INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 8, No. 1, p. 63-76 2016

RESEARCH PAPER OPEN ACCESS

Seed germination potential, phytochemical analysis and antioxidant activity of two tomato varieties

Mst. Samima Nasrin, Fatema Jesmin, M. Mostafizur Rahman, M. Firoz Alam*

Plant Biotechnology and Microbiology Laboratory, Department of Botany, University of Rajshahi, Rajshahi-6205, Bangladesh

Key words: Tomato, seed germination, phytochemical analysis, antioxidant activity, DPPH, free radicals.

http://dx.doi.org/10.12692/ijb/8.1.63-76 Article published on February 20, 2016

Abstract

The present study has carried out to evaluate seed germination potential, phytochemical analysis and antioxidant activity of two tomato varieties viz., Raton and Persimmon.Seed germination experiment has undertaken with an objective to determine how the rate of seed germination can be influenced by various concentrations (10^{-3} M, 10^{-4} M, 10^{-5} M) of plant hormones i.e. NAAand BA.Raton (BA 10^{-5} M) has showed highest germination percentage as well as the longestshoot and root length in contrast to other treatments. So, low concentration of plant hormones has showed more effectiveness for seed germination in both varieties. Phytochemical analysis and antioxidant activityof well ripen berry powder have assessed to explainthe scientific basis fornutritional and nutraceuticals benefits of tomato. Phytochemical screening of Raton and Persimmon have showed that alkaloids, flavonoids, tannins, terpenoids and glycosides are present in both Raton and Persimmon, but saponin and phenol are absent in Persimmon. Nutraceutical especially antioxidant activities of Raton and Persimmon have examined through DPPH free radical scavenging assay. Both the varieties have showed significant antioxidant activity. Where IC_{50} value of Raton and Persimmon are 29.2 mg/ml and 38.1 mg/ml respectively. The IC_{50} value of standard sample (ascorbic acid) is 11.5 mg/ml. The result of this study indicates that Raton contain higher antioxidant potential than Persimmon.The phytochemical analysis supportsantioxidant properties of both varieties and also indicating for developing herbal medicine from tomatoes.

* **Corresponding Author:** M. FirozAlam ✉ falambiotech@gmail.com

Introduction

Tomato (*Solanumlycopersicum* L.) is an herbaceous, usually sprawling plant in the Solanaceae family that is typically cultivated for the purpose of harvesting its fruit for human consumption. Tomato contains a variety of phytochemical constituents including carotenoids, phenols, tannin, flavonoids, alkaloid, saponin, phytates(Omodamiro and Amechi,2013). It is also a major source of antioxidants contributing to the daily intake of a significant amount of molecules, such as β-carotene, a precursor of vitamin A, lycopene, ascorbic acid, tocopherols, flavonoids and hydroxycinnamic acid derivatives (Clinton, 1998). Numerous studies have concluded that the more tomatoes people eat the lower their risks of certain cancers, especially lung, stomach and prostate cancers. The lycopene from tomatoes has no effect on the risk of developing diabetes, but may help relieve the oxidative stress of people who already have diabetes (Parnell *et al*., 2004).

Germination is an important factor for the growth and development of plant as well as for economic yield in crop production. Many field crops suffer differently due to lack of germination of seeds or for delay in germination. Germination of seeds is initiated by imbibition followed by radical emergence and growth of root and shoot as a result of high metabolic activity (Doganlar*et al*., 2000).The overall development of plant is regulated by the growth hormones, nutrient and environmental factors. Plant hormones are a group of organic substances which influence physiological processes mainly growth, differentiation and development (Philosoph-Hadas*et al*., 2005;Kucera*et al*., 2005).6-benzylaminopurine (BA) is a kind of cytokinin that promotes cell division and seed germination rate. Naphthylacetic Acid (NAA) could improve seed peroxidase and catalase activity, integrity of the cell membrane, seedgermination rate and promote the difficult-rooting plant to germinate (Zhang *et al*., 2006). As tomato is short duration crop and highly demanding in Bangladesh, it is important from economic point of view to increase its seed germination properties for better production. Moreover, it is not well reportedon concentration and type of hormone effective for good germination of tomato seeds.The investigation on growth hormones will help in determining the type and concentration of hormone suitable for high percentage of tomato seed germination.

Phytochemicals are natural and non-nutritive bioactive compounds produced by plants that act as protective agents against external stress and pathogenic attack (Chew *et al*., 2009).Phytonutrients have various health benefits, for example, they may have antimicrobial, anti-inflammatory, cancer preventive, antidiabetic and antihypertensive effects to mention but a few. The phytochemical constituent of a plant will often determine the physiological action on the human body (Pamplona-Roger, 1998). The most important of these bioactive constituents of plants are alkaloids, flavonoids, tannins, phenolic compounds etc. (Hill, 1952).Among secondary metabolites, the polyphenol compounds play a wide range of biological effects including antibacterial, anti-inflammatory, antiallergic, hepatoprotective, antithrombotic, antiviral, anticarcinogenic and cardioprotective and vasodilatory effects (Trigui*et al*., 2013). So, phytochemical analysis on studied tomato genotypes will help for determining nutraceuticals benefits of tomato.

Oxidation is a normal physiological and metabolic process in the cell. During the process, approximately 5%oxygen gets reduced to the oxygen based free radicals, includes superoxide, hydrogen peroxide, hydroxyl and nitric oxide radicals (Halliwell and Gutteridge, 1989). These free radicals are collectively known as Reactive Oxygen Species (ROS). Free radicals formed during metabolism are electrically charged and react with nucleic acids, mitochondria, proteins and enzymes, and resulting in their damage (Halliwell, 1996; Morrissey and O'Brien, 1998). An antioxidant is a molecule that inhibits the oxidation of other molecules. When formation of free radicals overtakes the antioxidant defense system, the free radicals start attacking the cell and resulting in several physiological disorders like Alzheimer's disease, cancer, atherosclerosis, diabetes, liver

cirrhosis and rheumatism (Frankel *et al.*, 1993; Goodwin and Brodwick, 1995).

Avarietyofpolyphenols,flavonoids,anthocyanins,vitamins have been reported as showing antioxidant (Kahkonen *et al.*, 2008). Therefore, investigation on antioxidant properties along with phytochemical analysis on studied genotypes will help for developing herbal medicine from tomatoes.

