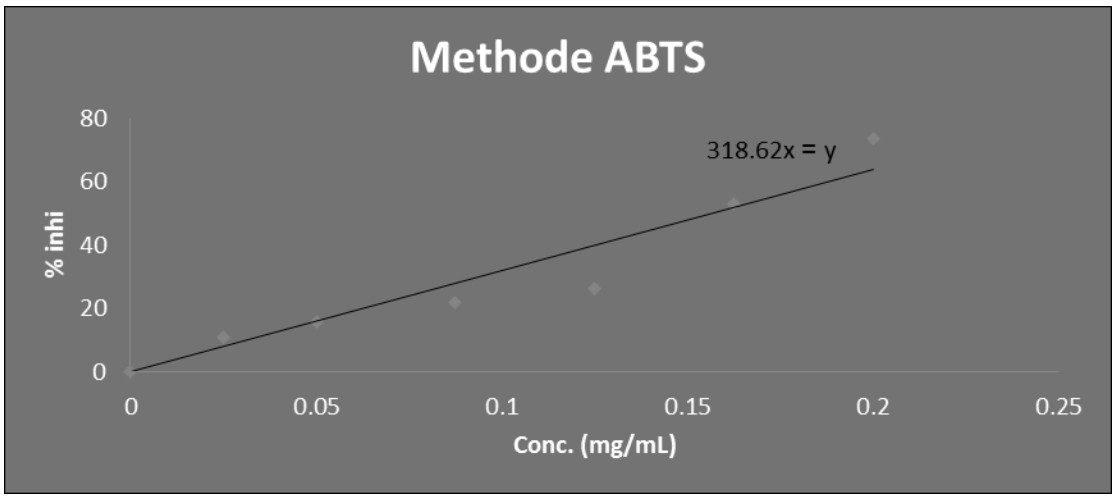
TEAC (µmol Trolox/g)		**Vit C(µmol Vit C/g)**	**Vit E (µmol Vit E/g)**
RJ	553.38	523.56	461.23
TEAC (g Trolox /g)		**Vit C (g Vit C /g)**	**Vit E (g Vit E /g)**
RJ	1.39E-01	9.22E-02	1.99E-01
	Antioxidant capacity		
	EC 50	**ARP**	
RJ	0.16	6.37	
		RJ	
IC50 =		**0.13**	

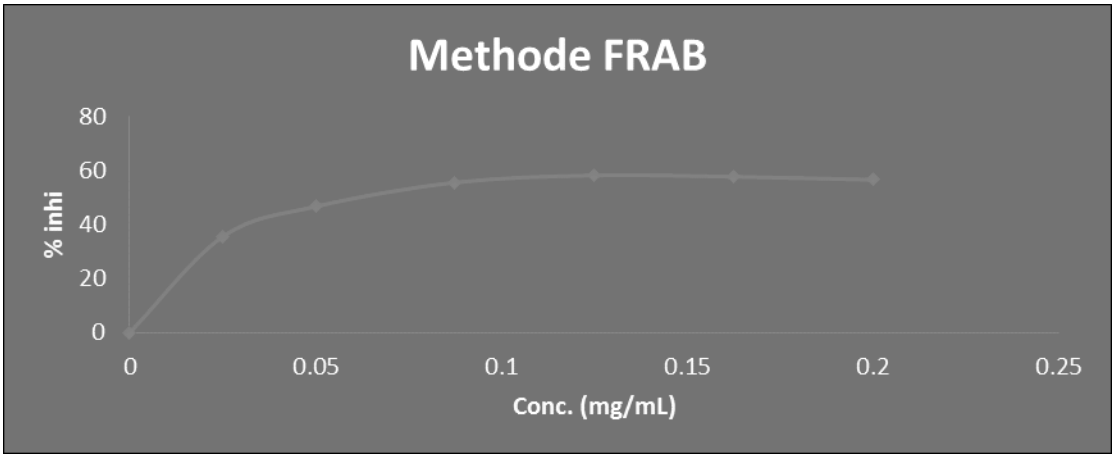
	TEAC (µmol Trolox/g)	**Vit C(µmol Vit C/g)**	**Vit E (µmol Vit E/g)**
RJ	674.54	638.19	562.22
	TEAC (gTrolox/g)	**Vit C(g Vit C/g)**	**Vit E (g Vit E/g)**
RJ	1.69E-01	1.12E-01	2.42E-01
	Antioxidant capacity		
	EC 50	**ARP**	
RJ	0.13	7.77	

Test Method	**EC50**	**ARP**	**TEAC (g Trolox/g)**	**Vit C(g Vit C/g)**	**Vit E (g Vit E/g)**

DPPH	0.13	7.77	0.068	0.045	0.097
ABTS	0.16	6.37	1.39E-01	9.22E-02	1.99E-01







For collection, propolis produced by bees in wooden hives was scarped from the cover and entrances of the hives with a stainless steel spatula. The samples were kept in glass bottles at 10 c◦ until used. Propolis samples (5g) were extracted by using distilled water 250 ml, sonicated for 1h, and left to stand for 24 h at 25 c◦ , the filtered extract was evaporated to dryness under reduced pressure to yield a brown powder (Chen *et al.,* 2004). Dry residue was redissolved distilled water to make up different concentrations (0,3 and 6 gL^{-1}).

Table (c) Some of the chemical characteristics of the propolis (Pp) and extracts identified by GC/MS.

Parameter (units)	Propolis	Parameter (units)	Propolis
Total terpenoids (%)	2.28	Potassium (ppm)	164
Total flavenoids (%)	0.26	Magnesium (ppm)	52
Phenolic acids (%)	0.31	Calcium (ppm)	67
Total sugars (%)	1.37	Iron (ppm)	23
Total amino acids (%)	0.21	Mn (ppm)	13
Ascorbic acid; vitamin C (ppm)	97	Iodine (ppm)	11
Total B-group vitamins (ppm)	158	Zn (ppm)	10
Vitamin E (ppm)	64	Cu (ppm)	7

Chemical characteristics of (Pp) which were determined and identified by GC/MS are presented in Table (c).

The plants were sprayed twice at the vegetative stage and once at the beginning ofthe flowering stage. Sprays were applied in the morning (8-10 a.m.) using a hand pressure sprayer. The control plants were sprayed with distilled water. The volume of the spraying solution was maintained just to cover completely the plant foliage until drip. All agriculture practices operations other than experimental treatments necessary for growth and development as cultivation, fertilization, irrigation and pest control were followed whenever it was necessary and were done according to the recommendations of Ministry of Agriculture, Egypt.

