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J. J. Jen

THE EFFECTS OF SEAWEED ON PLANT GROWTH

Department of Horticulture
and
Department of Food Science
Clemson University
Clemson, S. C.

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By
J. J. Jen
Clemson University
Clemson, S. C.

A) A Preliminary Study of Plant Hormones in Seaweed Extracts:

Auxins are the first group of plant hormones being isolated and studied by scientists. The characteristic of auxins is that they are responsible for the cell enlargement in plants. The first authentic auxin to be isolated from plant tissues was Indole-3-acetic acid (IAA). Most of the naturally occurring auxins have similar physiological properties and chemical structures to IAA, though differing in their biological activities quantitatively.

Methods & Materials

The five preparations of seaweed extracts being studied were designated as follows:

Sample No. 1 -- Liquid extract of *Ascophyllum nodosum* from Norway (Obtained from Seaborn Mineral Division of Skod Co.)

Sample No. 2 -- Liquid extract of *Ascophyllum nodosum* from eastern United States coast (Obtained from Marine Colloids, Inc.)

Sample No. 3 -- Liquid extract of fresh wet kelp from Norway (Obtained from Algea Produkter, Kristiansund, Norway)

Sample No. 4 -- *Ascophyllum nodosum* meal from Norway (Seaborn Mineral Div.)

Sample No. 5 -- Chondrus crispus meal from Maine coast
(Marine Colloids)

The methodology used to isolate auxins from seaweed extracts followed essentially the method described by Bentley (1961, 1962) with some modifications. Although methanol was reported as the best solvent for extraction of auxins (Nitsch, 1955), diethyl ether was used in this study because of the aqueous nature of the liquid seaweed extracts. For the meals, deionized distilled water was added to the meals before ether extractions. The ether extracts were reduced to small volume under reduced pressure and line-loaded on Whitman No. 1 paper pre-washed with water and acetone. The chromatograms were developed in water. A piece of the paper was cut and dried before sprayed with 2% p-dimethylaminobenzaldhyde in 2N HCl in 80% ethanol. This was to detect the presence of any auxins, especially IAA. The auxins were then eluted from the remainder of the paper with methanol, concentrated, and subjected to a second chromatographic separation in isopropanol:water (8:2v/v). Either Erlich's reagent or Salkowski reagent was used as spraying reagent to detect the spots. Part of the methanol elutes were tested for total auxin concentration by the method of Gordon & Weber (1951). A standard curve was prepared using authentic IAA (obtained from Nutritional Biochemical Corp., Cleveland, Ohio).

Results and Discussion

Two major problems were encountered in the initial trial. First, precipitation occurred in several samples in concentrating the extracts. The white precipitates were removed by filtration, it was not known whether any auxins have been lost. Second, the high pigment content of the extracts often interfere with the final color reaction. This was much more serious with samples 4 and 5. Their extracts showed dark black-green color. In addition, there were some very fine particles forming a sediment in the extract and could hardly be removed. Therefore, only samples 1, 2, and 3 were studied in further experiments. The pigment systems in samples 1, 2, and 3 were qualitatively characterized and found to contain water-soluble pigments only except sample No. 1 which also contained some chlorophyll derivatives which were fat-solvent soluble.

Table 1 shows the R_f values of the spots obtained by the above procedure. These values were the average of five runs. From the R_f values and the color of the spots, it is possible that both samples 1 and 3 contain IAA. However, the evidence is not conclusive in that the R_f value for IAA was 0.96 while the experimental spots was 0.93. The color difference may be attributed by concentration difference. There was one yellow spot common for all seaweed extracts which has R_f of 0.55 but the nature of this compound is not known. In addition, there were additional spots in both samples 1 and 3 indicating the complex nature of these seaweed extracts. Table 2 shows the total concentration of auxins in seaweed extracts calculated as the equivalent of micromoles of IAA per liter seaweed extracts. Both samples 1 and 2 contain about 1.50 micromoles while sample 3 contains 5.35 micromoles auxins or auxin-like compounds. This illustrates the fact that some of the auxins were destroyed through the heat treatments involved in the processing of samples 1 and 2. The exact nature of the compounds isolated cannot be determined at this stage due to the small quantities of these auxins involved. Either a more precised chemical analysis such as gas chromatography or bioassay methods have to be practiced for the final identification of the plant growth regulators in seaweed extracts. These methods are well documented in literature (Wrightman & Setterfield, 1968).

B) The Effect of Seaweed Extracts on the Ripening and Keeping Quality of Fresh Tomatoes and Peaches:

Seaweed extracts have been shown to increase the shelf-life of peaches (Skelton & Senn, 1968). Whether this benefit is due to a delay in ripening or a protective coating action against bacterial spoilage is not clear. On the other hand, auxin-like activities have been observed when applying seaweed extracts to plant growth (Senn & Skelton, 1968) (also, part A). It has been known for some time that plant growth regulators can either retard (Abdel-Kader et.al., 1966) or accelerate (Hartman, 1959) the ripening of tomatoes depending on the type of regulators applied, thus stimulating the investigation of the effect of seaweed extract on the ripening and keeping quality of fresh tomatoes and peaches.

Methods and Materials

The varieties of peaches studied were Coronet, Red Haven, and Rio Oso Gem. For tomatoes, Homestead and Marion were used.

