SUMMARY

Interactions of phenolic compounds with matrix components as a factor determining the quality of fortified food

In recent years, a considerable increase in incidence of diseases of civilization diseases has been observed. Therefore, seeking out the natural ways to support human metabolism which are characterized by acceptability, common availability and relatively low costs. These requirements seem to be fulfilled by the food for special health use, the so-called functional food. Among methods of the functional food preparation; the simplest and the most commonly used is a food fortification (enrichment). Food fortification is defined as the addition to food products one or more physiologically active components, which have favorable impact on the functioning of the human body. Due to well documented pro-healthy benefits, natural origin and safety in use in food products; phenolic compounds are a valuable components for food fortification. They are show a number of biological activities, of which the well-known is antioxidant activity. These compounds prevent human body against the oxidative stress, which is considered one of the main factors contributing to the incidence of civilization diseases.

Nevertheless, the scientific reports reviewed in article (**I**) entitled "The role of phenolic compounds and matrix components interactions in the aspect of food fortification" show that the properties of fortified products, including ability to induce favorable biological consequences, depend on the interactions of phenolic compounds with food matrix components, among other. These interactions, though often overlooked in the analysis of fortified products, can play a key role in the modification the bioavailability of physiologically active compounds and nutrients. Therefore, the following research hypotheses were put:

- Enrichment of food products with phenolic compounds results in changes of nutritional and pro-healthy potential of fortified foods
- The effectiveness of the fortification is affected by interactions of phenolic compounds with matrix components, which determine the quality of fortified products.

The subject of researches were fortified products such as: wheat bread fortified with quinoa leaves (*Chenopodium quinoa* Willd.) (**II**), wheat pasta fortified with parsley leaves (*Petroselinum crispum* L.) (**III**), wheat pasta fortified with carob flour

(*Ceratonia silique* L.) (**IV**), bean paste fortified with onion skin extract (*Allium cepa* L.) (**V**), soymilk fortified with green coffee extract (*Coffea arabica* L.) (**VI**).

In publications (**II-VI**) the effects of food fortification on the phenolic contents and antioxidant potential of studied products were determined. Additionally, based on the mathematical model; the predicted phenolic content and antioxidant potential of fortified products were determined and the obtained results were compared with the experimental data (**II-VI**). This operation allowed to determine whether and to what extent the efficiency of fortification is dependent on the interactions of phenolic compounds with food matrix components. Determination of predicted values gives information how the phenolic content and antioxidant potential could be developed in case of the absence of aforementioned interactions. In addition, under simulated gastrointestinal conditions; the potential bioaccessibility of phenolic compounds and their antioxidant activity (**II, III, V, VI**) were determined. This action allowed to a more reliable assessment of the pro-health potential of fortified products in the light of their accessibility and antioxidant activity (in similar conditions to those found in the gastrointestinal tract).

Based on analysis of main nutrients (protein and starch) digestibility after in vitro digestion; the effect of phenolic compounds on the nutritional potential of studied products (**II-VI**) was estimated. In publications (**IV, VI**), an innovative method for determining the relative digestibility of protein and starch was proposed and described. This method concerning about the comparison the digestibility of the nutrients in fortified product with respect to the control product (non-fortified). The relative digestibility of protein and starch were determined based on amounts of amino acids and peptides as well as reducing sugars released during the simulated digestion process, respectively. The occurrence of phenolic-protein complexes was confirmed by the use of chromatographic (SE-HPLC) (**II, III**) and electrophoretic (SDS-PAGE) (**III, V**) techniques. In publications (**III, V**) was shown the presence of indigestible phenol-protein complexes indicating significant influence of phenolic-protein interactions on digestibility of the protein. Follow studies highlight the importance of phenolics- food matrix interactions on the nutritional and pro-healthy potential of food; thus indicating the need for a comprehensive evaluation of fortified products.

Analysis of the obtained results allowed to draw the following conclusions:

- Fortification with phenolic rich ingredients is an effective way for increasing the antioxidant potential of food.

- The interactions of phenolic compounds with the food matrix determine the effects of the fortification.
- The consequence of the interactions of phenolic compounds with the food matrix is the modification of the antioxidant and nutritional potential of fortified products.
- Antioxidant and nutritional potential of fortified products depends on the source of the phenolic compounds and food matrix.
- The stability of interactions of phenolic compounds with food matrix components, and consequently their extraction and antioxidant activity, is determined by the selection of extraction system. Therefore, the use of *in vitro* digestion to evaluate the effectiveness of fortification seems to be more reliable way to reflect changes of food *in vivo*, which consequently justify its use to assess the health potential of fortified products.
- Due to the multitude of factors influencing the phenolic compounds interactions with the food matrix and their complexity, a universal model for assessing the effectiveness of the fortification cannot be elaborated.

References:

(I) **Sęczyk Ł.** Znaczenie interakcji związków fenolowych ze składnikami matrycy w aspekcie fortyfikacji żywności (2016). Dokonania Naukowe Młodych Naukowców. red. Mundryk K, wyd. Traicon S.C, 228-251.

(II) Świeca M., **Sęczyk Ł.**, Gawlik-Dziki U., & Dziki D., (2014). Bread enriched with quinoa leaves – The influence of protein–phenolics interactions on the nutritional and antioxidant quality. *Food Chemistry*, 162(1), 54-62

(III) **Sęczyk Ł.,** Świeca M., Gawlik-Dziki U., Luty M., & Czyż J. (2016). Effect of fortification with parsley (*Petroselinum crispum* Mill.) leaves on the nutraceutical and nutritional quality of wheat pasta. *Food Chemistry*, 190, 419-428.

(IV) **Sęczyk Ł.,** Świeca M., Gawlik-Dziki U., Luty M., & Czyż J. (2016). Effect of carob (*Ceratonia siliqua* L.) flour on the antioxidant potential, nutritional quality, and sensory characteristics of fortified durum wheat pasta. *Food Chemistry*, 194, 637-642.

(V) **Sęczyk Ł**., Świeca M., & Gawlik-Dziki U. (2015). Nutritional and health-promoting properties of bean paste fortified with onion skin in the light of phenolics–food matrix interactions. *Food & Function*, 6, 3560-3566.

(VI) **Sęczyk, Ł**., Świeca, M., & Gawlik-Dziki, U. (2017). Soymilk enriched with green coffee phenolics – antioxidant and nutritional properties in the light of phenolics-food matrix interactions. *Food Chemistry,* 223, 1-7