In view of the above back ground, the present investigation was undertaken to study the influence of growth substances by different concentration on seed germination, the qualitative phytochemical composition and nutraceutical like antioxidant activity of two tomato varieties namely Raton (red tomato) and Persimmon (yellow tomato).

Materials and methods

Plant material

Seed of Bangladeshi tomato variety "Raton" was collected from local farmer of Rajshahi-6205, Bangladesh. Seed of American tomato variety "Persimmon" was collected from Dr. Arun K Basak, Professor Emeritus, Department of physics, Rajshahi University, Bangladesh and was grown in home-garden. The identities of both varieties were confirmed by taxonomist Dr. A.H.M. MahbuburRahman, Associate Professor, Department of Botany, Rajshahi University, Rajshahi-6205, Bangladesh.

Chemicals and Reagents

6-benzylaminopurine (BA), α-napthaleneacetic acid (NAA), 2,2-Diphenyl-1-picrylhydrazyl (DPPH), ascorbic acid, methanol, ethanol, Dragendroff's,Hager's, Mayer's, Wagner's and Tannic acid reagents.

Seed germination

Seeds were treated for 10 min in 70 % alcohol, then washed and rinsedwith distilled water. These surface sterilized seeds were soaked in solution of (10^{-3}M, 10^{-4}M and 10^{-5}M) NAA and BA and maintained in a growth chamber in darkness for 24 h at 25 ˚C. Seeds, soaked in distilled water were considered as control. For each variety, 15 seeds with three replicates per treatment were sown in a Petri dish 9 cm in diameter, containing a singlelayer of sterile blotting paper, and germinated in an incubator at 28 ˚C. Then, dishes were moistened with equal amounts of 5 ml consecutively distilled water in control and various hormonal solutions as treatments. Observation aspects like germination count (recorded for 5 days), measurement of root and shoot length was measured (recorded for 7 days).

Spot phytochemical analysis

Preparation of sample

Initially well washed fruits were cut into small pieces and dried in hot air oven.The dried materials were grinded as fine powder. Spot phytochemical screening of Raton and Persimmon were carried out by using the following protocols as described below for the presence ofalkaloids, flavonoids, glycosides, saponins, tannins, terpenoids and phenols.

(a) Determination of Alkaloids

5 g fine powder was mixed up to moistered with 10 ml 2% HCl and heated in water at 60 ˚C for one hour. After cooling the sample was filtered through Whatmann No. 1 filter paper.Two drops of filtrates were put on a microscopic groove slide with one drop of the alkaloid detecting reagent. The relative abundance of precipitate, if any, formed in the plant sample with the reagents was considered as the presence of alkaloid(Aplin and Cannon, 1971).

(b) Determination of Flavonoids

About 10 g plant sample was extracted with 20 ml ethanol (1:2) in aspirator bottle by soaking about 72 hours. After that few drops of conc. HClwere added to the alcoholic extract resulting red color, indicates the presence of flavonoids (Farnsworth, 1985).

(c) Determination of Glycosides

A small amount of sample solution was mixed with 2ml of glacial acetic acid containing 1-2 drops of 2% solution of $FeCl_3$. The mixture was then poured into another test tube containing 2ml of concentrated

H_2SO_4. A brown ring at the interphase indicated the presence of cardiac glycosides(Trease and Evans, 1989).

(d)Determination of Saponins

20 ml water is added to 150 mg fine powder and shaken vigorously; layer of foam formation indicates the presence of saponins (Siddiqui and Ali, 1997).

(e) Determination of Tannins

2g fine powder was extracted with 10 ml distilled water (1:5), and was boiled for about 20 to 25 minutes. After cooling the extract was filtered.The filtrate was taken on 3 microscopic slides, two drops on each. Then to the first slide one drop 10% NaCl, to the second 1% gelatin and to the third 1% gelatin + 10% NaCl were added. The appearance of a white precipitate on the second and third was taken as positive test for tannins(Wall *et al.*, 1954).

(f)Determination ofTerpenoids

2ml of sample was mixed in 5ml of chloroform and concentrated $H_2SO_4$2ml was carefully added to form layer. A reddish brown coloration of the interface was formed show positive result for the presence of terpenoids (Harborne, 1973).

(g) Determination of Phenols

5ml of sample was mixed with 2ml of 2% solution of $FeCl_3$. A blue-green or black coloration indicated the presence of phenols.

Antioxidant activity

Antioxidant activity of Raton and Persimmon was estimated for their free radical scavenging activity by using DPPH (2, 2-Diphenyl-1-Picrylhydrazyl) as described by Hsu *et al.* (2007) with some modification.

Experimental procedure of Antioxidant activity test

First, various concentrations like 20, 40, 60, 80, 100 mg/ml of sample in methanol were prepared. 2 ml of methanol solution of plant sample or standard at different concentration was taken in test tube. 3 ml of 0.1 mMmethanol solution of DPPH was added into the test tube. The test tube was incubating at room temperature for 30 minutes in dark place to complete the reaction. Then the absorbance of the solution was measured at 517 nm using a spectrophotometer against control. Ascorbic acid was used as standards (positive control). Then the percentage (%) inhibition activity was calculated according to Pavlov *et al.* (2002).

$$\% I=\{(A_O- A_1)/A_O\}^*100.$$

Where,A_O is the absorbance of the control, andA_1 is the absorbance of the sample or standard. Sample was analyzed in two replications and data presented as mean (±) standard Error (SE). Then % of inhibition was plotted against blank concentration and from the graph IC_{50} was calculated. IC_{50} value, the concentration of sample required for 50% scavenging of DPPH free radical are completed (Mandal *et al.,* 2009).

Statistical analysis:

Statistical analysis was conducted using analysis of variance(ANOVA). Least Significant Difference (LSD) test was used to speculate further if there was a significant difference within varieties, various concentrations andplant hormones. P values <0.05 were considered as significant.