Growth and Fennel yield measurements

At the age of 160 days (during vegetative stage), the outer two rows (1st and 4th)of each plot were chosen from each experimental unit and cut off at ground level and submitted to the following determinations:-

Plant height (cm), number of branches $plant^{-1}$, fresh (FW) and dry weight (DW) $plant^{-1}$ (g), root weight $plant^{-1}$ (g), root length (cm) $plant^{-1}$

Oil production and Yield attributes

At full maturity fruit stage (190 days), the central ridges were chosen from each experimental unit, to estimation the following yield characters: -

Number of umbels plant^{-1}, fruit yield plant^{-1} (g), essential oil (%) was determined in the fruits (seeds) using water distillation methods and Essential oil yield plant^{-1} (ml) was calculated in proportion to fruit weight.

Oil yield= {fruit yield * oil content (%)}\ 100 = plant (ml)

Essential oils distillation (extraction):

Essential oil was quantified gravimetrically by hydro-distillation according to the European Pharmacopoeia (EP) (Anonymous, 2000). Fruit samples of each plot were hydro-distilled for 2 h using a Clevenger-type apparatus. The essential oil content was quantified gravimetrically. Each sample was analyzed in three replications and the average was used for statistical analyses. The essential oil concentration was calculated as the amount (g) of oil per weight (g) of dry anise fruits, while the oil yield per area was calculated from the fruit yields per area and oil content of every anise accession and replicate. In order to determine the seed's essential oil content, 100 g of powdered anise samples in 0.5 L of water were extracted from each plant population for determining the oil content (v/w%).

The oil was dried over anhydrous sodium sulphate N a2SO4. The obtained essential oil was kept at 4°C in dark glass containers for further lab analyses. 1.0 ml (density = 1.04 g/ml) (Cheronis and Entrikin, 1963)

Gas chromatography-mass spectrometry analysis of essential oil (GC-MS Conditions)

Gas chromatography–mass spectrometry analysis (GC-MS) was carried out using Agilent auto system 7890B GC-MS equipped with HB-5MS capillary column (5% phenyl–95% dimethyl polysiloxane, 30 m × 0.25 mm × 0.25 μm). Carrier gas was helium with flowrate of 1 ml/min. Oven temperature was kept at 50 °C for 5 min, and programmed to 250 °C at a rate of 5°C/min, then fixed at 250 °C for 10 min. The injector,GC–MS interface, ion source and mass detector temperature were maintained at 230, 270,200 and 150°C, respectively. Mass spectra were taken at 70 eV. Scan duration was 0.25 sec. and mass rang was 50–500 Da.

1μl of sample was injected at a split ratio of 1:50. The ionization of the sample was performed in the EI ion source (70 eV) and the acquisition mass range was set at 35- 500 amu. Identification of components was based on comparison of their mass spectra (using molecular ion (M+) peak and the m/z values) with those provided in mass spectra library NIST (2007) and in literature. The relative peak area percentages were used to report the abundance of a compound in the extracts.

Chlorophyll fluorescence measurements

Leaf pigments content was determined in freshly collected leaf samples which were extracted using acetone 80% and determined colorimetrically according to (Metzner *et al.,* 1965). Thereafter, the chlorophyll content was spectro--photometrically analyzed, in a UV visible spectrophotometer (Optizen Pop, Mecasys - Korea) using 3 ml sealed quartz-glass cuvettes with a path length of 1 cm at wave length of 663 µm for chlorophyll a, 644 µm for chlorophyll b and 452.5 µm for carotenoids. The chlorophyll content was calculated as mg/g fresh weight of leaves.

Determination of macro-nutrient concentrations, Total carbohydrates and Total soluble sugar

Total macronutrients (N, P and K) content in fennel leaves were determined after they were ground and wet washing. Total nitrogen was determined by using semi-micro Kjeldahl method according to (Black *et al.,* 1982). Total phosphorus was determined using Spectrophotometer and leaf content of potassium was estimated photo-metrically using a flame photometer as described by (Jackson, 1973).

Total carbohydrates content (%) were determined in powedered dry matter of Fennel herb determined color-metrically at the beginning of flowering stage according to (Herbert *et al.,* 1971).

Total soluble sugar concentration of Fennel fruit was assessed according to (Irigoyen *et al.,* 1992), using a UV-160A UV Visible Recording Spectrometer, Shimadzu, Japan.

Anti-oxidant enzyme assays:

Plant samples were prepared as described by (Mukherjee and Choudhuri, 1983). A fresh sample (250 mg) was frozen in liquid nitrogen and finely ground by pestle in a chilled motor. The frozen powder was added to 10 ml of 100 mM phosphate buffer (KH_2PO_4 /K_2HPO_4, pH 7.0) containing 0.1 mM Na_2EDTA and 0.1g of polyvinyl pyrrolidone (PVP). The homogenate was filtered through cheesecloth then centrifuged at 15000 g for 10 min. The supernatant was recentrifuged at 18000 g for 10 min; the resulted supernatant was collected and stored at 4 ˚C for assay of catalase (CAT), peroxidase (POD) and ascorbate peroxidase (APX).

CAT (EC 1.11.1.6) activity: CAT activity is measured by the decrease of absorbance at 240 nm as a consequence of H_2O_2consumption and was expressed according to (Havir and Mellate, 1987)

POD (EC 1.11.1.7) activity POD activity is determined according to (Maehly andChance, 1954).

APX (EC 1.11.1.11) activity: APX activity is determined from the decrease in absorbance ascorbic at 290 nm as ascorbic acid oxidized (Asada and Chen, 1992).
malondialdehyde (Lipid peroxidation MDA) measurements

A level of lipid peroxidation was measured in terms of malondialdehyde (MDA) content using the method of (Heath and Packer, 1968). To 2.0 ml aliquot of the supernatant 4.0 ml of 0.5% thiobarbituric acid (TBA) in 20 % TCA was added. The mixture was heated at 95^{o}C for 30 min and then quickly cooled in an ice bath centrifugation at 10000 g for 10 min. The absorbance of supernatant was recorded at 532 nm. The value for non-specific absorption at 600 nm was subtracted. The MDA content was calculated using its absorption coefficient of 155 $nmol^{-1}$ cm^{-1} and expressed as nmol (MDA) g^{-1} fresh weight.

