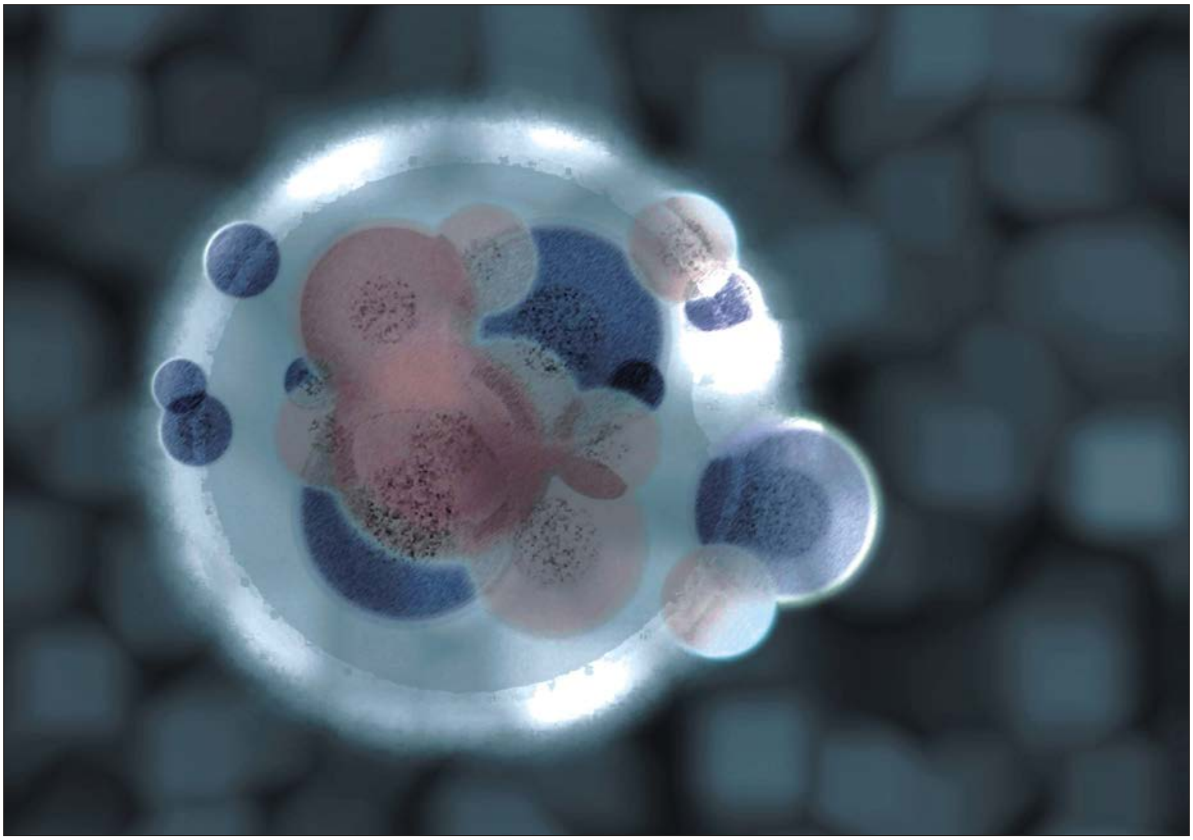

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Effect of Seaweed Suspensions on Seed Germination of Tomato, Pepper and Aubergine

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Abstract: Three seaweed suspensions obtained from green algae *Codium tomentosum* Stackhouse, red algae *Gracilaria gracilis* (Stackhouse) Steentoft, Irvine and Farnham and brown algae *Cystoseira barbata* (Stackhouse) C. Agardh were tested for their effects on the seed germination of tomato, pepper and aubergine at optimum (25°C) and low temperatures (15°C). Results showed that brown and green algal suspensions increased germination significantly ($p<0.05$) at both temperatures in pepper and aubergine, being more prominent at low temperature than that of optimum. All suspensions were not effective in tomato seeds at both temperatures. Treated tomato seeds had slightly higher or equal values to control at optimum and low temperature. Pepper seeds treated with green seaweed had higher germination than those of others and the percentages were recorded as 52 and 68% at 15 and 25°C, respectively. Germination percentages of aubergine seeds treated with green seaweed had 91% at low and 88% at optimum temperatures.

