Abd-Allah
The Journal of Basic and Applied Zoology (2022) 83:21
https://doi.org/10.1186/s41936-022-00285-8

The Journal of Basic and Applied Zoology

RESEARCH Open Access

Zamzam water may act as pesticide with and without globe artichoke extract against the cotton mealy bug, *Phenacoccus solenopsis*

Ghada E. Abd-Allah*

Abstract

Background: The holy water, Zamzam has many benefits to the human body. Therefore, the present study aims to clear new use of Zamzam water that it can be used as pesticide. In this study, Zamzam water was tested as pesticide alone and with globe artichoke extract and the globe artichoke extract also with tap water against the cotton mealybug, *Phenacoccus solenopsis*.

Results: The obtained results proved that, Zamzam water only has mortality rate approaches the mortality rate of the globe artichoke extract alone. Zamzam water achieved 60% mortality against the adult, *P. solenopsis*. While 20.000 ppm globe artichoke extract with tap water achieved 70% mortality. Zamzam water, also, improved the effect of globe artichoke extract when diluted with it and the mortality increased to be 86.67% at 15,000 ppm. Likewise, LC_{50} was 2055.4 ppm with globe artichoke extract with Zamzam water, while it was 13,494.8 ppm with globe artichoke extract without Zamzam water. However, LC_{90} was 35,791.5 ppm with globe artichoke extract with Zamzam water while it was 48,922.9 ppm with globe artichoke extract without Zamzam water. Also, the chemical analysis of Zamzam water proved the difference in its composition than tap water especially in cations and anions that causes properties like magnetism.

Conclusions: Based on the obtained results, the globe artichoke extract with Zamzam water was the most toxic in control of *P. solenopsis*. This may open great attention to the other uses of the holy water, Zamzam water in pests' management and encourage more researches about globe artichoke leaves extract and Zamzam water.

Keywords: *P. solenopsis*, Globe artichoke, Zamzam water, Plant extracts, Chemical analysis of water

Background

Water is a basic need for life and is essential for various physiological functions in human body (Cazier & Gekas, 2001). Although the sources of water are limited, and the existing sources are depleting rapidly, there is a source of water that is called Zamzam which is providing water to billions of people (Khalid et al., 2014; Naeem et al., 1983). Zamzam water is located in the Mecca area, which is a part of Saudi Arabia. Khalid et al., 2014 cleared in their review article that Zamzam water has a strong anti-inflammatory effect and can be used to recover from some diseases. Also, it has analytic action through an indirect effect on endocrine immunology and the growth system of the body (Ali et al., 2009). Artichoke, *Cynara cardunculus* L. is an ancient herbaceous plant, originating from the Mediterranean area and widely cultivated all over the world. Also, it represents a serious component of the Mediterranean diet and a rich source of bioactive phenolic compounds, minerals, fibres and

*Correspondence: g_nagah444@yahoo.com
Vegetable Pests Department, Plant Protection Research Institute, Agriculture Research Center, Dokki, Giza, Egypt

© The Author(s) 2022. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by/4.0/.

inulin (Lattanzio, 1982; Orlovskaya et al., 2007). Furthermore, the leaves, rich in phenolic compounds (Fratianni et al., 2007; Lattanzio et al., 1989, 1994) are used as herbal medicine since ancient times. Extracts from artichoke have been used for hepatoprotection as diuretic, choleretic, liver-protective, and lipid-lowering agents (Adzet et al., 1987; Gebhardt & Fausel, 1997; Preziosi, 1969). Artichoke leaf extract contains 0.3% flavonoids that expressed as luteolin-7-O-glucoside and 2.5% caffeoylquinic acid expressed as (Indena S.p.A. and chlorogenic acid) (Llorach et al., 2005).

The cotton mealybug, *Phenacoccus solenopsis* Tinsley (Homoptera: Pseudococcidae), has been caused severe damage to cotton in India and Pakistan (Hodgson et al., 2008), and also to many other crops, ornamentals, weeds and medicinal plants (Arif et al., 2009).

