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Home-cooked garlic remains a healthy food

D.A. Locatelli [a,b], J.C. Altamirano [c,d], R.E. González [b,d], A.B. Camargo [a,b,d,*]

[a] Instituto de Biología Agrícola de Mendoza (IBAM), CONICET, Mendoza, Argentina
[b] Laboratorio de Cromatografía para Agroalimentos, Facultad de Ciencias Agrarias, Universidad Nacional de Cuyo, Alte. Brown 500, 5505, Chacras de Coria, Mendoza, Argentina
[c] Laboratorio de Química Ambiental, Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA), CONICET, Mendoza, Argentina
[d] Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Cuyo, Mendoza, Argentina

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ABSTRACT

Numerous studies have demonstrated that garlic has many biological properties due to its phytochemicals. These components include organosulphur compounds (OSCs) such as allicin, which is a chemically unstable metabolite. The aim of this study was to evaluate whether garlic could still be considered a healthy food after home cooking procedures. For that purpose, an experimental design with two factors and three levels was used. Pre-cooking and cooking procedures were the selected factors. Allicin, ajoenes, 2-vinyl-4H-1,3-dithiin (2-VD), diallyl sulphide (DAS), diallyl disulphide (DADS) and diallyl trisulphide (DATS) were the target analytes. Samples were analyzed by high performance liquid chromatography coupled to ultraviolet detector (HPLC-UV). The results showed that it was possible to find OSCs with important biological activities after all pre-cooking and cooking treatments. This is the first study to our knowledge to investigate cooked garlic using an analytical methodology, which avoid artifacts formation.

1. Introduction

Garlic (*Allium sativum* L.) has been used as an ingredient, spices and flavouring since ancient times. Several studies have shown that garlic has numerous biological properties, (Fujisawa, Suma, Origuchi, Seki, & Ariga, 2008; Iciek, Kwiecien, & Wlodek, 2009; Lee, Lee, Kim, Rhee, & Pyo, 2015; Santhosha, Jamuna, & Prabhavathi, 2013) due to the presence of phytochemicals, which make garlic a healthy food. These compounds include organosulphur compounds (OSCs) that are synthesized using sulphate absorbed by roots as a source of sulphur. From that, the first OSC is formed in the plant, until the garlic bulb is ready for consumption; the OSCs undergo biological transformations resulting in different products (Block, 2010). The first group of OSCs that is generated when garlic tissue is broken are the thiosulphinates, allicin being the most abundantly found in fresh garlic. These compounds are responsible of the characteristic garlic pungency. The most stable among the OSCs are the polysulphides, which are the last set of transformation compounds. Within the group of OSCs with important biological activities diallyl sulphide (DAS), diallyl disulphide (DADS), diallyl trisulphide (DATS), ajoenes and vinyldithiins may be mentioned (Table 1). These compounds can occur upon cooking processes, distillation, storage of garlic or in aged garlic extracts (Kamel & Saleh, 2000; Kim, Wu, Kobayashi, Kubota, &

* *Corresponding author*. Laboratorio de Cromatografía para Agroalimentos, Facultad de Ciencias Agrarias, Universidad Nacional de Cuyo. Alte. Brown 500, Chacras de Coria, Luján de Cuyo, Mendoza (5505), Argentina. Tel.: +54 261 4135010; fax: +54 261 4960469.
E-mail address: acamargo@fca.uncu.edu.ar (A.B. Camargo).

Chemical compounds: Allyl sulphide (PubChem CID: 11617); Diallyl disulphide (PubChem CID: 16590); Diallyl trisulphide (PubChem CID: 16315); Allicin (PubChem CID: 65036); E-Ajoene (PubChem CID: 5386591); Z-Ajoene (PubChem CID: 9881148); Vinildithiin (Pub Chem CID: 54113692).

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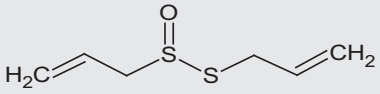
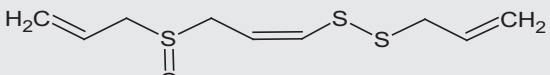
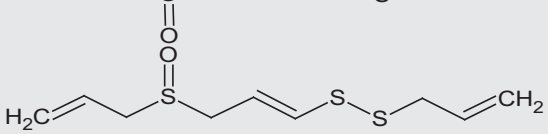
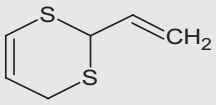
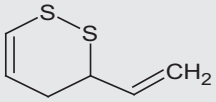
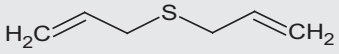
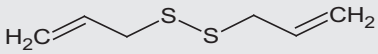
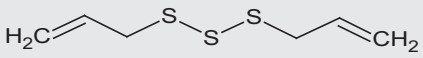
Table 1 – Target organosulphur compounds.

