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Effect of Orange Peel Extract or Ascorbic Acid on Growth, Yield and Some Biochemical Aspects of Quinoa Plants under Water Deficit

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Abstract : A field experiment was conducted to evaluate the potential of foliar treatment of orange extract (600 & 1200 mg/l) and ascorbic acid (200 & 400mg/l) on growth characters, photosynthetic pigments, seed yield quantity and quality and some biochemical aspects of quinoa plant under drought stress conditions (skipping irrigation). Exogenous application of orange extract and ascorbic acid led to marked increases in growth characters (plant height, shoot, root fresh and dry weight) concomitantly with an increase in the levels of IAA, photosynthetic pigments (chlorophyll a, chlorophyll b, and carotenoids), phenol, free amino acid contents, total carbohydrates and yield components, as compared with the control with skipping irrigation. All treatments increased seed yield and its components, also a marked increase in nutritional values of the yielded seed (carbohydrate contents, protein%, oil%, flavonoids and antioxidant activity). It is noticed that orange extract was more pronounced than ascorbic acid in increasing most of the tested parameters of quinoa plant. Moreover, orange extract at 600 mg/l was the most effective treatment.
Keywords: Ascorbic Acid, Growth, Orange peel extract, Quinoa, Sandy soil, Yield.

Introduction

Quinoa as a newly introduced food crop can replenish part of food gap. It is considered as a multipurpose crop, seeds can be utilized for human food, in flour products and in animal feedstock because of its high nutritive value (Bhargava etal[1]). Quinoa seeds was recognized as high-quality protein seeds, especially rich in essential amino acids, minerals, carbohydrates, antioxidant compounds as carotenoids, flavonoids, vitamin C and dietary fiber) compared to that of cereals such as corn, oat, rice and wheat (Repo-Carrasco-Valencia and Serna[2]). Quinoa crop was chosen by FAO as one of the important crops which play major role in food security assuring in the 21th century due to its high nutritional value and its good tolerance to adverse climatic conditions. Also, because this crop can grow in sandy soil of arid and semiarid regions so, it is used to replenish part of food gap.

Water deficiency which often linked with other major abiotic stress such heat stress, salinity stress, etc. so, it is considered as one of the primary factors responsible for crop productivity reduction (Ashraf [3]). Water deficiency caused adverse effect on plants via reduced growth, nutrient attainment reduction and alteration, in water status of plants (Ali and Ashraf[4]). During photosynthesis, water deficiency induced reduction of photosynthetic efficiency (Demirevska etal[5]) cause increased accumulation of reactive oxygen species (Hasanuzzaman etal [6]).

Ascorbic acid plays several roles in plant growth, cell division, cell wall expansion and gene expression, and other developmental processes, synthesis of many hormones, flavonoids and other developing processes (Pignocchi and Foyer[7]**).** In plants it is an important antioxidant that increased as an adaptive mechanism to environmental stress such as drought. In addition, ascorbic acid is a key substance in the network of plant antioxidant, that detoxify H_2O_2 to counteract oxygen radicals (Noctor and Foyer[8]**).**

The industrial by-products contain peels, seeds and pulp membrane residues. Citrus peel is an important source of essential oils (Espiard[**9**]**)** which are used for different biological properties (antifungal and antibacterial activities) according to Ma etal[**10**]**.** Orange peel is rich source of natural phenolic compounds especially flavanone glycosides as reported by Bocco etal[11]. The citrus flavonoids have antioxidant activities. Orange peel is rich in nutritional ingredients such as soluble sugars, proteins and minerals. It contains antioxidant such as flavonoids and vitamin C according to M'hiri etal[12]. Moreover, James etal[**13**] show that orange peels contain potassium, which is necessary for plants growth.

Therefore, the present study investigates the ability of quinoa plant's grown sandy soil conditions in Egypt. This region, as a part of the Sahara Desert of Northern Africa, is suffers to an environmental stress conditions including low water availability, temperature fluctuations and lack nutrients value. To study the possible role of ascorbic acid and orange peel waste in improving growth, some biochemical aspects , yield and nutritional values of the yielded of quinoa seeds.

Materıals and Methods

Plant material and growth conditions:

A field experiment was conducted at the Experimental Station of National Research Centre, Nubaria district Beheira Governorate, Egypt, during two successive seasons of 2013/2014 and 2014/2015. The soils of both experimental sites were reclaimed sandy soil where mechanical and chemical analysis is reported in Table (1) according to Chapman and Pratt [**14**]**.**

Table 1: Mechanical and chemical analysis of the experimental soil sites.