Because of problems caused due to huge use of chemical pesticides, many scientists have great attention to natural products to avoid these problems (Abou-Yousef et al., 2010). The aim of this study is to examine the efficiency of Zamzam water only, artichoke leaves extract with and without Zamzam water in managing *P. solenopsis.*

Methods

Cotton mealybug rearing

P. solenopsis was collected from infested okra plants (*Abelmoschus esculentus*), during fall season, at the field of Aga district, Dakhalia Governorate, Egypt and transferred to the laboratory. Sprouting potato tubers were used as a host plant for the rearing of mealybug and gravid females were inserted on it. Each sprouted potato was infested with an adult female and observed daily (Attia & Ebrahim, 2015). From these reared culture, the newly hatched crawlers were placed on each sprouted potato before being confined in a carton cylindrical box of 8 cm long and 12 cm diameter. Daily examination for morphological changes were recorded and monitored until adult emergence (Attia & Ebrahim, 2015).

Zamzam water

It had brought from Mekka and was used after about one year.

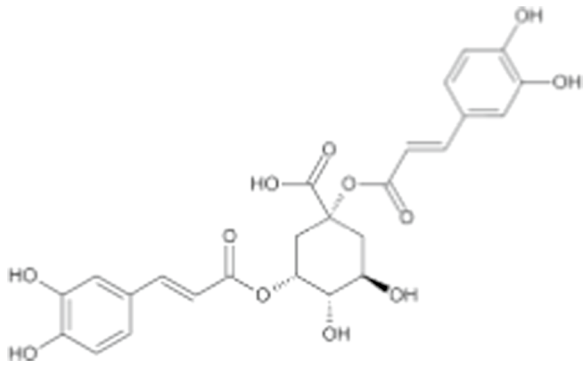
Preparation of plant sample and extraction

Leaves of globe artichoke plant were left to dry at room temperature for about one month then the dried leaves were grinded into fine powder. The powder was soaked in a mixture of methanol, acetone and hexane solvents of equal proportion (1:1:1) in a flask for about one week. After then, the flask was shaked in a shaker and the contents were filtered. Then, the solvents were evaporated under reduced pressure. Finally, the crude extract was weighted and then kept in the deep freezer until use.

Preparing the stock solution of the tested plant extract

Convenient stock concentrations of globe artichoke leaves extract, were prepared on basis of powder weight and volume of the tap water or Zamzam water (w/v) in the presence of tween 80 (0.1%) as emulsifier. The concentrations were kept inside glass stoppered bottles and stored under refrigeration. Four diluted concentrations for each artichoke plant extract were used to draw the LC-P Lines and three replicates were used for each concentration.

The leaves of globe artichoke contain cynarine ($C_{25}H_{24}O_{12}$) (Panizzi & Scarpati, 1954).



Cynarine formula **(Panizzi *et al.* 1954).**

Application method

For conducting the experiment, thirty newly emerged adults for each treatment, 10 individuals in each replicate, were placed on okra leaves in each Petri dish. Artichoke extract diluted with Zamzam water had four concentrations, 1000, 5000, 10,000 and 15,000 ppm. While artichoke extract diluted with tap water had concentrations, 5000, 10,000, 15,000 and 20,000 ppm. The concentrations were sprayed on the individuals comparing with control (tap water) and Zamzam water; that had three replicates for each. Mortality was recorded for 7 days after treatment and the mortality percentage was estimated and corrected according to (Abbott, 1925). LC_{50} values were determined using probit analysis statistical method of Finney (1971).

Sun equation, (1950) (to determine LC_{50} index)

$$\text{Toxicity index for } LC_{50} = \frac{LC_{50} \text{ of the most effective compound}}{LC_{50} \text{ of the least effective compound}} \times 100$$

Chemical analysis of Zamzam water and tap water

Chemical analysis of Zamzam water and tap water was conducted in Soil, Water & Environment Research Institute, Mansoura Branch. Analysis was corrected according to Ayers and Westcot (1985). Analysis of electric conductivity was determined using EC meter; while PH was determined by PH meter.

