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ROLE OF OXYGENATED PEPTONE IN ENHANCING GERMINATION OF TOMATO, BRINJAL AND CHILLI

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SUMMARY

Germination studies were carried out in seeds of solanaceous fruit vegetables viz. tomato, brinjal and chilli by giving pre-soaking treatment for 8 hrs with oxygenated peptone (1%). The treatment caused stimulation of germination percentage, root and shoot length, fresh weight, vigour index, mobilization efficiency, emergence index, speed of germination and coefficient of velocity of germination. The biochemical constituents like proteins, total carbohydrates, DNA and RNA showed increase as compared to non-treated. The activities of enzymes like amylase, protease and catalase have significant increase. The overall results indicate that pre–soaking treatment of oxygenated peptone induced enhancement in germination process in test crops.

***Key words*: Brinjal, chilli, germination, oxygenated peptone, tomato.**

INTRODUCTION

Oxygen, the framework element absorbed through air and water, constitutes about 44% of dry matter of plant material, (Sharma 2006). Plant requires oxygen for respiration and the energy released during respiration is utilized for growth. Oxygen also takes part in various oxygenation reactions of cell metabolism and transport of plant growth regulators. So, oxygen availability is a critical factor in plant growth. Oxygen supply is specifically important during germination because its requirement is highest at this stage, (Bewley and Black 1994). The impact of oxygen on seed germination is well known but the effect of super oxygenation on seed germination is not studied yet. So, the seeds of solanaceous fruit vegetables like tomato, brinjal and chilli were pre-treated with oxygenated peptone and its effect on germination and growth of seedling was studied in the present investigation.

MATERIALS AND METHODS

The experiments were conducted in P.G. Research Centre in Botany, Tuljaram Chaturchand College, Baramati, Dist. Pune (M.S.) on seeds of solanaceous fruit vegetables viz. tomato (*Lycopersicon esculentum* Mill. cv. S-41), brinjal (*Solanum melongena* Linn. cv. MHB-10), and chilli (*Capsicum annum* Linn. cv. MHP-1) procured from Mahyco seeds, Jalna (M.S.) The seeds were surface sterilized with 0.05 percent $HgCI_2$ for 1 min**.,** washed under running water and rinsed with distilled water.

Oxygenated peptone is a novel organic compound (brand name Chaitanya, manufactured by Chaitanya Biologicals, Malkapur, Dist. Buldhana M.S. India) in the form of white, neutral, eco-friendly, non-toxic powder. It contains oxygen (100 mg g^{-1}), peptone (650 mg g^{-1}) and silicate based inert filler compound (250 mg g^{-1}). The

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surface sterilized seeds were soaked in 1% aqueous solution of oxygenated peptone for 8 hours. This dose was selected on the basis of pilot experiments. For control, the seeds were soaked in distilled water for 8 hours. The seeds were allowed to germinate using petri plate method.

The various parameters like germination percentage, length of radical, that of plumule and biomass were measured on 6 DAS using routine laboratory methods. Vigour Index (VI) was calculated according to the method suggested by Abdul Baki and Anderson (1973) where,

Vigour Index = (Root length + shoot length) x Germination percentage

Emergence Index (EI) was calculated by the following formula given by Baskin (1969).

EI = n1 / dn1+ n2 / dn2 + n3 / dn3 …….. + nx / dnx

where, n = number of seeds emerged on the day (I^{st}), dn = number of days from the day of sowing, dnx = number of days to the final count.

Speed of Germination (SG) was calculated by the formula given by Maguire (1962).

$$SG = n / t$$

where, n = number of seeds emerged on the day, t = time or days from sowing.

Coefficient of Velocity of Germination (CVG) was calculated by the formula given by Kotowski (1962).

CVG = sum of n / sum of (nt) x 100

where, n = number of seeds emerged on the day, t = time or days from sowing.

Mobilization Efficiency (ME) of reserve food material present in seed during germination, was calculated as described by Bhalerao (2003).

$$\text{Mobilization Efficiency (ME)} = \frac{\text{Dry wt of embryonal axes}}{\text{Dry wt of residual grains}} \text{ X } 100$$

Biochemical constituents were analyzed on 12 DAS, using methods proposed by Lowry *et al.* (1951) for proteins, Sadasivam and Manickam (2005) for total carbohydrates, DNA and RNA. The enzyme activity of amylase and catalase was studied as described in Sadasivam and Manickam (2005), that of protease by the method of Penner and Ashton (1967). Enzyme activity was studied on 14 DAS. The experiments were done in triplicates. Emergence of radical was considered as indicator of germination. Number of seeds germinated were noted daily.

