Journal of Food Protection Vol. 41, No. 4, Pages 272-274 (April, 1978)

Activities of Five Acid Phosphatases in Purple, Green, and White Eggplants

GEORGE J. FLICK, Jr.*[1], ROBERT L. ORY[2] and ALLEN J. ST. ANGELO[2]

Department of Food Science and Technology
Virginia Polytechnic Institute and State University
Blacksburg, Virginia 24061 and
Southern Regional Research Center[3]
P.O. Box 19687
New Orleans, Louisiana 70179

(Received for publication March 14, 1977)

ABSTRACT

Tissues of purple, green, and white varieties of eggplant, *Solanum melongena*, were analyzed for relative activity of phenyl phosphatase, fructose-1, 6-diphosphatase, glucose-1-phosphatase, glucose-6-phosphatase, and ATPase. Activities of all phosphatases were highest in the purple variety and lowest in the white. Relative rates of activity decreased in the order: ATPase, phenyl phosphatase, fructose-1, 6-diphosphatase, glucose-6-phosphatase, and glucose-1-phosphatase (only found in the purple variety).

Phosphatases include a broad group of enzymes that catalyze the hydrolysis of mon-, di-, and triesters of phosphate bound to sugars, lipids, or nucleic acids. Another role suggested is related to the onset and development of senescence (*2*). Although phosphate esters and phosphatases play a major role in virtually all aspects of carbohydrate metabolism in plant tissues, no information is available on phosphatase activity in different varieties of eggplants. Eggplants (*Solanum melongena*) are not grown extensively in northern climates because they need a warm growing season of 14 to 16 weeks for good yields (*4*). Although the purple is the most popular variety, others differing in size, shape and color are known. A white variety has been grown in Europe for many years, but apparently for ornamental purposes only (*6*). A green eggplant, grown in India for several years (*12*), is now appearing in home gardens in the southern United States. Pink and black eggplants have also been cultivated in India (*11*).

Constantin et al. (*5*) compared the processing properties of purple and green eggplants, but not their composition. Flick et al. (*9*) examined proximate compositions of purple, green, and white eggplants, and found more fiber in white (22.3% dry white basis) than in purple (10.8%) or green (11.9%). Also differences in four enzyme activities (polyphenoloxidase, lipoxygenase, alcohol dehydrogenase, and catalase) were reported (*8,9*) between the three cultivars. Some of these enzymes have been correlated with flavor or organoleptic qualities in fruits and vegetables. The purpose of this research was to determine whether the three eggplant varieties differed in phosphatase activities and to correlate the activities with the fiber differences previously reported. The five acid phosphatases compared were: phenyl phosphatase, EC 3.1.3.2 (Ø-Pase); ATPase, EC 3.6.1.3; fructose-1, 6-diphosphatase, EC 3.1.3.11 (F-1, 6-di-Pase); glucose-1-phosphatase, EC 3.1.3.10 (G-1-Pase); and glucose-6-phosphatase, EC 3.1.3.9 (G-6-Pase).

MATERIALS AND METHODS

All eggplants were grown under identical conditions in the same outdoor plot in Chalmette, La., and were harvested at about the same stage of maturity (same age of fruit after flowering). The fruit were stored in a refrigerator at 4 C for 1 to 2 days until used. Peeled fruit were rapidly cut into 1-cm^3 pieces and immediately homogenized (50 g/250 ml cold deionized water) for 1 min in a food blender. Homogenates were centrifuged at 15,000 × *g* at 5-9 C for 15 min and the clear supernatant fluids wre decanted into test tubes placed in crushed ice. Nitrogen contents of tissue extracts for comparing enzyme and analyses were determined by the macroKjeldahl method. Triplicate analyses were repeated eight times on 2-4 fruit of each variety. Buffer salts and reagents were purchased commercially. Acid phosphatase activity was measured as described in the Worthington Enzyme Manual (*13*). Each cuvette contained 0.1 ml 0.15 M acetate buffer, pH 5.0, 0.05 ml 0.01 M substrate (disodium salt of phenyl phosphate, fructose-1, 6-diP, ATP, glucose-1-P, or glucose-6-P), 0.05 ml 0.01 M $MnCl_2$, 0.02 ml water, and 0.5 ml eggplant extract (or water in the blank control). Inorganic phosphorus released was determined by the Fiske-Subbarow (*7*) method at 710 nm in a spectrophometer from specific substrates after 45 min, pH 5.0, room temperature (25-26 C).