Results

Toxicity effect

Efficiency of globe artichoke extract with and without Zamzam water and Zamzam water alone against P. solenopsis

Results in Table 1 and Fig. 1 cleared that, Zamzam water only had high toxic effect on *P. solenopsis*. This effect was approaching the effect of the extract especially the artichoke without Zamzam water. The total mortality caused due to mealybug treatment by Zamzam water was 60% and this is the same proportion caused due to treatment with 5000 ppm of artichoke extract with Zamzam water and closed to the proportion caused due to treatment with 15,000 and 20,000 ppm artichoke extract without Zamzam water that represented 53.33% and 70% for the two concentrations, respectively. Mortality in control (tap water) was 0%.

Also, data in Table 1 represented that mortality after one day of *P. solenopsis* treated with Zamzam water only was 6.67% and this was the same proportion of *P. solenopsis* treated with globe artichoke without Zamzam water at 5000 ppm after one and three days, at 10,000 ppm after three and seven days and at 15,000 ppm after seven days of treatment. However, mortality after three day of *P. solenopsis* treated with Zamzam water only was 30% and this was the same proportion of *P. solenopsis* treated with globe artichoke with Zamzam water at 5000 ppm after five and seven days, at 10,000 ppm after one day, at

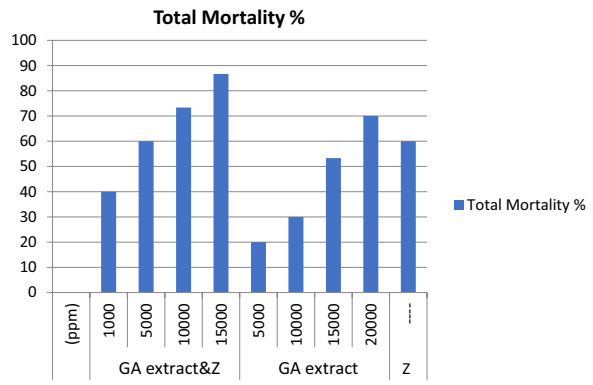


Fig. 1 Total mortality % of *P. solenopsis* treated with Zamzam water (*Z*), globe artichoke extract with (GA extract & *Z*) and without Zamzam water (GA extract)

15,000 ppm after seven days and after one day of globe artichoke extract without Zamzam water at 20,000 ppm. Likewise, mortality after five days was of *P. solenopsis* treated with Zamzam water only 13.33% and this was the same proportion of *P. solenopsis* treated with 10,000 ppm of globe artichoke extract with Zamzam water after five days and 10,000 ppm of globe artichoke extract without Zamzam water after one day.

As soon as after seven days of treatment with Zamzam water only, mortality was 10%. This proportion was the same proportion of *P. solenopsis* mortality after three days of treatment with 10,000 ppm of globe artichoke extract with Zamzam water; after five days of 15,000 ppm and after five and seven days of 20,000 ppm of globe artichoke extract without Zamzam water.

Moreover, Table 2 and Fig. 2 showed that, LC_{50} was 2055.4 ppm and LC_{90} was 35,791.5 ppm for the globe artichoke with Zamzam water. While, LC_{50} for the globe artichoke without Zamzam water was 13,494.8 ppm

Table 1 Corrected mortality % of *P. solenopsis* treated with Zamzam water, globe artichoke extract with and without Zamzam water under laboratory conditions

Treatments	Conc. (ppm)				Mortality after treatments %	Total mortality %
	One day	Three days	Five days	Seven days		
Globe artichoke with Zamzam water	1000	–	–	20	20	40
	5000	–	–	30	30	60
	10,000	30	10	13.33	20	73.33
	15,000	20	20	16.67	30	86.67
Globe artichoke without Zamzam water	5000	6.67	6.67	3.33	3.33	20
	10,000	13.33	6.67	3.33	6.67	30
	15,000	16.67	20	10	6.67	53.33
	20,000	30	20	10	10	70
Zamzam water	–	6.67	30	13.33	10	60