Results

Seed germination

The test period of germination and postgerminative growth was recorded for 7 days. Treatments on concentration of hormone were @ 10^{-3} M, 10^{-4} M and 10^{-5} M. The results at Table 1 show the percentage of germination at various concentrations of treatments of Raton and Persimmon. The seeds treated with NAA at 10^{-5} M and 10^{-4} M increase and at 10^{-3} M decrease germination percentage over control for both the variety.This indicates that high concentration was not good compare to low concentration of NAA for seed germination in Tomato. On the other hand, use of BA increase seed germination percentage for the studied three concentrations. However, for both NAA and BA the germination percentage decreases when the

concentration is increased (Fig. 1). It also indicates that cytokinin (BA) is better than auxin (NAA). Between two genotypes Raton shows better performance than Persimmon.

According to Table 2, the length of shoot for control was recorded 4.6 cm and 3.53 cm, where the length of root was 2.4 cm and 2.86 cmfor Raton and Persimmon respectively. Among the three concentrations (10^{-3}, 10^{-4} and 10^{-5} M) of NAA and BA, low concentration (10^{-5} M) showed effective for both shoot and root length elongation in both variety. The longest shoot and root length were observed for Raton, 9.5 cm and 6.5 cm respectivelyat 10^{-5} M of BA.Similar trends also observed for Persimmon. When control was compared with other treatments, it was observed that plant hormones enhance both shoot and root length. Here also BA (cytokinin) was more effective than NAA (auxin) like seed germination percentage trait. Fig. 2 and Fig. 3 represent the effect of plant hormones on shoot and root length during germination of seeds using histograms. Analysis of variance (Table 3) shows that except replication other items like variety (V), plant hormones (PH), concentration of PH and VXPH were significantly different at 5% level. Mean separation data for shoot and root length show that two tomato genotypes, types of plant hormone and concentrations of plant hormone are significantly different with each other.

Table 1. Seed germination rate (%) of two tomato varieties in different treatments. The mean values are calculated from 3 replications.

Treatment		Raton		Persimmon	
		Range	Mean	Range	Mean
Control		60-73.33	66.66	53.33-60	56.66
NAA	T1(10^{-3}M)	53.33-60	56.66 (-15%)	40-53.33	46.66 (-17.65%)
	T2(10^{-4}M)	66.66-73.33	69.99 (5%)	66.66-66.66	66.66 (17.65%)
	T3(10^{-5}M)	86.66-93.33	89.99 (35%)	73.33-80	77.77 (37.26%)
BA	T4(10^{-3}M)	60-86.66	73.33 (10%)	66.66-73.33	69.99 (23.53%)
	T5(10^{-4}M)	80-86.66	83.33 (25%)	80-86.66	83.33(47.07%)
	T6(10^{-5}M)	86.66-93.33	91.11(36.68%)	80-86.66	84.44 (49.02%)

Table 2. Shoot and Root length of two tomato varieties under various treatments.

Treatment		Raton				Persimmon			
		Shoot length (cm)		Root length (cm)		Shoot length (cm)		Root length (cm)	
		Range	Mean(x±se)	Range	Mean(x±se)	Range	Mean(x±se)	Range	Mean (x±se)
Control		4.2-5	4.6±0.23	2-2.7	2.4±0.21	3.4-3.7	3.53±0.17	2.7-3	2.86±0.09
NAA	T1	3.5-4	3.76±0.14	4.2-4.5	4.4±0.09	3.5-4.1	3.76±0.09	3-4	3.5±0.28
	T2	5.5-6	5.73±0.14	4.2-5	4.56±0.23	4.9-5.5	5.2±0.17	4.5-5	4.67±0.16
	T3	7-7.5	7.33±0.16	6-6.5	6.2±0.15	6.5-6.8	6.6±0.09	5.5-6	5.7±0.15
BA	T4	5.5-6	5.76±0.14	4-5	4.5±0.29	4-4.5	4.26±0.14	2.5-3.2	2.9±0.21
	T5	7-7.5	7.2±0.16	4-4.5	4.16±0.16	6.5-6.9	6.67±0.12	4-4.5	4.25±0.16
	T6	9-10	9.5±0.28	6-7	6.5±0.29	8-8.9	8.46±0.26	4-5	4.5±0.29

Values are mean of 3 replicates ± standard error (n=3).

Spot phytochemical analysis

Spot phytochemical analysis of two tomato (*Solanumlycopersicum* L.) varieties, Raton and Persimmon were examined qualitatively for their alkaloid, flavonoid, glycoside, terpenoid, saponin, tannin and phenol content. The result has revealed the presence of alkaloid, flavonoid, glycoside, terpenoid and tannin in both Raton and Persimmon, but absent of saponin and phenol in Persimmon(Table 4).

In 2,2-diphenyl-1-picrylhydrazyl radical scavenging assay, scavenging values (IC_{50}) are presented in (Table 5). The IC_{50} value of Raton and Persimmon

were respectively 29.2 mg/ml and 38.1 mg/ml. IC_{50} value of the positive control (ascorbic acid) was 11.5 mg/ml. Here, Bangladeshi variety Raton showed comparatively lower IC_{50} value (29.2 mg/ml) than American variety Persimmon (38.1 mg/ml). It is mentioned that lower IC_{50} value indicates highest antioxidant activity, and higher is lowest activity. So, this result shows that Raton (red tomato) contains higher antioxidant activity than Persimmon (yellow tomato). Fig. 4 shows the dose response curve of two tomato varieties (Raton and Persimmon).

Table 3. Statistical analysis (ANOVA) of shoot and root length of two tomato varieties.