Statistical analysis

Appropriate analysis of variance was performed on gained data. Comparisons among means of treatments were performed using the Revised Least Significant Difference procedure at P= 0.05 level as illustrated by (Waller and Duncan, 1969).

RESULTS

Effects of Pp and Rj aqueous extract as foliar application on some Fennel morphological traits and yield components as a Sole treatment

As (Table I) indicates, there was increment in all growth characters over the control because of the use of RJ or Pp as sole treatment in both seasons. The most rate to give the highest result was the moderate one of either substance (0.2 % RJ, 3 gL^{-1} Pp) with significant differences between results in all traits of vegetative growth except for Ppresults of plant height which show insignificant differences.

The same trend was found in yield components as 0.2 % of RJ fruited significantly with the highest Fruit weight $plant^{-1}$, oil content $plant^{-1}$, umbels number and oil percentage in both seasons. Concerning the effect of Pp on oil yield, 3 gL^{-1} of Pp significantly resulted in the highest Fruit weight $plant^{-1}$, oil content $plant^{-1}$ while the highest concentration of Pp significantly produced the highest values of umbels number and oil percentage in both seasons.

Influence of the interaction between Pp and Rj aqueous extract as foliar application onsome Fennel morphological traits and yield components

The interaction between RJ and Pp was of obvious positive significant effect on all growth and yield traits over the control. The mixture between the moderate rates of both materials together (2 % RJ and 3 gL^{-1} Pp) gave the best results of most growth and yield characters; fresh and dry weight $plant^{-1}$, root length and root weight $plant^{-1}$, fruit weight and oil percentage and content. 4% of RJ with 3 gL^{-}

^{1} Pp gave significantly the tallest plants in both seasons. Whereas, the highest rates of both materials (RJ and Pp) when sprayed together gave greatly and significantly the highest number of umbels in both seasons. The highest number of branches ranged between 2% RJ with 6 or 4 gL^{-1} of Pp in the first and second season respectively (Table I).

Effects of Pp and Rj aqueous extract as foliar application on some Fennel chemical constituents and Anti-oxidant enzyme assays as a Sole treatment

The use of either material (RJ and Pp) solely was of positive significant effect on all chemical components studied (Table II) over the control in both seasons. The most effective rate in this regard was 4% of RJ which gave the highest values of Ch a, b, c, total carbohydrates and content of N and P, ascorbate peroxidase (APX), Catalase $EUmg^{-1}$ protein and Peroxidase (POD). However, the moderate rate of RJ (2%) had the highest results of Percentage of K (%) and total soluble sugars of fennel seed. On the other side, most of the chemical traits were highly increased by the moderate concentration of Pp (3 gL^{-1}). But this was not true for the Percentage of K (%), total soluble sugars of fennel seed, Catalase $EUmg^{-1}$ protein and Peroxidase (POD) which showed increment with the highest rate of Pp (6 gL^{-1}) in both seasons. There were not significant differences between all values of ascorbate peroxidase in the first season however these differences were not found only between values of the moderate and the highest concentration in the second season with the moderate concentration having superiority in giving the highest value over other treatments. Differences between values were significant in all treatments except for percentage of K values which showed insignificant differences.

Influence of the interaction between Pp and Rj on chemical constituents and Anti-oxidant enzyme assays

Likewise, the interaction positively and significantly produced the best and highest results over the control in both seasons. Nevertheless, the best treatment to give the highest result for Ch. a, b, c, total carbohydrates, ascorbate peroxidase (APX), Peroxidase (POD) and content of N and P was 4% RJ with 3 gL^{-1} Pp. The highest concentration of both materials gave significantly the highest value of Catalase $EUmg^{-1}$ protein in both seasons. While 2% RJ with 3 or 6 gL^{-1} Pp fruited with the highest results of malondialdehyde nmol (MDA), Total soluble sugars of fennel seed and Percentage of K (%) (Table II).

Chemical constituents (%) of the essential oils of fennel as affected by RJ aqueous extractand Pp treatments.

The interaction between the moderate concentration of both materials; 0.2% Rjand 3 gL^{-1} Pp produced the highest percentage of α-Thujune, Anethole, Ý-

Terpinene, α- Thujune, Camphor, Anethole and Thymole. While the highest concentrations of both materials (0.4% Rj and 6 gL^{-1} Pp) when applied together gave the highest result of D.limonene, Estragole, α.pinene, Camphene, β.Terpinene, β.myrcene, α.phellandrene, D. limonene, Eucalyptol and Cis-ocimene, as shown (Table III) and (Figures, I and II).

Table 1. *Effects of Pp and Rj aqueous extract as foliar application and their interaction on someFennel morphological traits and yield components*

