

**Short Communication****Borage Consumption as a Possible Gastric Cancer Protective Factor<sup>1</sup>**

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In a recent paper we reported the main results of a case-control study of gastric cancer and dietary factors, carried out in four regions of Spain (1). The overall results supported the hypothesis of increased risk from salted and preserved foods and protection from vegetables and fruits. One of the most striking results for individual foods was a 3-fold reduction in risk observed for consumers compared to nonconsumers of borage (OR = 0.35; 95% CI = 0.18–0.71).<sup>3</sup>

Although we had no specific hypothesis about the possible effect of borage, it was included in the dietary questionnaire because it is highly consumed in one of the study areas (Zaragoza), where the leaves and stem are eaten cooked, usually boiled in water. After further analysis by regions, we found that in the province of Zaragoza 92% of controls ate borage at least 0.5 times a week during the previous year. The risk associated with the consumption of borage (consumers *versus* nonconsumers), adjusted for the total caloric intake and the consumption of fruits and other vegetables, was OR = 0.18 (95% CI, 0.06–0.52). Considering the level of consumption in four categories (nonconsumers as the referent category and three categories among consumers), the ORs (and 95% CI) were 0.31 (0.08–1.18) for the low level of consumption, 0.15 (0.03–0.72) for moderate consumers, and 0.09 (0.02–0.46) for high consumers, showing a clear dose-response relationship (*P* for trend, 0.0006). These results are based on 88 case-control pairs of residents of the province of Zaragoza. The consumption of borage was extremely low in two areas of the study (Barcelona and Galicia). In the province of Soria (72 case-control pairs) 22% of controls were consumers (at least 0.5 times a week); the risk for consumers, ad-

justed for calories and fruits and vegetables was 0.55 (95% CI = 0.23–1.31). The ORs and CIs were estimated by means of the conditional logistic regression.

Borage (*Borage officinalis*) is native to Europe and North Africa and is grown in North America. Alkaloids and potassium are natural components of the flowers, leaves, and stem. It has been used as a demulcent, astringent, diuretic, and emollient (2). BO, produced from the seed, is known to be an important source of GLA (3). Since we were unable to find published data on the fatty acid composition of the leaves of the plant, a fatty acid composition analysis was carried out. Samples of raw and cooked (boiled for 20 min) leaves and stems of borage were prepared, and methylated fatty acids were extracted for gas chromatography. Peaks and nominal retention index were integrated and compared to commercial BO, which was used as an external standard. The chromatographic analysis of the components of the leaves and stems of borage shows a fatty acid composition similar to that of the seed oil, even in the boiled plant products. The GLA content, expressed as mg/100 mg of total fatty acids, was 4.4% and 14.6% for boiled leaves and stems, respectively, and 25.3% for seed oil.

Essential fatty acids are of major importance in the cell membrane structure and membrane properties (e.g., permeability to enzymes and receptors). They also have a role as prostaglandin precursors. GLA (18:3 n-6) is found naturally and uniquely in BO and evening primrose oil. It can be converted to dihomo- $\gamma$ -linolenic acid (20:3 n-6), which is considered an important precursor of prostaglandins of the E<sub>1</sub> series (3). Dihomo- $\gamma$ -linolenic acid can also compete with arachidonic acid for oxidative enzymes, reducing the production of prostaglandins of the E<sub>2</sub> series (3, 4). The possible effect of GLA, BO, and evening primrose oil on prostaglandin production and cancer has been studied experimentally. In spite of some inconsistency in the results it has been suggested that GLA and prostaglandins may have a role in cancer development (4). The incidence of induced mammary tumors in rats fed a diet high in evening primrose oil was about 50% lower than in rats fed a diet high in corn oil (5). Another study of induced mammary tumors in rats showed that diet containing GLA significantly increased the synthesis of E<sub>1</sub> prostaglandins, but only inhibited mammary tumorigenesis if the diet also contained  $\alpha$ -linolenic acid (6). E<sub>1</sub> prostaglandins increased the stomach mucosal mass in dogs (7).

The analysis of fatty acids from the leaves and stems of borage have shown an important amount of GLA, even after cooking. There are approximately 60 mg of GLA in each 100 g of boiled borage. This finding may explain the possible protective effect against gastric cancer. However, our study does not eliminate alternative interpretations of our results: consumption of borage may

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<sup>3</sup> The abbreviations used are: OR, odds ratio; CI, confidence interval; GLA,  $\gamma$ -linolenic acid; BO, borage oil.

be a strong indicator of a diet rich in vegetables and fruits, or other components of borage may be responsible for its anticarcinogenic properties. It is also possible that the finding with regard to borage may be due to chance. Chemoprevention of cancer is considered a novel and promising approach, and dietary constituents appear to be the main candidates for clinical prevention trials (8). Our results should encourage new and more extended investigations.

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