[1] *Virginia Polytechnic Institute and State University.*
[2] *Southern Regional Research Center.*
[3] *One of the facilities of the U.S. Department of Agriculture, Agricultural Research Service, Southern Region, New Orleans, LA.*

RESULTS AND DISCUSSION

Figure 1 shows a photograph of the three varieties of eggplants used in these experiments. The purple eggplant is slightly larger and is pear-shaped whereas the green and white varieties are more round. Figure 2 shows the relative activites of the five acid phosphatases in all three varieties. The release of phosphate from ATP by ATPase activity appears to be inversely proportional to the high fiber contents reported earlier (*9*). In white eggplants, the ATPase activity was the lowest, whereas the fiber content was the highest. The opposite was observed for the purple variety. This suggests that ATPase activity in eggplants is not primarily associated with fiber formation. The high ATPase activity in all three varieties also indicates that the reactions requiring high energy phosphate are significantly greater than those involving hydrolysis of hexose mono- and diester phosphates. ATPase activity in purple eggplants was also eight times higher than Ø-Pase. Since Ø-Phosphate is not considered as a natural substrate in plants, it is possible that some of the observed Ø-Pase activity may be due to nonspecific esterases, as was reported in peanuts (*3*).

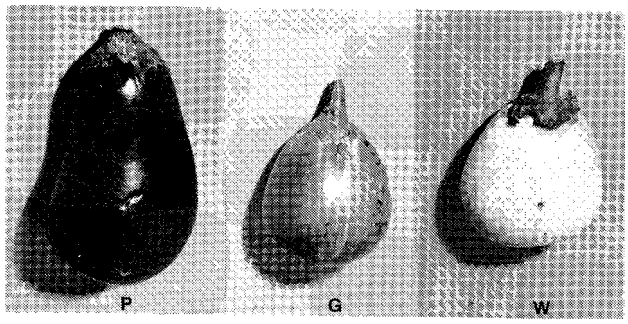

Figure 1. *Purple, green, and white eggplants picked at the same stage of maturity.*