Table 2 Efficiency of globe artichoke extract with and without Zamzam water against *P. solenopsis*

Treatments	Conc. ppm	Corrected mortality %	LC_{50} ppm	LC_{90} ppm	Slope ± SD	Toxicity index LC_{50}	LC_{50}/LC_{90}
Globe artichoke with Zamzam water	1000	40	2055.4	35,791.5	1.03 ± 0.15	100	17.4
	5000	60					
	10,000	73.33					
	15,000	86.67					
Globe artichoke without Zamzam water	5000	20	13,494.8	48,922.9	2.29 ± 0.31	15.23	3.6
	10,000	30					
	15,000	53.33					
	20,000	70					

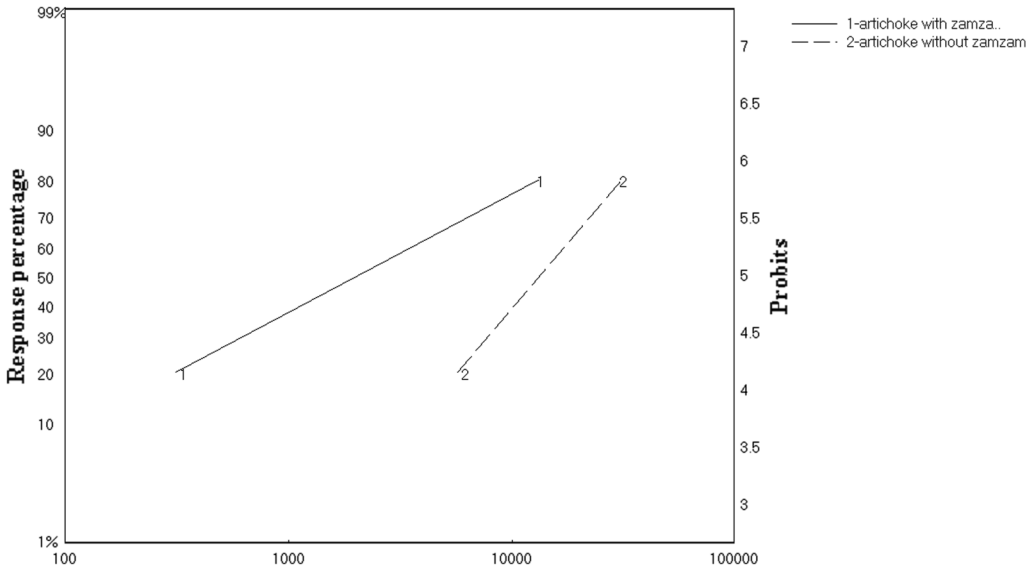


Fig. 2 LC-P line for artichoke extract with and without Zamzam water of *P. solenopsis*

and LC_{90} was 48,922.9 ppm. These results proved that, Zamzam water improve the efficiency of the globe artichoke extract.

Also, slope values indicated that, the globe artichoke extract without Zamzam water had a highest value 2.29 while the slop value of the globe artichoke with Zamzam water was: 1.03. Data also showed that the toxicity index (Ti = 100) 100% for the globe artichoke extract with Zamzam water, while it recorded 15.23% for the globe artichoke extract without Zamzam water.

In addition, The LC_{90}/LC_{50} confirm the value of this criterion recorded 17.4 and 3.6 for the globe artichoke extract with Zamzam water and the globe artichoke without Zamzam water, respectively.