A. Mechanical analysis:

Sand		**Silt 20-0µ%**	**Clay < 2µ%**	**Soil texture**
Course 2000-200µ%	**Fine 200-20µ %**			
47.46	36.19	12.86	4.28	Sandy

B. Chemical analysis:

pH	**EC dSm^{-1}**	**$CaCO_3$**	**OM%**	**Soluble Cations meq/l**				**Soluble anions meq/l**			
				Na^+	**K^+**	**Mg^+**	**Ca^{++}**	**CO_3^{--}**	**HCO_3^-**	**Cl^-**	**SO_4^{--}**
7.60	0.13	5.3	0.06	0.57	0.13	0.92	1.0	0.0	1.25	0.48	0.89
Available nutrients											
Macro element ppm				**Micro element ppm**							
+N	P	K		Zn	Fe	Mn		Cu			
52	12.0	75		0.14	1.4	0.3		0.00			

Seeds of quinoa (*Chenopodium quinoa* Willd.) were obtained from Agricultural Research Centre Giza, Egypt. The experimental design was in randomized complete block with four replications, quinoa seeds were sown on November in both seasons in rows 3.5 meters long, and the distance between rows was 20 cm apart.

Plot area was 10.5 m^2 (3.0 m in width and 3.5 m in length). The recommended agricultural practices of growing quinoa were applied. Pre-sowing, 150 kg/feddan of calcium super-phosphate (15.5% P_2O_5) was applied to the soil. Nitrogen was applied after emergence in the form of ammonium nitrate 33.5% at a rate of 75 Kg/feddan in five equal doses before the 1st, 2nd, 3rd, 4th and 5thirrigation. Potassium sulfate (48.52 % K_2O) was added in two equal doses of 50 kg/feddan, before the 1st and 3rdirrigations. Irrigation was carried out using the new sprinkler irrigation system where water was added every 5 days. Skipping the irrigation at 50 and 65 days after sowing

Materials: The applied substance, ascorbic acid used in the present work was supplied from Sigma Chemical Company, St. Louis, MO, USA.

Extraction of Orange peel: Orange peel wastes collected from fruits. The collected orange peel was air-dried, powdered and kept for extraction. The resulting powder (500 g) was extracted with 2L of distilled water and left to stand for 48 hours at room temperature. The extract was centrifuged at 4500 rpm for 10 min. After centrifugation the residue was reextracted twice with water as described above. The crude aqueous extract was concentrated using rotary evaporator under reduced pressure at 45oC then the concentrated extracts were lyophilized and kept at - 20°C.

The plants were sprayed twice with orange extract (600 & 1200 mg/l) and ascorbic acid (200 & 400 mg\l) while control plants were sprayed with distilled water during vegetative growth at 45 and 60 days after sowing . Data Recorded two weeks after the second spraying at 75 days from sowing plant samples were collected to determine plant height, fresh & dry weight of shoot and root and water contents in shoots & roots as well as some biochemical parameters in leaves photosynthetic pigments, indole acetic acid contents, total phenol contents and total free amino acid.

At harvest, the following items were estimated: plant height, fruiting branches number /plant, shoot weight, weight of seeds/ plant and weight of 1000 seeds. Air dried seeds were ground into fine powder and kept in desiccators for analysis .Some chemical parameters are measured in the yielded grains as carbohydrates %, proteins %, oil %, flavonoids and antioxidant activity.

Chemical analysis:

Photosynthetic pigments: Total chlorophyll a and b and carotenoids contents in fresh leaves were estimated using the method of Lichtenthaler and Buschmann[15] . Indole acetic acid content were extracted and analyzed by the method of Larsen et al[16]. Total phenol content, the extract was extracted as IAA extraction, and then measured as described by Danil and George[17]. Free amino acid was determined with the ninhydrin reagent method Yemm & Cocking[18]. The antioxidant enzyme (Superoxide dismutase. (SOD, EC 1.12.1.1) activity was spectrophotometrically assayed at 560 nmby nitro-blue-tetrazolium(NBT) reduction method Chen and Wang,[19]. Catalase. (CAT, EC 1.11.1.6) activity was determined spectrophotometrically by following the decrease in absorbance at 240 nm Chen and Wang[19]. Peroxidase. (POX, EC 1.11.1.7) activity was spectrophotometrically assayed by the method of Kumar and Khan[20]. Determination of total carbohydrates was carried out according to Herbert et al[21]. Total protein concentration of the supernatant was determined according to the method described by Bradford[22]. The oil was extracted according to Kates and Eberhardt[23]. Total flavonoids were determined using the method reported by Chang et al[24]. The antioxidant activity (DPPH radical scavenging) was determined using the method of Liyana-Pathiranan and Shahidi [25]

Statistical analysis:

The data were statistically analyzed on complete randomized design system according to Snedecor and Cochran [26]. Combined analysis of the two growing seasons was carried out. Means were compared by using least significant difference (LSD) at 5% levels of probability.

