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ORIGINAL PAPER

Influence of sulfur fertilization on S-containing, phenolic, and carbohydrate metabolites in rosy garlic (*Allium roseum* L.): a wild edible species in North Africa

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Abstract *Allium roseum* L., a North African endemic species, is a rich source of many important nutrients and bioactive compounds responsible for many promising beneficial health physiological effects. The influence of sulfur fertilization (S fertilization) on the flavor, total polyphenols, and carbohydrates content in *A. roseum* was studied, using three sulfur concentrations (0.01, 1.50 and 4.50 mmol L^{-1}) under controlled conditions. S fertilization showed a significant increase in the allicin concentration of *A. roseum* bulbs with an average of 0.859–2.285 g kg^{-1} FW for bulbs grown at 0.01 and 1.50 mmol L^{-1} SO_4^{2-}, respectively. The same trend was observed for total polyphenol content. On the contrary, the highest level of S decreased the content of reduced carbohydrates. These results provide evidence that the concentrations of allicin and polyphenols in *A. roseum* are increased by S fertilization, potentially amplifying its beneficial impacts on health.

Keywords *Allium roseum* · Sulfur supply · Allicin · Polyphenols · Carbohydrates

Introduction

The chemical composition of the metabolic products of the *Allium* species is of interest in photochemistry, plant–insect relationships, chemotaxonomy, flavor industry, quality control of food, pharmacology, and medicine [1, 2]. This genus is one of the major sources of dietary polyphenols and sulfur-containing compounds [3, 4].

The most important group of sulfur-containing compounds are *S*-alk(en)ylcysteine sulfoxides, which are the precursors of sensory-active and health-benefitting compounds of *Allium* vegetables. It is reported that the cysteine sulfoxide content of *Allium* species is an important quality parameter as it determines the taste and sharpness [5].

Allium pungency is closely dependant on cultivar and growth factors such as water, nitrogen, and sulfur supply [6]. Earlier studies have shown that sulfur fertilization (S fertilization) influences pungency and metabolic product of intermediates in the flavor biosynthetic pathway [7].

Sulfur fertilization was shown to increase a broad range of S-containing metabolites in plants such as cysteine, glutathione, and glucosinolates, as well as cysteine sulfoxide in *Allium* species [8, 9]. In a previous study, it was shown that alliin, cysteine, and glutathione content in garlic leaves during vegetation period was minor, but S fertilization significantly increased the cysteine, glutathione, and alliin concentration in garlic bulbs [8].

Allium roseum is a highly variable species represented in North Africa by 12 different taxa: 4 varieties, 4 subvarieties, and 4 forms [10, 11]. In Tunisia, Cuénod [10] and Le Floc'h [11] observed only three varieties: var. *grandiflorum*, var. *perrotii*, and var. *odoratissimum*. Considered as an endemic taxon in North Africa [10], the *odoratissimum* variety is a perennial, spontaneous weed. Its edible aerial parts are widely harvested and sold commercially. This taxon has been used since ancient times as a vegetable spice and herbal remedy [11]. The fresh young leaves and bulbs of *A. roseum* are valued for their distinctive pungent flavor and are an essential ingredient of the kitchens in Tunisia. Besides its culinary use, *A. roseum* is also used in

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