Pp / Rj	Plant height plant^{-1} (cm)							
	1st season (2017-18)				2nd season (2018-19)			
	0 gL^{-1}	3 gL^{-1}	6 gL^{-1}	Mean	0 gL^{-1}	3 gL^{-1}	6 gL^{-1}	Mean
0.0 %	87.67^{d}	116.67^{ab}	120.00^{a}	108.11^{a}	81.00^{e}	121.67^{abc}	120.00^{bc}	107.56^{a}
0.2 %	96.67^{cd}	123.33^{a}	116.67^{ab}	112.22^{a}	96.67^{d}	126.67^{ab}	116.67^{bc}	113.33^{a}
0.4 %	106.67^{bc}	126.67^{a}	93.33^{d}	108.89^{a}	110.00^{c}	133.33^{a}	96.67^{d}	113.33^{a}
Mean	97.00^{c}	122.22^{a}	110.00^{b}		95.89^{c}	127.22^{a}	111.11^{b}	
Branches number plant^{-1}								
0.0 %	3.33^{c}	4.00^{abc}	3.33^{c}	3.56^{b}	3.33^{d}	4.33^{bc}	4.67^{ab}	4.11^{b}
0.2 %	4.33^{ab}	4.33^{ab}	4.67^{a}	4.44^{a}	5.33^{a}	5.33^{a}	4.67^{ab}	5.11^{a}
0.4 %	3.33^{c}	4.00^{abc}	3.67^{bc}	3.67^{b}	3.67^{cd}	4.33^{bc}	4.33^{bc}	4.11^{b}
Mean	3.67^{b}	4.11^{a}	3.89^{ab}		4.11^{a}	4.67^{a}	4.56^{a}	
Fresh weight plant^{-1} (g)								
0.0 %	190.33^{e}	401.33^{bc}	239.67^{de}	277.11^{b}	194.67^{e}	403.67^{bc}	237.33^{de}	278.56^{b}
0.2 %	449.00^{b}	515.00^{a}	420.00^{b}	461.33^{a}	459.33^{ab}	522.33^{a}	424.67^{bc}	468.78^{a}
0.4 %	281.67^{d}	356.33^{c}	274.00^{d}	304.00^{b}	286.00^{d}	377.33^{c}	276.33^{d}	313.22^{b}
Mean	307.00^{b}	424.22^{a}	311.22^{b}		313.33^{b}	434.44^{a}	312.78^{b}	
Dry weight plant^{-1} (g)								
0.0 %	45.92^{f}	96.17^{bc}	58.25^{e}	66.78^{c}	50.33^{e}	101.75^{bc}	61.00^{de}	71.03^{b}
0.2 %	73.92^{d}	129.58^{a}	101.67^{b}	101.72^{a}	96.50^{bc}	129.75^{a}	106.17^{b}	110.81^{a}
0.4 %	67.25^{de}	89.75^{c}	69.33^{d}	75.44^{b}	71.33^{d}	90.33^{c}	71.58^{d}	77.75^{b}
Mean	62.36^{c}	105.17^{a}	76.42^{b}		72.72^{b}	107.28^{a}	79.58^{b}	
Root length plant^{-1} (cm)								
0.0 %	9.72^{d}	14.85^{b}	16.61^{ab}	13.73^{c}	9.26^{f}	13.10^{d}	14.23^{cd}	12.20^{c}
0.2 %	16.19^{ab}	17.25^{a}	17.05^{a}	16.83^{a}	15.47^{ab}	16.53^{a}	16.48^{a}	16.16^{a}
0.4 %	17.24^{a}	15.84^{ab}	12.02^{c}	15.03^{b}	16.52^{a}	15.02^{bc}	10.53^{e}	14.02^{b}
Mean	14.39^{b}	15.98^{a}	15.23^{ab}		13.75^{b}	14.88^{a}	13.75^{b}	
Root weight plant^{-1} (g)								
0.0 %	2.45^{e}	4.48^{d}	3.07^{de}	3.33^{b}	2.91^{e}	4.24^{d}	2.36^{e}	3.17^{c}
0.2 %	8.32^{ab}	8.93^{a}	6.78^{bc}	8.01^{a}	6.79^{bc}	8.94^{a}	8.21^{a}	7.98^{a}
0.4 %	8.56^{a}	6.50^{c}	6.71^{bc}	7.26^{a}	6.10^{c}	6.06^{c}	7.23^{b}	6.46^{b}
Mean	6.45^{b}	6.64^{a}	5.52^{b}		5.27^{b}	6.41^{a}	5.93^{a}	
Umbels umber plant^{-1}								
0.0 %	15.00^{e}	23.67^{cd}	19.67^{de}	19.44^{b}	18.67^{c}	20.67^{c}	27.33^{b}	22.22^{b}
0.2 %	22.67^{cd}	32.33^{ab}	27.33^{bc}	29.83^{a}	27.33^{b}	36.67^{a}	24.00^{bc}	30.34^{a}
0.4 %	23.67^{cd}	19.67^{de}	35.33^{a}	26.22^{a}	19.67^{c}	24.67^{bc}	39.00^{a}	27.78^{a}
Mean	20.45^{b}	25.22^{a}	27.44^{a}		21.89^{b}	27.34^{a}	30.11^{a}	
Fruit weight plant^{-1} (g)								
0.0 %	114.00^{g}	211.33^{c}	141.00^{fg}	155.44^{c}	123.33^{g}	214.67^{c}	156.67^{f}	164.89^{c}
0.2 %	206.00^{c}	286.67^{a}	159.67^{ef}	223.17^{a}	214.33^{c}	286.67^{a}	165.00^{ef}	225.84^{a}
0.4 %	200.00^{cd}	171.67^{de}	251.00^{b}	207.56^{b}	206.67^{cd}	186.67^{de}	254.33^{b}	215.84^{b}
Mean	173.33^{b}	223.22^{a}	183.89^{b}		181.44^{b}	229.33^{a}	192.00^{b}	
Oil percentage %								
0.0 %	0.65^{d}	0.79^{c}	0.85^{c}	0.76^{c}	0.66^{d}	0.83^{b}	0.84^{b}	0.75^{b}
0.2 %	0.93^{b}	1.05^{a}	1.03^{a}	1.00^{a}	0.88^{b}	1.02^{a}	1.01^{a}	0.97^{a}

0.4 %	0.83^{c}	1.04^{a}	1.01^{a}	0.96^{b}	0.75^{c}	1.01^{a}	0.99^{a}	0.95^{a}
Mean	0.80^{b}	0.96^{a}	0.96^{a}		0.79^{b}	0.93^{a}	0.95^{a}	
Oil content plant^{-1} (ml)								
0.0 %	0320^{f}	1.67^{cd}	1.20^{e}	1.20^{c}	0383^{f}	1.78^{c}	1.32^{e}	1.30^{c}
0.2 %	3397^{c}	3.01^{a}	1.64^{cd}	2.19^{a}	1.89^{c}	2.92^{a}	1.67^{c}	2.16^{a}
0.4 %	3399^{cd}	1.79^{cd}	2.54^{b}	1.99^{b}	1.55^{cd}	1.89^{c}	2.52^{b}	1.98^{b}
Mean	1.44^{c}	2.15 ^{a}	1.79^{b}		1.42^{c}	2.20^{a}	1.83^{ba}	

Means with a common letter are not significantly different (p > 0.05)

Table 2. *Effects of Pp and Rj and their interaction aqueous extract as foliar application on some Fennelchemicals constituents, Anti-oxidant enzyme assays*

