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Effect of Banana and Pomegranate Peels Extracts on Pea Growth and Productivity

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Abstract: This field experiment was carried out during the two winter seasons of 2019 and 2020 at the experimental farm of El-kassasein Station Farm, Ismailia governorate, Horticulture Research Institute, Agriculture Research Center, Egypt to investigate the response of pea plants (*Pisum sativum* L.) cv. Master-B to ethanol or aqueous extracts of banana and pomegranate fruit peels at three concentrations (0.0, 7.0 and 10.0%) as a foliar spray. The obtained results indicated that spraying pea plants with banana peels extracted by ethanol (BPEE) at 10% concentrate was the superior treatment for maintaining the vigorous plant growth, pod attributes and increasing the total pod yield ton/fed besides enhancing pea seeds chemical quality percentage *i.e.,* carbohydrate, protein and total soluble sugar compared to the other treatments or the control.

Key words: Banana · Pomegranat · Peels · Pea · yield

INTRODUCTION

Pea (*Pisum sativum* L.) is one of the important winter legume vegetables in Egypt. It is grown primarily for edible pods owing to its nutritional value i.e., digestible protein, carbohydrates, vitamins and minerals. Peas are ranked as export crops for green pods or dry seeds [1]. Resulting to increase in the worldwide demand for legumes enhances pea plant productivity and becomes an important target that could be achieved by using the foliar application which is prepared from some natural sources. The foliar nutrients usually penetrate the leaf cuticle or stomata and enter the cells with easy and rapid utilization [2]. Fruit peels are one of the sources of plant wastes which are often discarded and accumulate in huge quantities. Fruit peels are very rich in macro and micro-nutrients-dietary fiber, phenolic compounds and antioxidant, antibacterial and antibiotic activities, therefore providing nutrition to soil or plant which promote growth and productivity. As a result, fruit peels can be used as the cheapest and most harmless materials in agricultural cultivation as a natural fertilizer [3-5]. Banana peels represented 36-38% of total fruit weight and belong to organic waste used for animal feeding and implies a rich contains important compounds involving flavonoids, vitamin C, vitamin E, carbohydrates, essential amino acids and mineral elements such as K, P, Ca and Mg which via an enzymes activator and assist plants in initiating the process of photosynthesis [6-8]. Pomegranate peel constitutes approximately 50% of the total weight of the fruit, the principal organic acids in peels of pomegranate are ascorbic acid, malic acid and fumaric acid, in addition to minerals such as potassium, calcium, magnesium, phosphorus, iron, copper, zinc and sodium [9-11]. The extracts of fruit peels of bananas and pomegranates are natural fertilizers increasing plant growth and yield as reported by Mercy *et al.* [12]; Eapen [13]; Amin [14] and Wahba *et al.* [15]. This experiment focused on improving pea plant growth and productivity by using foliar fertilizer prepared from a natural source as fruit peels which carry vital plant nutrients and beneficial antioxidants. It is worth mentioning that one of the positive aspects of this research is the preservation of the environment from pollution.

MATERIALS AND METHODS

Preparation of Peels Extracts: Two kinds of peels were used i.e., banana (*Musa spp*.) cv. Williams (yellowish green colored) and Pomegranate (*Punica granatum* L.) cv. Manfalouty which was purchased from a private farm located at Ismaillia Governorate. Peels were washed and cut to 3-5cm then divided into two equal groups based on the fresh weight (each group 1 kg in weight). Both peels

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Table 1: Minerals and phyto-chemical composition in banana and pomegranate peels crude extracts

	Minerals composition (mg/100g dry extract)										
	Macro-elements					Micro-elements			Phyto-chemicals (mg/100g crude extract)		
Component	K	N	P	Ca	Mg	Fe	Zn	Mn	Total phenols	Total sugar	Ascorbic acid
BPWE	3.64	0.16	197.32	32.14	34.69	40.11	0.06	0.50	123.47	1.28	20.53
BPEE	5.11	0.24	224.7	80.09	49.72	52.01	0.23	0.82	216.55	4.64	14.75
PPWE	76.38	0.02	162.70	60.65	18.11	15.43	1.03	0.21	312.37	0.52	11.72
PPEE	103.50	0.12	123.42	41.20	26.40	21.00	1.09	0.52	264.42	0.89	5.63