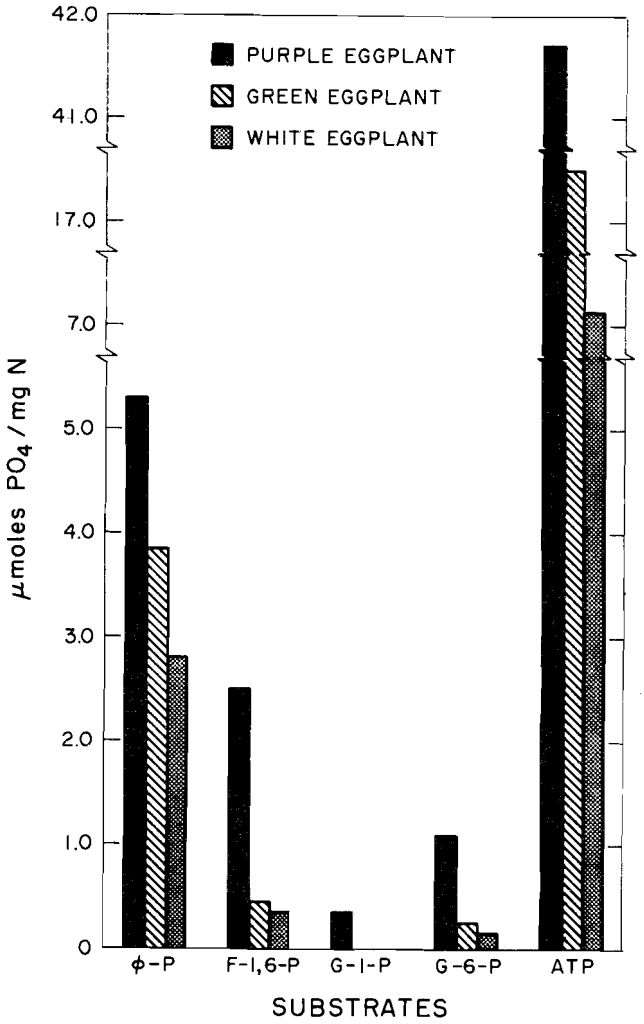

Figure 2. *Activities of acid phosphatases in purple, green, and white eggplants. Conditions as described in text. Substrates: ØP, phenyl phosphate; F-1 6-P, fructose-1, 6-diphosphate; G-1 Pase, glucose-1-phosphate; G-6-P, glucose-6-phosphate; and ATPase.*

F-1, 6-diPase (2.4) and G-6-Pase (1.0) activities were both higher in purple eggplants, with only trace amounts found in green and white. A small amount of G-1-Pase was found only in purple eggplants. This phosphatase is not common in fresh tissue as is G-6-Pase and F-1, 6-diPase. In a study of ungerminated barley grains (*10*), G-1-Pase was not present but significant activity was measured after 4 to 6 days germination (*1*), suggesting that G-1-Pase may not be a normal constituent of fresh seeds and vegetables. Some seeds were present in the pieces of tissue used to prepare eggplant extracts, but not enough to affect the measurements of G-1-Pase activity. G-1-Pase activity is present in the fleshy tissue of purple eggplants, but not in the other two varieties.

ACKNOWLEDGMENTS

The authors thank J. J. Bergquist (SRRC) for the photography and V. C. Scott (VPI&SU) for drawing Figure 2.

REFERENCES

1. Bøg-Hansen, T. C., O. M. Larson, and R. L. Ory. 1974. Phosphatase activites in barley. Properties and activity changes during germination. Bios 5:334-337.
2. Baker, J. E., and T. Takeo. 1973. Acid phosphatases in plants and tissues. I. Change in activity and multiple forms in tea leaves and tomato fruit during maturation and senescence. Plant Cell Physiol. 14:459-471.
3. Cherry, J. P., and R. L. Ory. Unpublished Data.
4. Combs, O. B., E. K. Wade, and J. L. Libby. 1973. Eggplant. Wisc. Univ. Cooperative Exten. Prog. Fact Sheet A 2360.
5. Constantin, R. K., J. E. Fontenot, and E. P. Barrios. 1974. Processing studies with eggplant. J. Amer. Soc. Hortic. Sci. 99: 505-507.
6. Dumonthay, J. 1936. Culture de l'aubergine. Rev. Hortic. Suisse 9:88-91.
7. Fiske, C. H., and Y. Subbarow. 1925. The colorimetric determination of phosphorus. J. Biol. Che. 66:375-400.
8. Flick, G. J., A. J. St. Angelo, and R. L. Ory. 1975. KCH Inhibition of lipoxygenase in purple, green, and white eggplants. Lipids 10:564-566.
9. Flick, G. J., R. L. Ory, and A. J. St. Angelo. 1976. Comparison of nutrient composition and of enzyme activity in purple, green and white eggplants. J. Agric. Food Chem. 25:117-120.
10. Ory, R. L., and K. W. Henningsen. 1969. Enzymes associated with protein bodies isolated from ungerminated barley seeds. Plant Physiol. 44:1488-1498.

11. Singh, R., J. Singh, and K. S. Nandpuri. 1974. Chemical evaluation of some promising varieites of brinjal (*Solanum melogena* L.). Indian J. Hortic. 31:242-245.
12. Viraktamath, C. S., B. Anadaswamy, K. R. Subba Rao, B. N. Syryanarayana, N. V. R. Iyengar, and H. C. Srivastana. 1963. Prepackaging studies of fresh produce. III. Brinjal-eggplant (*Solanum melongena*) Food Sci., Mysore 12:326-331.
13. Worthington Enzyme Manual. 1972. Acid phosphatase (wheat germ; EC 3.1.3.2. Worthington Biochemical Corp., Freehold, N.J. pp. 75-76.