Compound	Chemical structure
Diallyl thiosulphinate (Allicin)	
Trans-ajoene (Z-ajoene)	
Cis-ajoene (E-ajoene)	
2-vinyl-4H-1,3-dithiin (2-VD)	
3-vinyl-4H-1,2-dithiin (3-VD)	
Diallyl sulphide (DAS)	
Diallyl disulphide (DADS)	
Diallyl trisulphide (DATS)	

Okumura, 1995; Weinberg, Manier, Richardson, & Haibach, 1993; Yu, Lin, & Ho, 1994; Yu, Wu, & Ho, 1993) leading to different OSCs profiles. Sensory as well as biological or functional characteristics have been determined for OSCs in each garlic preparations (Amagase, Petesch, Matsuura, Kasuga, & Itakura, 2001; Fujisawa et al., 2008; Liang et al., 2015). Moreover, it has been reported that cooking processes induce changes in the chemical composition, which influence the concentration and bioavailability of bioactive compounds in vegetables (Jiménez-Monreal, García-Diz, Martínez-Tomé, Mariscal, & Murcia, 2009). However, OSCs levels in garlic samples under different pre-cooking or cooking treatments have received little attention. There are few reports regarding the analysis of these compounds in cooked garlic samples (Cavagnaro, Camargo, Galmarini, & Simon, 2007; Kim, Wu, Kobayashi, et al., 1995; Kim, Wu, Kubota, & Kobayashil, 1995; Yu & Wu, 1994; Yu et al., 1993). Works reported have been based on the analysis of OSCs by GC-MS (Artacho Martin-Lagos, Olea Serrano, & Ruiz Lopez, 1995; Tocmo, Lin, & Huang, 2014; Yan, Wang, & Barlow, 1992, 1993), using Lickens–Nickerson distillation and solvent extraction techniques (Kim, Wu, Kobayashi, et al., 1995; Kim, Wu, Kubota, et al., 1995; Yu et al., 1993, 1994; Yu & Wu, 1994; Yu, Wu, & Chen, 1989; Yu, Wu, & Liou, 1989).

It is worth emphasizing that those sample preparation techniques, as well as the subsequent analysis by GC, are inadvisable (Block, Putman, & Zhao, 1992). Consequently, at present the data available about the OSCs profiles in cooked garlic samples are controversial. In a previous work we demonstrated that OSCs should be analyzed by using techniques to avoid artifacts formation along the analysis due to their thermolability (Locatelli, Altamirano, Luco, Norlin, & Camargo, 2014).

The aim of this work was to determinate the phytochemical profile of garlic after home-cooking and to evaluate whether cooked garlic could still be considered as a healthy food. An experimental design with two factors (pre-cooking and cooking treatments) and three levels each was used. The OSCs profile of all samples was determined by using an HPLC technique. This is the first time that the OSCs profiles in home-cooked garlic samples were studied taking into account an analytical methodology in order to avoid artifacts formation.

2. Materials and methods

2.1. *Plant materials*

Red garlic clone "Rubi" from the germplasm collection of Instituto Nacional de Tecnología Agropecuaria (INTA) La Consulta, Mendoza, was used in all the experiments. Garlic was grown at INTA's experimental field located in La Consulta, Mendoza, Argentina (33°44′ S, 69° 07′ W) in 2013. Bulbs were harvested when leaves were senesced and then were fully cured. During postharvest the bulbs were stored at ambient condition in sheds for 2 months.

2.2. *Experimental design*

Multifactorial experimental design combining two factors and three levels was used. The selected factors were: pre-cooking and cooking treatments. For the first factor, the levels were: whole (uncrushed) (WG), sliced (SG) and chopped garlic cloves (ChG). For the second the levels were the cooking treatments: simmering (HS), rolling boil (RB) and stir-frying (SF); using raw garlic (R) as control (Barham et al., 2010).