Fresh peaches and tomatoes harvested from the fields were transported to the laboratory at Clemson. Upon arrival, the fruits were washed, dried, and sorted for uniform maturity and wholesomeness. The usable fruits were evenly divided into thirteen groups. Twelve groups of fruits were sprayed with one of the following 12 solutions until dripping occurred.

Treatments: Seaweed extracts sample No. 1 at 100, 1000, 10,000 p.p.m. (S-1)

Seaweed extracts sample No. 2 at 100, 1000, 10,000 p.p.m. (S-2)

Seaweed extracts sample No. 3 at 100, 1000, 10,000 p.p.m. (S-3)

Indole-3 acetic acid at 100 p.p.m. (IAA)

Gibberellic acid (potassium salt) at 100 p.p.m. (GA)

Kinetin at 10 p.p.m. (K)

The other group was sprayed with sterilized deionized distilled water and served as control. One thousand p.p.m. of Aqua-Gro was added in each solution as a non-ionic surface wetting agent. All solutions were made with sterilized deionized distilled water to avoid any contaminations. For the peaches, there were 29 Coronet, 20 Red Haven and 24 Rio Oso Gem in each group, respectively. For the tomatoes, 28 Homestead and 30 Marion in each group were used.

After drying at room temperature, the fruits were placed individually into cardboard boxes, one box per group, and stored in environators at 70 ± 1°F in the dark. The relative humidity was kept between 50-70%. Each day, the fruits were checked for ripeness, decay and general quality. Unsalable fruits were discarded. An unsalable condition was defined by mushy areas, brown rot, or any sign of mold or yeast. Storage time required for 50% of all fruits to reach ripeness, to show signs of decay, and to be discarded was used as an indicator for comparison between treatments.

For one group of tomatoes, the Homestead, some of the ripening characteristics were measured which included color analyses on a Gardener color difference meter and texture measurement on an Allo-Kramer shear pressor. Two fruits from each group were removed every two days in storage for these measurements.

Results and Discussion

For the first trial of the Homestead tomatoes, the tomatoes were immersed in treatment solutions for 30 minutes. Decay of tomatoes showed up the second day after storage and watery tomatoes were observed in large quantities every day. Insect and microbial spoilages were suspected and confirmed. Spraying methods utilizing sterilized deionized distilled water were incorporated for all subsequent experiments. No rotting appeared in later experiments.

In the second trial, Homestead tomatoes were stored for 14 days. Color and textural measurements were carried out once every two days. The results shown in Tables 3, 4, and 5 indicate no significant effects of any treatment except the usual pattern of ripening characteristics, the sudden drop of reflectance (L) and shear press values and the sudden increase of redness to yellowness ratio (a/b) near the tenth day of storage. Most treated tomatoes had slightly higher L values, lower a/b ratio, and shear press values at the end of the 14 days storage when compared with the control. The experiment needs to be extended to ascertain this finding.

Figures 1, 2, and 3 show the results of evaluation of storage stability on fresh peaches. Time required to reach 50% ripeness is very close among all treatments indicating relatively uniform maturity and the lack of effect on all treatments on ripeness. Depending upon the variety of peaches, the keeping quality of the fruits varies, but both the days required to 50% show sign of decay and 50% discarded do not seem to show any effect of the treatment as well. Therefore, the seaweed extracts do not seem to have any effect on the ripening and the keeping quality of detached peaches. If we plot the number of peaches discarded against storage time in days, a general pattern can be observed as illustrated in Figure 4 using selective representative treatments. A bell-shaped curve is shown showing that the use of 50% fruits being discarded is a true representative of the decaying phenomena of the total fruit population.

The results of the Marion tomato experiment were shown in Figure 5. Some differences resulted from the various treatments. Collectively, the treated tomatoes have a slightly better keeping quality than the untreated controls. Whether the difference is significant is uncertain, although this seems to agree with the findings of Abdel-Kader et.al. (1966) because all the growth regulators studied gave better shelf-life to the tomatoes. It is, therefore, likely that the effect of seaweed extracts was derived from the plant hormones in the extracts. This effect was not shown in peaches because of the relatively short shelf-life of the peaches under study. It would be interesting to use greener peaches in future studies for comparison.

Summary and Conclusions

The effect of the three liquid seaweed extracts on the ripening and keeping quality of fresh tomatoes and peaches was studied. Three kinds of plant growth regulators were also tested for comparison with the seaweed extracts. The results indicated that there is little effect on peaches, but somewhat better shelf-life of tomatoes can be obtained by spraying with either seaweed extracts or plant growth regulators studied. This finding is inconclusive due to the small differences found. It is known that spraying seaweed extracts onto peach trees extends shelf-life of the fruits (Skelton & Senn, 1968). The earlier applications of seaweed extracts, beginning with full bloom, gave better results than sprays during the last stages of the growing season. It is, therefore, likely from previous and present studies, that the benefit of seaweed extracts could arise from the physiological changes in the internal structure of plant cells which could be induced by the high contents of the micro-nutrients in the seaweed extracts. The seaweed extracts, when sprayed onto the surface of the fresh fruits, do not seem to form any protective coatings to prevent bacterial spoilage as the results from three concentration levels do not differ from one another. The small extension of shelf-life on fresh tomatoes sprayed with seaweed extracts may come from the auxin-like compounds suspected in the extracts.

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