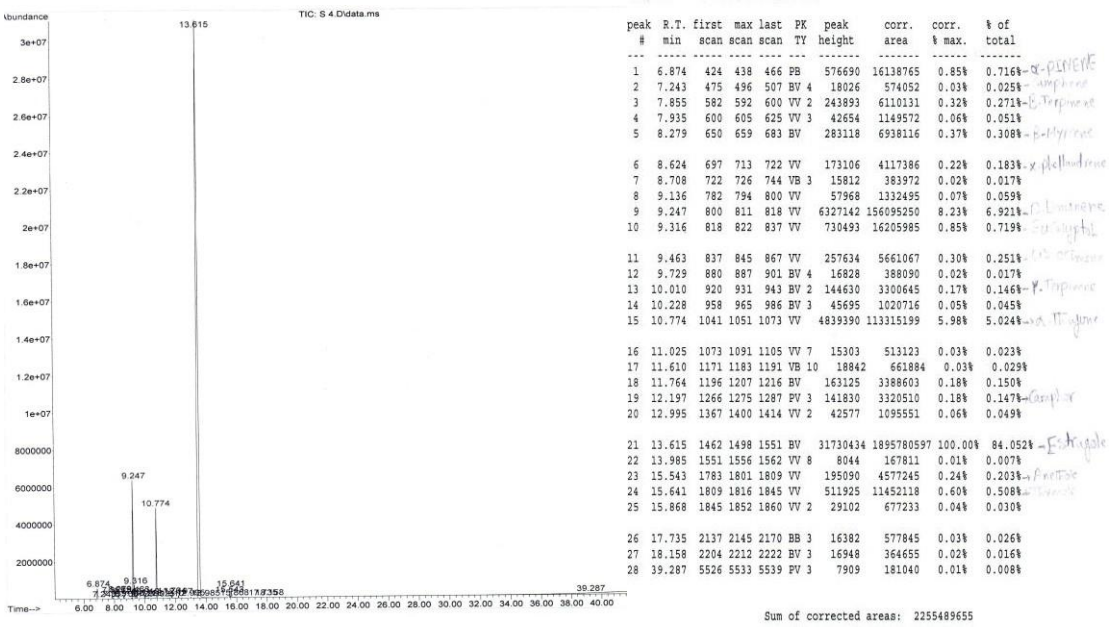
Pp / **Rj**	**Ch a (mgg^{-1} FW)**						
	1st season (2017-18)				**2nd season (2018-19)**		
	0 gL^{-1}	**3 gL^{-1}**	**6 gL^{-1}Mean**		**0 gL^{-1}**	**3 gL^{-1}6 gL^{-1}**	**Mean**
0.0 %	1.25^{f}	1.43^{de}	1.38 ^{e}1.36^{c}		1.24^{f}	1.42^{de}1.38^{e}	1.34^{c}
0.2 %	1.50^{cd}	1.55^{bc}	1.53^{cd}1.53^{b}		1.50^{cd}	1.56^{bc}1.55^{bc}	1.54^{b}
0.4 %	1.51^{cd}	1.68^{a}	1.63^{ab}1.61^{a}		1.52^{cd}	1.70^{a}1.64^{ab}	1.62^{a}
Mean	1.42^{b}	1.56^{a}	1.52^{a}		1.42^{b}1.56^{a}	1.52^{a}	
Ch b (mgg^{-1} FW)							
0.0 %	0.50 ^{f}	0.60^{de}	0.55^{ef}0.55^{c}		0.52^{f}	0.61^{de}0.57^{ef}	0.57^{c}
0.2 %	0.64^{cd}	0.64^{cd}	0.65^{cd}0.66^{b}		0.63^{d}	0.69^{c}0.66^{cd}	0.66^{b}
0.4 %	0.65^{cd}	0.86^{a}	0.76^{b}0.76^{a}		0.65^{cd}	0.84^{a}0.76^{b}	0.75^{a}
Mean	0.60^{c}	0.72^{a}	0.65^{b}		0.60^{c}	0.71^{a}0.66^{b}	
Carotenoids (mgg^{-1} FW)							
0.0 %	0.46^{e}	0.49^{cde}	0.47^{de}0.48^{b}		0.45^{c}	0.52^{abc}0.46^{bc}	0.48^{b}
0.2 %	0.52^{bc}	0.55^{ab}	0.54^{ab}0.54^{a}		0.52^{abc}	0.56^{a}0.54^{a}	0.54^{a}
0.4 %	0.52^{bcd}	0.58^{a}	0.56^{ab}0.55^{a}		0.53^{ab}	0.58^{a}0.57^{a}	0.56^{a}
Mean	0.50^{b}	0.54^{a}	0.53^{ab}		0.50^{b}	0.56^{a}0.52^{ab}	
Total Carbohydrates (mg g^{-1} DW)							
0.0 %	11.65^{bc}	12.95^{abc}	12.26^{abc}	12.29^{b}	10.96^{b}	13.29^{ab}14.65^{a}	12.97^{a}
0.2 %	13.23^{ab}	12.22^{abc}	11.44 ^{c}	12.30^{b}	13.14^{ab}	13.01^{ab}12.38^{ab}	12.84^{a}
0.4 %	13.05^{abc}	13.68^{a}	13.45^{a}	13.40^{a}	14.44^{a}	14.52^{a}13.45^{ab}	14.14^{a}
Mean	12.64^{a}	12.95^{a}	12.38^{a}		12.85^{a}	13.61^{a}13.49^{a}	
Percentage of N (%)							
0.0 %	3.21^{d}	3.53^{bc}	3.44^{cd}	3.39^{b}	3.18^{d}	3.47^{cd}3.51^{bc}	3.39^{b}
0.2 %	3.60^{abc}	3.71^{abc}	3.68^{abc}	3.66^{a}	3.63^{abc}	3.71^{abc}3.71^{abc}	3.68^{a}
0.4 %	3.64^{abc}	3.79^{ab}	3.85^{a}	3.76^{a}	3.63^{abc}	3.86^{a}3.76^{ab}	3.75^{a}
Mean	3.48^{b}	3.68^{a}	3.66^{a}		3.48^{b}	3.68^{a}3.66^{a}	
Percentage of P (%)							
0.0 %	0.48^{c}	0.54^{bc}	0.55^{abc}	0.52^{b}	0.49^{d}	0.54^{bcd}0.50^{cd}	0.51^{b}
0.2 %	0.57^{abc}	0.61^{ab}	0.61^{ab}	0.60^{a}	0.56abcd	0.61^{abc}0.60^{abc}	0.59^{a}
0.4 %	0.58^{abc}	0.67^{a}	0.62^{ab}	0.62^{a}	0.58abcd	0.63^{ab}0.65^{a}	0.62^{a}
Mean	0.54^{a}	0.60^{a}	0.59^{a}		0.54^{a}	0.59^{a}0.58^{a}	
Percentage of K (%)							
0.0 %	4.28^{d}	4.32^{d}	4.60^{c}	4.40^{b}	4.43^{d}	4.56^{cd}4.56^{cd}	4.52^{b}
0.2 %	4.66^{bc}	4.93^{a}	4.82^{ab}	4.80^{a}	4.65^{bc}	4.84^{a}4.78^{ab}	4.76^{a}
0.4 %	4.61^{c}	4.73^{bc}	4.76^{abc}	4.70^{a}	4.62^{bc}	4.71^{abc}4.76^{ab}	4.70^{a}
Mean	4.51^{b}	4.66^{a}	4.73^{a}		4.57^{b}	4.70^{a}4.70^{a}	
Total soluble sugars of fennel seed (mg g^{-1} DW)							
0.0 %	3.55 ^{g}	3.72^{e}	3.72^{e}	3.66^{c}	3.55^{g}	3.72^{e}3.72^{e}	3.66^{c}
0.2 %	3.88^{b}	4.08^{a}	4.08^{a}	4.02^{a}	3.88^{b}	4.08^{a}4.08^{a}	4.02^{a}
0.4 %	3.70^{f}	3.78^{c}	3.76^{d}	3.75^{b}	3.70^{f}	3.76^{d}3.78^{c}	3.75^{b}
Mean	3.71^{c}	3.86^{a}	3.86^{b}		3.71^{c}	3.85^{b}3.86^{a}	

