

Summary of the SCIENTIFIC REPORT
Period of implementation: January 1 – December 31, 2014

All objectives were achieved and all planned results were obtained during the 2014 stage. Scientific results show that fruit processing in jams by traditional method lead to significant changes in overall levels of antioxidant compounds, particularly anthocyanins compared to that of phenolics. Instead, the antioxidant compounds degradation during storage of jams at 18°C for 5 months occurs at very slow rates. However, fruit jams from various sources still contain important amounts of bioactive compounds, optimization of the process for less content losses being required. Scientific results obtained through addition of anthocyanin crude extracts in (poly)unsaturated lipids in reverse micellar systems, highlights the potential of these bioactive compounds to act as inhibitors of lipid peroxidation with possible applications in the food industry.

The visibility of the scientific production of the project team is guaranteed by the publication of 3 articles in international journals, acceptance for publication of 1 article in ISI journal, 2 articles published in journals indexed BDI, 1 book published in Lambert Academic Publishing and 5 papers presented/published at international conferences in 2014. Also, 2 articles have been evaluated for publication in ISI journal. 2 undergraduate theses were developed in the field. International visibility is proved by getting 3 citations in 2014 of articles already published in the project (according to ISI Web of Science). Project web page has been updated.

Assessment of the level of anthocyanins after food processing of anthocyanin-rich fruits. Analytical data evaluation and interpretation of results

Given the fact that fruits rich in antioxidant compounds are seasonal with limited availability throughout the year, we studied the influence not only of the preservation methods (freezing, drying) previously investigated but also the form of food processing. Thus, we studied the effect of fruits processing – jams, on the content of bioactive compounds (anthocyanins and phenolics) compared to fresh fruits. To this end, different phases of experimentation were involved, such as the extraction of anthocyanins and polyphenols using optimized extractive technologies described during previous phases of the project (2012, 2013), centrifugation and determination of the total content using standard spectrophotometric pH differential method. Polyphenols were analyzed quantitatively using the Folin-Ciocalteu method.

In the next phase, it was experimented and established a method of producing fruit jams with low added sugar (<40%) and no added additives, colorants or pectin.

The obtained results showed a decrease of more than 60% of the total content of phenolics, particularly for red raspberry samples. Instead, the study on the evolution of phenolics level of jams at 18°C showed that there was a significant decrease during 5 months of storage except cherry jam which registered a final decrease of 21% of total phenolics.

Regarding the content of anthocyanins, it was found a drastic decrease through in jams: more than 80% in blackberry and wild cherry jams, over 60% in red raspberry and cherry jams, compared with the anthocyanins content in fresh fruits. This is due to low stability of these molecules under the influence of different environmental factors.

The study on evolution of anthocyanins level during storage of jams at 18°C, showed a decrease of 36-62% over 5 months in all samples, depending on the fruit. The lowest value was recorded for wild cherry jam, and the highest value for red raspberry jam.

We conducted studies on the degradation of anthocyanins, considering that this process is a reaction following first order kinetics. We calculated the rate constant (k) and half-life ($t_{1/2}$) from the following equations:

$$\ln \frac{[TA]}{[TA_0]} = -kt \qquad t_{1/2} = -\frac{\ln 0.5}{k}$$

The highest stability was registered for wild cherry jam, followed by cherry, blackberry and red raspberry jams.

Experiments on the addition of crude anthocyanins extracts in edible oils. Testing the potential of bioextracts to inhibit lipid peroxidation of edible/dietary oils

Following the trend of replacing synthetic antioxidants from the additives market, we investigated the antioxidant potential of anthocyanin extracts for oxidative stabilization of edible or dietary oils. Such systems have been tested and evaluated in reverse micelles systems obtained by the addition of the anthocyanin extract to polyunsaturated lipids systems by extending the previously developed model for obtaining micellar systems.

The bilberry bioextract was tested for the *in vitro* antioxidant activity in rapeseed oil consisting of 62% monounsaturated fatty acids and 30% polyunsaturated fatty acids. The hydroethanolic extract was characterized by a total anthocyanins content of 111.14% and a total phenolics content 195.76%.

The oxidative stability was monitored by incubating the samples at 40°C for 14 days. After determination of two characteristic parameters (peroxide and TBARS values) very good results were obtained compared to the control sample and to the sample treated with a reference antioxidant, α -tocopherol.

The peroxidation process was shown to evolve much more slowly in the sample treated with anthocyanins extract (Figure 1). Statistical studies have shown a positive correlation of the peroxide value (PV) with the time of storage, the correlation coefficient being 0.98343. Instead, α -tocopherol proved a pro-oxidant effect after 3 days of storage.