Shoot length:

Source of variation	df	SS	MS	F	Comment
Variety (V)	1	6.248571	6.248571	77.57321	*
Plant hormone (PH)	2	44.98698	22.49349	279.2466	*
Concentration	2	0.055714	0.027857	0.345832	*
Replication	2	22.93643	11.46822	142.3728	ns
V X PH	2	57.20611	28.60306	355.0941	*
Error	32	2.57762	0.080551		
Total	41	134.0114			
Variables					Mean data
		Variety			
Raton					6.271429^{a}
Persimmon					5.5^{b}
LSD					0.1784
		Plant hormone			
Control					4.083333^{c}
NAA					5.4^{b}
BA					6.972222^{a}
LSD					0.1927
		Concentration			
10^{-3} M					4.391667^{c}
10^{-4} M					6.191667^{b}
10^{-5} M					7.975^{a}
LSD					0.2360

ns=not-significant, *=significant (P<0.05)

Root length:

Source of variation	df	SS	MS	F	Comment
Variety (V)	1	4.211667	4.211667	38.0408	*
Plant hormone (PH)	2	22.18063	11.09032	100.1704	*
Concentration	2	3.489524	1.744762	15.75911	*
Replication	2	0.190476	0.095238	0.860213	ns
V X PH	2	26.98603	13.49302	121.8722	*
Error	32	3.542863	0.110714		
Total	41	60.60119			
Variables					Mean data
		Variety			
Raton					4.67619^{a}
Persimmon					4.042857^{b}
LSD					0.209159
		Plant hormone			
Control					2.633333^{c}
NAA					4.838889^{a}
BA					4.455556^{b}
LSD					0.225918
		Concentration			
10^{-3} M					3.825^{c}
10^{-4} M					4.391667^{b}
10^{-5} M					5.725^{a}
LSD					0.276692

ns=not-significant, *=significant (P<0.05)

In case of five different concentrations (20, 40, 60, 80 and 100 mg/ml) the % scavenging activity of tomato variety Raton was respectively 38.82%, 63.82%, 66.44%, 67.76% and 70.39% (mean % 61.446), and in case of Persimmon, % of scavenging activity was 36.34%, 51.16%, 54.36%, 55.81% and 57.56% (mean % 51.046).For ascorbic acid % scavenging was 86.32%, 88.67%, 90.92%, 91.84% and 96.18% (mean % 90.786). Statistical analysis with mean separation data on antioxidant activities are presented at table 6. It is observed that the treatment sample and concentration of varietywere significantly different at 5% level. Treatment replication was not significant as expected. Mean separation data show that tomato genotypes Raton and Persimmon were significantly different with each other.

Table 4. Spot phytochemical screening of fruits of tomato (*Solanumlycopersicum* L.).

Phytochemicals	Raton	Persimmon
Alkaloids	+	+
Flavonoids	+	+
Glycosides	+	+
Saponins	+	_
Tannins	+	+
Terpenoids	+	+
Phenols	+	_

Note: + = Positive/ Present; - = Negative/Absent.

Table 5. DPPH radical scavenging activity of two tomato varieties comparing with ascorbic acid.

Name of sample	Concentration mg/ml	% of scavenging		Mean % of scavenging (x ± se)	IC_{50} mg/ml
		A	B		
Ascorbic acid	20	86.39	86.24	86.32±0.08	11.5
	40	88.74	88.60	88.67±0.06	
	60	90.95	90.88	90.92±0.04	
	80	91.91	91.76	91.84±0.08	
	100	96.25	96.10	96.18±0.08	
Raton	20	38.16	39.47	38.82±0.65	29.2
	40	63.63	64.01	63.82±0.18	
	60	65.94	66.87	66.44±0.46	
	80	67.11	68.42	67.76±0.66	
	100	69.74	71.05	70.39±0.65	
Persimmon	20	36.05	36.63	36.34±0.29	38.1
	40	50.56	51.78	51.16±0.61	
	60	54.68	55.98	54.36±0.64	
	80	55.93	55.71	55.81±0.11	
	100	57.33	57.79	57.56±0.23	

[Note: IC_{50} value, the concentration ofsample required for 50% scavenging of DPPH].

Discussion

The study was conducted to investigate the germination potential, phytochemical analysis and antioxidant activity of Raton and Persimmon.Seed germination was done to assess changes caused by plant hormones such as, NAA and BA. Although seed germination is an internallyregulated process influenced by genotype,external factors such as light, temperature,moisture and the presence of certain chemical compounds (phytohormones or organicacids) also strongly influence this process(Finkelstein, 2004; Kucera*et al.*, 2005). In this study, highest germination rate and the longest shoot, root length was observed at 10^{-5} M of BA in both varieties.NAA also showed significant changes in germination rate and seedling development

comparing to control (Table 1; Table 2).Nawaz *et al.* (2013) also reported improved germination potential and seedling establishment in tomato at 10 ppm of BA and kinetin. In other report, NAA treatments drastically inhibited both shoot and root elongation in tomato at any concentration and stage but did not affect germination percentage (Bakrim*et al.,* 2007).Several studies showed that application of differentbiostimulantes and plant growth regulator may increase the germination ability of seeds and seedling vigor in various terrestrial plants (Swaminathaan and Srinivasan, 1996). Lashbrook*et al.* (1998) reported that *Lycopersicumesculentum*seed germination has been shown to be promoted by the plant hormone ethylene. Cytokinins are involved in a variety of processes in the growth and development of plants including cell division, root formation, leaf senescence, stomatal behavior, and chloroplast development (Davies, 1995; Brault and Maldiney, 1999).

Table 6. Statistical analysis (ANOVA) of antioxidant activity of two tomato varieties.

Source of variation	df	SS	MS	F	Comment
Sample	2	8427.216	4213.608	218.2593	*
Concentration	4	1611.964	402.991	20.87439	*
Replication	1	1.708853	1.708853	0.088516	ns
Error	22	424.7214	19.30552		
Total	29	10465.61			
Variables					Mean data
		Sample			
Ascorbic acid					90.786[a]
Raton					61.446[b]
Persimmon					51.046[c]
LSD					4.075149
		Concentration			
20 mgml^{-1}					53.82333[b]
40 mgml^{-1}					67.88667[a]
60 mgml^{-1}					70.88333[a]
80 mgml^{-1}					71.80667[a]
100 mgml^{-1}					74.71[a]
LSD					5.260995

ns=not-significant, *=significant (P<0.05).

In another study, phytochemical investigation was made to identify the phytochemical constituents of Raton and Persimmon, and the results showed the presence of alkaloid, glycoside,flavonoid, tannin and terpenoid in both Raton and Persimmon, whereas saponin and phenol were absent in Persimmon (Table 4).The studied phytochemicals are reported to possess good antioxidant activities and has been reported toshow numerous biological effects including anti-inflammatory and antitumor activities (Sarla*et al.*, 2011).Therefore, tomato as one of the most versatile and widely-used food plants could play an important role in human diet.Plants contain some organic compounds which provide definite physiological action on the human body and these bioactive substances include tannins, alkaloids, carbohydrates, terpenoids, steroids and flavonoids (Edoga*et al.*, 2005).