BPWE= banana peels water extract BPEE= banana peels ethanol extract PPWE= pomegranate peels water extract PPEE= pomegranate peels ethanol extract

Table 2: Soil physical and chemical analyses

Soil physical analyses							Soil chemical analyses													
							Soluble cations (M/L)				Soluble anions (M/L)			Macro elements (ppm)				Micro elements (ppm)		
Text.	Sand (%)	Silt (%)	Loam (%)	pH	E.C. (dSm^{-1})	$CaCo_3$ (%)	Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	HCO^{-3}	Cl^{-2}	SO_4^{-2}	N	P	K	Fe	Cu	Zn	Mn
Sandy loam	80.3	2.0	17.6	8.4	0.2	5.2	1.0	0.5	0.3	0.2	0.2	0.5	1.3	40	66	40	3.0	0.8	1.0	1.5

were dried in an oven by hot air at 70°C till constant weight and grind to powder form then sieved using 2 mm sieve mesh. The first group was soaked in one liter of ethanol (80% aq.) for 24h, then the extract was filtrated twice through two layers of gauze cloth and the solvent was evaporated to get the crude extract [16]. The second group was soaked in one liter of hot water at 60°C for 45 min then lifted to stand for 24h and filtered. The obtained crude solution was considered 100% concentrate. The required doses were prepared by taking 10.0 and 7.0 ml from each crude extract and diluting with 90 and 93 ml of distilled water to obtain concentrates of 10.0 and 7.0%, respectively. The mineral and phytochemical compositions of different peel crude extracts are shown in Table 1.

Experimental Design and Field Cultivation: This study was carried out in the El-Kassasein station Farm, Ismailia Governorate, Horticulture Research Institute. Pea seeds cv. Master-B (purchased from Makka Company for Vegetables Seeds, Bab El-Khalk, Cairo), were inoculated with root nodules bacteria (*Rhizobium leguminosarum*) and sown on 2nd and 5th October during the two winter seasons of 2019 and 2020, respectively, at 7 cm apart between hills on one side of the ridge. The experimental plot area was 7.2 m^2 included 4 rows (each was 3 m length and 0.6 m width). The experiment was arranged in a randomized complete block design with three replicates including 9 treatments *i. e.,* two kinds of fruit peels, two extracts methods and two concentrates (7.0 and 10.0 %) beside the control 0.0%. All agricultural methods were applied according to the recommendation of Ministry of Agriculture. Plants at 25 days after sowing were sprayed with the different previous extracts as foliar spraying at once-a-week intervals till the first harvest. The farm soil physical and chemical analyses were shown in Table 2.

Vegetative Growth Measurements: Ten plants from each plot were taken randomly at flowering stage to evaluate plant fresh weight (g), plant length (cm), number of branches/plant, dry weight of plant (g). The total leaf chlorophyll content at the fourth upper leaves was recorded using Minolta chlorophyll meter SPAD-501 was recorded as SPAD unit.

Pod Yield and its Characters: A sample of ten fresh green pods at the marketable stage of Pea, cv Master-B were randomly taken from each plot at the second picking to determine pod weight (g), pod length (cm), pod diameter (cm), number of seeds/pod, fresh weight of 100 seeds (g) and percentage dry weight of 100 seeds as well as total green pods yield (ton/fed) were estimated (the weight of all pickings).

Seeds Chemical Content: A sample of 0.2 g from fine powder of dry seeds was digested in a mixture of sulphuric and perchloric acids according to Piper [17] to estimate protein and carbohydrate content (%) according to A.O.A.C [18] and total soluble sugars (%) were determined calorimetrically using the calorimetrically according to the method described by Dubois *et al.* [19].

Statistical Analysis: All data were subjected to statistical analysis according to the procedures reported by Snedecor and Cochran]20[using Statistix 8 software program and means were compared by L.S.D multiple range tests at the 0.05 level of probability in the two seasons of experimentation.