Catalase EUmg^{-1} protein									
0.0 %	4.20^{f}	4.90^{ef}	5.30^{de}	4.80^{c}	4.33^{e}	4.87^{de}	5.40^{cde}		4.87^{b}
0.2 %	5.67^{cde}	6.37^{bc}	6.70^{ab}	6.24^{b}	5.77^{bcde}	6.40^{abcd}	6.67^{abc}		6.28^{a}
0.4 %	6.27^{bcd}	7.13^{ab}	7.53^{a}	6.98^{a}	6.20^{abcd}	7.37^{ab}	7.67^{a}		7.08^{a}
Mean	5.38^{b}	6.13^{a}	6.51^{a}		5.43^{b}	6.21^{ab}	6.58^{a}		
Peroxidase (POD)									
0.0 %	1.71^{f}	1.73^{ef}	1.82^{cde}	1.75^{c}	1.73^{f}	1.7^{ef}	1.87^{cde}		1.78^{c}
0.2 %	1.80^{def}	1.88^{cd}	1.91^{c}	1.87^{b}	1.85^{def}	1.91^{bcd}	1.99^{bc}		1.92^{b}
0.4 %	1.87^{cd}	2.04^{b}	2.19^{a}	2.04^{a}	1.87^{cde}	2.00^{b}	2.14^{a}		2.00^{a}
Mean	1.80^{c}	1.88^{b}	1.98^{a}		1.81^{c}	1.89^{b}	2.00^{a}		
ascorbate peroxidase (APX)									
0.0 %	0.15^{d}	0.16^{bcd}	0.16^{bcd}	0.16^{b}	0.15^{e}	0.16^{de}	0.16^{de}		0.16^{c}
0.2 %	0.16^{cd}	0.16^{cd}	0.17^{abc}	0.16^{b}	0.16^{de}	0.17^{cd}	0.17^{bc}		0.17^{b}
0.4 %	0.16^{cd}	0.18^{ab}	0.18^{a}	0.17^{a}	0.16^{de}	0.19^{a}	0.18^{ab}		0.18^{a}
Mean	0.17^{a}	0.17^{a}	0.17^{a}		0.16^{b}	0.17^{a}	0.17^{a}		
malondialdehyde nmol (MDA) g^{-1} FW									
0.0 %	119.60^{c}	121.08^{bc}	120.51^{c}	120.39^{b}	119.93^{b}	123.70^{ab}	120.85^{b}		121.49^{b}
0.2 %	125.88^{abc}	133.95^{a}	130.61^{a}	130.14^{a}	127.52^{ab}	131.72^{a}	130.81^{a}		130.02^{a}
0.4 %	125.73^{abc}	129.39^{ab}	129.13^{ab}	128.09^{a}	124.12^{ab}	130.71^{a}	127.79^{ab}		127.54^{a}
Mean	123.74^{a}	128.14^{a}	126.75^{a}		123.86^{a}	128.71^{a}	126.48^{a}		

Means with a common letter are not significantly different (p > 0.05)

Table 3. *Chemical constituents (%) of the essential oils of fennel as affected by RJ aqueous extract and Pp treatments*

	RJ (%)	0.0			0.2			0.4		
	Pp (gL^{-1})	0	3	6	0	3	6	0	3	6
Components (%)	α pinene	0.70	0.71	0.88	0.71	0.72	1.01	0.98	1.05	1.08
	Camphene	0.03	0.04	0.05	0.03	0.04	0.05	0.03	0.04	0.06
	β.Terpinene	0.21	0.23	0.25	0.22	0.27	0.27	0.21	0.28	0.38
	β.myrcene	0.22	0.25	0.26	0.25	0.31	0.32	0.23	0.29	0.32
	α.phellandrene	0.14	0.13	0.17	0.15	0.18	0.18	0.15	0.21	0.21
	D.limonene	5.55	5.89	5.87	5.09	6.92	6.79	6.22	6.73	7.09
	Eucalyptol	0.67	0.66	0.71	0.70	0.72	0.73	0.66	0.82	0.86
	Cis-ocimene	0.73	0.58	0.69	----	0.25	0.77	0.67	0.78	0.80
	Ý-Terpinene	----	0.09	0.08	0.11	0.15	0.08	----	0.09	0.08
	α-Thujune	4.48	4.82	4.87	4.67	5.02	4.90	4.33	4.88	4.49
	Camphor	0.12	0.12	0.11	0.10	0.15	0.12	0.08	0.11	0.13
	Estragole	79.99	81.44	82.88	78.76	84.05	83.33	80.82	82.89	84.27
	Anethole	0.17	0.20	0.21	0.22	0.29	0.28	0.23	0.28	0.25
	Thymole	0.44	0.45	0.48	0.49	0.51	0.50	0.47	0.46	0.45