Key words: Seaweed suspension, seed germination, *Capsicum annuum*, *Lycopersicon esculentum*, *Solanum melongena*, *Codium tomentosum*, *Gracilaria gracilis*, *Cystoseira barbata*

INTRODUCTION

Algae have lots of economical uses. The seaweed suspensions or extracts obtained from algae gain a commercial importance. The seaweed suspensions can be an alternative treatment especially for organic farming. Numerous papers have been published on the foliar application, evaluation of seaweed extracts on horticultural or agricultural plants (Abetz, 1980; Crouch *et al*., 1990; Möller and Smith, 1998). Seaweed extracts reported to improve seed germination in several species such as table beet (Wilczek and Ng, 1982), lettuce (Möller and Smith, 1998) and faba bean (El-Sheekh and El-Saled, 2000). Effect of seaweed extracts as seed treatments was limited on seed germination under optimal conditions, but a promotion of germination under stress conditions is more prominent. For instance, it alleviates the thermoinhibition of lettuce seed germination (Möller and Smith, 1999).

The brown algae, like *Ascophyllum nodosum* (L.) Le Jolis and *Laminaria hyperborea* (Gunn.) Foslie are generally used for the commercial seaweed extracts. However, in experimental studies it was shown that growth of seedlings was stimulated by the crude extracts of green (*Cladophora dalmatica*, *Enteromorpha intestinalis*, *Ulva lactuca*, *Caulerpa chemnitzia*), brown (*Sargassum wightii*) and red algae (*Corallina mediterranea*, *Jania rubens*, *Pterocladia pinnate*) (El-Sheekh and El-Saled, 2000; Sivasankari *et al*., 2006). *Codium tomentosum* from Chlorophyceae, *Gracilaria gracilis* from Rhodophyceae and *Cystoseira barbata* from Phaeophyceae are common marine algae in the Turkish coast. In the present study, we aimed to compare the effects of seaweed suspensions obtained from algae belonging to three different classes. Moreover, the applicability of three different seaweed solutions was tested regarding stimulation of seed germination at optimum and stress temperatures (low temperature) in tomato, pepper and aubergine.

MATERIALS AND METHODS

Seed material: Seeds of pepper (*Capsicum annuum* L.) cv. Demre, tomato (*Lycopersicon esculentum* Mill.) cv. Rio Grande, aubergine (*Solanum melongena* L.) cv. Pala were obtained from Beta Seed Company (Mithatpasa

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Street, 19/7, Yenisehir/Ankara/Turkey). Seeds were stored in cold store at 5°C (40% RH) in sealed aluminum foil bags until use. Pepper seeds were produced two years ago.

Collection of seaweeds: The three algal species, *Codium tomentosum* Stackhouse, *Gracilaria gracilis* (Stackhouse) Steentoft, Irvine and Farnham and *Cystoseira barbata* (Stackhouse) C. Agardh were collected from the coastal area of Marmara Sea (40°25' N and 27°46' E), during August, 2005. The plants were hand picked and washed thoroughly with seawater to remove the unwanted impurities, adhering sand particles and epiphytes. They were transported to the laboratory in polythene bags. Samples then washed thoroughly using tap water to remove salt on the surface of the sample (Sivasankari *et al*., 2006).

Preparation of seaweed suspensions: The seaweed suspensions were prepared by a physical integration method, gradually reducing the particle size, without application of heat, acid or alkaline hydrolysis and a final 1:3 dilution with water. One batch of each seaweed suspensions was used throughout all experiments, stored frozen at -20°C in aliquots of 500 mL. Aliquots of seaweed suspension were thawed shortly before use (Möller and Smith, 1998).

Seaweed treatment: Three hundred seeds of tomato, pepper and aubergine were placed on top of the Whatman No. 5 filter paper wetted with 5 mL of each different seaweed suspensions in the Petri dishes at 25°C for 16 h in the dark. Having treated, seeds were washed under tap water for 2 min and dried at 25°C for 2 h. Two controls were used. In wet control, seeds were wetted with distilled water on the paper in the petri dishes under the same conditions. Dry control was used as those seeds not treated at all.