RESULTS AND DISCUSSION

Vegetative Growth Measurements: Data in Table 3 revealed that the vegetative growth of pea plants varied (P<0.05) among the application treatments. Both water and ethanol extracts of banana peels (BPWE and BPEE), or pomegranate peels (PPWE and PPEE) significantly enhanced pea growth more than those of untreated plants (control), especially at 10.0% concentrate because fruits peels used in this investigation contain a bioactive component and essential amounts of macro and micronutrients as presented in Table 1, however, these components have been reported to induce significant effects on various biological aspects in plants besides its containing common growth-promoting substances which induce plant growth such plant height, the number of branches and dry weight as reported by Hariyono and Ayunin [21]. The important physiological processes related to various nutritional elements in fruit peels extract component were evidenced in several searches since; N is responsible for the biosynthesis of enzymes, nucleoproteins, amino acids, protein, sugars, polypeptides, chlorophylls and encourages cell division [22]. K is essential for activating enzymes, synthesizing the protein and assisting in the opening and closing of stomata, P promotes rooting, flowering and fruit set. Ca is also a component of the cell wall in plants and it is needed for enzyme formation, nitrate uptake and root development, however, Mg plays a role in ATP synthesis, biosynthesis of chlorophyll, fatty acids, lipids and proteins thereby induce plant vegetative growth [23, 24, 7, 25]. For instance, micronutrients estimated in fruit peel extracts such as Zn, Fe and Mn can be accounted by their essential role in respiration, their metabolism activation of the enzyme, photosynthesis, chloroplast formation, chlorophyll synthesis and natural hormone biosynthesis [26]. Further, this inducer growth may be returned to the presence of natural antioxidants such as vitamins, flavonoids phenolic compounds which is necessary for plant growth as reported by Lee *et al.* [27]. So that supplementary fruit peels extract as foliar fertilization during plant growth stages improves plant mass. Ofosu-Anim and Leitech [28] reported that fertilizer application increase plant dry weight implies boosts plant growth.

In comparison to the two fruit peels, data in Table 3 obvious that sprayed plants with banana peel extract were more sufficient than pomegranate peels for producing vigorous growth. These supporting effect regarding banana peels may be due to their containing many plant nutrients and bio-active components such as tryptophan which consider important for increasing endogenous hormone levels, promoting cell division and/or enlargement and ultimately promoting plant growth [29]. Dayarathna and Karunarathna [30] deduced that banana peel extract is a rich source of phytochemicals and antioxidants such as phenolic compounds, flavonoids, vitamins, beta-carotene, potassium, calcium and magnesium elements. Therefore, It is used as a natural fertilizer for foliar or soil applications and contains plant growth-promoting substance that enhances plant growth and production. Regarding chlorophyll content in leaves, it's recorded in Table 3 that the highest chlorophyll content was recorded in leaves of pea plants treated with banana peel extract than in pomegranate one or untreated plants which recorded the lowest results. The findings are in agreement with those found by Bakry *et al.* [31] who stated that banana peel extract significantly increased chlorophyll a, chlorophyll b, total carotenoids and consequently total pigments and a maximum increase of the photosynthetic pigments. Banana peels contains also manganese which helps in the photosynthesis process and magnesium and sulfur, which are helpful in the formation of chlorophyll. Moreover, banana peel is characterized by essential elements that are required in the structure of porphyrin, which is involved in the

Table 3: Pea plant vegetative growth with respect to foliar application by banana and pomegranate peels ethanol and aqueous extracts during the two seasons of 2019 and 2020.

Treatments		Plant fresh weight (g)	Plant length (cm)	No. of branches/ plant	Plant dry weight (g)	Chlorophyll (SPAD)	Plant fresh weight (g)	Plant length (cm)	Number of branches/ plant	Plant dry weight (g)	Chlorophyll (SPAD)
Control	Concentrate (%)	1st Season					2nd Season				
	0.0	43.31	43.16	1.20	7.30	46.20	43.88	43.24	1.23	7.33	46.96
BPWE	7.0	46.45	43.88	1.63	11.42	49.71	46.40	47.25	2.06	10.83	49.33
	10.0	49.62	51.09	1.86	12.08	51.90	50.41	48.43	2.20	12.52	51.29
PPWE	7.0	45.78	43.49	1.33	8.19	47.16	44.86	43.98	1.43	8.09	47.29
	10.0	47.22	50.03	1.73	9.00	50.06	45.37	45.66	1.53	9.60	50.03
BPEE	7.0	53.45	50.46	2.16	14.56	55.00	51.35	49.42	2.00	11.40	54.15
	10.0	56.03	51.35	2.66	15.37	56.57	54.51	51.27	3.00	13.07	56.31
PPEE	7.0	50.45	47.64	1.33	8.75	52.76	50.43	45.97	1.66	10.20	54.03
	10.0	54.74	50.75	2.20	10.21	55.70	52.46	50.38	2.40	11.55	55.09
L.S.D. at 5%		2.60	2.60	2.35	0.64	0.86	1.57	2.35	1.67	0.38	0.85

