Borage: A neglected and underutilized plant with health benefices

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INTRODUCTION:

Healthy eating is one of the most pursued objectives in today's society. The increased demand for food with beneficial properties against diseases has made herbal products a principal target for industry requirements. However, reports that show protective effects in some plant species are often conflicting or present variable results.

Borage (*Borago officinalis* L.) is an annual herb, native to the Mediterranean region that has been used since ancient times for culinary and medicinal purposes. Nowadays, interest in borage has been renewed due to the *gamma linolenic acid* contained in its seeds. The leaves and seed oil of borage contain small amounts of pyrrolizidine alkaloids that could impair the benefits of these products.

MATERIALS AND METHODS:

Plant and oil material:

Two *Borago officinalis* L. varieties were selected for this work: blue-flowered (*BF*, wild type) and white-flowered (*WF*, cultivated type). Leaves from both varieties were lyophilized for treatments. Also, we selected two borage oils: Commercial crude borage seed oil (purchase) and refined borage seed oil (obtained by supercritical fluid extraction).

Drosophila Assay:

For simple treatments, larvae from hybrid eggs were fed with *BF* and *WF* samples, as well as borage oils. For combined treatments, the same samples were assayed but mixed with hydrogen peroxide (H₂O₂) a potent genotoxicant. Emerged flies were counted for toxicity evaluation and wing hair mutations (spots) scored.

HL-60 Assay:

Cells were exposed to *BF* and *WF* samples, as well as borage oils. Cell viability was determined by the Trypan Blue Dye Exclusion Test and cytotoxic activity was measured as growing inhibition by treatments.

RESULTS AND DISCUSSION:

Drosophila Assay:

Our results for genotoxicity showed that no assayed concentration of *B. officinalis* plant samples were significantly different from the negative control (H₂O), but contrarily, some of the treatments showed lower mutation rates than the negative control.

For these reasons, *B. officinalis* plant did not exert any DNA damage on the eukaryotic system of *D. melanogaster*.

In the antigenotoxicity evaluation, the inhibition percentage (numbers in brackets) ranged between 38.46% and 73.85% in tested samples and the highest detoxification potential appeared in the highest *B. officinalis* BF assayed concentration (i.e.: 5 mg·mL⁻¹).

Summarizing, this *in vivo* assay showed the safe use for human consumption and their antigenotoxicity potency of *B. officinalis* leaves, supporting their protective DNA damage activity and consequently, their health benefits.

*Significant difference respect to positive control (H₂O₂)

HL-60 Assay:

All *B. officinalis* assayed concentrations of both varieties inhibited HL-60 cell growth. Moreover, a dose-response curve was observed for *B. officinalis* BF and WF plant material which exhibited IC₅₀ values of 0.49 and 0.28 mg·mL⁻¹ respectively.

It is remarkable that no viable cells were founded in samples when applied *B. officinalis* concentrations around 2 mg·mL⁻¹.

These results in the *in vitro* assays highlight *B. officinalis* fresh plant use as a nutraceutical with an outstanding anticarcinogenic activity.

Drosophila Assay:

Our results for genotoxicity showed that none of the studied borage commercial oil concentrations was genotoxic in the S.M.A.R.T. wing spot assay, with no significant differences from the negative water control.

The results of antigenotoxicity assays indicated that borage commercial seed oil was able to desmutagenise the genotoxic activity of hydrogen peroxide (selected mutagen for experiments).

All assayed borage commercial seed oil concentration reached to reduce mutations produced by the hydrogen with an inhibitory potential against it between the 19 and 41%.

Our antigenotoxicity assays demonstrated that borage commercial seed oil exerts a role in the genomic stability of *D. melanogaster*, acting as a desmutagenic agent by scavenging the reactive oxygen species originated by the model genotoxicant used.

HL-60 Assay:

Both commercial crude and refined borage oils showed tumoricide activity against HL-60 promyelocytic cells, but the IC₅₀ is reached at lower concentration for commercial crude borage oil (3.8 µl/ml) than for refined borage oil (4.8 µl/ml).

As observed for *B. officinalis* leaves, there is a concentration limit in the application of Borage oils that avoid HL-60 cell growth (between 8 and 16 µl/ml for commercial crude and refined oil respectively).

In this sense, commercial crude oil seems to be more effective against tumor growth.

GENOTOXICITY:
in vivo
Drosophila assay

CITOTOXICITY:
in vitro
HL-60 cell assay

CONCLUSION:

The lack of toxicity and the tumoricide activity of leaves and seed oil from borage highlight the benefits of consumption of this plant.