RESULTS

The experiments revealed that the seeds of tomato, brinjal and chilli showed a positive response to pre-soaking treatment of oxygenated peptone. The increase in germination percentage over non-treated was evident in all the three fruit vegetable crops, viz. tomato (50%), brinjal (42%) and chilli (25%). All these plants showed increase in root length as well as shoot length. The percent increase in Vigour Index (VI) over non-treated was highest in brinjal (185%), followed by tomato (118.4%) and chilli (61.2%). The percent increase in biomass was equal in tomato and chilli (100%) and somewhat less in brinjal (80%). The Mobilization Efficiency (ME) increased by 10.6% in brinjal and by 3.0% and 3.1% in tomato and chilli respectively. Emergence Index (EI) revealed 100% increase in tomato, brinjal and chilli over non-treated. The Speed of Germination (SG) showed increase over control sequentially in tomato (53%), brinjal (43%) and chilli (26%). Increase in Coefficient of Velocity of Germination (CVG) was to the same tune in tomato and brinjal (50.3% and 49.3% respectively) and significantly low in chilli (25.1%) (Table 1).

Biochemical constituents were analyzed at 12 DAS. Brinjal and chilli showed a significant percent increase over non-treated in protein content as compared to tomato with the values like 66.6%, 52.7% and 14.2%

Table 1. Effect of pre-soaking treatment of oxygenated peptone (1g / lit for 8 hr) on germination of tomato (*Lycopersicon esculentum* Mill.) cv. S-41, Brinjal (*Solanum melongena* L.) cv. MHB-10 and chilli (*Capsicum annum* L.) cv. MHP-1 seeds.

Parameter	Tomato			Brinjal			Chilli		
	Non-treated	Treated	Increase (%)	Non-treated	Treated	Increase (%)	Non-treated	Treated	Increase (%)
Germination percentage	40 ± 0.05	60± 0.05	50	70± 0.04	100± 0.04	42	80± 0.06	100± 0.06	25
Root length (cm)	2.4 ±0.05	3.4± 0.1	41.6	2.6± 0.05	3.8± 0.1	46.1	2.9±0.05	3.4 ± 0.1	17.2
Shoot length (cm)	3.5 ± 0.1	3.6 ± 0.1	2.8	2.3± 0.05	3.4± 0.1	47.8	3.0± 0.05	3.3 ± 0.1	10
Vigour index	336 ± 1	734± 1	118.4	418± 1	1292± 1	185	696± 1	1122 ± 1	61.2
Biomass (mg)	5.0 ± 0.02	10.0± 0.04	100	10± 0.04	18± 0.07	80	8± 0.03	16± 0.06	100
Mobilization efficiency	166± 0.5	171± 0.5	3.0	150± 0.5	166± 0.5	10.6	157± 0.5	162± 0.5	3.1
Emergence index	0.1± 0.02	0.2± 0.02	100	0.2± 0.02	0.4± 0.02	100	0.2± 0.02	0.4± 0.02	100
Speed of germination	1.3± 0.06	2.0± 0.05	53	2.3± 0.03	3.3± 0.03	43	2.6± 0.06	3.3± 0.05	26
Coefficient of velocity of germination	13.3± 0.05	20.0± 0.1	50.3	23.3± 0.05	33.3± 0.1	49.3	26.6± 0.05	33.3± 0.1	25.1

respectively. However, the percent increase in total carbohydrates was 50%, 32.5% and 3.4% in chilli, tomato and brinjal respectively. DNA content increased by 28.5% in chilli while tomato and brinjal showed 15.3% increase. Chilli, tomato and brinjal recorded an increase of 44.4%, 25.0% and 12.5 % respectively over non-treated in case of RNA content (Table 2).

The enzyme activity (Table 3) was studied at 14 DAS. Percent increase in amylase activity was highest in chilli (53.2%) followed by brinjal (25.4%) and tomato (24.3%). Protease activity was surprisingly very high in chilli (233%) and tomato (150%), but to a lower tune in brinjal (57.1%). Catalase activity showed similar increase in tomato and brinjal (100% each) and a marginal increase of 25% in chilli.

Table 2. Effect of pre-soaking treatment of oxygenated peptone (1g / lit for 8 hr) on biochemical constituents of tomato (*Lycopersicon esculentum* Mill.) cv. S-41, Brinjal (*Solanum melongena* L.) cv. MHB-10 and chilli (*Capsicum annum* L.) cv. MHP-1 seeds.

Parameter	Tomato			Brinjal			Chilli		
	Non-treated	Treated	Increase (%)	Non-treated	Treated	Increase (%)	Non-treated	Treated	Increase (%)
Protein content (mg/ fw)	14± 0.5	16± 0.5	14.2	6± 0.2	10± 0.3	66.6	7.2± 0.2	11± 0.3	52.7
Total carbohydrates (mg/g fw)	43± 0.5	57± 0.5	32.5	58± 0.5	60± 0.3	3.4	34± 0.2	51± 0.4	50
DNA(mg/g fw)	2.6± 0.04	3.0± 0.04	15.3	2.6± 0.04	3.0± 0.04	15.3	1.4± 0.02	1.8± 0.02	28.5
RNA(mg/g fw)	2.4± 0.04	3.0± 0.04	25	1.6± 0.02	1.8± 0.02	12.5	1.8± 0.02	2.6± 0.04	44.4

Table 3. Effect of pre-soaking treatment of oxygenated peptone (1g / lit for 8 hr) on enzyme activity of tomato (*Lycopersicon esculentum* Mill.) cv. S-41, Brinjal (*Solanum melongena* L.) cv. MHB-10 and chilli (*Capsicum annum* L.) cv. MHP-1 seeds.

