

Comparative study of the biochemical properties of the fruits of wild (*Lycopersicon pimpinellifolium* Jusl. (Mill.)) and the cultivated (*L. esculentum* Mill.) tomato cultivars in Nigeria

O. Adedeji¹ and I.O. Adewale²

¹Department of Botany, ²Department of Biochemistry, Obafemi Awolowo University, Ile-Ife, Nigeria.

E-mail: iadewale@oauife.edu.ng or olusanjo2002@yahoo.co.uk

Abstract

The fruits of three cultivars of the cultivated tomato (*Lycopersicon esculentum*) and the wild species (*L. pimpinellifolium*) were analysed and compared for their biochemical properties. Ripe fruits at the orange-red stage were used for all the analyses. Both the cultivated and the wild tomato species showed high moisture contents. The wild tomato cultivar had a higher crude protein content and quantitatively represents the better source of protein intake when compared with the cultivated cultivars. The crude fibre content was highest in *L. esculentum* cv. Roma V.F. The ash content was higher in the Ibadan local and wild cultivars than in the other cultivars. Peroxidase activity was found to be highest in *L. pimpinellifolium*, while catalase activity was highest in *L. esculentum* cv. Ife-1. Glutathione transferase activities was negligible in all the samples analysed.

Key words: Tomato, *Lycopersicon esculentum*, *L. pimpinellifolium*, cultivars, biochemical properties, peroxidase, catalase

Introduction

Lycopersicon is a relatively small genus within the extremely large and diverse family Solanaceae. The family is considered to consist of around 90 genera (D'Arcy, 1972). This small genus *Lycopersicon* is thought to consist of the cultivated tomato, *L. esculentum* and seven closely related wild *Lycopersicon* species (Rick, 1976). A sub-generic classification divides the genus into those species which can be easily crossed with the commercial tomato (*esculentum* complex) and those which cannot (*peruvianum* complex). Species forming the *esculentum* complex consists of six *Lycopersicon* species, three of which have coloured fruit and three have green fruit. Two of these coloured fruit species, *L. esculentum* and *L. pimpinellifolium* are found in Nigeria.

L. pimpinellifolium is a wild species that is very closely related to the cultivated tomato. It is the only wild species which has shown natural introgression with *L. esculentum* (Rick, 1958). Because of its close relationship with modern cultivars and ease of backcrossing, *L. pimpinellifolium* has frequently provided an attractive gene source for plant breeders, for example, resistance to *Fusarium* wilts (Bohn and Tucker, 1940) and also resistance to bacterial speck caused by *Pseudomonas tomato* (Pilowsky, 1982).

The economic and nutritional importance of tomato fruits cannot be over-emphasized. It provides a source of nutrients through its use mainly as a soup ingredient and is a major source of income for many farmers who cultivate them for fresh produce markets. Adverse physical and biochemical change in the fruit tissue can lower acceptability and nutritional value. To understand these changes, information is required about the initial chemical composition of the fruit and particularly about the levels of some of the enzymes present. Out of the several enzymes which could

cause unwanted changes, peroxidase, EC: 1.11.1.7 isoenzymes have been shown to be useful as markers of the reaction of plants to external environmental stress (Palavan *et al.*, 2000). Peroxidase also modulate the endogenous levels of the main growth promoting factor and are involved in the rigidification and lignification processes (De Forchetti and Tigier, 1990).

Catalase (EC. 1.11.1.6) catalyses the decomposition of hydrogen peroxide, a cytotoxic by-product of metabolism (Brennen and Frenkel, 1977), while glutathione transferase is one of the phase II detoxication enzymes that is used by organisms to detoxicate both foreign and endogenously generated electrophiles.

Quite a number of works had been done to compare the biochemical properties of the cultivars of the cultivated species, *L. esculentum*, these include the works of Aluko (1989) and Ereifej *et al.* (1997). However, there has been no report on the comparative study of the biochemical properties of the cultivars of this cultivated tomato species with the wild species. The aim of this work is therefore, to study and compare some of the biochemical properties of these cultivated species with that of the wild species.