BPWE= banana peels water extract PPWE= pomegranate peels water extract BPEE= banana peels ethanol extract PPEE= pomegranate peels ethanol extract

Table 4: Pea pod yield and its characters with respect to foliar application by banana and pomegranate peels ethanol and aqueous extracts during the two seasons of 2019 and 2020.

Treatments		Pod weight (g)	Pod length (cm)	Pod diameter (cm)	No. of seeds /pod	Ave. weight of 100 seed	Seed dry weight (%)	Total yield (ton/fed)	Pod weight (g)	Pod length (cm)	Pod diameter (cm)	No. of seeds /pod	Ave. weight of 100 seed	Seed dry weight (%)	Total yield (ton/fed)
Control	Concentrate (%)	----------1st Season----------							----------2nd Season----------						
	0.0	4.06	7.95	0.98	5.23	35.11	19.37	3.22	4.31	8.13	0.97	4.71	34.76	19.47	3.10
BPWE	7.0	4.85	8.99	1.04	6.60	41.04	25.04	3.44	4.70	8.71	1.09	6.00	40.50	25.33	3.30
	10.0	5.42	9.10	1.05	6.86	42.66	26.07	3.50	4.90	9.00	1.12	6.41	41.16	26.27	3.51
PPWE	7.0	4.73	8.03	1.00	6.00	40.38	20.69	3.26	4.45	7.89	1.01	5.49	38.65	19.99	3.28
	10.0	4.94	8.72	1.02	6.23	40.95	24.00	3.32	4.60	8.53	1.05	5.68	39.79	24.84	3.42
BPEE	7.0	5.30	9.20	1.14	7.22	47.31	27.10	3.50	5.12	9.43	1.13	7.50	48.16	27.57	3.54
	10.0	5.74	9.55	1.32	7.60	49.77	30.71	3.88	5.57	9.78	1.32	7.88	49.53	32.00	3.78
PPEE	7.0	5.15	9.13	1.10	7.12	43.11	26.89	3.43	5.06	9.25	1.10	6.62	43.11	27.00	3.48
	10.0	5.68	9.48	1.25	7.46	47.52	30.17	3.65	5.38	9.59	1.25	7.70	48.86	30.13	3.60
L.S.D. at 5%		0.35	0.24	0.05	0.31	1.59	2.08	0.13	0.13	0.18	0.06	0.24	1.27	2.05	0.16

BPWE= banana peels water extract PPWE= pomegranate peels water extract BPEE= banana peels ethanol extract PPEE= pomegranate peels ethanol extract

construction of chlorophyll and thereby increased the production of chlorophyll [32]. On the other side, ascorbic acid which is found in different extracts (Table 1) regulates and protects photosynthetic processes [33]. The same conclusion was found by Sakpere *et al.* [34] on *Solanum scabrum* and Gayathri and Seran [35] on okra.