There are reports where screening revealed the presence of compounds such as tannins, flavonoids, alkaloids, phenols etc. in tomato (Akilan*et al.*, 2014).Wilcox *et al.* (2003) shows that tomato contains many nutrients and secondary metabolites that are important for human health: folate, potassium, vitamins C and E, flavonoids, chlorophyll, β-carotene and lycopene.

On the basis of the scavenging ability of the free radicals for DPPH, the highest antioxidant activity was found in Raton (Table 5).

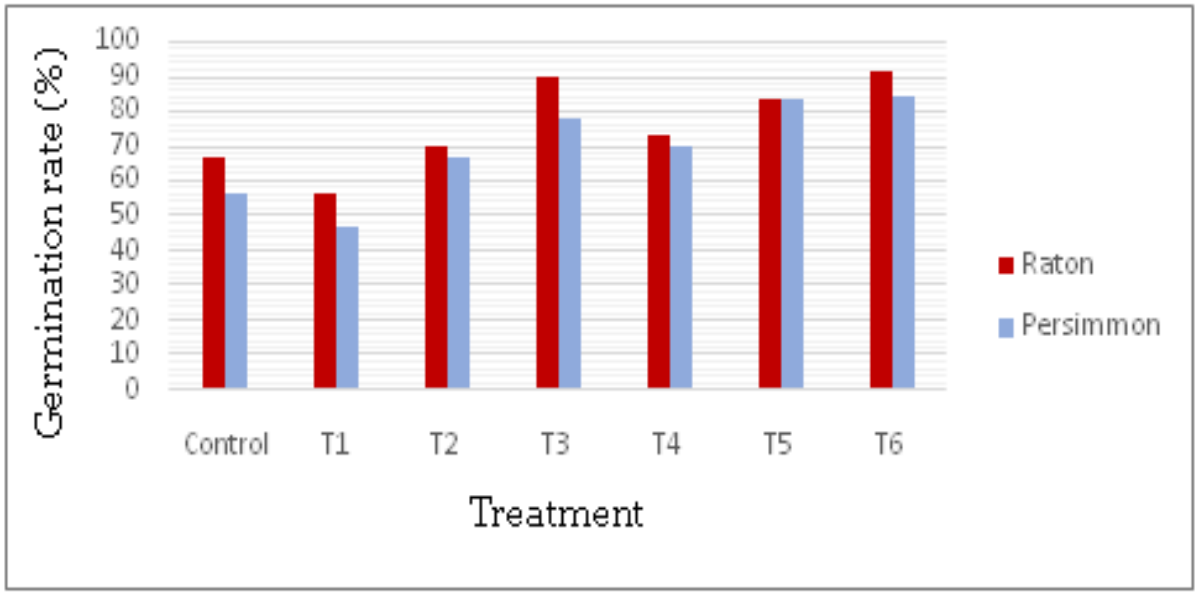

Fig. 1. The effect of plant hormones on germination percentage of Raton and Persimmon.

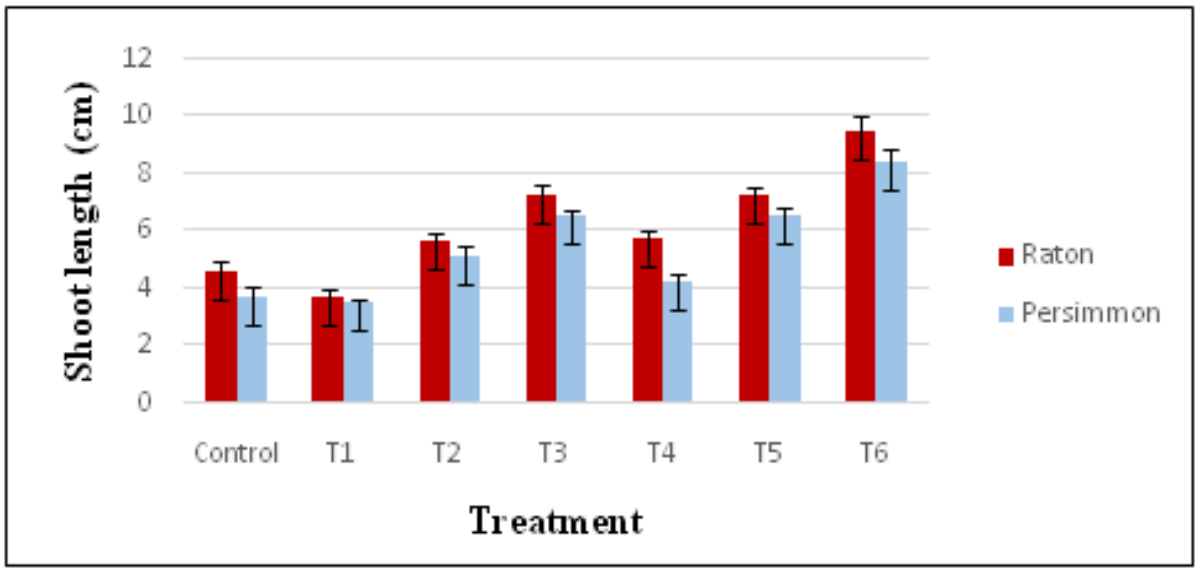

Fig. 2. The effect of plant hormones at three concentrations on shoot lengthofRaton and Persimmon. Each value represents the mean ± SE of 3 replications.

The DPPH assay has been largely used as a quick, reliable and reproducible parameter to search for the *in vitro*general antioxidant activity of pure compounds as well as plant extracts (Kolev*aet al.*, 2002; Goncalves*et al.*,2005). DPPH is one of the compounds that possess a proton free radical with a characteristic absorption, which decreases significantly on exposure to proton radical scavengers (Yamaguchi *et al.*, 1998). A freshly prepared DPPH solution exhibits a deep purple color. The transformation of color change from purple to yellow, which is measured spectrophotometrically. The DPPH free radical, which is at its maximum wavelength at 517 nm, can easily receive an electron or hydrogen from antioxidant molecules to become a stable diamagnetic molecule (Soares*et al.*, 1997).There are already many reports where several scientists said that tomato contains antioxidants. Fernandez-Ruiz *et al.* (2011) reported that tomato is a good source of antioxidants like lycopene, vitamin C and tocopherols, additional carotenoids (β-carotene, lutein and zeaxanthin), trace minerals (selenium, copper, manganese and zinc) and phytonutrients including flavonoids (naringenin, rutin, kaempferol

and quercetin) and hydroxycinnamic acids (caffeic, ferulic and coumaric acid). Kaur and Harish (2002) have found that tomato has 70.8% (ethanol extract) and 56.3% (water extract) antioxidant activity using a model system consisting of β carotene-linoleic acid. The difference between their result and the present study might be due to differences in the methodology or the difference in the solvent used for extraction of the sample and genotypes of tomato.