Chemical analysis of water

Data in Table 3 demonstrated that, PH value for Zamzam water (*Z*) was higher than tap water (*T*) that was 7.40 and

Table 3 Chemical analysis of two used water samples (Zamzam and tap) water

Parameter	Zamzam water	Tap water
pH	7.40	7.10
EC (dSm^{-1})	1.05	0.8
Soluble cations (meq L^{-1})		
Ca^{2+}	3.24	2.81
Mg^{2+}	3.12	2.7
K^{+}	2.85	1.45
Na^{+}	1.34	1.04
Soluble anions (meq L^{-1})		
CO_3^{2-}	N.D	N.D
HCO_3^{-}	3.92	3.55
Cl^{-}	3.18	2.4
SO_4^{2-}	3.45	2.05
Water class	Normal	

7.10, respectively. The electrical conductivity (EC) of *Z* was higher than *T* and was 1.05 and 0.8, respectively. As result to higher electrical conductivety of *Z*, the soluble salts values in *Z* was higher than soluble salts values in *T*; Calcium, Magnesium, Potassium and Sodium values were 3.24, 3.12, 2.85 and 1.34, respectively for *Z* comparing with the same values for *T*, that were 2.81, 2.7, 1.45 and 1.04, respectively.Also, anion values for *Z* exeeds *T*; bicarbonate, chlorine and sulfate values were 3.92, 3.18 and 3.45, respectively for Z but 3.55, 2.4 and 2.05, respectively for *T*. There's no difference in Carbonate value *Z*&*T*.

Discussion

Zamzam water that used in management of *P. solenopsis* was stored for about one year and its properties didn't change. Basem (2011) proved that, the quality of the water did not change for 2 years and there was an excellent agreement among the results of the 30 water samples as well as between the results of the 2 years for the same samples analyzed in 2007 and 2008. Many researches made studies to compare between Zamzam water and magnetic water, so in the present study, the toxic effect of Zamzam water on the pest may be due to the magnetic effect of Zamzam water because Zamzam well lies besides magnetic rocks. Aseel et al. (2016) made a study on the comparative effect between Zamzam water and magnetic water on carcinoid and normal in vivo inside the mice body, the study confirmed that the best and safest therapies in the treatment of mammary gland could be achieved by using Zamzam water, beside that the magnetic water seemed to have a similar but lesser effect on cancer cells. The researchers confirmed that the treatment of water by magnetic zone causing changes in its specifications by making it more absorbing from the cells, after being noticed that water molecules were disassembly much more quick, due to that water consists from high number of cluster molecules (Davis, 2004). This molecule disassembly is accompanied by the hydrogen: oxygen connective. Disassembly causing changing in some water properties likes pH, Surface tention, viscosity and electrical conduction (Alkhazan and Amna, 2010). Also, it plays an important role in treatment of many diseases (Barnstable, 2014), as well as cancer cells because these cells do not live in alkaline environment (Mohammed et al., 2009); all these properties were applied on Zamzam water. Ivan (2011) studied the refraction index of tap water, magnetic water and Zamzam water and proved that Zamzam water had the highest refraction index as soon as more than magnetic water; and added that, the properties of magnetic water approached the properties of Zamzam water then concluded that, Zamzam water may be mainly magnetized due to the nature of strong rocks that surrounded it.

Also, Zamzam water improved the efficiency of globe artichoke extract and caused raise in mortality rate against *P. solenopsis* than globe artichoke extract alone. Hegazy and Fatma (2019) proved that the use of zamzam water and its various concentrations and magnetic water 50% + zamzam water 50% improve the degree of water up take, vase life of survival flowers, fresh weight and recommended the use of zamzam water and magnetic water and its various concentrations for the longevity of cut Rose flowers.

Amalia (2019) conducted the antimicrobial activity of Zamzam water against *Salmonella typhi* in vitro and proved that zamzam water had antimicrobial activity against *S. typhii*.

The chemical analysis of Zamzam water comparing with tap water proved that Zamzam water had quality features than tap water. Basem (2011) determined that Zamzam water is alkaline (average pH is 8) with an average Li concentration of 15 μg L (− 1), the alkalinity of Zamzam water and the presence of trace amounts of As and Li may cause the healing power.

