Acta Biologica Szeged. 27 (1—4), pp. 25—31 (1981)

SOME DATA ON THE SUPEROXIDE DISMUTASE AND PEROXIDASE CONTENTS OF FRUITS, SEEDS AND DIFFERENT PARTS OF PLANTS*

B. MATKOVICS, SZ. I. VARGA and ILONA MATKOVICS

Biological Isotope Laboratory, Attila József University, Szeged
(Received July 22, 1980)

Abstract

As a supplement to earlier work, in the present paper we deal with a comparison of the superoxide dismutase (SOD) and peroxidase (P-ase) contents of various commercial fruits and vegetables, and also with the values of these enzymes in certain seeds, and with their comparison in plant parts of different ages, and particularly the leaves.

Introduction

In previous work we studied and compared the peroxide metabolism enzymes in *Phaseolus bulgaris* plant parts of various ages, viz. the contents of superoxide dismutase (SOD; EC 1.15.1.), peroxidase (P-ase; EC 1.11.1.7) and catalase (C-ase; EC 1.11.1.16) (SIMON et al., 1974).

We subsequently dealt in detail with the comparison of the seeds' peroxidase (SP-ase) and SOD contents of some mono- and dicotyledonous plants (DO QUY HAI et al., 1975).

The present paper is a supplement to these eralier investigations.

Materials and Methods

Preparation of plant seeds and plant parts for examination of the enzymes:

The seeds were prepared as described previously (DO QUY HAI et al., 1975).

The plant parts were first separated, cuted into pieces with scissors, weighed and ground with quartz sand. If P-ase was being determined, moistening was performed with 10 mmol/1 phosphate buffer pH 7.0. The homogenate was filtered through gauze, and an aliquot of the solution was taken for determination of the P-ase activity after requisite dilution with the above buffer. P-ase activity was determined by the quaiacol method (COLOWICK et al., 1955). (The basic principles described for the P-ase calculations were employed in the calculations given in the graph.) The results were transformed to specific activity units, and are given as follows: for the seeds: in enzyme units/g dry seed (d.s.w.) weight; and for the plant parts, vegetables, fruits and leaves: in enzyme units/g wet weight (w.w.).

The preparation of the seeds for the SOD measurement was as described previously (DO QUY HAI et al., 1975.); after the above weighing, pretreatment and grinding, the other parts were generally

* Part VI/A. Properties of enzymes. Serial publication.

moistened with 0.1 M K_2HPO_4 solution. Pressing through gauze was followed by addition of an ethanol-chloroform mixture (0.25:0.15) to the filtrate, 0.35 ml of this organic solvent mixture being taken for each 1 ml of the K_2HPO_4 extract. Shaking with the solvent was succeeded by centrifugation at 5000 rpm. An aliquot (0.005—0.1 ml) of the SOD-enriched solvent extract was used for determination of the enzyme (MISRA et al., 1972).

SOD activity was investigated via the inhibition of the spontaneous transformation adrenaline — adrenochrome in alkaline medium, in which the O_2^- anion takes part (MISRA et al., 1972).

The plant materials were collected, and the determinations were performed, in March and April in 1974.

Those plants the roots, stem and leaves of which were analyzed, were planted out in pots, and were grown in greenhouses.

The plants examined were: *Allium cepa* L. (onion), *Allium sativum* L. (garlic), *Capsicum annuum* L. var *abbreviatum Cecei* (pepper), *Capsicum annuum* L. var. *Lycopersiciforme* (pepper), *Citrus aurantiacum* L. ssp. *sinesis* PALL (orange), *Solanum tuberosum* L. (potato), *Raphanus sativus* L. (radish), *Citrus medica* L. (lemon), *Matthiola bicornis* (S. SM.) DC. *Sorgum vulgare* L. hybrid (sorghum), Triticale, *Ipomoea purpurea* (L.) LAM. *Lactuca sativa* L. (lettuce), *Glycine soia* L. (soya bean), *Phaseolus coccineus* L. (runner bean), *Linum usitatissimum* L. (flax), *Daucus carota* L. (carrot), *Aster novibelgii* L. (aster), *Cannabis sativa* L. (hemp), *Petroselium hortense* L. (parsley), *Chenopodium amaranti-color, Chenopodium quinoa, Ocinum basilicum* L., *Nicotiana tabacum* L. var. *glutinosa, Nicotiana tabacum* L. var. *samsum, Nicotiana tabacum* L. var. *Bell, Spinacia oleracea* L. (spinach), *Brassica oleracea* L. var. *capitata* L. forma *alba* (white cabbage), *Brassica oleracea* L. var. forma *rubra* (red cabbage).