Results

Growth parameters:

The growth parameters of quinoa plants in response to treatment with different concentrations of orange peel (600 & 1200) and ascorbic acid (200 & 400 mg/l) and grown under water deficit (by skipping irrigation) are presented in Table (2). Results are reveal that, using orange peel extract and ascorbic acid as foliar treatment

at different concentrations increased shoot length, shoot fresh and dry weight as well as root fresh and dry weight of quinoa plant as compared with control plant. While, the highest plant fresh and dry weight (shoot, root) were recorded at 600 mg/l orange peel. In addition, foliar treatment of different concentrations increased significantly water content in both shoot and root. As the percentage of increases in response to 600mg/l orange peel extract reached to 46% & 139 % in fresh and dry weights of shoots and 169% & 122% in fresh and dry weights of roots comparison to 34 % & 95% in fresh and dry weights of shoots and 126 & 62% in fresh and dry weights of roots response to 400 mg/l ascorbic acid treatment as compared to the untreated plants.

Table 2: Effect of orange peel extract or ascorbic acid on growth parameters of quinoa plant at 75 days after sowing grown in water deficit.

Treatment mg/l		Shoot length (cm)	Shoot Fw (g)	Shoot Dw (g)	Water content	Root Fw (g)	Root Dw (g)	Water content
Control		18.50 ±0.286	27.75±0.49	4.35±0.085	23.39±0.578	1.87±0.110	0.60±0.050	1.26±0.160
Orange extract	**600**	25.67±0.448	40.50±0.799	10.40±0.350	30.10±0.946	5.03±0.176	1.33±0.068	3.70±0.202
	1200	22.67±0.1.22	34.59±0.464	7.90±0.208	26.69±0.265	3.03±0.176	0.93±0.091	2.10±0.254
Ascorbic acid	**200**	20.40±0.987	32.65±0.284	5.40±0.407	27.25±0.548	2.90±0.115	0.90±0.057	2.00±0.058
	400	23.33±0.653	37.20±1.097	8.50±0.494	28.70±0.702	4.23±0.193	0.97±0.067	3.27±0.149
LSD 5%		1.84	2.42	0.88	1.99	0.57	0.19	0.62

Photosynthetic Pigments:

The effect of different concentrations of orange peel (600 & 1200 mg/l) and ascorbic acid (200 &400 mg/l) and grown under water deficit (by skipping irrigation) on photosynthetic pigments (chlorophyll a, chlorophyll b, carotenoids and total pigments) of quinoa plant are shown in Table 3. Orange peel or ascorbic acid significantly increased chlorophyll a chlorophyll b, total carotenoids and consequently total pigments. The maximum increases of the photosynthetic pigments were obtained by foliar application with orange peel extract (600 mg/l) followed by ascorbic acid (400mg/l). As the percentage of increases in response to 600mg /l orange peel extract reached to 75 %, chlorophyll b by 178%, carotenoid by 163% and total pigments by 101%.

Table 3: Effect of orange peel extract or ascorbic acid on photosynthetic pigments (µg/g fresh weight) of quinoa plant at 75 days after sowing grown in water deficit.

Treatment mg/l		Chlorophyll a	Chlorophyll b	Carotenoids	Total pigments
Control		9.35±0.329	2.01±0.130	1.86±0.0433	13.40±0.373
Orange extract	600	16 39±0.569	5.60±0.025	4.90±0.316	26.88±0.815
	1200	12.63±0.526	4.09±0.127	3.50±0.278	20.23±0.532
Ascorbic acid	200	10.51±0.360	3.44±0.207	3.92±0.455	17.87±0.949
	400	14.01±0.012	4.38±0.203	4.79±0.127	23.17±0.229
LSD 5%		0.82	0.56	0.72	1.54

Change in IAA, Phenol and free amino acid contents:

Data in Table 4. showed that, foliar application at different concentrations of orange peel extract (600 & 1200 mg/l) and ascorbic acid (200and 400 mg/l) caused significant increases in IAA, total phenol and free amino acid contents .Table 4 clearly shows that the effect of orange peel extract at 600 mg/l and 400 mg/l ascorbic acid were the most effective treatments respectively, since it increased IAA by 63 % & 46%, phenol by 64% & 39% and free amino acid by 57% & 55% .