peak #	R.T. min	first scan	max scan	last scan	PK TY	peak height	corr. area	corr. % max.	% of total
1	6.874	424	438	466	PB	576690	16138765	0.85%	0.716%
2	7.243	475	496	507	BV 4	18026	574052	0.03%	0.025%
3	7.855	582	592	600	VV 2	243893	6110131	0.32%	0.271%
4	7.935	600	605	625	VV 3	42654	1149572	0.06%	0.051%
5	8.279	650	659	683	BV	283118	6938116	0.37%	0.308%
6	8.624	697	713	722	VV	173106	4117386	0.22%	0.183%
7	8.708	722	726	744	VB 3	15812	383972	0.02%	0.017%
8	9.136	782	794	800	VV	57968	1332495	0.07%	0.059%
9	9.247	800	811	818	VV	6327142	156095250	8.23%	6.921%
10	9.316	818	822	837	VV	730493	16205985	0.85%	0.719%
11	9.463	837	845	867	VV	257634	5661067	0.30%	0.251%
12	9.729	880	887	901	BV 4	16828	388090	0.02%	0.017%
13	10.010	920	931	943	BV 2	144630	3300645	0.17%	0.146%
14	10.228	958	965	986	BV 3	45695	1020716	0.05%	0.045%
15	10.774	1041	1051	1073	VV	4839390	113315199	5.98%	5.024%
16	11.025	1073	1091	1105	VV 7	15303	513123	0.03%	0.023%
17	11.610	1171	1183	1191	VB 10	18842	661884	0.03%	0.029%
18	11.764	1196	1207	1216	BV	163125	3388603	0.18%	0.150%
19	12.197	1266	1275	1287	PV 3	141830	3320510	0.18%	0.147%
20	12.995	1367	1400	1414	VV 2	42577	1095551	0.06%	0.049%
21	13.615	1462	1498	1551	BV	31730434	1895780597	100.00%	84.052%
22	13.985	1551	1556	1562	VV 8	8044	167811	0.01%	0.007%
23	15.543	1783	1801	1809	VV	195090	4577245	0.24%	0.203%
24	15.641	1809	1816	1845	VV	511925	11452118	0.60%	0.508%
25	15.868	1845	1852	1860	VV 2	29102	677233	0.04%	0.030%
26	17.735	2137	2145	2170	BB 3	16382	577845	0.03%	0.026%
27	18.158	2204	2212	2222	BV 3	16948	364655	0.02%	0.016%
28	39.287	5526	5533	5539	PV 3	7909	181040	0.01%	0.008%

Sum of corrected areas: 2255489655

Fig.1. *Chromatograms of essential oils extracted from Foeniculum vulgare, Mill fruits: 0.2% RJ aqueous extract+ 3 gL-1 Pp aqueous extract.*

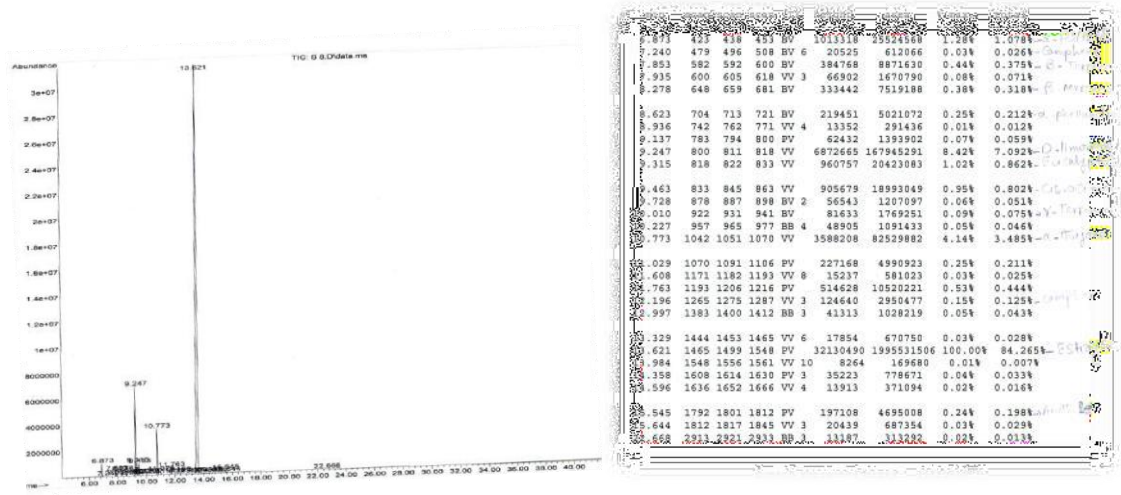


Fig. 2. *Chromatograms of essential oils extracted from Foeniculum vulgare, Mill fruits: 0.4% RJ aqueous extract+ 6 gL-1 Pp aqueous extract*

DISCUSSION

RJ is regarded as a valuable food supplement because of its functional, biological, and pharmaceutical properties (Seven *et al.,* 2014). The significant increase by RJ in all parameters studied especially when added at moderate rate (2 gL^{-1}) may turns back to the higher content of royal jelly from sugar, proteins, lipids,

some mineral salts and vitamins (Melliou and Chinou, 2005) amino acids and other antioxidants (Townsend and Lucas, 1966). RJ contains vitamins B1, B2, B5, B6, B8 and B9, vitamin C and at least 17 amino acids, different nutrients (K, Na, Mg, Zn, Ca, Fe, P, S, Mn and Si) and six hormones (Hyel, 1951 and Nation and Robinson, 1971). This may present an interpretation of the increase of N, P and K concentration in the plant and the pigments in leaves. The increment in the carbohydrates rate in the plant may naturally due to fatty acids and sugars present in RJ. AS well, flavonoids, organic compounds, fatty acids, and other active ingredients found in RJ can improve growth performance (Seven *et al.,* 2014). Also 15% of royal jelly is 10-hydroxy-trans-(2)-decanoic acid (HDA), which possibly causes the queen bee to grow so large (Gene Bruno, 2005) which could also introduce an explanation to the increase in plants growth. Phenolic compounds as well are considered the principal components that stand behind the biological activities of RJ as the antioxidant capacity (Viuda-Martos *et al.,* 2008) that protect lipid and other compounds such as vitamin C from being oxidized or destroyed (Poperkovic *et al.,* 1980) and regulate plant growth (Havsteen, 2002). The way of RJ extraction may add to its effectiveness as the aqueous extract has good antioxidant activity, associated with high content of phenolic compounds (Santos, 2012).