Spektromom 360 photometer (MOM, Budapest, Hungary) was used for the spectrophotometric measurements at 470 and 480 nm.

The chemicals and solvents employed were commercial products of Reanal (Budapest, Hungary)

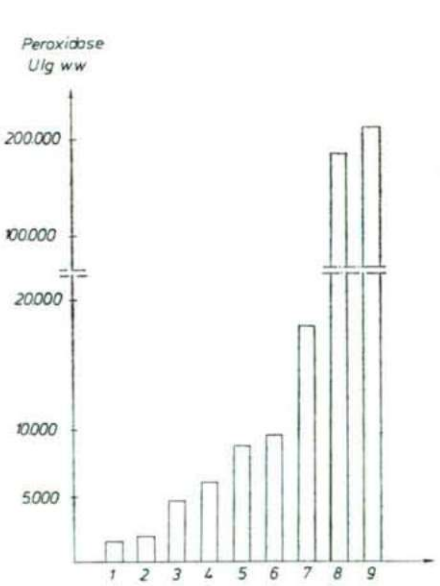

Fig. 1

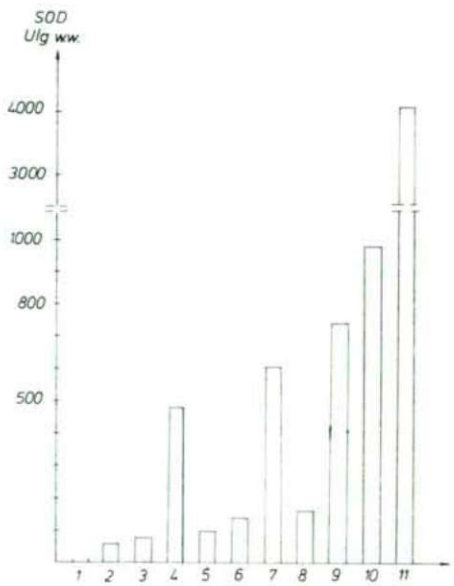

Fig. 2

Fig. 1. P-ase contents of various vegetables and lemon peel, in U/g w.w. Sequence of columns: 1. onion; 2. garlic; 3. *Capsicum annuum* var. *abbreviatum* Cecei; pepper but var. *lycopersiciforme;* 5. orange peel; 6. potato tissue; 7. potato peel; radish; 9. lemon peel.

Fig. 2. SOD contents of various vegetables and friuts, in U/g w.w. Sequence of columns: 1. potato peel; 2. potato tissue; 3. orange peel; 4. orange tissue; 5. onion; 6. lemon peel; 7. lemon tissue; 8. garlic; 9. Cecei's pepper; 10. radish; 11. tomatoform pepper.

Results and discussion

Presenting the results in the sequence of the graphs, we deal first with the P-ase, and then with the SOD values. Figure 1 shows the P-ase contents of some vegetables and orange and lemon peel. It can be seen from the Figure that of the vegetables listed, the radish has the highest P-ase content, but this is exceeded by that of lemon peel.