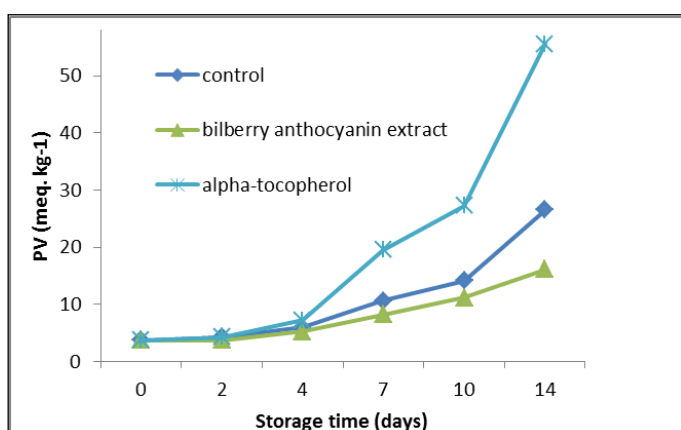


Fig. 1. The oxidative stability of rapeseed oil with added anthocyanins extract and α -tocopherol, monitored by peroxid value.

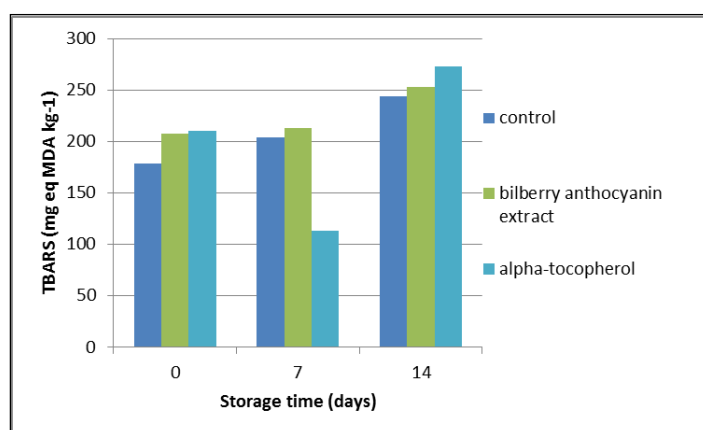


Fig. 2. The oxidative stability of rapeseed oil with added anthocyanins extract and α -tocopherol, monitored by TBARS.

Research on evolution of oxidation byproducts during storage of samples at 40°C for 14 days showed similar trend for the control sample and for the sample with added anthocyanin extract (Figure 2).

The results achieved by addition of crude anthocyanin extracts to polyunsaturated lipids in reverse micelles systems, highlights the potential of these bioactive compounds to act as inhibitors of lipid peroxidation leading to possible applications in the food industry.

Throughout the implementation of the project, acquisition of materials, chemical reagents and instruments necessary to conduct the planned research activities was also conducted.

Dissemination and evaluation of research results by publication of articles, participation at scientific conferences

Scientific information collected during this period have been disseminated within the published scientific articles, scientific papers developed and/or presented at international scientific conferences/workshops, thus reaching the specific objectives of facilitating transnational collaboration, the increase of international visibility through which the project may become an important element in the system of organic farming - food - food supplements - health.

Published/in press/under evaluation scientific papers:

- 3 articles *published* in ISI quoted journals with total impact factor = 1.691 and relative influence score = 1.199
- 1 article *accepted* in ISI quoted journal
- 2 articles *under evaluation* in ISI quoted journals
- 2 articles *published* in journals indexed in BDI
- 1 book *published* in LAP Lambert Academic Publishing
- 5 scientific papers *published and presented* at international conferences/congresses.

Training young researchers:

- 2 undergraduate theses were developed in the field
- Oral presentation of scientific papers by students at Student's Scientific Symposia ("Advanced polymeric materials obtained by the use of natural extracts", Textile Technology section, ULBS)

3 ISI citations according to Web of Science of the published articles: articles of the following ISI journals cited our articles:

- *Food chemistry* (Elsevier)
<http://www.sciencedirect.com/science/article/pii/S0308814614000806>
- *Industrial Crops & Products* (Elsevier)
<http://www.sciencedirect.com/science/article/pii/S0926669013007383>
- *Molecular Breeding* (Springer) <http://link.springer.com/article/10.1007%2Fs11032-014-0018-2>

All these activities prove the project contributions to the development of human resources for research. Such activities led to increased collaboration and encouraged interdisciplinary needed to ensure the project sustainability.

In the coming period, in order to complete all the project objectives, activities regarding applications of natural extracts in textile dyings will be planned by testing the optimal conditions for dyeing of cellulosic materials with natural extracts rich in anthocyanins. These results will lead to opportunities for innovative products and processes, in the framework of the new environmental requirements including eco-compatibility of textile wastewater as an alternative to the use of synthetic dyes.

Project director,
Professor OANCEA Simona, PhD