Conclusions

Zamzam water improved the properties of globe artichoke extract and achieved higher mortality than globe artichoke extract alone; as soon as Zamzam water alone caused mortality to *P. solenopsis*. So, Zamzam water has a new use beside its medical use that it can be used as a pesticide or helps in improvement of efficiency of natural pesticides for management of the destructive pest, the cotton mealybug, *Phenacoccus solenopsis.*

Acknowledgements
Not applicable.

Authors' contributions
GE collected the data. GE analyzed the results. GE collected and reared the pest. GE prepared the extract. GE developed and implemented this research. GE wrote the manuscript. All authors read and approved the final manuscript.

Funding
There was no funding for this work.

Availability of data and materials
All data generated during this study are included in this published article.

Declarations

Ethics approval and consent to participate
The manuscript does not contain any studies involving human participants, human data or human tissue.

Consent for publication
Not applicable.

Competing interests
The author declares that there are no competing interests.

Received: 28 May 2021 Accepted: 20 March 2022
Published online: 01 April 2022

References

Abbott, W. S. (1925). A method of computing the effectiveness of an insecticide. *Journal of Economic Entomology, 18*, 265–267.
Abou-Yousef, H. M., Farghaly, F. S., & Torkey, H. M. (2010). Insecticidal activity of some plant extracts against some sap-sucking insects under laboratory conditions. *World Journal of Agricultural Sciences, 6*(4), 434–439.
Adzet, T., Camarasa, J., & Carlos, J. (1987). Hepatoprotective activity of polyphenolic compounds from *Cynara scolymus* against CCl4 toxicity in isolated rat hepatocytes. *Journal of Natural Products, 50*, 612–617.
Ali, S. M., Hussein, M., Hassan, A., El Husseiny, A., & Farid, L. (2009). Treatment of cervical insufficiency abortion by Zamzam water activated autologeous human peripheral blood mononuclear cell, modern trend. In *13th International Water Technology Conference on IWTC, Hurghada, Egypt* (pp. 1533–1541).
Alkhazan, M. M. K., & Amna, A. A. N. (2010). The effect of magnetic field on the physical, chemical and microbiological properties of the lake water in Saudi Arabia. *Journal of Evolutionary Biology Research, 2*(1), 7–14.
Amalia, T. U. (2019). Antimicrobial activity of Zamzam water against *Salmonella typhii* in vitro, microbiol. *Sociology, 1*(1), 66.
Arif, M. J., Rafiq, M., & Ghaffar, A. (2009). Host plants of cotton mealybug (*Phenacoccus solenopsis*): A new menace to cotton agroecosystem of Punjab. *International Journal of Agriculture and Biology, 11*, 163–167.
Attia, A. R., & Ebrahim, A. M. (2015). Biological studies on the predator Dicrodiplosis manihoti Harris (Diptera, Cecidomyiidae) on the mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera, Pseudococcidae). *Egyptian Journal of Biological Pest Control, 25*(3), 565–568.
Ayers, R. S., & Westcot, D. W. (1985). *Water quality for agriculture*. FAO Irrigation and Drainage Paper 29. Rev. 1. Rome: FAO United Nations.
Barnstable, C. D. (2014). *County department of health and environment, data and statistics*. Barnstable Country Septic Database. HYPERLINK https://septic.barnstabecountryHealth.org/posts%20/, https://septic.BarnstabecountryHealth.org/posts/data-andstatistics
Basem, S. (2011). Zamzam water: Concentration of trace elements and other characteristics. *Chemosphere, 86*(6), 600–605.
Cazier, J. B., & Gekas, V. (2001). Water activity and its prediction: A review. *International Journal of Food Properties, 4*, 35–43.