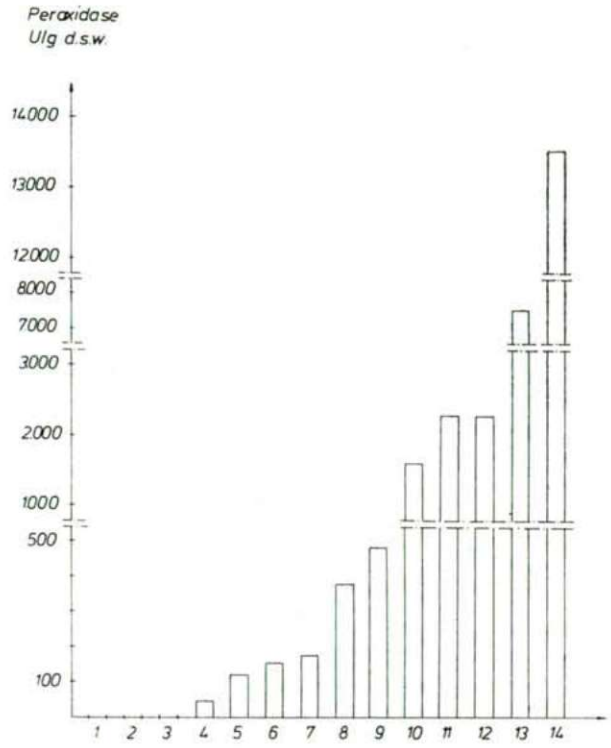

Fig. 3. Seeds examined for SP-ase content: 1. flax; 2. carrot; 3. *Matthiola bicornis;* 4. cabbage; 5. aster; 6. sorghum (hybrid); 7. radish; 8. hemp; 9. Triticale; 10. persley; 11. Ipomea purpurea; 12. lettuce; 13. soya bean; 14. runner bean.

Substantially lower activity values are found for the SOD contents of these vegetables and fruits. Here the activity sequence too is different (see Fig. 2). The high SOD values of the early radish and the *Capsicum annuum* L. var. *abbreviatum* Cecei (Cecei's pepper) must be singled out. It is intersting that potato peel contains no SOD at all, and the SOD content of the tissue of potatoes is very low.

Figure 3 shows the seed peroxidase (SP-ase) values. These measurements supplement our earlier data, in the same way as Figure 4 does for the SOD values (Do Quy Hai et al., 1975). In both Figures the high SP-ase and SOD values of the soya

bean should be emphasized. It must be mentioned that the seeds in the first three columns of Figure 3 and 4 do not contain SP-ase and SOD. An example of this is the carrot seed. Of all the seeds examined to date that of the soya bean has the highest SOD content. On the basis of the SP-ase content the soya bean can be classified among the seeds with medium SP-ase content. In the present comparison its SP-ase content is exceeded by that of the runner bean.

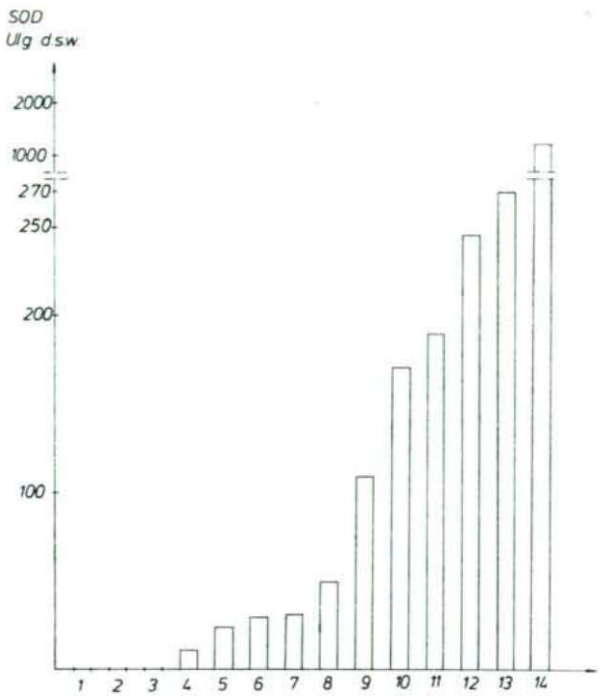

Fig. 4. Seeds examined for SOD content: 1. lettuce; 2. *Ipomoea purpurea;* 3. carrot; 4. sorghum (hybrid); 5. parsley; 6. hemp; 7. Triticale; 8. aster; 9. flax; 10. *Matthiola bicornis;* 11. runner bean; 12. radish; 13. cabbage; 14. soya bean.