Pod Yield and its Characters: According to the statistical analysis, Table (4) show that significant differences were detected in pod characters expressed as pod weight, pod length, pod diameter, number of seeds/pod, the weight of 100 seed and percentage of seed dry weight among the treatments. The maximum results of the previous parameters were obtained by BPEE followed by PPEE extracts both at a concentration of 10.0%. While the minimum values are attained by the control treatment in both seasons. These favorable responses of pea crop performance to varied foliar spray are pronounced to the nutrient elements supplied and presented in different extracts as shown in Table 1. However, potassium increases crop yield and improves its quality due to its role in enhancing different enzyme activation, photosynthesis and protein synthesis [36, 37]. Moreover, ascorbic acid is an assist component in crop production, where it is an abundant component of many principal metabolic and physiological processes such as plant photosynthesis and biosynthesis of soluble sugars and carbohydrates which are vital steps in stepping up plant tissues, cell wall growth, cell expansion, beside synthesis of gibberellins and anthocyanine that reflected on pea plant health growth and yield production [38-41]. These findings are in harmony with those found by Alqurainy [42]; Sultana *et al.* [43] and Gad El-Hak *et al.* [44] who pointed out that ascorbic acid as an antioxidant was sufficient to support pea pod attributes (pod length and diameter, fresh pod weight and number of seeds/pod) consequently increase total yield/fed. Nevertheless, increased vegetative growth of pea plant traits as plant dry weight refers to the quality of the photosynthesis process and stored the carbohydrates in plant organs thereby increasing pea yield and enhancing pod characters. It was reported that carbohydrates stored in plant foliage mainly translocate to the yield and its related traits leading to increasing its attributed [45]. In addition, the response of pea yield to various foliar supplies used in this experiment probably returns to phenol presented in extracts which act a role in this positive result. Thus, it is documented that phenolic compounds exert their influence on physiological and biochemical processes including, photosynthesis, ion uptake, membrane permeability, enzyme activities, flowering consequently plant growth and production [46-48]. The superiority of total yield/fed which appears with banana peel treatment in the current experiment is agreeable with Bakry et al. [31] who stated that the effect of foliar application of banana peel extract significantly increased the yield of quinoa Hariyono and Ayunin, [21] on eggplant and Dozet *et al.* [49] on soybean.

Generally, Figure 1 showed that treated plants with 10.0 ml of BPEE exhibited a highly significant increment in total yield per feddan by 21.2% (as average of both seasons), over the corresponding untreated plants (control) followed by PPEE BY 14.7%.

Seeds Chemical Content: Data in Table (5) revealed that fruit peels extracts significantly affected on seeds chemical composition *i. e.,* carbohydrate, protein and total soluble sugar as compared to the control treatment. It could notice that there were differs between results according to method of extract, since extracts using ethanol has the capability to rise seeds chemical traits, meanwhile, the aqueous extracts were not efficient to

Table 5: Carbohydrate, protein and total soluble sugar in pea seeds with respect to foliar application by banana and pomegranate peels ethanol and aqueous extracts during the two seasons of 2019 and 2020.

Treatments		Carbohydrate (%)	Protein (%)	Total soluble sugar (%)	Carbohydrate (%)	Protein (%)	Total soluble sugar (%)
Control	Conc. (%)	----------1st Season----------			----------2nd Season----------		
	0.0	37.63	19.16	3.17	33.33	20.54	3.14
BPWE	7.0	41.45	22.00	3.23	41.60	22.11	3.40
	10.0	41.61	22.04	3.32	41.91	23.50	3.45
PPWE	7.0	39.20	19.34	3.20	39.75	20.66	3.18
	10.0	40.05	21.23	3.28	39.91	21.54	3.20
BPEE	7.0	44.47	22.22	3.58	44.33	22.44	3.76
	10.0	46.45	22.94	3.81	48.20	26.08	4.06
PPEE	7.0	42.12	20.40	3.42	42.87	22.42	3.58
	10.0	45.59	22.50	3.60	46.37	23.00	3.89
L.S.D. at 5%	1.87	1.59	0.27	1.74	1.82	0.36	

BPWE= banana peels water extract PPWE= pomegranate peels water extract BPEE= banana peels ethanol extract PPEE= pomegranate peels ethanol extract