Table 4: Effect of orange peel extract or ascorbic acid on IAA (µg/g fresh weight), total phenol (mg/100g fresh weight) and free amino acid (mg/g dry weight) of quinoa plant at 75 days after sowing grown in water deficit.

Treatment mg/l		IAA	Phenol	Free amino acid
Control		46.22±0.299	112.66 ±1.667	236.26±2.90
Orange extract	600	75.33± 0.097	184.88±0.595	371.82±3.06
	1200	64.45± 0.300	145.40±0.328	356.24±3.014
Ascorbic acid	200	59.39±0.603	134.67±0.451	352.01±5.92
	400	67.34±0.614	156.57±0.416	366.24±4.043
LSD 5%		1.39	2.19	13.47

Antioxidant enzyme activities:

Superoxide dismutase, catalase and peroxidase activities were increased in response to application of different concentrations of orange peel extract or ascorbic acid and grown under water deficit (by skipping irrigation) on quinoa plants as compared to those of untreated control plants (Table 5). The most effective treatment was detected with orange peel extracts at 600mg/l followed by treatment with ascorbic acid 400 mg/l since; it increased the activities of SOD by 60% & 50%, CAT by 15 % & 11% and POX by 56% and 36 % as compared to control plants respectively.

Table 5: Effect of orange peel extract or ascorbic acid on enzyme activities (ug/g fresh weight/hour) of quinoa plant at 75 days after sowing grown in water deficit.

Treatment		SOD	CAT	POX
Control		25.55±0.498	60.34±0.429	26.96±1.126
Orange extract	600	40.78±0.887	69.28±1.009	42.13±1.233
	1200	35.86±1.769	63.30±0.323	33.68±0.968
Ascorbic acid	200	33.38±0.482	61.08±0.482	36.70±1.242
	400	38.38±0.760	67.27±0.688	36.70±1.488
LSD 5%		2.98	2.16	3.16

Yield and yield components:

Data presented in (Table 6) show the effect of foliar application of orange peel extract (600 and 1200 mg/l) and ascorbic acid (200 & 400 mg/l) on yield parameters of quinoa plants grown under sandy soil and skipping irrigation. Data clearly show that, application of different treatments increased significantly yield and yield components such as shoot length, fruiting branches number /plant, shoot weight, seed weight/ plant and 1000 seed weight The maximum increases of the yield parameters were obtained by foliar application with orange peel extract 600 mg/l followed by ascorbic acid at 400 mg/l . Orange peel extract with 600mg/l concentration was more effective than 1200 mg/l as compared with control plants. As the percentage of increases in response to 600 mg /l orange peel extract reached to 68%, 73%, 153%, 149% and 38% as shoot length, fruiting branches number /plant, shoot weight, seed weight/ plant and 1000 seed weig.ht as compared to the untreated plants, respectively.

Table 6: Effect of orange peel extract or ascorbic acid on yield and yield components of quinoa plant grown in water deficit.

Treatment mg/l		Shoot length(cm)	branches No /plant	Shoot weight (g)	Seed weight/ Plant (g)	1000 seed weight (g)
Control		47.90±0.551	13.67±0.667	25.00±0.481	5.87±0.366	0.90± 0.028
Orange extract	600	80.33±0.474	23.67±0.333	63.33±0.371	14.60±0.309	1.34±0.100
	1200	67.67±0.545	20.33±0.333	55.00±0.574	11.30±0.181	1.18±0.012
Ascorbic acid	200	64.33±0.442	18.33±0.333	44.90±0.124	10.23±0.281	1.15±0.009
	400	71.00±0.577	21.67±0.333	58.50±0.312	12.47± 0.209	1.22±0.008
LSD 5%		1.47	1.46	1.00	0.88	0.14

Nutritive value of the yielded seeds:

Data in (Table 7) show that foliar application of orange peel extract or ascorbic acid led to significant increases in the nutritional value of the yielded quinoa seeds as compared with control plant. Moreover, the percentage of carbohydrate, protein oil, flavonoid, and antioxidant activity (as DPPH- radical scavenging capacity) were gradually increased with increasing concentrations of ascorbic acid. Meanwhile, the increases in carbohydrate, protein and oil, flavonoids, and antioxidant activity % of the yielded quinoa seeds were obtained by 600 mg/l more than 1200 mg/l in orange peel extract as it reached to 24% for carbohydrate 37% for protein, 59% for oil, 23% for flavonoid, and 25% antioxidant activity relative to control plant.