Germination tests: Germination test were carried out according to ISTA rules (ISTA, 1996). Triplicates of fifty seeds were used for germination test. Fifty seeds were placed on top of two layers Whatman No. 5 filter paper, wetted with 5 mL distilled water in Petri dishes (9 cm diameter). Petri dishes were put in to plastic bags in order to prevent water loss and placed at 25 and 15°C incubators in dark. Germination counts were made every day during 14 days. Two millimeter radicle protrusion was considered to be a germination criterion.

The Mean Germination Time (MGT) was calculated according to formula of Ellis and Roberts (1981) and expressed as days.

Statistical analysis: All measurements were performed with triplicates. ANOVA was performed on all data following percentages were angle transformed, using MINITAB 11. The comparison of mean values was made by Duncan test, calculated for probabilities of p = 0.05.

RESULTS AND DISCUSSION

In tomato both wet and dry control seeds had 95-99% germination. Treated seeds had slightly higher or equal values to control ones. At low temperature seeds treated with green seaweed had 99.3% of germination while seeds treated with green, red seaweed and wet control had the similar values at optimum temperature. Maximum advantage in pepper seeds were obtained from green seaweed. Germination percentages of pepper seeds treated with green seaweed had significantly ($p<0.05$) higher values than those of others and were recorded as 52 and 68 % at 15 and 25°C, respectively. Green seaweed was found to be the most stimulating treatment in aubergine seeds. Germination percentages of seeds treated with green seaweed had 91% at low and 88% at high temperatures. Although effects of green and brown seaweed suspensions are insignificant ($p>0.05$) both were significantly better than the rest of the treatments (Table 1). Either of the treatment has not reduced mean germination time at optimum temperature in tomato and pepper seeds. However, green seaweed treatment reduced mean time to germination of aubergine significantly ($p<0.05$) to 3.9 days at 25°C. Differences between mean germination time in pepper and aubergine was not significant but in tomato seeds treated with red seaweed had the lowest level of germination time as 6.0 days at 15°C (Table 2).

Table 1: The germination percentages of tomato, pepper and aubergine seeds treated with red, brown, green seaweed suspensions, wet and dry controls at two different temperatures

		Seed germination (%)	
Species	Application	15°C	25°C
Tomato	Red seaweed	98.7^{A}	97.6^{A}
	Brown seaweed	98.8^{A}	95.3^{BC}
	Green seaweed	99.3^{A}	97.3^{AB}
	Wet control	95.3^{B}	98.0^{A}
	Dry control	98.6^{A}	95.0^{C}
Pepper	Red seaweed	44.0^{C}	58.3^{C}
	Brown seaweed	39.7^{D}	64.0^{B}
	Green seaweed	52.0^{A}	68.0^{A}
	Wet control	47.0^{B}	57.3^{C}
	Dry control	35.0^{E}	57.3^{C}
Aubergine	Red seaweed	79.0^{C}	80.0^{B}
	Brown seaweed	90.6^{A}	86.3^{A}
	Green seaweed	91.0^{A}	88.0^{A}
	Wet control	85.0^{B}	82.0^{B}
	Dry control	78.0^{C}	79.7^{B}

*ABCDEDifferences between means of each species with the different letter(s) in a column are significant ($p<0.05$)

Table 2: Mean germination time of tomato, pepper and aubergine seeds treated with red, brown, green seaweed suspensions, wet and dry controls at two different temperatures

		Germination time (day)	
Species	Application	15°C	25°C
Tomato	Red seaweed	6.0^{C}	3.2^{A}
	Brown seaweed	6.8^{B}	3.3^{A}
	Green seaweed	6.1^{C}	3.5^{A}
	Wet control	7.2^{B}	3.2^{A}
	Dry control	7.8^{A}	3.3^{A}
Pepper	Red seaweed	20.5^{A}	8.0^{A}
	Brown seaweed	23.6^{A}	7.8^{A}
	Green seaweed	20.2^{A}	7.5^{A}
	Wet control	19.7^{A}	8.1^{A}
	Dry control	21.3^{A}	9.8^{A}
Aubergine	Red seaweed	13.3^{AB}	7.9^{A}
	Brown seaweed	12.6^{AB}	5.7^{B}
	Green seaweed	12.0^{B}	3.9^{C}
	Wet control	11.9^{B}	5.6^{B}
	Dry control	13.9^{A}	4.5^{BC}

