FACULTY OF FOOD SCIENCE AND NUTRITION

Impact of Bird Cherry (*Prunus padus*) extracts on the fatty acid peroxidation in a model O/W linoleic acid emulsion

G. Neunert, P. Siejak*, W. Kamińska, K. Polewski

Department of Physics and Biophysics, Poznań University of Life Sciences, Wojska Polskiego 38/42, 60-637 Poznań, Poland
* e-mail: przemyslaw.siejak@up.poznan.pl

INTRODUCTION

The susceptibility of acids to oxidation in emulsion systems is one of the factors limiting their long shelf life and storage time. The other main factor is the time degradation of emulsion systems present in foods. Those parameters could be improved using selected additives, including antioxidants, such as tocopherol (Toc) or gallic acid (GA). Bird cherry (*Prunus padus*) extracts are rich in phenolic compounds and flavonoids [1], known for their strong antioxidant properties. So, aqueous solutions of those extracts are good candidates for the natural additives improving the oxidative stability of lipids in micellar and emulsion systems.

The aim of this study was to evaluate whether bird cherry extracts either alone or in combination with GA are able to improve the oxidative stability of linoleic acid in a model oil-in-water (O/W) emulsion system. The effect of these extracts on the physicochemical properties of the produced emulsion and their influence on time degradation of the emulsions was also examined.

Materials and Methods

The detailed procedure of preparation of the extracts (ethanolic, acetone, water, methanolic) was thoroughly described in our previous article [1]. The O/W linoleic acid emulsions were formulated at room temperature using a two-step homogenization process, described on details in [2]. The properties of the prepared emulsions with added extracts were characterized by dynamic light scattering (DLS) measurements, which determined the droplet size distribution, mean droplet diameter (Z-ave), polydispersity index (PDI), and zeta potential (ZP). The progression of thermal oxidation in the emulsion was measured with C11-BODIPY581/591 probe used as a fluorescent indicator (λ_{obs}= 520 nm, λ_{exc}= 505 nm). The measurements of Z-ave, ZP, PDI, and oxidative stability of each sample were carried out directly after preparation, and after 7 and 14 days.

RESULTS

	Mean Droplet Size by Intensity Z-Ave (nm)		Dominant Droplet Diameter by Number (nm)		PDI		ZP (mV)	
	Without Gallic Acid	With Gallic Acid	Without Gallic Acid	With Gallic Acid	Without Gallic Acid	With Gallic Acid	Without Gallic Acid	With Gallic Acid
Reference sample	511.0 ± 13.1 ^{b}	496.5 ± 21.4 ^{b,c}	260.6 ± 74.7 ^{a}	268.4 ± 27.4 ^{a}	0.414 ± 0.072 ^{a}	0.406 ± 0.028 ^{a}	−26.5 ± 3.1 ^{e,f}	−22.3 ± 1.8 ^{f}
Tocopherol	587.5 ± 38.2 ^{a}	587.8 ± 41.5 ^{a}	280.9 ± 44.1 ^{a}	294.8 ± 120.1 ^{a}	0.379 ± 0.048 ^{a,b}	0.385 ± 0.055 ^{a,b}	−28.8 ± 1.9 ^{c,d,e}	−28.4 ± 3.6 ^{d,e}
Ethanolic	433.2 ± 28.2 ^{e}	441.5 ± 40.2 ^{d,e}	208.4 ± 83.9 ^{a}	225.1 ± 27.9 ^{a}	0.343 ± 0.035 ^{a,b,c}	0.397 ± 0.055 ^{a,b}	−32.1 ± 4.0 ^{b,c,d}	−33.5 ± 3.9 ^{b,c}
Acetone	302.2 ± 5.2 ^{f,g}	269.0 ± 6.4 ^{g}	187.1 ± 27.4 ^{a}	203.2 ± 43.2 ^{a}	0.308 ± 0.012 ^{b,c}	0.255 ± 0.027 ^{c}	−41.1 ± 5.8 ^{a}	−40.5 ± 5.0 ^{a}
Water	494.8 ± 17.6 ^{b,c,d}	442.3 ± 26.4 ^{c,d,e}	230.8 ± 70.8 ^{a}	181.9 ± 55.9 ^{a}	0.376 ± 0.035 ^{a,b}	0.364 ± 0.052 ^{a,b}	−32.8 ± 4.0 ^{b,c,d}	−28.7 ± 5.4 ^{c,d,e}
Methanolic	357.0 ± 14.3 ^{f}	330.3 ± 12.5 ^{f}	214.9 ± 44.4 ^{a}	216.1 ± 30.3 ^{a}	0.342 ± 0.020 ^{a,b,c}	0.339 ± 0.013 ^{a,b,c}	−36.3 ± 4.0 ^{a,b}	−34.2 ± 3.5 ^{b}

Table 1. DLS results of freshly prepared linoleic emulsions with the addition of different bird cherry extracts (PDI, polydispersity index; ZP, zeta potential). The superscript letters indicate significant differences at the 0.05 level. Values in columns that do not share the same letter are significantly different.