Table 7: Effect of orange peel extract or ascorbic acid on nutritive value and antioxidant substances of the yielded seeds of quinoa plant grown in water deficit.

Treatment mg/l		Carbohydrates %	Protein %	Oil %	Flavenoids %	DPPH %
Control		54.60±0.089	13.72 ±0.533	5.10±0.052	61.36±0.364	43.29±0.309
Orange extract	600	67.84±0.240	18.86±0.450	8.13±0.268	75.24±0.067	54.12±0.383
	1200	62.95±0.344	15.48±0.035	6.62±0.038	70.12±0.136	48.12±0.136
Ascorbic acid	200	58.88±0.069	14.66±0.124	6.09±0.038	69.62±0.367	46.70±0.551
	400	64.42±0.254	17.05±0.473	7.49±0.092	72.78±0.023	52.55±0.173
LSD 5%		0.82	1.28	0.37	0.53	1.22

Discussion

The growth parameters:

The growth parameters of quinoa plants in response to treatment with different concentrations of orange peel (600 & 1200) or ascorbic acid (200 & 400 mg/l) found that, foliar treatment at different concentrations increased shoot fresh and dry weight as well as root fresh and dry weight and water content in both shoot and root of quinoa plant as compared with control plant. Orange peel or ascorbic acid has been reported to induce significant effects on various biological aspects in plants. Chemical analysis of orange peel extract shows that, orange peel extract has high contents of natural phenolic compounds as flavanone glycosides which include antioxidant activities[11]. Orange peel is affluent in nutritional components such as soluble sugars, proteins and minerals. It contains antioxidant such as flavonoids and vitamin C[12]. Moreover, **[13]**show that orange peels contain potassium, which is necessary for plants growth. Exogenous application of ascorbic acid mitigated the adverse effects of water deficit on growth parameters[27]. In addition**,** [28] reported that, ascorbic acid improved many physiological processes such as regulated the plant growth, differentiation and metabolism of plants under water stress and increasing physiological availability of water and nutrients. The increase in growth of plant in response to ascorbic acid treatment relative to untreated plants might be a result from increased levels of endogenous hormones (Table 4) consequently stimulation of cell division and/or cell enlargement and subsequently growth[29].

Photosynthetic pigments

Applications of orange peel extract or ascorbic acid as foliar treatment at different concentrations and grown under water deficit (by skipping irrigation) significantly increased chlorophyll a chlorophyll b, total carotenoids and consequently total pigments in quinoa plants (Table 3). The increases in photosynthetic pigments of quinoa plant in response to ascorbic acid treatment, these results were confirmed by the findings of **[30].** These increases could be attributed to the ascorbic acid application depends on the scavenging of reactive oxygen species by this antioxidant molecule. Also, the promotive effect of orange peel extract may be due to the presence of natural antioxidants such as flavonoids and vitamin C**[12]**. These increases could be attributed to the orange peel application depends on the scavenging of reactive oxygen species by this antioxidant molecule and/or by increasing the antioxidant enzyme activity (Table 5) and promoting photosynthesis, maintaining enzyme activity[31]. Moreover, it is noticed that, carotenoids content was significantly higher in quinoa plants under treatment with orange peel extract or ascorbic acid. Carotenoids play a role as a free radical scavenger which, enhance their capacity to reduce the damage caused by ROS, which in turn increased chlorophyll content of such plants[32, 33]**.**

Change in indole acetic acid and total phenol contents:

Applications of orange peel extract or ascorbic acid as foliar treatment at different concentrations and grown under water deficit (by skipping irrigation) in quinoa plants increased total indole acetic acid contents (Table 4). It is notice that the increase in auxin contents concurrent with the increase in growth rate as shown in Table (2). Similar results were obtained by[34, 35] who suggested that ascorbic acid increase contents of IAA. It could be concluded that this increase may be due to the role of endogenous hormone in stimulating cell division and/or the cell enlargement and this in turn improve plant growth (Table 2). Abdallah et al [36] confirmed this result in quinoa plant.

