Research Article

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Brassica oleracea var. *costata*: comparative study on organic acids and biomass production with other cabbage varieties

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Abstract

BACKGROUND: A study was undertaken to evaluate the effect of agronomic practices, harvesting time and leaf age on the organic acid composition and biomass production of *Brassica oleracea* L. var. *costata* DC (tronchuda cabbage). Samples were cultivated under eight different fertilisation regimes (two levels each of nitrogen, boron and sulfur, an organic fertiliser and no fertiliser) and collected at three different times.

RESULTS: Principal component analysis of the data indicated significant differences. Three principal components with an eigenvalue higher than one accounted for 79.0% of the total variance of the data set. Samples obtained with conventional fertilisation were characterised by the highest values of fresh weight. External leaves showed higher total organic acid and malic acid contents than internal leaves, while the latter were characterised by higher proportions of citric acid. For consecutive harvests, total organic acid concentration decreased in both external and internal leaves.

CONCLUSION: The use of a conventional fertilisation regime (nitrogen, boron or sulfur) improved the growth of *B. oleracea* var. *costata* without affecting its organic acid profile. However, for consecutive harvests, total organic acid concentration was observed to decrease independently of the agronomic practices tested. Leaf age influenced the quantitative composition of organic acids.

Keywords: *Brassica oleracea* L. var. *costata* DC; organic acids; fertilisation; principal component analysis

INTRODUCTION

Plants have the ability to accumulate organic acids in the cell vacuoles[1] in quantities that depend on their type of carbon fixation, nutritional status and degradative activities. The predominant organic acids are also determined by factors such as the age of the plant and the type of tissue.[2,3]

Among the organic acids found in plants, those from the tricarboxylic acid (Krebs) cycle, namely citric, aconitic, isocitric, ketoglutaric, succinic, fumaric, malic and oxalacetic acids, can be distinguished. All these acids occur in catalytic amounts in plant tissues, although only citric and malic acids are regularly accumulated.[1] Shikimic and quinic acids, not present in the Krebs cycle, are also of interest, being precursors of aromatic compounds in plants. Several organic acids have been found in previous studies involving *Brassica* species.[4–7]

Apart from the above, malic, citric, aconitic and fumaric acids carry out other functions in plant metabolism. Malic and citric acids are the most abundant organic acids in *Brassica oleracea* L. var. *costata* DC, commonly known as tronchuda cabbage,[4–6] and their storage in the tissues and possible release are regulated by the plant cells independently.[8] Malic acid is a versatile compound that can easily be transported across the cellular membranes or stored in the vacuoles. It can perform various functions, such as acting as a substrate for mitochondrial adenosine 5′-triphosphate (ATP) production, providing nicotinamide adenine dinucleotide (NADH) to the cytosol, maintaining the cytosolic pH value[8,9] and acting as an osmoticum and as a counterion for potassium or sodium.[2,8] Citric acid plays an important role in the translocation of iron in the roots and in its long-distance transport through the xylem to the leaves.[10] Aconitic acid is involved in carbohydrate biosynthesis in the glioxalate cycle and presents allelopathic activity.[11] Fumaric acid can be metabolised to yield energy and carbon skeletons for production of other compounds and may also help in the maintenance of cellular pH and turgor pressure.[12]

The synthesis and intracellular accumulation of oxalic acid in plants are implicated in cell calcium homeostasis,[13] although from a nutritional standpoint this acid is considered to be an antinutrient because it renders calcium, and sometimes other minerals, unavailable for nutritional absorption.[14] However,

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