Enzymes	Tomato			Brinjal			Chilli		
	Non-treated	Treated	Increase (%)	Non-treated	Treated	Increase (%)	Non-treated	Treated	Increase (%)
Amylase (mg maltose/ 5 min/g fw)	16.4± 0.5	20.4± 0.5	24.3	11± 0.4	13.8± 0.4	25.4	12.4± 0.4	19± 0.5	53.2
Protease (µg tyrosine/ hr/mg protein)	0.4± 0.01	1.0± 0.05	150	1.4± 0.05	2.2± 0.08	57.1	0.24± 0.01	0.80± 0.02	233
Catalase (µmole H_2O_2/ min/mg protein)	0.16± 0.02	0.32± 0.02	100	0.16± 0.02	0.32± 0.02	100	0.32± 0.02	0.40± 0.03	25

DISCUSSION

The overall response of the seeds of solanacous fruit vegetables like tomato, brinjal and chilli showed a positive response to the pre-soaking treatment of oxygenated peptone. Ample supply of oxygen during pre-soaking of seeds with oxygenated peptone is useful to meet the increased oxygen demand. This is supported by the observation of Bewley and Black (1994) in maize, which showed sequential increase in oxygen consumption in maize seeds when incubated in water for 6 hours from start of germination. This higher oxygen demand is due to increase in mitochondrial oxidation as a result of both repair of mitochondria already existing within mature dry seed and production of new mitochondria during germination. Ample supply of oxygen allows the operation of citric acid pathway liberating more energy per hexose molecule (38 ATPs) and suppresses anaerobic pathway liberating less energy (8 ATPs). Pre-soaking of seeds with oxygenated peptone in the present investigation gives the same advantage. Wijte and Gallagher (1996 A) observed reduced germination percentage under decreased oxygen level in *Spartina alterniflora*. In the consecutive paper, they showed that no plumule or root growth occurred under anoxia in the early stages of development. (Wijte and Gallagher 1996 B). The results of the present investigation are also supported by observations of Cherif *et al.* (1997), who mentioned that high oxygen treatment resulted in an increase in plant growth in terms of shoot and root weights. Further, Williumsen and Roeber (1997) noted that low content of air in propagation substrates may restrict germination and initial growth of seedling in cabbage.

Besides oxygen, the oxygenated peptone used in the present investigation for pre-soaking treatment of seeds contains peptone, a soluble form of nitrogen. Peptone provides soluble nitrogen to the seeds, useful for germination which leads to better growth. This is supported by observation of Bose and Pandey (2003), who found that soaking of seeds with various nitrate salts prior to sowing of okra has a positive impact on germination as well as growth.

Vigour Index (VI) is the best criterion to assess the effect of any external agent on seed germination and seedling growth because it is calculated on the basis of germination percentage, root length and shoot length. The present investigation assures higher vigour index by pre-soaking treatment with oxygenated peptone. The same is true for mobilization efficiency, emergence index, speed of germination and coefficient of velocity of germination.

The biochemical constituents like soluble proteins, total carbohydrates and nucleic acids like DNA and RNA showed an increasing trend in concentration in the seeds of tomato, brinjal and chilli (though to a varying level of response) to pre-soaking treatment of oxygenated peptone, which supplies both oxygen and peptone (a source of soluble organic nitrogen). Seed germination is

associated with degradation and mobilization of reserve food, accumulated during seed maturation. The efficiency of reserve food mobilization during germination and seedling establishment depends on the extent of reserve accumulation during seed maturation along with synthesis and activation of enzymes. So germination and mobilization of storage reserve are independently regulated (Fait *et al*. 2006). This is well reflected in the results of present investigation where protein and carbohydrate content showed increase along with increase in enzyme activity of protease and amylase.

The present investigation showed increase in the activity of enzymes amylase, protease and catalase in all the three vegetables studied. The peptone supplied organic nitrogen which stimulated the enzyme activities. Superoxygenation during early stages of germination might be helpful for this process. Sousa *et al*. (2002) reported that along with respiration, nitrogen metabolism is affected under hypoxic condition. Under present experimental condition, there may be superoxygenation along with supply of nitrogen in soluble organic form (peptone). With such booster dose, the enzyme synthesis might have accelerated showing increase in the activity of amylase, protease and catalase. The oxygenated peptone may serve as the best dormancy breaking compound in vegetable screened and may work as an additional tool in this type of work (Patil *et al*. 2005).

The overall results showed that pre-soaking treatment with oxygenated peptone increased germination percentage, root length, vigour index, mobilization efficiency, emergence index, speed of germination and coefficient of velocity of germination. It also improved the concentration of biochemical constituents like proteins, total carbohydrates and nucleic acids like DNA and RNA. In addition enzyme activity (amylase, protease and catalase) was also found to be enhanced. This may lead to early growth and early maturity so that life cycle can be completed earlier.

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