

**Control of *Shigella sonnei* and *Shigella flexneri* in hummus (Chickpea dip) using
citric acid and garlic extract**

**Amin N. Olaimat¹, Murad A. Al-Holy¹, Mahmoud H. Abu-Ghoush¹, Tareq M. Osaili², Anas
A. Al-Nabulsi²**

¹ Department of Clinical Nutrition, Faculty of Allied Health Sciences, Hashemite University, Zarq-13115- Jordan.

² Department of Nutrition and Food Technology, Jordan University of Science and Technology, P.O. Box 3030, Irbid – Jordan.

ABSTRACT

Studies on the prevalence and inhibition of *Shigella* spp. in food are scarce. This study investigated the growth pattern of *Sh. sonnei* and *Sh. flexneri* in hummus at different temperatures (4, 10, and 24°C). Additionally, the inhibitory activity of different concentrations of citric acid (CA) (0.5, 1.0, and 2.0%) and garlic extract (GE) (1.0, 2.0 and 3.0%) against *Sh. sonnei* and *Sh. flexneri* inoculated in hummus and stored at 4 and 10°C was investigated. Both *Sh. sonnei* and *Sh. flexneri* survived well at 4°C, where the numbers remained stable during the storage period of 10 d, while at 10°C, both *Sh. sonnei* and *Sh. flexneri* grew to > 7.0 log₁₀ CFU/g after 4 d of storage. Whereas at 24°C, *Sh. sonnei* and *Sh. flexneri* reached to >8.0 log₁₀ CFU/g and > 7.0 log₁₀ CFU/g, respectively. At 4°C, CA at 0.5 and 1.0% levels resulted in a slight reduction in the count (~ 1.0 log₁₀ CFU/g); however, a complete elimination of *Sh. sonnei* was attained by using 2.0% CA. In comparison at 10°C, about 3.0 log₁₀ CFU/g reduction in *Sh. sonnei* was obtained. For *Sh. flexneri*, CA at 0.5 and 1.0% concentrations resulted in a bacteriostatic effect and the extent of inhibition ranged from ca. 1.0 log₁₀ CFU/g to ca.

1.5 log₁₀ CFU/g reductions at 10 and 4°C, respectively. GE at 1.0 and 2.0% levels resulted in ca. 1.0-2.0 log₁₀ CFU/g reduction in *Sh. sonnei* count at 4°C, while at 3.0% GE, ca 4.0 and 3.0 log₁₀ CFU/g reductions were obtained at 4 and 10°C, respectively. In comparison, the 2.0% and 3.0% GE resulted in a bacteriostatic effect against *Sh. flexneri* at 4 and 10°C. Yet, at 1.0% GE, the number of *Sh. flexneri* increased slightly in hummus stored at 10°C. The combined effect of 1.0% CA and 2.0% GE did not result in an additional inhibitory effect against either *Sh. sonnei* or *Sh. flexneri* compared to the single treatment alone. This study indicates that *Sh. sonnei* and *Sh. flexneri* can survive at 4°C and can grow well in hummus at abused storage temperature (10°C). CA and GE posed a noticeable inhibitory activity against *Shigella* spp. and can be used as natural antimicrobial substances to preclude or restrict the growth of *Shigella* spp. in hummus.