



Stability of tocopherols and tocotrienols during high-moisture extrusion of plant-based protein ingredients

Anna-Maija Lampi, Aino Siitonen, Veronika Kallio, Fabio Tuccillo, Katja Kantanen, Jose Martin Ramos Diaz, Kirsi Jouppila, Vieno Piironen,

Department of Food and Nutrition, University of Helsinki
Helsinki, Finland

INTRODUCTION

There is an increasing demand for plant-based protein ingredients and products made from them due to environmental and nutritional reasons. High-moisture extrusion (HME) is a processing technique that can be used to produce meat alternatives. The ingredients are rich in many bioactive compounds, e.g., tocopherols and tocotrienols (tocols), but it is poorly known how stable they are during processing. Thus, the aim was to study stability of tocols in plant-based protein ingredients during HME.

MATERIALS AND METHODS

Ingredients included commercial faba bean flour (FBF), protein concentrate (FBPC) and isolate (FBPI), pea protein isolate (PPI), lupine flour (LF), protein concentrate (LPC) and isolate (LPI), and oat fiber concentrate (OFC). Ingredients and mixtures were subjected to HME using a twin-screw extruder equipped with a long cooling die¹⁾. The effects of the long cooling die temperature (LCDT) and screw speed were tested.

Tocols were extracted from the ingredients and the freeze-dried extrudates by accelerated solvent extraction using ethanol as the solvent and analyzed by normal-phase high performance liquid chromatography with fluorescence detection²⁾. All results are given on dry matter (dm) basis.

RESULTS

There was a large variation in tocol contents in the ingredients: LPC had the highest content (171 µg/g dm) and LPI the lowest one (4 µg/g dm) (Fig 1).

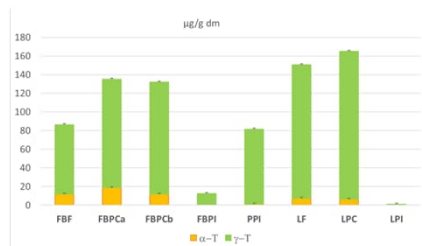


Fig 1. α - and γ -tocopherol contents of legume ingredients (for abbreviations, see text)

γ - and α -tocopherols were the major tocols in all legume ingredients with only neglectable contents of other tocols, while OFC contained also α - and β -tocotrienols.

In general, tocol levels were lower in extrudates compared to their ingredient mixtures. HME of FBPC alone or as mixtures with FBF and FBPI was done at LCDT of 80 °C and screw speed of 500 rpm (Fig 2)²⁾. Here, extrusion of FBPC decreased tocol levels by 17–31%, while extrusion of FBPC, FBF and FBPI mixtures tocol levels decreased more (40–50%). In this experiment, the proportion of α -tocopherol decreased more than that of γ -tocopherol, which is in line with lower stability of α -tocopherol than the others. However, this could not be found in other experiments.

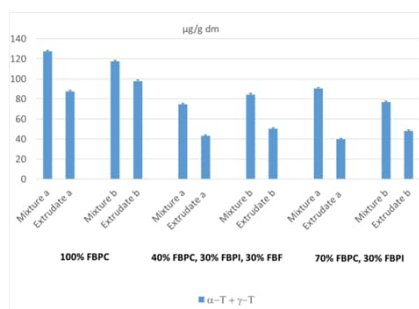


Fig 2. Sum of α - and γ -tocopherol contents of faba bean ingredients (with FBC a or b) as mixtures and after HME (data taken from ²⁾)

The effects of LCDTs and/or screw speeds during extrusion were studied. In PPI:OFC mixtures no changes in tocol contents occurred during HME at LCDT of 40 and 80 °C¹⁾, and screw speeds of 300 and 500 rpm (Fig 3). Tocols were stable in these ingredients during HME even at LCDT of 80 °C.

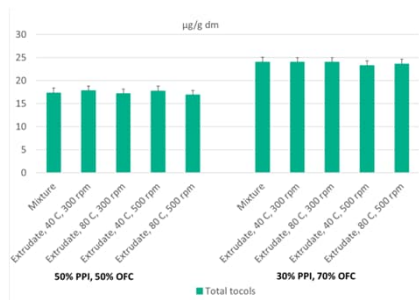


Fig 3. Total tocol contents of pea protein isolate (PPI) and oat fiber concentrate (PFC) as mixtures and after HME with varying processing parameters

On the other hand, in mixtures of FBPC and FBPI tocol levels were lowered by 10–30% during HME at LCDT of 40 and 80 °C³⁾, whereas extrusion of LPC, LF and LPI mixtures⁴⁾ caused even greater losses (41–58%) under similar LCDT (Fig 4).

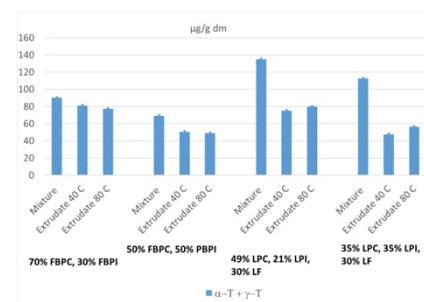


Fig 4. Sum of α - and γ -tocopherol contents of faba bean and lupine based ingredients as mixtures and after HME at LCDT of 40 and 80 °C

CONCLUSIONS

Processing plant-based protein ingredients using HME is expected to cause some losses of tocols, but the effect is likely dependent on the chemical composition of ingredients and their interactions, and also on the processing parameters of HME. Moreover, lower levels of tocols may partly be due to poorer extractability of tocols from extrudates.

Tocols in mixtures of PPI and OFC seemed to be the most stable during HME, but the overall level of tocols in these extrudates were low. Although tocol levels decreased in most ingredients and mixtures during HME, the final products had 40–100 µg/g tocols. Thus meat alternative based on plant-based protein ingredients can be considered as good sources of tocols.

REFERENCES

- 1) Ramos-Diaz et al. 2022. *Innov. Food Sci. Emerg. Technol.*, 77, 102954
- 2) Tuccillo et al. 2022 *Food Res. Int.*, 162, 112036
- 3) Kantanen et al. 2022 *Foods*, 11, 1280
- 4) Ramos-Diaz et al. 2023 (unpublished data)