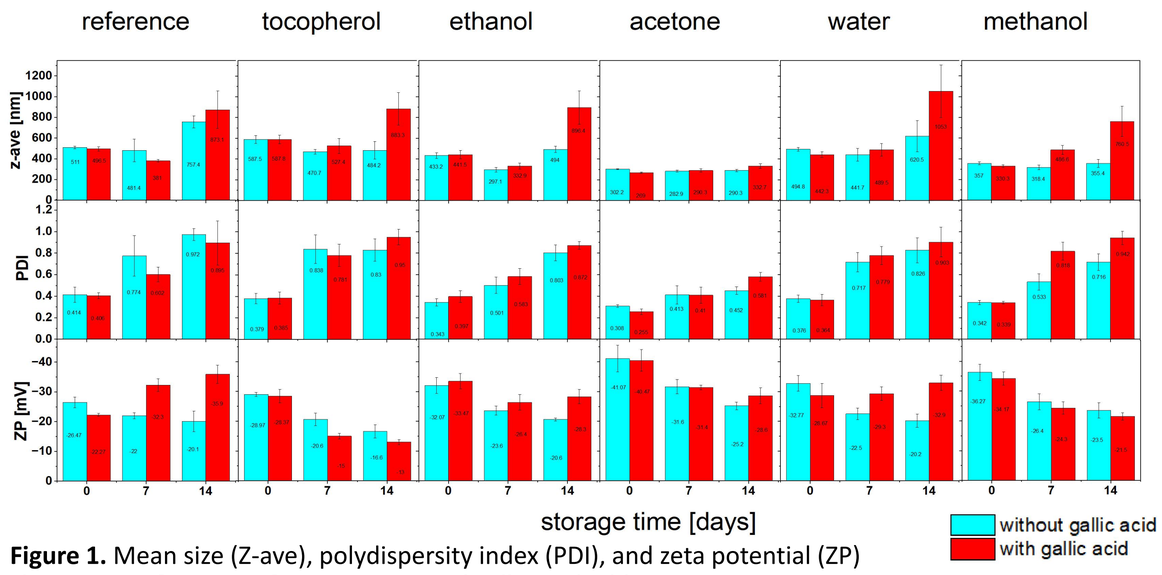

Figure 1. Mean size (Z-ave), polydispersity index (PDI), and zeta potential (ZP) changes as a function of storage time and gallic acid addition.

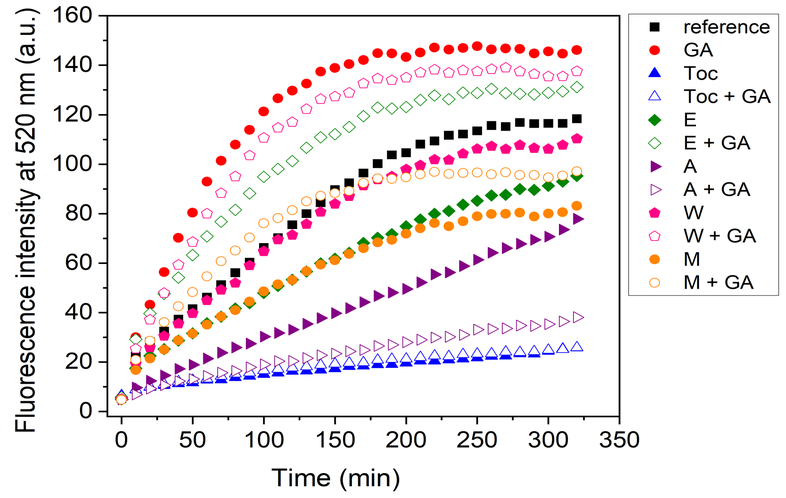

Figure 2. C11-BODIPY581/591 fluorescence intensity changes as a function of time. Legend: reference, non-doped emulsion; GA, gallic acid; Toc, tocopherol; E, ethanolic extract; A, acetone extract; W, water extract; M, methanolic extract.