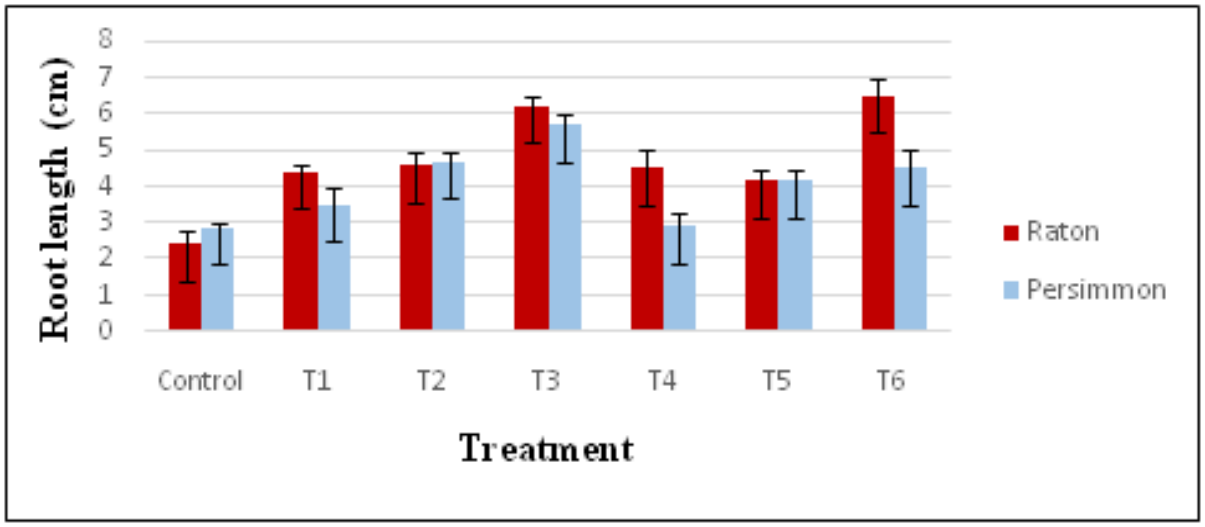

Fig. 3. The effect of plant hormones at three concentrations on root length ofRaton and Persimmon. Each value represents the mean ± SE of 3 replications.

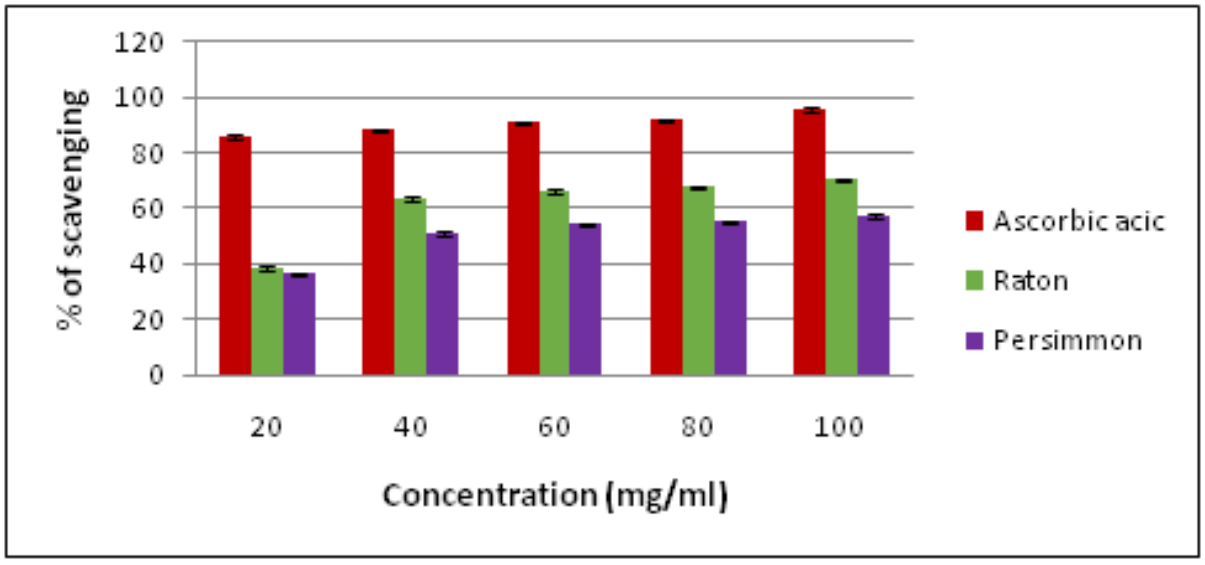

Fig. 4. DPPH radical scavenging activity of two tomato varieties (Raton and Persimmon).

The studied sample Raton was red and Persimmon was Yellowish in color. In an experiment Walia*et al.* (2010) reported that there are differences in antioxidant composition between red and yellow tomato cultivars. They analyzed fourteen commercial cultivars of tomato for their antioxidant composition. There was significant difference ($p<0.05$) in lycopene and phenolic contents between red and yellow cultivars. Red cultivars had higher lycopene content than yellow cultivars. Mean total polyphenolic content and total antioxidant activity in red cultivars was also higher than those in yellow cultivars. The result is same in the present investigation. The tomato variety Raton which is red in color shows higher antioxidant activity than yellow color Persimmon which is significantly different ($P<0.05$)

according to studied ANOVA.This result isalso supported by our phytochemical analysis. Here, the studied sample showed the presence of alkaloid, terpenoid, saponin, glycoside, tannin, phenol and flavonoid. From the previous reports it is noticed that mentioned phytochemicals have antioxidant properties. As for example, Adnan *et al.* (2013), PlantaMedica (2004), Foti (2007), Pietta (2000), Plumb *et al.* (1999), Grassmann (2005) reported that alkaloid, saponin, phenol, flavonoid, glycoside, terpenoid (respectively) have antioxidant properties. So, due to the presence of examined phytochemicals in both Raton and Persimmon varieties showed significant antioxidant activity. As Raton is red in color supposed to be contained high amount of those biochemicals than Persimmon (yellow color). Though, in this experiment quantitative test had not been done but there are reports, where it showed that red tomato contains higher antioxidant compound than yellow tomato (Walia*et al.*, 2010).