Davis, L. M. (2004). Structural is changing models large water-molecule claster may be cracial to cellular processes. *The Scientist LLC, 18*(21), 14–20.
Finney, D. J. (1971). *Probit analysis* (p. 333). Cambridge University Press.
Fratianni, F., Tucci, M., De Palma, M., Pepe, R., & Nazzaro, F. (2007). Polyphenolic composition in different parts of some cultivars of globe artichoke (*Cynara cardunculus* L. var. scolymus (L.) Fiori). *Food Chemistry, 104*, 1282–1286.
Gebhardt, R., & Fausel, M. (1997). Antioxidant and hepatoprotective effects of artichoke extracts and constituents in cultured rat hepatocytes. *Toxicology in Vitro, 11*, 669–672.
Hegazy, A. A., & Fatma, R. (2019). Impact of different water types on some post-harvest characteristics of Rosa Spp. Cv. Top Secret Flowers Ibrahim. *Journal of Plant Production, 10*(7), 489–49.
Hodgson, C., Abbas, G., Arif, M. J., Saeed, S., & Karar, H. (2008). *Phenacoccus solenopsis* Tinsley (Sternorrhyncha: Coccoidea: Pseudococcidae), an invasive mealybug damaging cotton in Pakistan and India, with a discussion on seasonal morphological variation. *Zootaxa, 1913*, 1–35.
Ivan, K. (2011). Optical properties: A comparative study of Zamzam water, magnetized water, normal water and distilled water. *Journal of Science Education, 24*(2), 148–158.
Khalid, N., Ahmad, A., Khalid, S., Ahmed, A., & Irfan, M. (2014). Mineral composition and health functionality of Zamzam water: A review. *International Journal of Food Properties, 17*(3), 661–677.
Lattanzio, V. (1982). Composizione, valore nutritivo e terapeutico del carciofo. *Informatore Agrario, XXXVIII, 1*, 18727–18731.
Lattanzio, V., Cardinali, A., Venere, D., Linsalata, V., & Palmieri, S. (1994). Browning phenomena in stored artichoke (*Cynara scolymus* L.) heads: Enzymic or chemical reactions? *Food Chemistry, 50*, 1–7.
Lattanzio, V., Linsalata, V., Palmieri, S., & Van Sumere, C. F. (1989). The beneficial effect of citric and ascorbic acid on the phenolic browning reaction in stored artichoke (*Cynara scolymus* L.) heads. *Food Chemistry, 33*, 93–106.
Llorach, R., Tomás-Barberán, F. A., & Ferreres, F. (2005). Functionalisation of commercial chicken soup with enriched polyphenol extract from vegetable by products. *European Food Research and Technology, 220*, 31–36.
Mohammed, A., Cosemi, E., & Kamel, S. (2009). Oncolytic action of Zamzam water on azoxyonethone (AOM) induced colon tumor in rats. In *Thirteenth international water technology conference on IWTC, Hurghada, Egypt* (pp. 1550–1557).
Naeem, N., Alsanussi, H., & Almohandis, A. (1983). Multielemental and hydrochemical study of holy Zamzam water. *J New England Water Works Association, 97*(2), 159–169.
Orlovskaya, T. V., Luneva, I. L., & Chelombit'ko, V. A. (2007). Chemical composition of *Cynara scolymus* leaves. *Chemistry of Natural Compounds, 43*, 239–240.
Panizzi, L., & Scarpati, M. (1954). Constitution of cynarine, the active principle of the artichoke. *Nature, 174*(4440), 1062–1065.
Preziosi, P. (1969). Valutazione farmacologica dei principi attivi del carciofo. In *Atti del I Congresso Internazionale di Studi sul Carciofo* (pp. 237–281).
Sun, Y. P. (1950). Toxicity index an improved method of comparing the relative toxicity of insecticides. *Journal of Economic Entomology, 43*, 45–53.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Submit your manuscript to a SpringerOpen journal and benefit from:

- ► Convenient online submission
- ► Rigorous peer review
- ► Open access: articles freely available online
- ► High visibility within the field
- ► Retaining the copyright to your article

Submit your next manuscript at ► springeropen.com