Figure 5 shows the P-ase values of the parts of four plants grown in the greenhouse: The two varieties of *Chenopodium, Ocimum,* pepper and tobacco. Details on these same plants as regards SOD content are given in Figure 6. In general the P-ase values exhibit a variable distribution. On the other hand, the SOD values are the highest in the leaves in every case.

Figure 7 and 8 present the P-ase and SOD valwes of plant leaves and vegetables of various ages.

The high P-ase activity values of cabbage varieties in Figure 7 should be singled out, the highest value being that of red cabbage.

The SOD content too is the highest in the above plants (see Fig. 8).

The large number of comparisons relating to the two enzymes of the peroxide metabolism well support the role of the metabolite considered of importance in con-

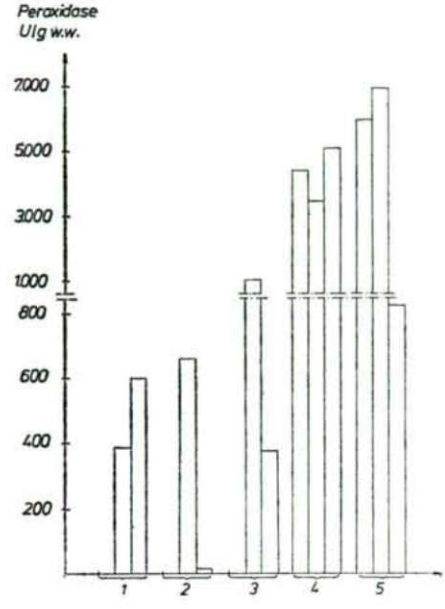

Fig. 5. Sequence of numbers relating to the P-ase activities of the plant parts: 1. *Chemopodium amaranticolor;* 2. *Ocimum basilicum;* 3. *Chenopodium quinoa;* 4. pepper; 5. *Nicotiana tabacum* var. *glutinosa.* (As regards the relevant columns, in all cases the first refers to the root, the second to the stem, and the third to the leaf.)

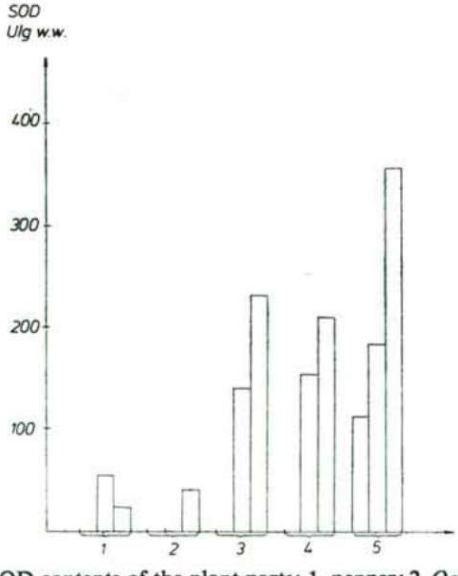

Fig. 6. Sequence for the SOD contents of the plant parts: 1. pepper; 2. *Ocimum basilicum;* 3. *Chenopodium quinoa;* 4. *Chenopodium amaranti-color;* 5. *Nicotiana tabacum* var. *glutinosa.* (The same refers to sequence of the columns as in Fig. 5.)