Conclusion

From the above discussion, it can beconcluded that as tomato is easy to seed germinate and because it is ranked among the most important crops throughout the world, the improved capacity of seed germination by the plant hormones could be useful in increasing commercial exploitation of tomato in the field of biotechnology.Moreover, qualitative phytochemical screening and nutraceutical like antioxidant activity of tomato suggests that tomatohas a rich amount of valuable ingredients that are beneficial for health. So, further investigations on the isolation and identification of bioactive components would help to ascertain its potency.

References

Adnan JM, Zearah SA, Alwan NA. 2013. Total antioxidant capacity and antihyperlipidemic activity of alkaloid extract from aerial part of *Anethumgraveolens* L. plant. European Scientific Journal **9(33),** 1857-7881.

Ahmad I, Beg Z. 2001. Antimicrobial and phytochemical studies on 45 Indian medicinal plants against multi-drug resistant human pathogens. Journal ofEthnopharmacology **74,** 87-91.

Akilan CA, Srividhya M, Mohana PC, Jeba SCS,Sundara MMA. 2014. Comparative Analysis ofPhytochemicals, Antibiogram of Selected Plants in Solanaceae Family and its Characterization Studies. International Journal of Pharmacy and PharmaceuticalSciences **6(2),** 946-950.

Akueshi CO, Kadiri CO, Akueshi EU, Agina SE, Ngurukwem B. 2002. Antimicrobial potentials of *Hyptissauvedens*Poit(Lamiaceae).Nigerian Journal of Botany **15,** 37-41.

Aplin THE, Cannon JR. 1971. Distribution of Alkaloids in some western Australian plants.Economic Botany **25(4),** 366-380.

Bakrim A, Lamhamdi M, Sayah F, Chibi F.2007. Effects of plant hormones and 20-hydroxyecdysone on tomato (*Lycopersicumesculentum*) seed germination and seedling growth.African Journal of Biotechnology **6(24),** 2792-2802.

Brault M, Maldiney R. 1999. Mechanisms of cytokinin action. Plant Physiology andBiochemistry **37**, 403-412.

Chew YL, Goh JK, Lim YY. 2009. Assessment of *in vitro* antioxidant capacity and polyphenolic composition of selected medicinal herbs from Leguminosae family in Peninsular Malaysia. Food Chemistry **119,** 373-378.

Clinton SK. 1998. Lycopene; Chemistry, biology and implications for human health and diseases. Nutrition Reviews**56,** 35-51.

Davies PJ. 1995. The plant hormone concept: concentration, sensitivity and transport. In: Davies, P.J. (ed.): Plant Hormones. Kluwer Academic Publishers, Dordrecht, Boston, London.pp. 13-38.

Doganlar S, Frary A, Tanksley SD. 2000. The genetic basis of seed-weight variation:tomato as a model system. Theoretical andApplied Genetics**100**, 1267-1273.

Edoga HO,Okwu DE, Mbaebie BO. 2005. Phytochemicals constituents of some Nigerian medicinal plants. African Journal ofBiotechnology **4(7),** 685-688.

Ekwenye UN, Elegalam NN. 2005. Antibacterial activity of Ginger (*Zingiberofficinale*) Roscoe and Garlic (*Allium sativum* L.) extracts on *Escherichia coli* and *Salmonella typhi*. International Journal of Molecular Medicine and Advance Sciences **1(4),** 411-416.

Farnsworth NR, Kinghorn AD, Soehart DD, Waller. 1985. Siberian Ginseng (*Eleutheroccussenticosus*): Current status as an adaptogen. In: Wagner H. Hikino H. and Farnsworth NR, (eds) In economic and Medicinal plant Research.Vol. 1 p.155-215. Academic press, Orlando, Florida, USA.

Fernandez-Ruiz V, Olives AI, Camara M, Sanchez-Mata MDE,Toriza ME. 2011. Mineral and trace elements content in 30 accessions of tomato fruits (*Solanumlycopersicum* L.) and wild relatives (*Solanumpimpinellifolium* L., *Solanumcheesmaniae* L. Riley and *Solanumhabrochaites*S. Knapp and D.M. Spooner). Biological Trace Element Research **141,** 329-339.

Finkelstein RR. 2004. Hormones in seed development and germination. In: Davies, P.J. (ed.). Plant hormones: Biosynthesis, signal transduction and action. Kluwer Academic Publishers. 513–537 p.

Foti MC. 2007. Antioxidant properties of phenols. Journal of Pharmacy and Pharmacology **59(12),** 1673-85.

Frankel EN, Kanner J, German JB, Parks E, Kinsella JE. 1993. Inhibition of oxidation of human low density lipoprotein by phenolic substances in red wine. Lancet**341,** 454-457.

Frusciante L, Baroneb A, Carputob D, Ercolanoa MR, della Roccaa F, Espositoa S. 2000. Evaluation and use of plant diversity for food and pharmaceuticals.Fitoterapia **71**, 66-72.

Gonçalves C, Dinis T, Batista MT. 2005. Antioxidant properties of proanthocyanidins of *Uncariatomentosa* bark decoction: a mechanism for anti-inflammatory activity. Phytochemistry **66,** 89-98.

Goodwin JS, Brodwick M. 1995. Diet, aging and cancer. Clinics in Geriatric Medicine **11(4),** 577-589.

Grassman J. 2005. Terpenoids as plant antioxidants. Vitamins & Hormones **72,** 505-35.

Halliwell B. 1995. How to characterize an antioxidant- An update. Biochemical Society Symposium **61,** 73-101.