Materials and methods

Fruit samples used: Seeds of the cultivated cultivars were obtained from the National Institute of Horticultural Research and Training (NIHORT), Ibadan, Oyo State, Nigeria. They are *L. esculentum* cv. Ibadan local, *L. esculentum* cv. Ife-1 and *L. esculentum* cv. Roma V.F. The seeds of *L. pimpinellifolium*, the wild tomato species were obtained from the wild. The seeds were sown and nursery was raised at the Obafemi Awolowo University research farm. Thirty five days old seedlings were transplanted at a distance of 0.5 m within rows. Each cultivar was replicated three times (25 plants per replicate). Fully matured

and ripened fresh tomato were harvested on the day the experiments were carried out.

Proximate analysis: Samples of 10 fruits per treatment were homogenized in a warring blender for 1 min. The moisture, ether extract, ash, crude fibre, and crude protein contents were determined as described in AOAC (1980).

Enzyme assay and soluble protein determination: About 50 g of each of the fruits were homogenized in a warring blender for one minute. The homogenate was spun at 18000 g for 30 mins. to obtain a crude supernatant which was used for the assay. Protein concentration in the supernatant was determined by the method of Lowry *et al.* (1951) using Bovine serum albumin as the standard protein. Peroxidase activity was assayed according to the method of Kay *et al.* (1967), using 0-dianisidine as the electron donor. Catalase activity was assayed by monitoring the decomposition of H₂O₂ at 240 nm (Beers and Sizer, 1952). Glutathione transferase activity was assayed according to the method of Habig *et al.* (1974) by monitoring the conjugation of glutathione (GSH) and 1-chloro, 2,4-dinitrobenzene (CDNB) in a Cecil double beam spectrophotometer. One unit of enzyme activity is defined as the amount of enzyme that will catalyze the formation of one micromole of product per minute.

Results and discussion

Proximate analysis: The results of the proximate analysis for the wild and the cultivated tomato cultivars are shown in Table 1. The wild tomato (*L. pimpinellifolium*) had the highest crude protein content (1.25 + 0.03%) when compared with the cultivated cultivars of *L. esculentum*. Ether extract was highest in *L. esculentum* cv. Roma V.F. (0.74 + 0.01%) and lowest in *L. pimpinellifolium* (0.52 + 0.14%). The crude fibre content of the *L. esculentum* cv. Roma V.F. was the highest (1.73 + 0.28%) followed by *L. esculentum* cv. Ife-1 (1.68 + 0.17%), it was lowest in *L. pimpinellifolium* (1.08 + 0.18%). *L. pimpinellifolium* had the highest ash content (0.50 + 0.01%) and in *L. esculentum* cv. Roma V.F. it was lowest (0.29 + 0.08%). All the cultivars of tomato studied, that is, both wild and cultivated showed high moisture content with *L. esculentum* cv. Ibadan local having the highest value (95.88 + 0.53%) followed by *L. esculentum* cv. Roma V.F. with a value of 94.60 + 0.11%.

Enzyme analysis: The summary of the results is shown in Table 2. All the samples investigated had negligible glutathione transferase activity. *L. pimpinellifolium*, had the highest

peroxidase activity (4.22 + 0.16 units/mg protein followed by *L. esculentum* cv. Roma V.F. (2.58 + 0.10 units/mg protein) and *L. esculentum* cv. Ife-1 (2.52 + 0.06 units/mg protein). *L. esculentum* cv. Ibadan local had the least peroxidase activity (1.61 + 0.05 units/mg protein).

Catalase activity was highest in *L. esculentum* cv. Ife-1 (22.18 + 0.53 units/mg protein), followed by *L. esculentum* cv. Roma V.F. (21.3 + 0.8 units/mg protein). *L. pimpinellifolium*, the wild tomato species had the least catalase activity of 12.25 + 0.28 units/mg protein.

Both the cultivated and the wild tomato species showed high moisture contents. This is typical of fleshy vegetables (Ereifej *et al.*, 1997). The wild tomato cultivar, *L. pimpinellifolium* had a higher crude protein content and quantitatively represent the best source of protein intake when compared with the three cultivated cultivars of *L. esculentum*. The crude fibre content of the *L. esculentum* cv. Roma V.F. was higher than those of the other cultivars including the wild cultivar. This is of interest as dietary fibre is considered to be helpful in maintaining good health (Davidson *et al.*, 1975). *L. esculentum* cv. Roma V.F. also had the high ether extract content.