*ABCDE Differences between means of each species with the different letter(s) in a column are significant ($p<0.05$)

Table 3: The advantage in mean germination time (day) of seaweed suspensions to dry control in tomato, pepper and aubergine seeds at 15 and 25°C temperatures (Values were derived from Table 2)

	Tomato		Pepper		Aubergine	
Application	15°C	25°C	15°C	25°C	15°C	25°C
Green seaweed	1.7	-0.2	1.1	2.3	1.9	0.6
Brown seaweed	1.0	0.0	-2.3	2.0	1.3	-1.2
Red seaweed	1.8	0.1	0.8	1.8	0.6	-3.4

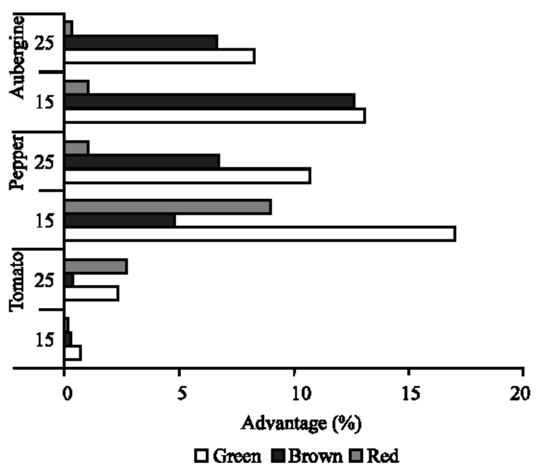

Fig. 1: The advantage in germination percentage of seaweed suspensions to dry control in tomato, pepper and aubergine seeds at 15 and 25°C temperatures (Values were derived from Table 1)

Total advantages of seaweed suspensions on germination and mean germination time were given in Table 3 and Fig. 1. The maximum increase compared to dry control was obtained from green seaweed suspension. This was followed by brown and red seaweed suspensions. The advantages of seaweed treatment were more prominent at low temperatures.

The effects of seaweed extracts and suspensions on germination of various crops have been shown previously (Miers and Perry, 1986; Taylor *et al.*, 1990; Möller and Smith, 1998). It was indicated that promoting effect of seaweed extracts may originate from higher level of seed moisture around the seeds after drying phase (Weges and Karssen, 1990), seaweed extracts also induce leakage of inhibitors possibly absisic acid from the seeds (Speer and Tupper, 1975). The involvement of growth regulating substances in seaweed extracts is another possibility. Dunlap and Morgan (1977) found that ethylene, kinetin and gibberellic acid were effective on reversal of induced dormancy in lettuce seeds.

The beneficial effects of commercial seaweed suspensions are attributed to the presence of cytokinins and in some instances, auxin (Sanderson and Jameson, 1986; Sanderson *et al.*, 1987; Crouch *et al.*, 1992). On the other hand, Möller (1996) found that gibberellic acid and cytokinin activity were very low to have any effect. However, the seaweed suspensions in their study were obtained from *Laminaria hyperborea* and *Ascophyllum nodosum*. Contrastingly we used *Codium tomentosum, Gracialaria gracilis* and *Cystoseira barbata*.

Therefore, the effect may vary between species due to their chemical contents. It has been known that gibberellic acid was found to be promoting the germination in various crop seeds. Jennings (1968) reported that green and brown algae contain gibberellic acid which may play a promoting role in germination in this study. Stirk and van Staden (2003) stated that green algae contain cytokinins the free bases of isopentenyladenosine and Z and their riboside and ribotide conjugates. El-Sheekh and El-Saled (2000) reported that the cytokinin content of the green algae was higher than that in red algae. This conclusion obviously shows that not all seaweed suspensions give the similar results. The response of the crop seeds may vary according to chemical contents of the seaweed suspension, that the nature and the compounds in seaweed suspensions need further research.