Halliwell B. 1996. Antioxidants in human health and disease. Annual Reviews of Nutrition **16,** 33-50.

Halliwell B, Gutteridge JMC. 1989. Free Radicals in Biology and Medicine. Clarendon Press, Oxford, UK.

Harborne JB. 1973. Phytochemicals Methods. Chapman and Hall Ltd., London, 49-188.

Hill AF. 1952. Economic Botany. A textbook of useful plants and plant products. 2nd edn. McGarw-Hill Book Company Inc, New York.

Hsu CY, Chan YP, Chang J. 2007. Antioxidant activity of extract from *Polygonumcuspidatum*. Biological Research **40,** 13-21.

Kahkonen MP, Hopia AI, Vuorela HJ. 2008. Antioxidant activity of plant extracts containing phenolic compounds. Journal of Agricultural and

Food chemistry **47,** 3954-3962.

Kaur C, Harish K. 2002. Antioxidant activity and total phenolic content of some Asian vegetables. International Journal of Food Science and Technology**37,** 153-161.

Koleva II, van Beek T, Linssen JPH, de Groot A, Evstatieva LN. 2002. Screening of plant extracts for antioxidant activity: a comparative study on three testing methods. Phytochemical Analysis **13,** 8-17.

Kucera B, Cohn MA, Leubner-Metzger G. 2005. Plant hormone interaction during seed dormancy release and germination. Seed Science Research **15,** 281-307.

Lasbrook CC, Tieman DM, Klee HJ. 1998. Differential regulation of the tomato ETR gene family throught plant development. Plant Journal**15**, 243-252.

Mandal P, Misra TK, Ghosal M. 2009. Free-radical scavenging activity and phytochemical analysis in the leaf and stem of *Drymariadiandra*Blume. International Journal of Integrative Biology **7(2),** 80-84.

Morrissey PA, O'Brien NM. 1998. Dietary antioxidants in health and disease. International Dairy Journal **8,** 463-472.

Nawaz A, Amjad M, Khan SM, Afzal I, Ahmed T, Iqbal Q, Iqbal J. 2013.Tomato seed invigoration with cytokinins. The Journal of Animal & Plant Sciences **23(1),** 121-128.

Omodamiro OD, Amechi U. 2013. The phytochemical content, antioxidant, antimicrobial and anti-inflammatory activities of *Lycopersiconesculentum* (tomato). Asian Journal of Plant Science and Research **3(5),** 70-81.

Pamplona-Roger D. 1998. Encyclopedia of Medicinal Plants, Saeliz, Spain.

Parnell TL, Suslow TV, Harris LJ. 2004. Tomatoes: Safe Methods to Store, Preserve, and Enjoy. *ANR Catalog*. University of California: Division of Agriculture and Natural Resources. Retrieved 18-02-2013.

Pavlov A, Kovatcheva P, Georgiev V, Koleva I. 2002. Biosynthesis and Radical Scavenging Activity of Betalains during the Cultivation of Red Beet (*Beta vulgaris*) Hairy Root Cultures. Zeitschrift fur Naturforschung **57,** 640-644.

Philosoph-Hadas S, Friedman H, Meir S. 2005. Gravitropic Bending and Plant Hormones. Vitamins & Hormones **72**, 31-78.

Pietta PG. 2000. Flavonoids as antioxidants. Journal of Natural Products **63(7),** 1035-42.

Planta Medica. 2004. Antioxidant activity of saponins isolated from ivy: alpha-hederin, hederasaponin-C, hederacolchiside-E and hederacolchiside-F. **70(6),** 561-3.

Plumb GW, Price KR, Williamson G. 1999. Antioxidant properties of flavonol glycosides from green beans. Redox Report **4(3),** 123-7.

Sarla S, Prakash MA, Apeksha R, Subhash C. 2011. Free radical scavenging (DPPH) and ferric reducing ability (FRAP) of *Aphanamixispolystachya* (Wall) Parker. International Journal ofDrug Development and Research **3(4),** 271-274.

Siddiqui AA, Ali M. 1997. Practical pharmaceutical chemistry. 1st Edition. CBS publishers and distributors New Delhi. 126-131.

Soares JR, Dins TCP, Cunha AP, Almeida LM. 1997. Antioxidant activity of some extracts of *Thymus zygis*. Free Radical Research**26,** 469-478.

Swaminathaan C, Srinivasan VM. 1996. Seedling invigoration through plant growth substances in teak (*Tectonagrandis*). Journal Tropical Forest Science **8**,

310-316.

Trease GE, Evans WC. 1989. Pharmacognosy, 11thedn., BailliereTindall, London, 45-50.

Trigui M, Hsouna AB, Tounsi S, Jaoua S. 2013. Efficacy of *Lawsoniainermis* leaves extract and its phenolic compounds against olive knot and crown gall diseases. Industrial Crops and Products**45,** 83-88.

Walia S, Sing M, Kaur C, Kumar R, Joshi S. 2010. Antioxidant Composition of Red and Orange Cultivars of Tomatoes (*Solanumlycopersicon*L): A Comparative Evaluation. Journal of Plant Biochemistry and Biotechnology **19(1),** 95-97.

Wall ME, Krider MM, Krewson CF, Eddy CR, Willaman JJ, Corell SS, Gentry HS. 1954. Steroidal sapogenins Survey of plants for steroidal sapogenins and other constituents. Journal of Pharmaceutical Sciences 1-7.

Wilcox JK, Catignani GL, Lazarus C. 2003. Tomatoes and cardiovascular health. Critical Reviews in Food Science and Nutrition **43(1),** 1-18.

Yamaguchi T, Takamura H, Matoba T, Terao J. 1998. HPLC method for evaluation of the free radical-scavenging activity of foods by using 1,1-diphenyl-2-picrylhydrazyl. Bioscience Biotechnology and Biochemistry **62,** 1201-1204.

Yu BP. 1994. Cellular defenses against damage from reactive oxygen species. Physiological Reviews **74(1),** 139-162.

Zhang LJ, Yuan YJ, Wang CG, Pan XL. 2006. Physiological effects of NAA and SA on seed germination of *Cornusofficinalis*. Journal of Shaanxi Normal University Natural Science Edition **20(4),** 75-79.