The ash content is higher in the *L. esculentum* cv. Ibadan local and *L. pimpinellifolium*, the wild cultivar than in the *L. esculentum* cvs Ife-1 and Roma V.F. This implies higher mineral constituents in the wild and the Ibadan local cultivars. *L. pimpinellifolium*, the wild tomato cultivar had a higher peroxidase activity than the three cultivated *L. esculentum* cultivars. Peroxidase has been implicated in lignin and suberin formation. Lignin and suberin are involved in making cell walls rigid, reducing wall extensibility and cell expansion (Goldberg *et al.*, 1986). Tissues containing high level of peroxidase have been shown to have higher disease resistance potential than those containing low level of peroxidase (Macko *et al.*, 1968; Seevers and Daly, 1970; Lowell and Cunningham, 1972). Thus, wild cultivar is expected to be more resistant to infections and diseases than the other cultivars during storage, and this is in agreement with Atherton and Rudich (1986) who reported that *L. pimpinellifolium* are more resistant to diseases during storage.

Catalase activity was highest in *L. esculentum* cv. Ife-1 followed by cultivar Roma VF. It was lowest in *L. pimpinellifolium*, the wild cultivar. The main physiological role of catalase in an organism is to breakdown hydrogen peroxide. Removal of hydrogen peroxide from cells is desirable in order to avoid the

Table 1. Proximate analysis for the wild and the cultivated tomato cultivars

Tomato cultivar/species	Crude protein(%)	Ether extract(%)	Crude Fibre(%)	Ash(%)	Moisture(%)
<i>L. pimpinellifolium</i>	1.25 + 0.03	0.52 + 0.14	1.08 + 0.18	0.50 + 0.01	93.31 + 0.19
<i>L. esculentum</i> cv. Roma V.F.	1.15 + 0.04	0.74 + 0.01	1.73 + 0.28	0.29 + 0.08	94.60 + 0.11
<i>L. esculentum</i> cv. Ife-1	1.09 + 0.01	0.55 + 0.20	1.68 + 0.17	0.35 + 0.21	93.97 + 1.01
<i>L. esculentum</i> cv. Ibadan local	0.99 + 0.01	0.54 + 0.08	1.31 + 0.07	0.46 + 0.12	95.88 + 0.53

Table 2. Specific Activity of the enzymes in the crude preparation of the fruits of the wild and the cultivated tomato cultivars.

Tomato cultivar/species	Peroxidase activity (units/mg protein)	Catalase activity (units/mg protein)	Glutathione transferase
<i>L. pimpinellifolium</i>	4.22 + 0.16	12.25 + 0.28	Negligible
<i>L. esculentum</i> cv. Roma V.F.	2.58 + 0.11	21.30 + 0.80	Negligible
<i>L. esculentum</i> cv. Ife-1	2.52 + 0.06	22.18 + 0.53	Negligible
<i>L. esculentum</i> cv. Ibadan local	1.61 + 0.05	16.46 + 0.55	Negligible

adverse effects it has on cellular components. The pattern of catalase activity in the varieties probably shows that more hydrogen peroxide is produced by *L. esculentum* cvs. Roma VF and Ite-1 than the *L. pimpinellifolium* and *L. esculentum* cv. Ibadan local which necessitates a higher concentration of catalase in their tissues.

All the cultivars of tomato studied have negligible Glutathione Transferases (GSTs). GSTs are inducible by xenobiotics upon exposure of an organism to such xenobiotic. GST was negligible in all the extracts because there was probably no obvious exposure to xenobiotics, which could cause the induction of the enzyme. It is however, possible that the type of GST isoenzyme present could not be detected because the universal substrate (CDNB) utilized for assay in this study was not a substrate for the particular isoenzyme present.

In conclusion, this study shows that there is a correlation between the level of peroxidase expression in the tomato cultivars and the observed shelf keeping quality and disease resistance of such cultivars. Moreover, *L. pimpinellifolium* the wild cultivar which is rarely grown for food or any economic purposes, appears to have better nutritional (protein) and shelf life than the cultivated cultivars.