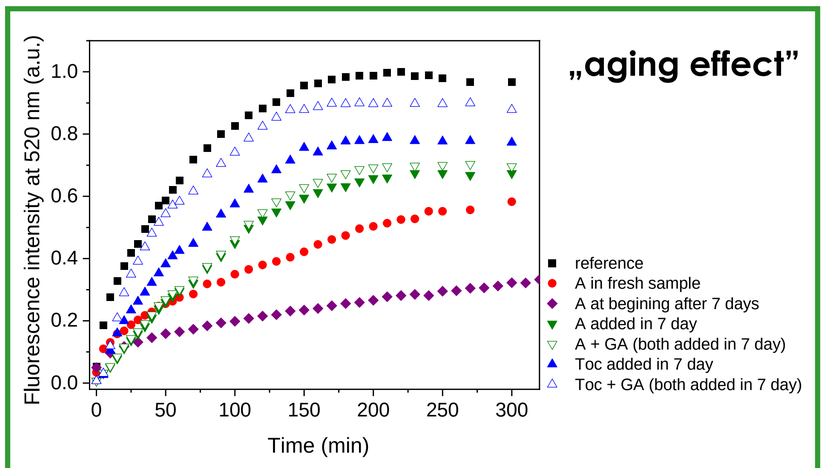

Figure 4. C11-BODIPY581/591 fluorescence intensity changes as a function of time for the emulsion with or without gallic acid (GA) and: acetone extract (A) or tocopherol (Toc), added to fresh emulsion and added after 7 days after preparation of emulsion.

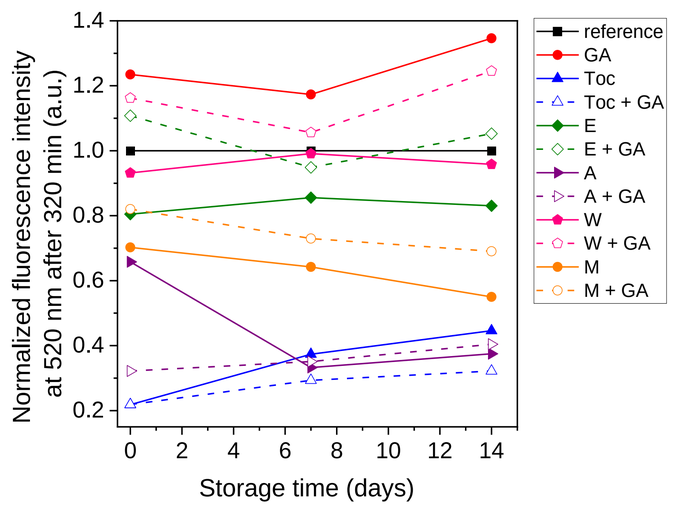

Figure 3. C11-BODIPY581/591 fluorescence intensity after 320 min of oxidation as a function of storage time. Legend: reference, non-doped emulsion; GA, gallic acid; Toc, tocopherol; E, ethanolic extract; A, acetone extract; W, water extract; M, methanolic extract.

CONCLUSIONS

- Antioxidative efficacy of extracts were differed significantly, depending on extraction method and conditions. These differences may arise from different specific composition of extracts used, more or less rich in antioxidants or its synergistic effect.
- Acetone extract was the most effective in both, oxidation stability and time degradation tests of linoleic acid emulsions.
- The addition of gallic acid did not always have a positive effect on the oxidation stability and time degradation of the emulsions.
- The oxidation tests indicated that other mechanisms may be responsible for the oxidation of the freshly prepared emulsion and its oxidation during storage.
- The results showed that the emulsion aging process might enhance the protective properties of certain antioxidant compounds that come from the extracts.

[1] Siejak, P.; Smułek, W.; Karnowska, J.N.; Dembska, A.; Neunert, G.; Polewski, K. Bird Cherry (*Prunus padus*) Fruit Extracts Inhibit Lipid Peroxidation in PC Liposomes: Spectroscopic, HPLC, and GC–MS Studies. Appl. Sci. 2022, 12, 7820, DOI: doi.org/10.3390/app12157820.
[2] Siejak, P.; Neunert, G.; Smułek, W.; Polewski, K. Impact of Bird Cherry (*Prunus padus*) Extracts on the Oxidative Stability of a Model O/W Linoleic Acid Emulsion. Appl. Sci. 2023, 13, 9560. DOI: https://doi.org/ 10.3390/app13179560