Foliar applications of orange peel extract or ascorbic acid increased significantly in total phenol contents (Table 4). Increase in phenol contents in different treatments under osmotic stress have been reported in sunflower cultivars plants[37]. This increase may be due to total phenols role to play a significant mechanism in regulation of plant metabolic processes[38, 39, 40]. Moreover, phenols act as a substrate for many antioxidants enzymes, so, it mitigates the water stress injuries[41]. In addition, the phenolic compounds has antioxidant role of as free radical scavenger through their reactivity as electron or hydrogen donor, to stabilize and delocalize the unpaired electron, and from their role as transition metal ions chelator[41]**.**

Change in free amino acid contents:

Orange peel extract or ascorbic acid application caused significant increases of free amino acids as compared with control plant at water deficient stress (by skipping irrigation) (Table 4). The osmotic adjustment in plants subjected to drought stress occurs by the accumulation of high concentrations of osmotically active compounds known as compatible solutes such as proline, soluble sugars, free amino acids and polyamines stress[43]**, [32].** They revealed also that such substance play an important role in the adaptation of cells to various adverse environmental conditions through raising osmotic pressure in the cytoplasm, stabilizing proteins and membranes, and maintaining the relatively high water content (Table 2) engaged for plant growth and cellular functions.

Antioxidant enzymes

Superoxide dismutase, catalase and peroxidase are enzymes that responsible for ROS-scavenging[44]. Orange peel extract or ascorbic acid application caused significant increases activities in quinoa leaves as compared to control plants (Table 5). These results are in agreement with[45] on *Vicia faba*. At stress conditions higher content of hydrogen peroxide is detoxified by catalase and glutathione peroxidase[46]**.** Superoxide dismutase (SOD) is the first defense enzyme that converts superoxide to H_2O_2, which can be scavenged by catalase (CAT) and different classes of peroxidases (POX) and ascorbate peroxidase. These results are in agreement with the results observed by[47]. In addition, ascorbic acid decreases the damage of many enzyme activities which induced by oxidative process[48].

Yield and yield components:

Foliar application of orange peel extract (600 and 1200 mg/l) or ascorbic acid (200 &400 mg/l) increased significantly yield and yield components of quinoa plants grown under sandy soil and skipping tow irrigation as compared to control (Table 6). Orange peel extract at 600 mg/l was the most effective treatment which, returned to the antioxidant capacity caused by vitamin C and phenolic constituents but does not seem to be a property of a single phytochemical compound[49]. In addition, these changes may be attributed to the increase in nutrients uptake and assimilation. The stimulatory effect were found to be correlated with the increase in content and activity levels of endogenous promoters particularly IAA (table 4). Thus, it can be concluded that the increment of seed yield/plant, in response to the applied treatments is mainly due to the increases in the number of branches/ plant which increases the fruits number /plant. Moreover, the increase in yield and its components might be due to the effect of antioxidants role on enhancing protein synthesis (Table 7) and delaying senescence[45].

Nutritive value of the yielded seeds:

The different treatments of orange peel extract or ascorbic acid effectively increased the total carbohydrate, protein and oil percentage of yielded quinoa seeds (Table 7). Similar finding were obtained in different plant species in response to ascorbic acid application[44, 45], who found that, total carbohydrate, and protein concentrations were increased in cotton and faba bean plants respectively. In addition, [50]found that ascorbic acid application increase oil percent in different flax cultivars.

Total flavonoids content in yielded seeds:

Data represented in (Table7) indicated that foliar application of orange peel extract and ascorbic acid for significant increase in total flavonoids content. Flavonoids are secondary metabolites of phenolic nature which play important roles in the protection of plants against environment stress [51]**.** Ascorbic acid plays a role for synthesis flavonoids[7]**.**

Antioxidant activity in yielded grains:

Data in (Table 7) show that foliar application of orange peel extract and ascorbic acid led to significant increases in the antioxidant activity (as DPPH- radical scavenging capacity) of the yielded quinoa seeds as compared with control plant. The increase in the antioxidant activity can be considered an advantage of treatment used [52, 53]. The increases in total phenols and total flavonoids lead to antioxidant activity increase [54, 55]**.**

Conclusion

The growth enhanced by foliar application of orange peel extract or ascorbic acid, which stimulating growth regulators level (IAA) and involved in protecting the photosynthetic apparatus and consequently increasing the photosynthetic. Moreover, quinoa plant gave higher nutritional value of carbohydrate%, protein%, oil %, total flavonoids, and antioxidant activity in yielded seeds. Orange peel extract was the most effective in enhancing the above parameters which, may be returned to the antioxidant capacity caused by vitamin C and phenolic constituents but does not seem to be a property of a single phytochemical compound.

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