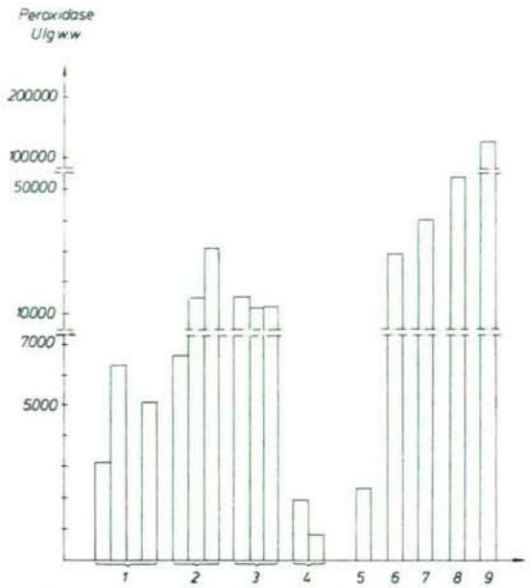

Fig. 7. P-ase of the leaves (in some cases of different ages) of various vegetables: 1. pepper (2-leaf, 30, 50 and 80 days old); 2. 3 types of 30 days old tobacco (*Nicotiana tabacum* var. *glutinosa*, var. *samsum* and var. *Bell*); 3. the same 3 types of 80 days old tobacco; 4. *Chenopodium* (*Qunoa* and *amarati-color*); 5. lettuce; 6. spinach; 7. radish; 8. white cabbage; 9. red cabbage.

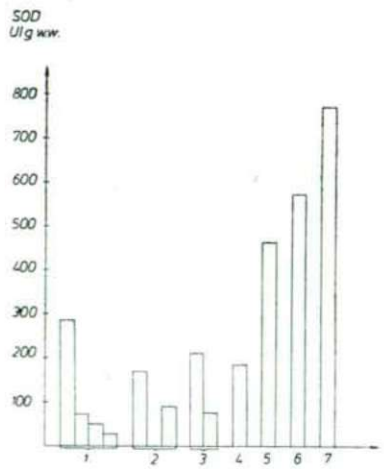

Fig. 8. SOD activities of vegetable leaves: 1. pepper (2-leaf), 30, 50 and 80 days old); 2. *Nicotiana tabacum* var. (as in Fig. 7.); 3. the 2 *Chenopodium* species; 4. spinach; 5. radish; 6. white cabbage; 7. red cabbage.

nection with the P-ase, and the role of the SOD in the protection against the O_2^- anion.

We carried out the examinations reported in the paper in 1975. Since then, only a two-part paper on this topic has been published (GIANNOPOLITIS et al., 1977 a, b).

Accordingly, the work appearing in this field is still in the descriptive stage.

References

COLOWICK, S. P. and KAPLAN, N. O. (1955): Methods in Enzymology, Vol. II. pp. 764. Academic Press, London

DO QUY HAI, KOVÁCS, K., MATKOVICS, I. and MATKOVICS, B. (1975): Properies of Enzymes, Part X. Peroxidase and Superoxide dismutase Contents of Plant Seeds. — Biochem. Physiol. Pflanzen *167*, 357—359.

GIANNOPOLITIS, C. N. and RIES S. K. (1977a): Superoxide dismutases. I. Occurence in higher plants. — Plant Physiol. *59*, 309—314.

GIANNOPOLITIS, C. N. and RIES S. K. (1977b): Superoxide dismutases. II. Purification and quantitative relationspip with water-soluble protein in seedlings. — Plant Physiol. *59*, 315—318.

MISRA, H. P. and FRIDOVICH, I. (1972): The role of superoxide anion in the autoxidation of epinephrine and a simple assay for superoxide dismutase. — J. Biol. Chem. *247*, 3170—3175.

SIMON, L. M., FÁTRAY, Zs., JÓNÁS, D. E. and MATKOVICS, B. (1974): Study of peroxide metabolism enzymes during the development of *Phaseolus vulgaris*. — Biochem. Physiol. Pflanzen *166*, 387—392.

Address of the authors:
Dr. B. MATKOVICS
Dr. SZ. I. VARGA, ILONA MATKOVICS
P. O. Box 539.
H-6701 Szeged, Hungary