References

- Aluko, R.E. 1989. Biochemical properties of some tomato fruit cultivars grown in Northern Nigeria. *Nig. J. Bot.*, 2: 157-164.
- AOAC, 1980. *Official methods of Analysis*. 13th edition, Association of Official Analytical Chemists, Washington.
- Atherton, J.G. and J. Rudich, 1986. *The tomato crop*. Chapman and Hall, London.
- Beers, R. and I. Sizer, 1952. A spectrophotometric method for measuring the breakdown of hydrogen peroxide by catalase. *J. Biol. Chem.*, 195: 133-136.
- Bohn, G.W. and C.M. Tucker, 1940. Studies on *Fusarium* wilt of the tomato. 1. Immunity in *Lycopersicon pimpinellifolium* Mill. and its inheritance in hybrids. *Mo. Agr. Exp. Sta. Res. Bull.*, 311: 82.
- Brennan, T. and C. Frenkel, 1977. Involvement of hydrogen peroxide in the regulation of senescence in plant. *Plant Physiology*, 59: 411-416.
- D'Arcy, W.G. 1972. Solanaceae Studies II: Typification of subdivisions of *Solanum*. *Ann. Missouri Botanical Garden*, 59: 262-278.
- Davidson, S., R. Passmore, J.F. Brock and A.S. Trustwell, 1975. *Human Nutrition and Dietetics*. 6th edition, Churchill Livingstone, pp. 390-629.
- De Forchetti, S.M. and H.A. Tigier, 1990. Indole-3-acetic acid oxidase and syringaldazine oxidase activities of peroxidase isoenzymes in soybean root nodules. *Physiol. Plant.*, 79: 327-330.
- Ereifej, K.I., R.A. Shibli, M.M. Ajlouni and A. Hussain, 1997. Physico-chemical characteristics and processing quality of newly introduced seven tomato cultivars into Jordan in comparison with local variety. *J. Food Sci. Technol.*, 34 (2): 171-174.
- Goldberg R., M. Liberman, C. Mathien, M. Pierron, A.M. Catesson, 1986. Development of epidermal cell wall peroxidases along the mung bean hypocotyl: possible involvement in the cell wall stiffening process. *J. Exp. Bot.*, 38: 1378-1390.
- Habig, W.H., M.I. Pabst and W.B. Jakoby, 1974. Glutathione S-transferases. The first enzymatic step in mercapturic acid formation. *J. Biol. Chem.*, 249: 7130-7139.
- Kay, E., L.M. Shannon and J.Y. Lew, 1967. Peroxidase isoenzymes from horse radish roots. II Catalytic properties. *J. Biol. Chem.*, 242: 2470-2473.
- Lowell, B.I. and B.A. Cunningham, 1972. Peroxidase activity in healthy and leaf rust infected wheat leaves. *Phytochemistry*, 11: 547-551.
- Lowry, O.H., N.J. Rosebrough, A.L. Farr and R.J. Rondall, 1951. Protein measurement with the Folin-phenol reagent. *J. Biol. Chem.*, 193: 265-275.
- Macko, V., W. Woodbury and M.A. Stahman, 1968. The effect of peroxidase on the germination and growth of mycelium of *Puccinia graminis* f. sp. tritici. *Phytopathology*, 58: 1250-1254.
- Palavan, U.N., E. Aetin and A. Kadioglu, 2000. Boron stress affects peroxidase activity. *Plant Peroxidase Newsletter*, 15: 37-44.
- Pilowsky, M. 1982. Screening wild tomatoes for resistance to bacterial speck pathogen (*Pseudomonas tomato*). *Plant Dis.*, 66: 46-47.
- Rick, C.M. 1958. The role of natural hybridization in the derivation of cultivated tomatoes in western South America. *Econ. Bot.*, 12: 346-367.
- Rick, C.M. 1976. Tomato (Family Solanaceae) *In: Evolution of crop plants* (ed. N.W. Simmonds) Longman Publications, pp. 268-273.
- SeEVERS, P. and J.M. DALY, 1970. Peroxidase isoenzyme in resistant and susceptible reaction of wheat stem rust controlled at the Sr 6 locus. *Phytopathology*, 60: 1313.