From commercial point of view non-toxicity and promoting effect of seaweed suspensions indicated potential of commercial application of seaweed as priming media. This gains more importance in our study since all three species are produced through transplants and seaweed suspensions have potential to enhance the developed and fast transplant production particularly due to the lower mean germination time of treated seeds under low temperature which is the common phenomenon in early sowings. On the other hand, whether present findings are effective on seeds of other species would need further investigations.

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REFERENCES

Abetz, P., 1980. Seaweed extracts: Have they a place in Australian agriculture or horticulture? J. Aust. Inst. Agric. Sci., 46: 23-29.

Crouch, I.J., M.T. Smith, J. van Staden, M.J. Lewis and G.V. Hoad, 1992. Identification of auxins in a commercial seaweed concentrate. J. Plant Physiol., 139: 590-594.

Dunlap, J.R. and P.W. Morgan, 1977. Reversal of induced dormancy in lettuce by ethylene, kinetin and gibberellic acid. Plant Physiol., 60: 222-224.

Ellis, R.H. and E.H. Roberts, 1981. The quantification of ageing and survival in orthodox seeds. Seed Sci. Technol., 9: 373-409.

El-Sheekh, M.M. and A. El-D. El-Saled, 2000. Effect of crude seaweed extracts on seed germination, seedling growth and some metabolic processes of *Vicia faba* L. Cytobios, 101: 23-35.

ISTA, 1996. International rules for seed testing. Seed Sci. Technol., 24: 1-335.

Jennings, R.C., 1968. Gibberellins as endogenous growth regulators in green and brown algae. Planta, 80: 34-42.

Miers, D.J. and M.W. Perry, 1986. Organic materials applied as seed treatments or foliar sprays fail to increase grain yield of wheat. Aust. J. Exp. Agric., 26: 367-373.

Möller, M., 1996. Effects of seaweed suspensions on seed germination and seedling growth of barley (*Hordeum vulgare* L.) and lettuce (*Lactuca sativa* L.). Ph.D Thesis, The Univ. of Edinburgh.

Möller, M. and M.L. Smith, 1998. The applicability of seaweed suspensions as priming treatments of lettuce (*Lactuca sativa* L.) seeds. Seed Sci. Technol., 26: 425-438.

Möller, M. and M.L. Smith, 1999. The effects of priming treatments using seaweed suspensions on the water sensitivity of barley (*Hordeum vulgare* L.) caryopses. Ann. Applied Biol., 135: 515-521.

Sanderson, K.J. and P.E. Jameson, 1986. The cytokinins in a liquid seaweed extract: Could they be active ingredients? Acta Hortic., 179: 113-116.

Sanderson, K.J., P.E. Jameson and J.A. Zabkiewicz, 1987. Auxin in a seaweed extract: Identification and quantification of indole-3-acetic acid by gas chromatography-mass spectrometry. J. Plant Physiol., 129: 363-367.

Sivasankari, S., V. Venkatesalu, M. Anantharaj and M. Chandrasekaran, 2006. Effect of seaweed extracts on the growth and biochemical constituents of *Vigna sinensis*. Bioresour. Technol., 97: 1745-1751.

Speer, H.L. and D. Tupper, 1975. The effects of lettuce seed extracts on lettuce seed germination. Can. J. Bot., 53: 593-599.

Stirk, W.A. and J. van Staden, 2003. Occurrence of ciytokinin-like compounds in two aquatic ferns and their exudates. Environ. Exp. Bot., 49: 77-85.

Taylor, J.S., K.N. Harker, J.M. Robertson and K.R. Foster, 1990. The effect of a seaweed extract containing cytokinin on the growth and yield of barley. Can. J. Plant Sci., 70: 1163-1167.

Weges, R. and C.M. Karssen, 1990. The influence of redesiccation on dormancy and K^+ leakage of primed lettuce seeds. Israeli J. Bot., 39: 327-336.

Wilczek, C.A. and T. Ng, 1982. The promotion of seed germination in table beet by an aqueous seaweed extract. HortScience, 17: 629-630.