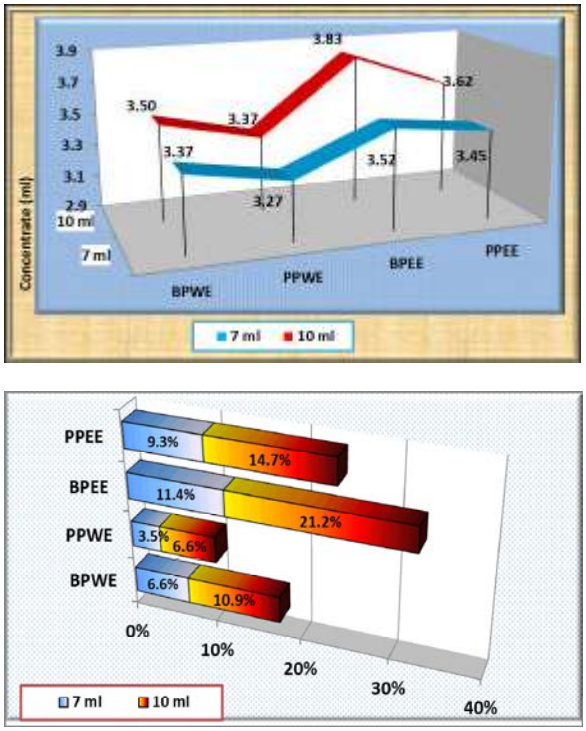

Fig. 1: Pea pod yield/ton per fed. (above) and its increment (down) comparing to control as affected by foliar application with banana and pomegranate peels ethanol and aqueous extracts (average of both seasons).

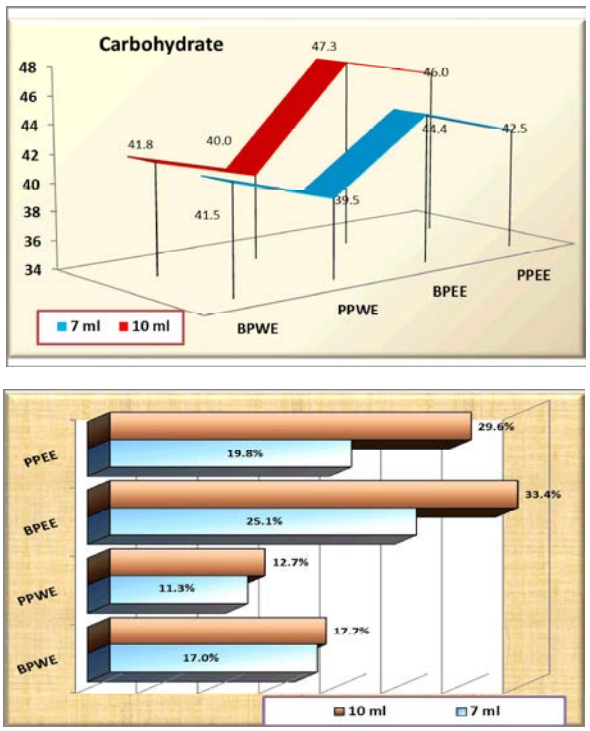

Fig. 2: Carbohydrates % (above) and its increment (down) comparing to control as affected by foliar application with banana and pomegranate peels ethanol and aqueous extracts (average of both seasons).

appear encouragement results. Data also mentioned that, the significantly superior values for pea seeds chemical content were obtained by either banana or pomegranate peels extracts than those plants grown without spraying (control) especially applications with banana peels at high levels 10.0%. This effective ability related to treatments is likely to increasing the chlorophyll content in leaves which led to increase the photosynthesis processes therefore, the nutrient product transmitted from leaves to store in pea seeds [50, 51]. The augment effect of banana extracts return to its contain much amount of main nutrients (Table 1) that extends and contributed the formation of processed food compounds [41]. Furthermore, it was confirmed that a small amount of microelements (Zn, Fe and Mn) foliar applications significantly increased plant nutrient product particular Fe which act essential roles in photosynthesis [52, 53]. In this respect Hussien *et al.* [54] reported that the provided essential nutrients causing changes in plant chemical composition and improved crop quality.