Bee products had minor components such as carotenes, ascorbic acid, organic acids, and α-tocopherol show antioxidant properties (Viuda-Martos *et al.,* 2008). (Isidorov *et al.,* 2011) stated that the unique feature of RJ was a set of C8-, C10-, and C12-hydroxy fatty acids. Ten acid characteristics of this bee product were identified in different combinations, namely 7- and 8-hydroxyoctanoic, 3-hydroxydecanoic, 9-hydroxydecanoic, 9-hydroxy-2- decenoic, 10-hydroxydecanoic, 10-hydroxy-2-decenoic (10-HDA), 3,10-dihydroxydecanoic, 2-octene-1,8- dioic, and 2-decene-1,10-dioic acids.

(Guo *et al.,* 2008) stated that RJ proteins had powerful antioxidative activity against the peroxidation of unsaturated fatty acids. They reported 29 antioxidant peptides in RJ, and, among these, 12 small peptides had 2–4 amino acids that showed strong hydroxyl radical scavenging activity but neither metal-chelating activity nor superoxide-anion radical scavenging activity. Moreover, 3 dipeptides containing tyrosine residues at the C-terminal had strong hydroxyl-radical and hydrogenperoxide scavenging activity.

Amazing promotion on growth characters, nutritional status, yield and fruit quality of horticultural crops was observed using royal jelly (Townsend and Lucas, 1966; El- Maziny and Hassan, 1990; El-Shaikh, 2010; Al-Wasfy, 2013; Gad El-Kareem and Abada, 2014; Abada and Ahmed 2015; and Nassef and El-Aref 2016).

Pp showed positive effect upon all attributes studied over the control either in sole or in interaction treatments. This enhancing and stimulatory effect of propolis aqueous extract as foliar spray may be thanks to the wide range of

beneficial constituents that propolis includes. Propolis has variable organic acids, considerable amount of minerals (including, manganese, zinc, calcium, phosphorus, copper) (Marcucci, 1995), (Burdock, 1998), (Marcucci, *et al.,* 2000), (Ahn, *et al.,* 2007); which may contribute in increasing their concentration in the plant and the pigments in leaves. Vitamins B1, B2, B6, C and E,acids (nicotinic acid and pantothenic acid) and amino acids which found in propolis extract could play a role in increasing the amount of amino acid and the protein in the plant. Nowadays there are multiple substances known in propolis with distinct chemical structures from following classes: alcohols, aldehydes, aliphatic acids, aliphatic esters, aromatic acids, aromatic esters, ethers, ketones, terpenoids and steroids (Manara, *et al.,* 1999) that could explain the increase in the essential oil components such as sesquiterpene hydrocarbons and sesquiterphenols. Including flavonoids, hydrocarbohydrates esters, fatty acids and sugars may have a role in increasing the carbohydrates amount in the plant.

Sterols, flavonoids and phenolic compounds in addition to few numbers of phenolic acids (coumaric, ferulic, salicylic, and benzoic acid) which were also detected on TLC plates (Noweer and Mona, 2009) besides aromatic acids and diterpenic acids are considered the main components that are responsible for the biological activities ofpropolis (Kosalec *et al.,* 2004).

Besides, propolis extract contains some compounds that stimulate or alter plant metabolism resulting in the rise within the leaf area (El-Assiuty, *et al.,* 2000), such as terpenoids which can enhance the vigorous growth and /or stimulate plant metabolism resulting in an increase in each fresh and dry weight (Bankova, *et al.,* 2000) i.e., terpenoids have the potential to enhance plant growth, hence provide the plants a lucid vigor in growth. Also, propolis extract includes some matter as terpenoids (Walker and Crane, 1987) and (Bankova, *et al.,* 2000) from that GA3 is synthesized.

In this respect, (Nikolaev, 1978) and (Salama *et al.,* 1992) stated that the increase in leaf pigments concentration might well be attached to the increament in their hormones, and that propolis extract stimulates mineral absorption, i.e. (Fe and Mn)required for chlorophyll synthesis, as these parts are found among mineral composition ofpropolis extract.

The total sugars concentration increase may go back to the sweetening of photosynthesis by the impact of propolis aquous extract.

Similarly, the increase in protein concentration in propolis extract-treated plants can be attributed to B- group vitamins that propolis extract contains [Salama, *et al.,* 1992]which act as coenzymes, which possess some freelance roles within the biochemical processes of plants (EL-Tayeb, 1995). In addition, (Gopala Rao *et al.,* 1987) found associated increased protein synthesis with the increase in

B-group vitamins accumulation that might well be through functioning at the interpretation level of protein synthesis.

The presence of amino acids together with tryptophan among the parts of propolis extract (Walker and Crane, 1987) may be attributed to the increament in total free amino acids and that propolis extract inhibits amino acid incorporation into proteins.

149 compounds and twenty two minerals from totally different samples of propolis were listed (Walker and Crane, 1987) and this may explain the rise in macroparts in propolis extract-treated plants.

The results are greatly matching with those obtained by (Abou-Sreea *et al.,* 2017)showing that foliar spray with propolis aqueous extract increased all studied parameters; all vegetative growth and flowering attributes, chemical constituents and constituents of plant essential oil of calendula plants. Similarly, propolis extract applied as foliar application or presoaking had also positive response on other crops as with (El-Assiuty *et al.,* 2000), (Rady, 2002), (Noweer and Mona, 2009), (Semida and Rady, 2014) and (Seif El-Yazal, 2019) who stated the efficacy of propolis extract on *Phaseolus vulgaris* L. plants as foliar application on chlorophyll a and b, cartotenoids, protein and carbohydrates content and shot dry weight plant^{-1}.

CONCLUSIONS

Hence, it could be concluded that Rj or Pp, some of honey bee products that are natural safe effective substances, proved their positive effect on the fennel plants growth attributes, oil and fruit yield and components and chemical composition. They both used together or in apartment gave superior results over the control in all characters investigated. This may be taken seriously for using them in the field of agriculture, but this still needs more investigation on other plants, as a replacement of poisonous chemical fertilizers substances in improving the plants quality with no dangerous harms upon the environment or the plants which are the dietary source for animals and humans.

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