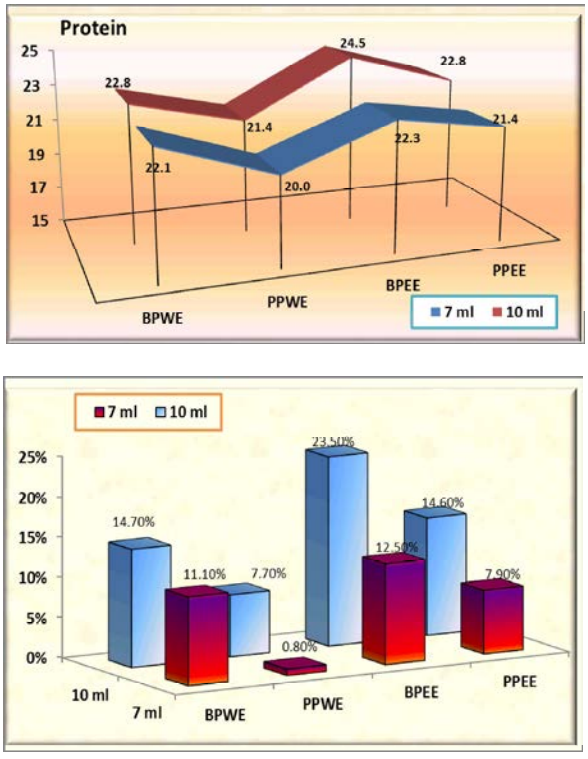

Fig. 3: Seed protein (above) and its increment (down) comparing to control as affected by foliar application with banana and pomegranate peels ethanol and aqueous extracts (average of both seasons)

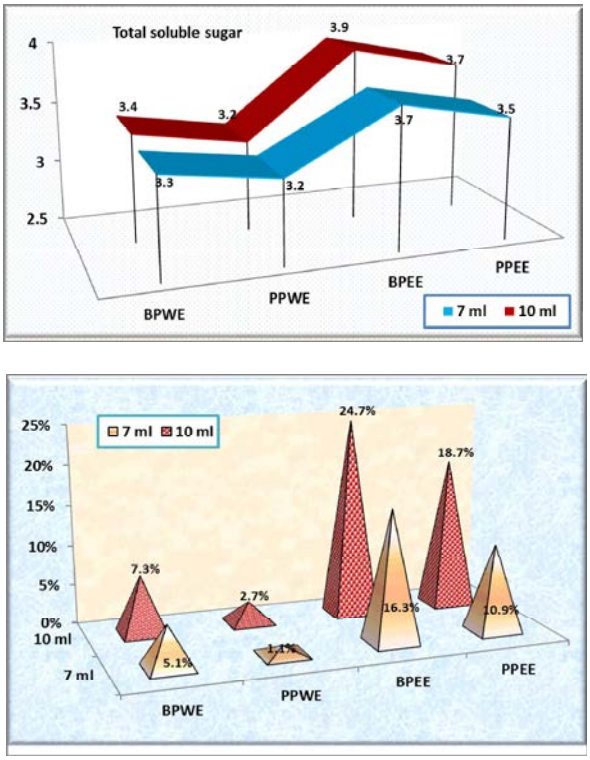

Fig. 4: Total soluble sugar% in seeds (above) and its increment (down) comparing to control as affected by foliar application with banana and pomegranate peels ethanol and aqueous extracts (average of both seasons)

These results are agreement with those obtained by Bakry *et al.* [31] on quinoa and Abdel Rasoul *et al.* [55] on carrot. Different extracts contain amounts of ascorbic acid (Table 1) the role of this antioxidant supplied as foliar spray in increase seeds contents of carbohydrate and crude protein was evidenced by El-Bassiouny *et al.* [56] on *Vicia faba* and Gad El-Hak *et al.* [44] on pea. Similarly, Barakat, *et al.* [57] illustrated that ascorbic acid causes enhancing of protein and carbohydrate content in dry seeds that related to the major role of ascorbic acid in multifarious metabolic processes such as photosynthesis and regulating co-enzymatic reactions by which carbohydrates and proteins are metabolized.

Generally, Figures 2, 3 and 4 showed that treated plants with 10.0 ml of BPEE exhibited a highly significant increment in seeds chemical contents, *i.e.,* carbohydrates, protein and total soluble sugar by 33.4%, 23.5% and 24.7% followed by PPEE with increment by 29.6%, 14.6% and 18.7%, respectively (as average of both seasons), over the corresponding untreated plants (control).

CONCLUSION:

From this study, it could conclude that fruits peels (banana or pomegranate) extracted by ethanol at a high concentration of 10.0% had a positive effect on the vegetative growth of pea plants this reflects to produced high total yield per feddan with high pod quality characteristics, in addition improving seeds chemical content of carbohydrates, protein and total soluble sugars percentage.

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